



August 2, 2024

TO ALL HOLDERS OF BIDDING DOCUMENTS:

SUBJECT: NEW ORCHARD FARM ELEMENTARY SCHOOL  
ORCHARD FARM R-V SCHOOL DISTRICT  
ST. CHARLES, MISSOURI  
PROJECT # 23-09B

Enclosed please find one (1) electronic .pdf copy of Addendum No. 2, dated August 1, 2024, for the above-named project.

**Addendum No. 2 is being EMAILED to the General Contractors, Subcontractors and Plan Rooms on the Plan Holders List at Hoener Associates.**

**BID DATE: The bids are due at 2:00 p.m. CDT, on Thursday, August 8, 2024.**

**BID LOCATION: Sealed bids will be received by the Orchard Farm R-V School District, Orchard Farm Administration Office, 3489 Boschertown Road, St. Charles, MO.**

Please notify the appropriate subcontractors and/or suppliers of this addendum.

Sincerely,

HOENER ASSOCIATES, INC.

Matt McDermott, Project Manager

ORCHARD FARM R-V SCHOOL DISTRICT  
NEW ELEMENTARY SCHOOL  
ST. CHARLES, MISSOURI

August 2, 2024

The drawings and specifications are hereby supplemented and amended to include the following particulars:

**GENERAL**

**ITEM NO. 1: GENERAL QUESTIONS**

- A. **Q:** Will products of Duro-Last Roofing be approved for this project. **A: Duro-Last products are not approved for this project.**
- B. **Q:** In the materials listed for the wall tile, they show PWT-1 American Olean chic 12x24, but is not show anywhere. Where would this go? **A: This is for the floor tile in the ELC toilet rooms. Specification Section 09300, Section 2.2.**
- C. **Q:** Will products of Alfrex FR Metal Composite Material be approved? **A: Products of Alfrex FR Metal Composite are approved for Section 07412 when meeting or exceeding the specific product.**
- D. **Q:** Please clarify the type of insulation and R-value to figure for precast walls? **A: Extruded polystyrene with a minimum R-value of 11.40 (2") rigid insulation.**
- E. **Q:** Will products of Clutch Court Performance Wood Flooring be approved for the New ES.? **A: Products of Clutch Court Performance will not be approved for this project.**
- F. **Q:** Can I figure ¼" glass for all the interior storefront openings? DA sheets call out 1" insulated, but normally not required if interior application. **A: Correct, ¼" glazing tempered clear glass for all interior storefront openings.**
- G. **Q:** Elementary School DA 8.03C- Door type A3 calls out 7/16" Armor Glass, but most elevations I see just call out security film applied to 1" glazing. Please confirm what is required. If Armor glass is required, please provide a spec. **A: Provide security film applied to the glazing.**
- H. **Q:** Admin and ELC DA 8.05- Frame types M-3 and M-4 call out Bullet Resistant Glass, but the doors for those frames call out security film on 1" glazing. Please confirm what is required. **A: Provide security film applied to the glazing.**
- I. **Q:** The spec calls for both end panels and end curtains to close off the ends of the bleachers. Only one can be used so I wanted to clarify which option they would like. **A: Provide end curtains to close off the ends of the bleachers.**
- J. **Q:** The spec calls for each row of the bleachers to be 12" high. It's standard for most floor bleachers to be 10" so I wanted to make sure they truly wanted 12". **A: Provide manufacturers with a standard system of 10" high or 12" high.**
- K. **Q:** Will products of Savaria M-Series Clinical Lifts be approved for this project in Section 11700. **A: Due to consistency in the school district, this product will not be approved.**
- L. **Q:** Can we have more information on the performance bond for the city of St. Charles? What is the scope of work and what is the projected cost? **A: Contact the City of St. Charles to coordinate that requirement.**
- M. **Q:** On the combination bid form should both allowances be acknowledged (\$400,000 not \$200,000)? **A: Include \$200,000 for the New ES. Include \$200,000 for the Admin/ELC addition and include \$200,000 for the combined bid of the New ES and Admin/ELC.**
- N. **Q:** Who is responsible for builder's risk insurance? **A: The School District covers Builders Risk insurance.**
- O. **Q:** Is the Hard play area and Grass areas by the GC or the School District? If by the GC, please provide more detail on what exactly the school district expects there. **A:**
- P. **Q:** The landscaping plan only shows plantings. Please clarify if there is to be Sod/Seed and in what areas. **A: All areas inside the building drive loop are to have sod. All areas outside of the building drive are to have seed mat including all areas disturbed by construction activities.**

- Q. **Q:** Specification section 07500, protection board states 1/4" Dens Deck. The drawings call out 1/2" cover board. **A: 1/2" Dens Deck to be used.**
- R. **Q:** On the floors room schedule shows epoxy is that the armor shield from Sherwin-Williams also were calls for seal concrete. Is that the armor shield and can we use the pre-catalyze epoxy on the walls in Lou of catalyzed and can we use acrylic dry in Lou of the epoxy dry on the exposed ceilings. **A: The epoxy is for the restroom floors. The sealed concrete is the armor shield. Pre C is fine for the epoxy walls. Acrylic Dry is fine for the exposed ceilings.**
- S. **Q:** Spec section 07240, 2.4 specifies Bird Barrier Bird-Flite Wide bird spikes. Can Bird-X Extra Wide Stainless Steel Spikes be approved as an equal and used to bid this scope? **A: Yes.**
- T. **Q:** The specs read that we are to provide all temporary power and utilities. This is an existing building, are we able to use the existing utilities? Please advise. **A: The existing HVAC system may not be utilized for any temporary heat or AC.**
- U. **Q:** It is unclear if the 3/4" plywood has nail base, there is a note on the plans that states 5" but there is no clarification in the specs in Asphalt shingles or Carpentry. Please advise. **A: The note on the plans of 5" is for the insulation thickness required. The plywood goes on top of the insulation.**
- V. **Q:** Section 07500, Line: Products: General, J- Pipe supports. Who furnishes the pipe blocks? Usually, the Mechanical Trade does that as well as installing. **A: The trade installing the pipes shall include the pipe supports and installation. The roofer to include flashing the pipe supports and coordination of the installation with the other trades.**
- W: **Q:** Detail Sheet DA: 2.06. Clarify the 3'-0" dimension off the building for soil remediation. **A: "Delete" 3'-0" and "Replace" with 5'-0" off the building. See the Civil drawings for additional information.**

## ARCHITECTURAL

### ITEM NO. 2: ARCHITECTURAL SPECIFICATION SECTION 07610 – METAL SIDING

- A. Metal siding 07610.2.1 is installed horizontally and vertically. That's keyed note 10 and 11 on the drawings. Metal wall panels 07610 2.2 are Multi-color panels keyed note 7 on the drawings. All metal siding and metal wall panels are to be "smooth" texture.

### ITEM NO. 3: ARCHITECTURAL SPECIFICATION SECTION 09640 – WOOD GYMNASIUM FLOORING

- A. Subparagraph 2.1, E: **All** maple flooring to be 2<sup>nd</sup> grade and better.
- B. Subparagraph 2.1, A: Include in the bid the moisture mitigation for the Verashield Traxx 95 and the 15 mil poly.

### ITEM NO. 4 : ARCHITECTURAL SPECIFICATION SECTION 09710 – RUBBER FLOORING

- A. **Addendum No. 1** – Spec Section 09710 – Rubber Flooring from Nora Sports Flooring, Subparagraph 2.2: **"Delete"** Nora Sportsfloor 1334 and **"Replace"** with "Norament Grano 1880" rubber tile. 3.5" mm thick and 39.53" x 39.53" square tile with hammered surface finish. Include the Endura Prime lock primer and Endura EX-2C SFC Topcoat with reduced gloss finish for all games lines.
- B. Spec Section 09710 – Rubber Flooring: **Add** products of Pulastic 60 seamless flooring when meeting or exceeding the specified product.

## CIVIL DRAWINGS

### ITEM NO. 5: CIVIL DRAWING C3.00

- A. **"ADD"** Supplementary Drawing No. SD 73, dated August 1, 2024 included with this Addendum, and hereby made a part of the Contract Documents that shows the added Perimeter Drain Line.

ITEM NO. 6: CIVIL DRAWING C3.20

- A. **“ADD”** Supplementary Drawing No. SD 74, dated August 1, 2024 included with this Addendum, and hereby made a part of the Contract Documents that shows the Sub-Soil Drain renamed to Footing Underdrain and added Downspout Table J.

ITEM NO. 7: CIVIL DRAWING C6.00

- A. **“ADD”** Supplementary Drawing No. SD 75, dated August 1, 2024 included with this Addendum, and hereby made a part of the Contract Documents that shows the added drain line connections added on storm sewer profiles.

**FOOD SERVICE SPECIFICATIONS**

ITEM NO. 8: FOODSERVICE SPECIFICATION SECTION 11400

A. . **CHANGE TO READ:**

ITEM 40, FLOOR TROUGH: ONE (1) REQUIRED N.I.C.

**CONTRACTOR MEPFP QUESTIONS**

ITEM NO. 9 – MPFP QUESTIONS

1. **Question:** Sheet P0.0 – Detail - Appliance Connections Wall Box - Above Counter – (detail with disposer) please identify where this detail applies.  
**Answer:** Detail title has been updated – this detail applies to dishwasher connection.
2. **Question:** Sheet P0.0 – Detail - Appliance Connections Wall Box - Below Counter – the wall box is not specified please clarify. Also please identify where this detail applies.  
**Answer:** This detail is not required. It has been removed from drawings.
3. **Question:** Sheet P0.0 – Detail - Appliance Connections Wall Box - Above Counter – (detail without disposer) please identify where this detail applies.  
**Answer:** Detail title has been updated – this detail applies to outlet box connections.
4. **Question:** Sheet P2.2 – Custodial #300 – Lint interceptor not specified, please clarify.  
**Answer:** Lint interceptor has been added to specifications as Trench Drain TD-C.
5. **Question:** Sheet P2.2 – Custodial #300 – MWB-1 not called out on plans, possible location adjacent to lint interceptor, please clarify.  
**Answer:** No washing machine outlet box required – WMB-A has been removed from specifications and the plumbing fixture schedule.
6. **Question:** Sheet P2.2 – Custodial #300 – Should FD-A adjacent to mop basin be FD-B?  
**Answer:** Yes, it should be FD-B. It has been adjusted on plans. See Sheet P2.2.
7. **Question:** Sheet P2.3 – Kiln Rm #208 – ODN-A not specified, possibly mislabeled, is this OFN-A?  
**Answer:** Yes, it should be OFN-A. It has been adjusted on plans. See Sheet P2.3.



8. **Question:** Sheet P2.3 – Nurses Suite #125 – EW-A not scheduled or specified, please clarify.  
**Answer:** There shall be no EW-A in the Nurse’s Suite or anywhere else in the building. It has been removed from the floor plans. See Sheet P2.3.
9. **Question:** Sheet P2.3 – Kindergarten Clrm’s #133, 134, 135, & 136 – SK-D spec’d as oval drawings show rectangular sink, please clarify.  
**Answer:** SK-D has been adjusted in specifications and in plumbing fixture schedule. The sink shall be rectangular.
10. **Question:** Sheet P2.4 – Office #423 – Wall hydrant not tagged.  
**Answer:** Tag added. See Sheet P2.4.
11. **Question:** Sheet P2.5 – Classrooms #147, 148, 149, 150, 151, 153, 154, & 156 – SK-D spec’d as oval drawings show rectangular sink, please clarify.  
**Answer:** SK-D has been adjusted in specifications and in plumbing fixture schedule. The sink shall be rectangular.
12. **Question:** Sheet P4.1 – Main Mechanical #305 – ES-A scheduled but not specified, please clarify.  
**Answer:** ES-A has been added to specifications.
13. **Question:** Sheet P4.1 – Main Mechanical #305 – ET-3 not specified, possibly mislabeled and should be ET-DHW, please clarify.  
**Answer:** ET-3 is mislabeled on plans and should be ET-DHW. Plans have been adjusted.
14. **Question:** Sheet P4.2 – Alcove #309 – Lint interceptor not specified, please clarify.  
**Answer:** Lint interceptor has been added to specifications as Trench Drain TD-C.
15. **Question:** Sheet P4.2 – Alcove #309 – MWB-1 not called out on plans, possible location adjacent to lint interceptor, please clarify.  
**Answer:** No washing machine outlet box required – WMB-A has been removed from specifications and the plumbing fixture schedule.
16. **Question:** Sheet P4.2 – Kitchen #314 – TD-B not specified, please clarify.  
**Answer:** TD-B is to be furnished by kitchen equipment contractor and installed by plumbing contractor. See drain schedule on Sheet P6.0 for adjustment.
17. **Question:** Sheet P6.0 – Circulating Pump Schedule – DWCP-2 gpm seems high (25 gpm through a 1” pipe is at the high end of the pipes capacity), please clarify.  
**Answer:** Pipe size has been increased to accommodate flow. See floorplans for revisions.
18. **Question:** Sheet M3.11 – Roof area near EF-5 – ORD-A not specified, possibly mislabeled, are these OFD-A?  
**Answer:** Yes, they should be labelled OFD-A. See Sheet M3.11 for adjustments on plan.
19. **Question:** Spec Sec 224301 & 224303 Sinks and Faucets – Please clarify which sinks receive which faucets.  
**Answer:** See adjusted Plumbing Fixture Schedule on sheet P6.0 “TRIM” for clarification.
20. **Question:** Spec Sec 224301 Sinks – Please clarify which sinks receive disposers if any.  
**Answer:** No sinks shall have disposers.

21. **Question:** Spec Sec 224301 Sinks – SK-D states self-rim in spec, model number is for undermount sink please clarify.  
**Answer:** Specifications and plumbing fixture schedule have been modified for adjustment to SK-D. Sink shall be lay-in style rectangular.
22. **Question:** Spec Sec 224703 Emergency Eyewash/Drench Hose EEW-A – EEW-A not found on drawings, but drawings show EW-A (Sheet P2.3) and ES-A (P4.1) locations and they are not specified.  
**Answer:** Specifications have been updated to include ES-A. EEW-A and EW-A are removed from the specifications and plans.
23. **Question:** There are no sizes shown on the Alternate #1 and #2 area water lines. Can they be noted or identified?  
**Answer:** Plans have been updated to show area water line sizes. See sheet P2.4.
24. **Question:** Is the intent of the restroom partition copper to be ran full size (2.5") to the end of the line as a header, or can the pipe step down in size as demand lowers? If the pipe can step down in size, can you provide a detail showing where the line sizes decrease?  
**Answer:** The pipe can step down in size as demand lowers. Updated isometrics to be provided at a later date.
25. **Question:** Spec section 22 20 01 material schedule lists SDR-11 HDPE for all underground domestic water piping. Can PEX piping be ran as "homeruns" in the kitchen area instead of HDPE? Can the domestic water riser in the mechanical room be installed with ductile iron pipe and mechanically restrained fittings instead of a stainless steel riser?  
**Answer:** No, PEX piping is not acceptable for any installation.
26. **Question:** Spec section 22 20 02 material schedule lists hub and spigot cast iron as the only pipe/fitting system approved for underground grease waste piping. Can SCH40 PVC be used in place of hub and spigot cast iron if there will not be temperatures in excess of 140 degrees flowing through the pipes?  
**Answer:** No, SCH 40 PVC is not equivalent for this application.
27. **Question:** Spec section 22 20 03 material schedule lists copper pipe with solder joints as the only pipe/fitting system approved for above ground domestic water piping. Can ProPress fittings and/or PEX pipe/fittings be used in any capacity?  
**Answer:** No, PEX piping nor compression style fittings similar to pro-press are not acceptable for any installation.
28. **Question:** Spec section 22 20 04 material schedule lists no-hub cast iron as the only pipe/fitting system approved for above ground DWV and storm piping. Can SCH40 PVC be used in non-plenum spaces and/or wall cavities?  
**Answer:** No, No-hub cast iron is the only approved pipe/fitting system for above ground DWV and storm piping.
29. **Question:** Spec section 22 20 08 material schedule lists SCH40 PVC perforated as the only pipe/fitting system approved for subsoil drainage. Can flexible corrugated "sock pipe" be used instead of perforated SCH40 PVC?  
**Answer:** No corrugated sock piping is not equivalent to SCH 40 perforated PVC.
30. **Question:** Is a fire pump required for the fire suppression system?  
**Answer:** No fire pump is required.

31. **Question:** Are we expected to wire to auxiliary contact on lighting occupancy sensors?  
**Answer:** Yes VAVs are to connect to lighting occupancy sensors wherever sensors are located. Sequence of Operations has been updated to reflect this.
32. **Question:** Please see E0.20 (Lighting Control Matrix), which calls for BAS integration of several different areas of the New Elementary School. Is this required?  
**Answer:** Lighting controls BAS integration is not necessary.
33. **Question:** Please provide specifications for Chiller and Condenser Systems. We are unclear as to which components we will be responsible for providing. Please confirm who is to provide the following items:
- i. Refrigerant Monitor
  - ii. Cooling tower level sensor
  - iii. Vibration switch
  - iv. Chiller makeup water meter
  - v. Boiler makeup water meter
  - vi. Condenser makeup water meter
  - vii. Condenser blowdown meter
- Answer:** While the design team is not the final authority on which contractor provides which device, typically these items are provided by the following:
- i. Refrigerant Monitor: Mechanical contractor (23 61 01)
  - ii. Cooling tower level sensor: Cooling Tower manufacturer.
  - iii. Vibration switch: Cooling tower manufacturer.
  - iv. Chiller makeup water meter: Mechanical contractor (23 10 05 F).
  - v. Boiler makeup water meter: Mechanical contractor (23 10 05 F).
  - vi. Condenser makeup water meter: Mechanical contractor (23 10 05 F).
  - vii. Condenser blowdown meter: Mechanical contractor (23 10 05 F).
34. **Question:** Will you please let us know which systems are to be integrated to the BAS in “25 00 09 C.” below (electrical power monitoring, lighting control devices, network lighting controls)?  
**Answer:** Electrical power monitoring, lighting control devices, and network lighting controls do not have to be integrated into the BAS. Specifications have been updated.

## **MECHANICAL SPECIFICATIONS**

### **ITEM NO. 10 – SPECIFICATION SECTION 20 00 50 A**

- A. “**REVISE**” Contractor warranties to be for 2 years for all materials and workmanship.

### **ITEM NO. 11 – SPECIFICATION SECTION 20 25 14 C 1**

- A. “**ADD**” Insulation jacketing for outdoor elastomeric foam insulation.

### **ITEM NO.12 - SPECIFICATION SECTION 22 30 06**

- A. “**REVISE**” FD-A to be 6” round.

### **ITEM NO. 13 – SPECIFICATION SECTION 22 47 02**

- A. “**REVISE**” Emergency drench hose to be emergency shower.

ITEM NO. 14 – SPECIFICATION SECTION 22 80 09

- A. **“REMOVE”** Washing Machine Box WMB-A

ITEM NO. 15 – SPECIFICATION SECTION 23 65 01 J

- A. **“REVISE”** Cooling Tower motor warranty to be 2 years.

ITEM NO. 16 – SPECIFICATION SECTION 25 00 09 C

- A. **“REMOVE”** 26 09 00 Electrical power monitoring, lighting control devices, and network lighting controls from the Division 25 specifications

ITEM NO. 17 – SPECIFICATION SECTION 25 00 12 B

- A. **“REVISE”** Temperature controls system warranty period to be (2) years.

ITEM NO. 18 – SPECIFICATION SECTION 25 95 12

- A. **“REVISE”** Control sequence for VAVs to include integration with lighting occupancy sensors and provide operational language for demand control ventilation.

**MECHANICAL DRAWINGS**

ITEM NO. 19 – MECHANICAL DRAWING SHEET M3.2

- A. **“REVISE”** Storm Duct in Mezzanine.
- B. **“REVISE”** Note 2 to be for 50 cfm.
- C. **“REVISE”** Supply air duct sizes to Mech Office 303 and DZ Office 321
- D. **“REVISE”** RTU-4 Return air duct.

ITEM NO. 20 – MECHANICAL DRAWING SHEET M3.3

- A. **“ADD”** Kiln fume exhaust duct to Kiln Room 208.
- B. **“ADD”** Corridor 1B supply air ductwork.

ITEM NO. 21 – MECHANICAL DRAWING SHEET M3.4

- A. **“ADD”** Supply air duct and devices to hand washing 426 and Custodial 420

ITEM NO. 22 – MECHANICAL DRAWING SHEET M3.5

- A. **“ADD”** Supply air duct and devices to hand washing 144 and Custodial 137.
- B. **“ADD”** Corridor 1B supply air ductwork.

ITEM NO. 23 – MECHANICAL DRAWING SHEET M3.12 – NO DRAWING ISSUED

- A. **“ADD”** Note calling for 4” VTR at column line intersection “N5”.

ITEM NO. 24 – MECHANICAL DRAWING SHEET M3.13

- A. **“ADD”** Penetration and gooseneck fitting for Kiln fume exhaust.

ITEM NO. 25 – MECHANICAL DRAWING SHEET M4.1 – NO DRAWING ISSUED

- A. **“REVISE”** ET-3 to be ET-DHW.

ITEM NO. 26 – MECHANICAL DRAWING SHEET M4.4

- B. **“REVISE”** RTU-4 Duct system layout. See sheet for additional detail.

ITEM NO. 27 – MECHANICAL DRAWING SHEET M5.0

- A. **“ADD”** RLF-1 points list
- B. **“ADD”** Typ Exhaust Fans points list
- C. **“REMOVE”** Filter DP sensors from flow diagram.
- D. **“ADD”** HWV-C to flow diagram.
- E. **“ADD”** Demand Control Ventilation reset flowrate.

ITEM NO. 28 – MECHANICAL DRAWING SHEET M5.1

- A. **“ADD”** Fan coil units points list, cabinet unit heater points list, kitchen fan system points list.
- B. **“ADD”** Demand Control Ventilation reset flowrate.
- C. **“REMOVE”** Preheat pump PHP-2 from flow diagram. Pump not required.
- D. **“ADD”** PHV-C and SA-TL to points list.

ITEM NO. 29 – MECHANICAL DRAWING SHEET M5.2

- A. **“ADD”** EF-4 points list.
- B. **“REVISE”** OAD-C location on flow diagram.
- C. **“ADD”** AL-RFG to points list.
- D. **“REMOVE”** Filter DP sensors from flow diagram.

ITEM NO. 30 – MECHANICAL DRAWING SHEET M5.3

- A. **“ADD”** HWV-C to flow diagram and points list.
- B. **“REVISE”** H-OCC to be ZN-H.
- C. **“REVISE”** ZN-P location, input/output symbols for EF-ST and EF-SS.
- D. **“ADD”** Storm shelter system points list.
- E. **“REMOVE”** Filter DP sensors from flow diagram.

ITEM NO. 31 - MECHANICAL DRAWING SHEET M5.4

- A. **“ADD”** RLF-2 points list, VAV points list, Kiln Fan points list.
- B. **“REVISE”** Points list title.
- C. **“REMOVE”** Filter DP sensors from flow diagram.

ITEM NO. 32 – MECHANICAL DRAWING SHEET M5.5

- A. **“REMOVE”** Filter DP sensors from flow diagram.

ITEM NO. 33 – MECHANICAL DRAWING SHEET M5.6

- A. **“ADD”** RTU-7 points list.
- B. **“REMOVE”** Filter DP sensors from flow diagram.

ITEM NO. 34 – MECHANICAL DRAWING SHEET M5.7

- A. **“ADD”** RTU-8 points list.
- B. **“REMOVE”** Filter DP sensors from flow diagram.

ITEM NO. 35 – MECHANICAL DRAWING SHEET M5.8

- A. **“REVISE”** BPYV-C to be BYP-C on points list and flow diagrams

ITEM NO. 36 – MECHANICAL DRAWING SHEET M5.9

- A. **“REVISE”** Condenser water bypass line on cell 2 to be 8”.
- B. **“ADD”** HX1-DP to points list.

ITEM NO. 37 – MECHANICAL DRAWING SHEET M5.10

- A. **“ADD”** OA-T, OA-H, EPO-ST. CV-BYP to flow diagram.
- B. **“REMOVE”** B-SS, HWS-SP, ESW-SP, T-BLR from flow diagram.

ITEM NO. 38 – MECHANICAL DRAWING SHEET M5.11

- A. **“ADD”** “Misc Points” Points list to sheet.
- B. **“REVISE”** VAV 6.3 heating water flowrate.

ITEM NO. 39 – MECHANICAL DRAWING SHEET M6.1

- A. **“REVISE”** Fan schedule.

ITEM NO. 40 – MECHANICAL DRAWING SHEET M6.2

- A. **“REVISE”** Control damper schedule.

ITEM NO. 41 – MECHANICAL DRAWING SHEET M7.0

- A. **“REVISE”** Inline pump detail to include neoprene isolation pads.

ITEM NO. 42 – MECHANICAL DRAWING SHEET M7.1 – NO DRAWING ISSUED

- A. **“REMOVE”** Remove duct installation detail “ROOF DUCT SUPPORT DETAIL”
- B. **“REVISE”** Detail titles for accuracy.

ITEM NO. 43 – MECHANICAL DRAWING SHEET P0.0

- A. **“REMOVE”** Appliance connections: Wall box – below counter detail from sheet.

ITEM NO. 44 – MECHANICAL DRAWING SHEET P1.2

- A. **“ADD”** Secondary perimeter subsoil drainage.

ITEM NO. 45 – MECHANICAL DRAWING SHEET P1.3

- A. **“ADD”** Secondary perimeter subsoil drainage.
- B. **“ADD”** Piping for floor cleanouts.

ITEM NO. 46 – MECHANICAL DRAWING SHEET P1.4

- A. **“ADD”** Secondary perimeter subsoil drainage.

ITEM NO. 47 – MECHANICAL DRAWING SHEET P1.5

- A. **“ADD”** Secondary perimeter subsoil drainage.
- B. **“ADD”** Piping for floor cleanouts.

ITEM NO. 48 – MECHANICAL DRAWING SHEET P2.2

- A. **“REVISE”** Domestic hot water return pipe sizes.
- B. **“ADD”** Tags for wall hydrants.
- C. **“ADD”** Yard cleanouts for secondary subsoil drainage.

ITEM NO. 49 – MECHANICAL DRAWING SHEET P2.3

- A. **“REVISE”** Overflow drain designations to match specifications.
- B. **“REVISE”** Domestic hot water return pipe sizes.
- C. **“ADD”** Floor cleanouts.
- D. **“ADD”** Yard cleanouts for secondary subsoil drainage.

ITEM NO. 50– MECHANICAL DRAWING SHEET P2.4

- A. **“REVISE”** Domestic hot water return pipe sizes.

ITEM NO. 51 – MECHANICAL DRAWING SHEET P2.5

- A. **“REVISE”** Domestic hot water return pipe sizes.
- B. **“ADD”** Floor cleanouts.

ITEM NO. 52 – MECHANICAL DRAWING SHEET P4.1

- A. **“REVISE”** Domestic hot water return pipe sizes.
- B. **“REVISE”** ET-3 to be ET-DHW

ITEM NO. 53 – MECHANICAL DRAWING SHEET P4.2 – NO DRAWING ISSUED

- A. **“REVISE”** Lint Interceptor to be tagged as Trench Drain TD-C.

ITEM NO. 54 – MECHANICAL DRAWING SHEET P5.1

- A. **“ADD”** Plumbing points list.
- B. **“REMOVE”** TD-DHW from flow diagram (typ 2)
- C. **“REVISE”** flow rates and pipe sizes. See sheet for additional information.

ITEM NO. 55 – MECHANICAL DRAWING SHEET P6.0

- A. **“REVISE”** Plumbing schedules for readability.
- B. **“REVISE”** Drain schedule for TD-B and TD-C.
- C. **“REVISE”** Plumbing fixture schedule for faucet designations and ES-A

ITEM NO. 56 – MECHANICAL DRAWING SHEET FP2.3

- A. **“ADD”** Fire protection piping connection to kitchen hood.

**ELECTRICAL SPECIFICATIONS**

ITEM NO. 57 – SPECIFICATION SECTION 28 13 00, 2.2 D

- A. **“ADD”**
  - “4. S2 Security to match High School, no exceptions (Access Control System); provide all necessary licensing upgrades for elementary school system to be integrated into District S2 Security system at new High School and Early Learning Center.”

**ELECTRICAL DRAWINGS**

ITEM NO. 58 – ELECTRICAL DRAWING E0.20

- A. **“ADD”** DE fixture to luminaire schedule.

ITEM NO. 59 – ELECTRICAL DRAWING E0.40

- A. **“CHANGE”** ‘B-1’, ‘B-2’, and ‘B-3’ voltage, source, disconnect type and size.

ITEM NO. 60 – ELECTRICAL DRAWING E0.41 (NO DRAWING ATTACHED)

- A. **“REVISE”** Boiler, domestic hot water heater & hot water pump shut-down diagram to show 3 pole breakers for each boiler.

ITEM NO. 61 – ELECTRICAL DRAWING E2.3

- A. **“DELETE”** School logo on building.
- B. **“ADD”** DE fixture to light school logo sign.

ITEM NO. 62 – ELECTRICAL DRAWING E6.2

- A. **“CHANGE”** Boiler disconnects and circuits.

END OF ADDENDUM #2



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### DIVISION 20 ES – BASIC MECHANICAL CONDITIONS

|                                                               |           |
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## **20 00 00 BASIC MECHANICAL CONDITIONS**

### **20 00 01 GENERAL**

- A. This Section includes general contractual, administrative and procedural requirements for the Work of Divisions 20 – 29 to supplement the requirements specified in Division 1.
- B. The organization of the Specifications into Divisions, Sections and Subsections, and the arrangement of the Plans shall not in and of itself divide the Work among the Contractors and Subcontractors nor establish the Work to be performed by any trade.
- C. The “Scope of Work” and “Work Included” under each respective sectional heading, nevertheless, attempts to segregate the Work by known contracting activities. In the final analysis, the General Contractor shall be responsible for scoping the work for each trade based on local practice to include all the Work of a given type in the related proposal, regardless of where and how identified in the Bid Documents.

### **20 00 02 SCOPE OF WORK**

- A. This project is for a new elementary school for Orchard Farms School District located at 2525 Highway B, St. Charles, MO 63301. The design, defined by the Project Documents, provides for the new educational facilities.
- B. The Mechanical Work for this project shall include all material, labor and services necessary for and incidental to providing the following systems (respective Sections of the Specifications are noted in the right hand column):
  - 1. Basic Mechanical Materials and Methods 20
  - 2. Insulation Work 20
  - 3. Fire protection system 21
  - 4. Plumbing Work 22
  - 5. HVAC Piping and Equipment 23
  - 6. Air Distribution 24
  - 7. Temperature Control Systems 25

### **20 00 03 REFERENCES**

- A. The Plans, the general provisions of the Contract, including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 29 of the Specifications.
- B. All provisions and conditions cited in this Section shall apply to Work for all other sections of Divisions 20 – 29 of these Specifications.

### **20 00 04 REFERENCES, REGULATORY REQUIREMENTS**

- A. All material and equipment shall be listed, labeled or certified by Underwriters Laboratories, Inc., where relevant standards have been established (see also Paragraph 20 00 60). Material and equipment, which are not covered by UL Standards, will be acceptable provided they meet safety requirements of a nationally recognized testing laboratory. Products which no nationally recognized testing laboratory accepts, lists, labels, certifies or determines to be safe will be considered if inspected or tested in accordance with national industrial standards such as NEMA or ANSI. Evidence of compliance shall include test reports and definitive submittals.

- B. Pressure vessels and pressure retaining safety devices shall be certified in accordance with applicable requirements of the ASME Boiler Code.
- C. Definitions:
1. **“Listed”**: A product is “listed” if of a kind mentioned in a list which: Is published by a nationally recognized laboratory which makes periodic inspections of such production. States that such product meets nationally recognized standards or has been tested and found safe for use in a specified manner.
  2. **“Labeled”**: The product is “labeled” if: It embodies a valid label or other identifying mark of a nationally recognized testing laboratory such as UL, Inc. Production is inspected periodically by a nationally recognized testing laboratory. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
  3. **“Certified”**: The product is “certified” if: The product has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in specific manner. Production is inspected periodically by a nationally recognized testing laboratory. The product bears a label, tag or other record of certification.

20 00 05 DEFINITIONS

- A. The term **“Work”** used in this Division shall be the furnishing of material, labor and/or services necessary for and reasonably incidental to providing specific component(s), consideration(s) and/or system(s) of the design for the mechanical facilities for this Project as hereinafter defined by the Project Documents.
- B. The term **“Project Documents”** used in this Division shall be the compilation of the Specifications, the Plans and any Attachment and Addendum which collectively define the design and the intent of the Work to construct the Project.
- C. The terms **“Architect”** and **“Engineer”** as used in this Division of the Specifications shall be the professional individual and/or company developing the respective portion(s) of the Project Documents and administering the responsibility for the adherence to the intent of these documents. The “Architect/Engineer” is the agent of the “Owner”, and shall represent and discharge authority on all matters unless the matter is referred to the Owner or the Owner elects to perform in their own behalf.
- D. The term **“General Contractor, Construction Manager, or Prime Contractor”** as used in Division 20 shall mean the Contractor who has the prime contract with the Owner and who is responsible for general conditions of the project and is responsible for seeking experienced and qualified Trade Subcontractors to perform the Work.
- E. The terms **“Contractor”** and **“Subcontractor”** where used in this Division shall mean any Company, regularly in business, to perform the type of work for which the Contract was sought, who has contracted with the Owner or General Contractor to perform the work included in and defined by this section and any other section or sections of this Division.
- F. The term **“submittal”** as used in this Section of the Specifications shall be construed to be information in various forms compiled by the Contractor to transmit to the Architect/Engineer for review, comment and/or approval and return same to the Contractor with notice to react. The information shall support and/or substantiate that the given product complies with the intent of the Project Documents, should be incorporated in the Work and therefore, warrants approval to permit proceeding with that Work. The information may be any form or accepted practice of shop drawings, data, published catalogs, etc. that sufficiently provide the Architect/Engineer with basis of making a determination.

- G. The term “**unfinished space**” as used in Division 20 - 25 of the Specifications shall be a mechanical or electrical equipment room. These are rooms that are generally unpainted and accessible only to building maintenance personnel.
- H. The term “**finished space**” as used in Division 20 - 25 of the Specifications shall mean any space not defined as “unfinished space” (i.e. occupied rooms, corridors, stairways, closets, etc.).
- I. The term “**exterior**” or “**outdoors**” as used in Division 20 - 25 of the Specifications shall mean exposed to atmospheric weather conditions.
- J. The term “**interior**” or “**indoors**” as used in Division 20 - 25 of the Specifications shall mean not exposed to atmospheric weather conditions.
- K. The term “**concealed**” as used in Division 20 - 25 of the Specifications shall mean anything that is not visible in a “finished space”.
- L. The term “**inaccessible**” as used in Division 20 - 25 of the Specifications shall mean located within walls or above non-lay-in ceiling (i.e., drywall, plaster).
- M. The term “**packaged**” as used in Division 20 - 25 of the Specifications shall be construed to be a factory manufactured piece of equipment for which all components are totally assembled, prepiped and prewired within its own structure and ready to operate when connected to proper external mechanical and electrical services.
- N. The term “**cold piping system**” as used in Division 20 - 25 of the Specifications shall be a piping system containing media at or below 79 degrees F temperature.
- O. The term “**ambient piping system**” as used in Division 20 - 25 of the Specifications shall be a piping system containing media which is neither heated nor chilled and remains at a temperature range between 80 and 109 degrees F temperature.
- P. The term “**hot piping system**” as used in Division 20 - 25 of the Specifications shall be a piping system containing media at or above 110 degrees temperature.

20 00 06 CODES, STANDARDS, ETC.

- A. The material, workmanship and systems for Work of this Division shall comply with all applicable codes, standards, regulations and laws of the legal governmental jurisdiction at the project site.
- B. Should the Contractor perform any work that does not comply with the requirements of the applicable codes, standards, regulations, statutes, laws, acts, or which does not receive the approval of the responsible inspection authority, Contractor shall bear all costs arising in correcting the deficiencies.
- C. Applicable requirements of the current and accepted edition of the following codes shall apply to the Work for Divisions 20 – 29:
  - International Building Code 2021
  - International Mechanical Code 2021
  - International Plumbing Code 2021
  - International Fire Code 2021
  - International Fuel Gas Code 2021
  - International Energy Conservation Code 2015
  - National Electrical Code, 2020
  - Code of Federal Regulations (CFR)
  - Code of State of Missouri Regulation
  - City of St. Charles adopting Ordinances, Laws and Statutes

- D. Applicable requirements of the current and accepted edition of the following industry standards, codes and specifications shall apply to the Work for Divisions 20 - 29:

|        |                                                                                     |          |
|--------|-------------------------------------------------------------------------------------|----------|
| AGA    | American Gas Association                                                            | 20       |
| AMCA   | Air Moving and Conditioning Association                                             | 24 00 00 |
| ANSI   | American National Standards Institute                                               | 20 10 00 |
| ASHRAE | American Society of Heating, Refrigerating and Air Conditioning Engineers           |          |
| ASME   | American Society of Mechanical Engineers                                            | 20 10 00 |
| ASSE   | American Society of Sanitary Engineers                                              | 22 00 00 |
| ASTM   | American Society of Testing and Materials                                           | 20 10 00 |
| AWS    | American Welding Society                                                            | 23 00 00 |
| AWWA   | American Water Works Association                                                    | 22 00 00 |
| CISPI  | Cast Iron Soil Pipe Institution                                                     | 22 00 00 |
| IEEE   | Institute of Electrical & Electronic Engineers                                      |          |
| IPCEA  | Insulated Power Cable Engineers Association                                         |          |
| MSS    | Manufacturers Standardization Society of Valve and Fitting Industry                 | 20 10 00 |
| NEC    | National Electric Code, including amendments by local authority having jurisdiction |          |
| NEMA   | National Electrical Manufacturers Association                                       |          |
| NFPA   | National Fire Protection Association                                                | 21 00 00 |
| NSF    | National Sanitation Foundation                                                      | 22 00 00 |
| NIOSH  | National Institute of Occupational Safety and Health                                |          |
| OSHA   | Occupational Safety and Health Act                                                  |          |
| SMACNA | Sheet Metal and Air Conditioning Contractors National Association                   | 24 00 00 |
| UL     | Underwriters Laboratory, Inc.                                                       |          |

- E. Applicable requirements of all the relevant Federal laws including current and accepted edition of the Americans with Disabilities Act (ADA).

## **20 00 10 CONDITIONS, BID**

### **20 00 11 REQUEST FOR PROPOSAL**

- A. The terms for Contractor's proposal shall be as described in the General Conditions, Supplementary and/or Special Conditions and Specification Sections of Division 1.

### **20 00 12 TAXES**

- A. The Owner is tax exempt, see General Conditions, Supplementary and/or Special Conditions and Specifications Sections of Division 1.

### **20 00 13 FREIGHT**

- A. The respective Contractor or Subcontractor shall pay all shipping and/or freight charges coincidental with the purchase of material and equipment for the fulfillment of their respective Work.

### **20 00 14 PERMITS AND FEES**

- A. The respective Contractor or Subcontractor shall apply for, obtain and pay for all charges for permits and fees required to install the respective Work. The Contractor shall arrange for and pay all required charges and/or fees to inspect and accept the Work by the appropriate authority.

- B. Any deficiency arising from the improper administering or complying with requirements for permits, fees, or inspections shall be corrected by the Contractor without additional compensation.

## **20 00 20 CONDITIONS, JOBSITE**

### **20 00 21 TEMPORARY FACILITIES**

#### **A. General**

In general, the General Contractor or the Owner to the extent as described in Division 1 of the Specifications will provide temporary facilities. However, if that is not the case, the specific conditions of this project are identified as follows:

#### **B. CONSTRUCTION ELECTRIC POWER and LIGHTING:**

1. The General Contractor shall provide 120 volt, 60 Hz, single phase electric service to a single distribution panel at the job site and shall provide minimal temporary lighting throughout the Project.
2. It shall be the responsibility of the respective Contractor or Subcontractor to provide extension(s) and any necessary protection devices from the distribution panel(s) for their requirement(s). All cords shall be grounded.
3. The respective Contractor or Subcontractor shall provide his own three (3) phase electric power requirements.

#### **C. TEMPORARY CONDITIONING OF AIR (HEATING/COOLING):**

1. The permanent heating, ventilating and air conditioning systems and machinery shall not be used for temporary heating or cooling during construction. Any devices required for temporary conditioning of the spaces would be the responsibility of the General Contractor.
2. The respective Contractor or Subcontractor shall provide temporary conditioning to all areas affected by the scope of work. All spaces affected shall have no interruptions in any utility services including, heating, ventilation, air conditioning, plumbing, compressed air, specialty gases, steam, ect.. Contractor shall provide temporary piping, ductwork, spot coolers/heaters as necessary to maintain the existing conditions of all spaces affected by the scope of work.
3. If the Contractor should request through a separate agreement with the Owner to utilize the permanent systems or equipment for temporary space conditioning, the following minimum conditions will be a part of that agreement:
  - a. The return air system shall not be used. This shall include the return air ductwork, return air inlets at air devices and return air connections at air handling equipment. Air shall be returned directly through the filter section at the air handling equipment and the return air system shall be isolated and sealed tightly.
  - b. All safety devices shall be installed and operative.
  - c. Temporary filters shall be installed in the filter section(s). These filters shall be removed and discarded at the end of the temporary period.
  - d. At the end of the temporary period and before acceptance, all coils shall be chemically cleaned, and all supply air system(s) including ductwork, plenums, and air devices shall be cleaned and return air system(s) activated all to the satisfaction of the Architect/Engineer.

#### **D. TEMPORARY TOILETS and WATER:**



1. The General Contractor shall be responsible for providing temporary toilets and water for contractor's use during construction.
- E. JOB SITE SECURITY:
  1. The Contractor shall cooperate with the General Contractor in the procedures and requirements for opening and securing the job site for each workday.
- F. JOB SITE PARKING:
  1. Contractor shall park in only the designated areas assigned to them for use by the General Contractor or Owner and shall not park in No Parking Areas, on lawns, or unpaved areas and shall not block access to loading docks, fire hydrants, etc. See Division 1 for additional requirements or restrictions.

#### **20 00 22 REQUIREMENTS TO PURSUE THE WORK**

- A. Work space: The respective Contractors and Subcontractors shall be assigned areas at the job site for construction trailers, lay-down, storage and work spaces as arranged with the General Contractor/Owner. All spaces shall be accessible to the Architect/Engineer. All material and equipment shall be protected during the course of construction against weather, dirt, comprehensive damage and theft. All items subject to water damage shall be adequately protected. Damage occurring or defects detected before acceptance shall be repaired or replaced at no additional compensation.
- B. Tools: The Contractors and Subcontractors shall provide their own tools and services to perform their respective Work. Rented or leased services shall have proper and adequate insurance in accordance with requirements of Division 1.
- C. Temporary storage: The Contractors and Subcontractors shall be responsible for any requirements to temporarily store material and equipment until it is incorporated into the Project.

#### **20 00 23 ADDITIONAL REQUIREMENTS AND SPECIAL CONDITIONS**

### **20 00 30 PROJECT DOCUMENTS**

#### **20 00 31 GENERAL**

- A. The Plans and the Specifications are intended to define complete and satisfactorily functioning systems. The Contractor shall be responsible for providing all necessary material, labor and services to provide the completed, operating systems at no additional compensation even though each and every element thereof is not specifically identified.
- B. The Plans are diagrammatic and indicate general arrangements, approximate sizes and relative locations of principal equipment and materials to provide for the design and intent of the Mechanical Work, and shall be followed as closely as actual building and site conditions and other work permit. Because of the scale of the drawings, the Plans do not represent every offset, fitting, accessory, etc. that may be required for the piping, ductwork or other appurtenances, nor is it implied that all conflicts between elements of the Work or building components have been resolved. The Contractor shall prepare details and/or coordination drawings where it may be required and submit to the Architect/Engineer for approval before proceeding with the Work (see Subsection 20 10 53, Coordination).
- C. To the extent contained in the Project Documents, elevations, sections, isometrics, typical details, and schematic diagrams are included for instructions to the craftsperson. If any additional isometrics or diagrams are desired and/or required for further instruction to the

craftsperson, for permit applications, or for any other reason, the Contractor shall develop the drawings.

- D. Significant discrepancies and/or changes required to accomplish the intent of the Project Documents, in the opinion of the Contractor, shall be identified and submitted to the Architect/Engineer for approval before proceeding with the Work in question. Changes originated by the Architect/Engineer shall be processed under the subsection heading "Changes in the Work".
- E. The Plans and the Specifications are mutually complementary. Work required by one, but not the other, shall be performed as if required by both.
- F. In the event of conflict between the Plans and the Specifications, the Contractor shall notify the Engineer for clarification. The Contractor shall assume that the stricter requirements apply when there is not sufficient time for the clarification request, or when there is not sufficient time for it to be answered.

## 20 00 32 PLANS

- A. The Plans for the Work for Divisions 20 – 29 are as follows:

| <u>Sheet No./</u>   | <u>Description</u>                               |
|---------------------|--------------------------------------------------|
| <u>Revision No.</u> |                                                  |
| M0.0                | SYMBOLS ABBREVIATIONS AND SEISMIC CODE BLOCK     |
| M3.1                | OVERALL - MECHANICAL                             |
| M3.2                | FIRST FLOOR PLAN - AREA A - MECHANICAL           |
| M3.3                | FIRST FLOOR PLAN - AREA B - MECHANICAL           |
| M3.4                | FIRST FLOOR PLAN - AREA C - MECHANICAL           |
| M3.5                | FIRST FLOOR PLAN - AREA D - MECHANICAL           |
| M3.11               | OVERALL ROOF - MECHANICAL                        |
| M3.12               | ROOF PLAN - AREA A - MECHANICAL                  |
| M3.13               | ROOF PLAN - AREA B - MECHANICAL                  |
| M3.14               | ROOF PLAN - AREA C - MECHANICAL                  |
| M3.15               | ROOF PLAN - AREA D - MECHANICAL                  |
| M4.1                | ENLARGED PLANS - MECHANICAL                      |
| M4.2                | ENLARGED PLANS - MECHANICAL                      |
| M5.0                | RTU-1 AIR FLOW DIAGRAM                           |
| M5.1                | RTU-2 AIR FLOW DIAGRAM                           |
| M5.2                | RTU-3 AIR FLOW DIAGRAM                           |
| M5.3                | RTU-4 AIR FLOW DIAGRAM                           |
| M5.4                | RTU-5 AIR FLOW DIAGRAM                           |
| M5.5                | RTU-6 AIR FLOW DIAGRAM                           |
| M5.6                | RTU-7 AIR FLOW DIAGRAM                           |
| M5.7                | RTU-8 AIR FLOW DIAGRAM                           |
| M5.8                | CHILLED WATER FLOW DIAGRAM                       |
| M5.9                | CONDENSER WATER FLOW DIAGRAM                     |
| M5.10               | HEATING WATER FLOW DIAGRAM                       |
| M5.11               | HEATING WATER FLOW DIAGRAM                       |
| M5.12               | MISCELLANEOUS FLOW DIAGRAMS                      |
| M6.0                | MECHANICAL SCHEDULES                             |
| M6.1                | MECHANICAL SCHEDULES                             |
| M6.2                | MECHANICAL SCHEDULES                             |
| M7.1                | MECHANICAL DETAILS                               |
| P0.0                | PLUMBING SYMBOLS ABBREVIATIONS AND DETAILS       |
| P1.1                | OVERALL - BELOW GRADE PLUMBING                   |
| P1.2                | FIRST FLOOR PLAN - AREA A - BELOW GRADE PLUMBING |

P1.3 FIRST FLOOR PLAN - AREA B - BELOW GRADE PLUMBING  
 P1.4 FIRST FLOOR PLAN - AREA C - BELOW GRADE PLUMBING  
 P1.5 FIRST FLOOR PLAN - AREA D - BELOW GRADE PLUMBING  
 P2.1 OVERALL FIRST FLOOR PLAN - PLUMBING  
 P2.2 FIRST FLOOR PLAN - AREA A - PLUMBING  
 P2.3 FIRST FLOOR PLAN - AREA B - PLUMBING  
 P2.4 FIRST FLOOR PLAN - AREA C - PLUMBING  
 P2.5 FIRST FLOOR PLAN - AREA D - PLUMBING  
 P4.1 ENLARGED PLANS - PLUMBING  
 P4.2 ENLARGED PLANS - PLUMBING  
 P5.1 PLUMBING FLOW DIAGRAMS  
 P6.0 PLUMBING SCHEDULES  
 P7.0 PLUMBING RISERS  
 P7.1 PLUMBING RISERS  
 FP1.0 FIRE PROTECTION SYMBOLS ABBREVIATIONS AND DETAILS  
 FP2.1 FIRST FLOOR MASTER PLAN - FIRE PROTECTION  
 FP2.2 FIRST FLOOR PLAN - AREA A - FIRE PROTECTION  
 FP2.3 FIRST FLOOR PLAN - AREA B - FIRE PROTECTION  
 FP2.4 FIRST FLOOR PLAN - AREA C - FIRE PROTECTION  
 FP2.5 FIRST FLOOR PLAN - AREA D - FIRE PROTECTION  
  
 E0.00 ELECTRICAL SYMBOLS AND ABBREVIATIONS  
 E0.10 ELECTRICAL SEISMIC CODE BLOCK  
 E0.20 LIGHTING - SCHEDULES  
 E0.21 LIGHTING - DETAILS  
 E0.22 LIGHTING - WIRING DIAGRAMS  
 E0.23 LIGHTING - WIRING DIAGRAMS  
 E0.30 ONE LINE DIAGRAM  
 E0.31 POWER - DETAILS AND DIAGRAMS  
 E0.40 MECHANICAL-ELECTRICAL INTERFACE SCHEDULE  
 E0.41 HVAC POWER - DETAILS AND DIAGRAMS  
 E0.42 HVAC POWER - DETAILS AND DIAGRAMS  
 E0.50 SYSTEMS – SCHEDULES, DETAILS AND DIAGRAMS  
 E1.0 SITE PLAN - ELECTRICAL  
 E1.1 SITE PLAN - ELECTRICAL - ELEMENTARY  
 E2.2 FLOOR PLAN - AREA A - LIGHTING  
 E2.3 FLOOR PLAN - AREA B - LIGHTING  
 E2.4 FLOOR PLAN - AREA C - LIGHTING  
 E2.5 FLOOR PLAN - AREA D - LIGHTING  
 E3.1 OVERALL FLOOR PLAN - ELECTRICAL  
 E3.2 FLOOR PLAN - AREA A - POWER AND DATA  
 E3.3 FLOOR PLAN - AREA B - POWER AND DATA  
 E3.4 FLOOR PLAN - AREA C - POWER AND DATA  
 E3.5 FLOOR PLAN - AREA D - POWER AND DATA  
 E4.2 FLOOR PLAN - AREA A - HVAC POWER  
 E4.3 FLOOR PLAN - AREA B - HVAC POWER  
 E4.4 FLOOR PLAN - AREA C - HVAC POWER  
 E4.5 FLOOR PLAN - AREA D - HVAC POWER  
 E4.12 ROOF PLAN - AREA A - ELECTRICAL  
 E4.13 ROOF PLAN - AREA B - ELECTRICAL  
 E4.14 ROOF PLAN - AREA C - ELECTRICAL  
 E4.15 ROOF PLAN - AREA D - ELECTRICAL  
 E5.1 OVERALL FLOOR PLAN - SYSTEMS  
 E5.2 FLOOR PLAN - AREA A - SYSTEMS  
 E5.3 FLOOR PLAN - AREA B - SYSTEMS  
 E5.4 FLOOR PLAN - AREA C - SYSTEMS

- E5.5 FLOOR PLAN - AREA D - SYSTEMS
- E6.1 ENLARGED PLANS - FOOD SERVICE
- E6.2 ENLARGED PLANS - MAIN MECHANICAL AND ELECTRIC
- E6.3 ENLARGED PLANS - ELECTRICAL ROOMS

#### 20 00 33 SPECIFICATIONS

A. The specification for Divisions 20 – 29 includes the following sections:

- 20 Basic Mechanical Conditions
- 20 Basic Mechanical Materials and Methods
- 20 Insulation Work
- 21 Fire Protection System
- 22 Plumbing Systems
- 23 HVAC Piping and Equipment
- 24 Air Distribution System
- 25 Temperature Control System

B. Referenced sections of other Divisions whether attached or in separate volumes or binders shall be a part of the Contract Documents.

#### 20 00 34 ADDENDUM

- A. The Architect/Engineer may issue revisions, modifications, attachments or other documentation in the form of an “addendum” to the Project (Bid) Documents during the bidding phase only to change, detail or clarify the scope of the Work.
- B. The “addendum” shall become a part of the Contract Documents. Contractor shall indicate on his Bid the addenda received and therefore included in the Bid.

#### 20 00 35 INTERPRETATIONS

- A. The Architect/Engineer shall be the sole source of interpretation of the design and intent of the Project Documents.

#### 20 00 36 CONSTRUCTION SCHEDULE

- A. The Contractor shall furnish sufficient manpower as the schedule dictates and is required to maintain the overall project schedule. Manpower or overtime to meet the project schedule including, but not limited to, premium time, inefficiencies associated with longer days/hours, inefficiencies associated with additional manpower, or other labor burdens shall be included in the Contract Sum.
- B. The Work shall be scheduled in accordance with the General, Supplementary and/or Special Conditions and specification sections of Division 1. The respective contractor shall coordinate with this schedule in preparation of his schedule for his portion of the Work.
- C. The respective Contractor shall cooperate with the General Contractor and other trades to develop an overall project schedule.

#### 20 00 37 RECORD DRAWINGS

- A. The respective Contractor shall maintain a separate set of plans at the jobsite, and mark thereon as a “record” any changes in the Work as the construction proceeds. These record drawings shall include exact locations and relevant details (i.e. inverts, elevations, sizes, dimensions related to building lines, etc.) of all underground work, all concealed work, all considerations

requiring periodic attention and access thereto (i.e. valves, air vents, dampers, drives, control devices, terminal units, filters, steam traps, strainers, etc.).

#### **20 00 38 AS-BUILT DRAWINGS**

- A. At the completion of the project, the Architect/Engineer will provide Contractor CADD files in AutoCAD Release 2000 format, or lower, for the Contractors use to transfer all of the information on the "record" drawings to CADD. The layering system on the drawings provided shall be strictly adhered to. The Contractor for their representation and accuracy of the final installation conditions shall certify these "as-built" drawings. The "as-built" diskette and blue line prints shall be submitted to the Architect/Engineer for approval. Upon approval contractor shall provide a mylar plot in addition to the diskette/CD-ROM and blue line prints. The Contractor shall be responsible for all costs associated with the preparation and printing of the "as-built" drawings.
- B. In addition to the information on the "record" drawings the "as-built" drawings will contain the following information: Updated Equipment Schedules with shop drawing data and valve tag numbers placed on the flow diagrams.
- C. Contractor shall maintain one copy of the specification, including addenda as Record Specifications. Mark to show variations in Work performed in comparison with the text of the specifications. Such variations shall only be permitted where agreed to by the Architect/Engineer in writing.

#### **20 00 40 DUTIES OF CONTRACTOR**

##### **20 00 41 GENERAL (PURSUIT OF WORK)**

- A. The Contractor shall thoroughly examine all Bid Documents before submitting a bid/proposal for the Work. If in the opinion of the Contractor there are any deficiencies in the Documents that might impact on the intent or the scope of the work, the Contractor shall bring the matter to the attention of the Architect/ Engineer for clarification. If in the judgment of the Architect/Engineer such clarification is warranted, an addendum to the Documents will be issued. If the Contractor fails to request clarification or otherwise submits a bid without qualifications; the Contractor thereby agrees to install a complete and functional system with no change in the contract price.
- B. The Contractor shall be responsible for changes required for compliance with codes, standards, regulations, ordinances, etc. and implementing any such change at no change in contract price. In the event of conflict with the Project Documents or other requirements, the more stringent shall apply. The Contractor shall promptly notify the Architect/Engineer of any discrepancy.
- C. The Contractor shall perform the Work to comply with all terms, conditions and intentions, whether explicit or implicit, of this Section and applicable requirements of other Sections of Divisions 20 - 29, the Plans and any other documentation so identified. Should the Contractor perform any Work, which does not comply with the Project Documents or is not in accordance with common trade practices, the Contractor shall bear all costs, at no change in contract price, arising in correcting the Work.
- D. The Contractor shall be responsible for all aspects of the Work for their respective contractual agreement. The Work of the respective suppliers and subcontractors shall be administered properly to assure that all elements thereof have been provided for complete and functioning system(s).

#### 20 00 42 COMMENCEMENT OF CONTRACT

- A. The commencement of the Contract work shall be the receipt by the Contractor of a written "Notice to Proceed" via certified United States Postal Service (USPS) mail.
- B. Any further notices to stop and/or restart the Work shall also be transmitted via certified USPS mail. All other correspondence shall be at the discretion of the sender.

#### 20 00 43 SEISMIC ANCHORAGE, BRACING AND SWAY BRACING

- A. The Contractor shall be responsible for preparing drawings, calculations and details for any anchorage, bracing and/or sway bracing as required by the Authority Having Jurisdiction. Submitted drawings, calculations and details shall be signed and sealed by a Professional Engineer licensed in the State of Missouri.

#### 20 00 44 SUBMITTALS FOR APPROVAL

- A. The Contractor shall submit a list of proposed subcontractors and equipment suppliers within two (2) weeks of a Notice to Proceed. The list shall identify the Work to be subcontracted and the name of the proposed subcontractor; the equipment to be provided including the make, model number and vendor's name and reference to the specific subsection(s) of the Specifications. Approval of this list does not obligate the Architect/Engineer to approve the subsequent detailed submittal if it is not acceptable.
- B. All shop drawings (except sprinkler drawings) must be submitted prior to the receipt of second partial payment request. After the first payment has been made, no further payment will be made until the shop drawings have been submitted and approved. Sprinkler shop drawings must be submitted prior to the receipt of the fourth partial payment request. After the third payment has been made, no further payment will be made until these shop drawings have been submitted and approved.
- C. The Contractor shall forward the quantity required for distribution within a reasonable time following the award of the contract. In addition to the quantity the Contractor requires the Engineer will retain one (1) copy and four (4) sets should be reserved for closeout documentation (see Section 20 00 47 Catalog Data). Prior to submitting shop drawings, Contractor shall verify equipment delivery for compliance with the overall project schedule. Any delays due to delivery or due to submittals being late, inadequate, or incorrect and therefore rejected by the Architect/Engineer shall be the responsibility of the Contractor making said submittal. The Contractor shall bear all cost for expediting charges or obtaining materials from another vendor to meet the overall project schedule.
- D. The Engineer may take up to three (3) weeks to review a submittal from the time it arrives at the Engineer's office until the time it is returned to the Architect. Resubmittals will be reviewed within two (2) weeks from the time they arrive at the Engineer's office until the time they are returned to the Architect.
- E. The submittals shall include shop drawings, engineering data and support information to sufficiently substantiate compliance with the Project Documents, and shall have been processed in accordance with Subsection 20 00 43. All submittals must include the following information in order to be considered for review. Submittals found to be lacking will be processed without review.
  - 1. Shop drawing shall be manufacturer's original documents; no reproductions or telefaxes will be accepted.
  - 2. Stamped date of receipt by the Contractor.
  - 3. Identification of the project name.

4. Indication that the Contractor has reviewed the submittal.
  5. Identification of the Specification section or subsection that specifies the submitted item.
  6. Identification of the submitted item by the same description that is used in the Project Documents.
  7. Quantity to be provided. The Contractor shall make an independent count and not rely on the Project Documents.
- F. The approval of the submittal shall not relieve the Contractor from complying with all of the terms and conditions of the Project Documents. The Contractor shall be responsible for all physical and performance requirements of equipment provided, including any differences in the cost of installation for variations from these requirements.
- G. Include one (1) copy of the manufacturer's installation instructions and maintenance manual with the equipment submittal for approval for inclusion in the Operations and Maintenance Manuals as specified in Subsection 20 00 46.
- H. Items requiring submittals are listed in each section where the equipment or materials are specified. In general, all items purchased by Contractor for installation where a make and model is specified shall require submittals. Items required for the Work such as sand paper, bolts, gaskets, welding rods, etc. which are not specified are not required to be submitted unless specifically requested.
- I. The following shall be submitted under this section of the specifications:
1. List of subcontractors and equipment supplier.
  2. Payment breakdown.
  3. Construction Schedule.
  4. Detailed submittals.
  5. Catalog Data
  6. Operating and maintenance manuals.
  7. As-built drawings.
  8. Contractor developed details and coordination drawings (when applicable).
  9. Proposed substitution (when applicable).

#### 20 00 45 CHANGES IN WORK

- A. The only condition under which a change in the contract price will be considered is if there is to be a change in the scope of intent of the project requirements. Such changes would be limited to revisions in the project initiated by the Owner. The Architect/Engineer will issue a proposal for the new scope of work for the Contractor to prepare a price. When the price and time are agreed upon, the Architect/Engineer will prepare change order or change orders to adjust the contract sum and/or the contract time as necessary to carry out the changes.
- B. No claim for an addition to the Contract Sum will be valid unless authorized as aforesaid in writing by the Owner. Any work completed by the Contractor outside the original project scope without written approval from the Owner will be deemed as a waiver by the Contractor for additional compensation for said work.
- C. No requests for change orders will be reviewed or considered for approval that are not submitted with all of the following information. No cost associated with labor burden or manpower inefficiencies will be approved for a change order without documentation of the present labor burden, manpower requirements, and the critical path nature of the scope change.
1. A complete and detailed line item takeoff of materials and equipment.

2. A unit cost identified for each line item with material cost, labor hours, and labor rate identified separately for each line item.
3. All fringes and mark-ups identified separately.
- D. Where major subcontracts are involved, the respective subcontractor's calculation, including all of the above data, shall be included with the Contractor's request.
- E. Where there are net differences, the above data shall be included for all items added and for all items deducted with the net calculation clearly identified. Mark-ups shall be applied only after net differences are calculated.
- F. The overhead charged by the Contractor shall be considered to include, but not limited to, performance bond, insurance, job site office expense, normal hand tools, man-lifts, incidental job supervision, field supervision, safety training, general office overhead, and cost associated with the preparation of design documents, layout drawings, shop drawings, or as-built drawings.
- G. In evaluating the value of the contractor's request, for comparison purposes, the Architect/Engineer may use cost and unit data from the current edition of the R. S. Means Company's Cost Data, or information from appropriate suppliers or vendors of the respective materials or equipment.
- H. Any requests submitted without the above details will be returned without review for resubmittal in the proper form.

#### 20 00 46 COMPLETION AND ACCEPTANCE

- A. If, at the Owner's option, a portion of the building is to be occupied or a portion of the mechanical work is utilized for beneficial use by the Owner prior to completion and acceptance of the Project, the start of the guarantee shall begin with the "beneficial use" of the related Work.
- B. The Engineer shall inspect the portion of the system for approval prior to acceptance of the system or subsystem.
- C. The Contractor shall prepare a certificate of acceptance for approval by the Owner for that portion of the Work and submit a copy to the Architect/Engineer for record purposes.

#### 20 00 47 OPERATIONS AND MAINTENANCE MANUALS

- A. As a part of the contractual agreement, the Contractor shall submit and receive approval for the following to receive payment beyond 75% of the contract amount. This information shall be submitted as soon as practical and while the Contractor is on site.
  1. Provide four (4) sets of manufacturers printed information in three (3) ring binders containing information on installation operation and maintenance for each piece of equipment supplied. Manufacturer's information shall be original copies, no reproduction or telefaxes will be accepted.
  2. The information shall list any maintenance requirements and schedule for required maintenance.
  3. The information shall show all parts and part numbers of available replacement parts available for each piece of equipment.
  4. A cross-index of material and equipment furnished containing:
  5. An alphabetical listing of material and equipment.
  6. An alphabetical listing by manufacturer's name, address and contact person of the local sales representative.



7. An alphabetical listing of all subcontractors including name, address, contact person, and specific work performed.

#### 20 00 48 CATALOG DATA

- A. As a part of the contractual agreement, the Contractor shall submit and receive approval for the following to receive payment beyond 75% of the contract amount. This information shall be submitted as soon as all shop drawings have been approved and while the Contractor is on site.
  1. Provide four (4) sets of only those shop drawings that were approved and incorporated into the project.
  2. A cross-index of material and equipment furnished containing:
  3. An alphabetical listing of material and equipment.
  4. An alphabetical listing by manufacturer's name, address and contact person of the local sales representative.
  5. An alphabetical listing of all subcontractors including name, address, contact person, and specific work performed.

#### 20 00 49 CLOSE-OUT REQUIREMENTS

- A. As a part of the contractual agreement, the Contractor shall submit and receive approval for the following before final payment will be released. This information shall be submitted as soon as practical after project completion:
  1. Testing and Balancing Reports.
  2. Temperature controls as-built wiring diagrams, sequences of operation with daily, holiday and special operating schedules, and final calibrations of all instruments.
  3. Valve tag list.
  4. As-built drawings.
  5. At the completion of the project, all contractors/subcontractors shall submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

#### 20 00 50 GUARANTEE

- A. The Contractor shall guarantee all material, equipment and workmanship provided for this project to be free from defects for a period of two (2) years after final acceptance. The guarantee shall include replacement of the defective part(s) and related labor. Manufacturer's written guarantees shall be provided where it is published.
- B. Any obvious defects shall be corrected before final acceptance. For additional defects after final acceptance, the Owner shall advise the Contractor in writing, unless the situation is urgent, to address the deficiency or malfunction. The Contractor shall respond promptly and with no additional compensation for a valid guarantee claim.
- C. Longer guarantee periods of time or special conditions may be specified. See particular specifications for these requirements.
- D. If a written guarantee is offered for conditions or period exceeding specified requirements; this guarantee shall be included in the "Close-out" specifications of Subsection 20 00 48.
- E. The Contractor shall not qualify the guarantee with requirements placed upon the Owner. If the Contractor has concerns with maintenance of a piece of equipment then Contractor shall allow for making periodic inspections, adjustments, etc. during the warranty period.

## 20 00 50 MATERIAL AND EQUIPMENT

- A. General
- B. All equipment and materials furnished and installed by Contractor shall be new. The equipment to be furnished and installed shall be standard cataloged products of manufacturers regularly engaged in the production of this type of equipment and shall be of the latest design. Equipment of the same general type shall be of the same make throughout the Project.
- C. Manufacturers shall have been in business for two (2) consecutive years operating under the same name
- D. Products shall be in production at time of the bid date. A scheduled release of a new product during construction is not acceptable. Prototype, alpha or beta products shall not be used.
- E. Products for which fewer than 100 units have been produced and which have been in service for less than one year shall be submitted for approval, in writing, to the Engineer in writing prior to bid date.
- F. The Contractor shall be responsible for the physical fit and configuration of the equipment to suit the space available and the intent of the Work. Due consideration shall be included for external connections and service maintenance access to the equipment.
- G. The Contractor shall verify in the course of preparing the submittal that the respective material and equipment comply with the following criteria of the Project Documents:
- H. The performance ratings meet the specified requirements.
- I. The mechanical and electrical physical characteristics meet the specified requirements.
- J. The identification of the material or equipment to catalog data is correct and proper.
- K. Confirm (or establish) the quantity required.
- L. The application of the material or equipment is acceptable to the manufacturer and to the intent of the scope of Work.
- M. Any inability of material and/or equipment to comply with the aforementioned criteria shall be promptly brought to the attention of Architect/Engineer.

## 20 00 51 EQUIPMENT MANUFACTURERS

- A. The equipment manufacturer may be specified in any one of the following manners. "Equivalent" shall mean, equivalent in the opinion of the Engineer. Where equipment is scheduled on the drawings, the scheduled manufacturer is what the design is based upon:
  - 1. Single manufacturer named, "No substitution allowed":  
The intent is to use the particular make and model only, no other shall be considered.
  - 2. Single manufacturer named:  
Single manufacturer named followed by "or approved equivalent":  
The design has been based on this particular make and model for acceptable physical characteristics, performance and quality. Any other comparable and equivalent product may be substituted in accordance with procedures for submittals and approvals (Subsection 20 00 43) and conditions of Subsection 20 00 52, Equipment substitution.
  - 3. Limited multiple manufacturers named:

The design has been based on the first named manufacturer for acceptable physical characteristics, performance and quality. Any one of the other limited named manufacturers is equally acceptable in quality and may be substituted in accordance with procedures for submittals and approvals (Subsection 20 00 43) and conditions of Subsection 20 00 52, Equipment substitution.

4. Limited multiple manufacturers named followed by "or approved equivalent": The design is based on the first named manufacturer for acceptable physical characteristics, performance and quality. Any one of the other limited named manufacturers is equally acceptable in quality and along with other comparable and equivalent product may be substituted in accordance with procedures for submittals and approvals (Subsection 20 00 43) and conditions of Subsection 20 00 52, Equipment substitution.
5. List of "Acceptable Manufacturers":  
Where a specific product from a manufacturer is listed along with the words "Acceptable Manufacturers" and a list of manufacturers this equal product(s) of any of the limited list may be submitted without concern from Subsection 20 00 52.
- B. The Contractor shall follow the option specified from above as applied to each respective material and equipment specification subsection. The Contractor shall indicate within the options allowed the respective supply source(s) for the listing requested in Subsection 20 00 43. The Contractor shall assume all responsibilities and liabilities of "or equivalent" substitutions (see Subsection 20 00 52).
- C. The Contractor shall prepare and transmit submittals for approval, even for the option of Subsection 20 00 51.

#### 20 00 52 EQUIPMENT SUBSTITUTION

- A. General: As previously stated, the design has been based on a single manufacturer and model. Substitution, where permitted (as described above), may cause consequential effects that may impact on the Project. These effects may take various forms and may require changes in the design. These changes and any additional costs associated therewith are the responsibility of the Contractor proposing the substitution; no additional compensation shall be provided to the Contractor.
- B. A possible change in design may result from the proposed substitution from one or more of, but not limited to, the following conditions:
  1. Architectural: different physical configuration, size or fit, aesthetics effected.
  2. Structural: different bearing or heavier loading.
  3. Capacity: different performance, lesser output is unacceptable.
  4. Mechanical: change in flow rates (air, water, etc.), different configuration and size of external piping or ductwork connections.
  5. Electrical: different horsepower requirements, effect on distribution.
  6. Controls: interconnections with control devices and equipment, additional requirements.
  7. Impact on environmental or energy efficiency issues.
  8. Departure from intent of original design or Project Documents.
- C. Changes in loading, sizing and/or performance of the proposed substitution shall consider the total requirements served or needed by the particular equipment. A revised design to accommodate the substitution shall be extended to the point where the change has no effect on the parameters used in the original design.
- D. An equipment substitution requiring a change in the design shall be processed as follows:

1. The Contractor shall prepare and submit to the Architect/Engineer for review, a proposal to provide a substitution that shall require a change in the design. Substantiate that the substitution complies with the intent of the Project Documents and include sufficient information of the changes required so that a judgment may be rendered.
  2. Proposal shall include an original drawing originated by the Contractor, and shall not be a catalog cut, assembly manual, or other generic documented printed by the manufacturer or their representative. The design shall show the intended installation to the same level of detail as that of the original design.
  3. Prior to submitting the proposal, the Contractor shall notify all other contractors whose work may be affected and request details and pricing for their respective changes. This information along with the Contractor's details shall be transmitted to the Architect/Engineer for approval.
  4. The Contractor in preparing the proposal recognizes that they shall compensate other trades that are affected by said proposal.
  5. If the proposal and the substitution are acceptable, the Architect/Engineer will approve the submittal and initiate a change order, at no additional compensation, and a notice to proceed.
- E. Equipment that was listed as a multiple manufacturer with a model number shall be submitted as a shop drawing. Contractor shall be responsible for all other provisions of Section 20 00 52. If, and only if, the material or equipment substitution requires no design change, the Work shall proceed in accordance with the Product Documents.
- F. Equipment that is being proposed as 'or equivalent' or was listed as a multiple manufacturer without a model number shall be in the form of a written proposal before the shop drawing phase. 'Or equivalent' shall mean or equivalent in the opinion of the Architect/Engineer and they shall have sole discretion to determine whether or not a proposed substitute manufacturer and/or model is to be considered as acceptably equivalent and may be submitted in the form of shop drawings. If, and only if, the material or equipment substitution requires no design change, the Work shall proceed in accordance with the Project Documents.
- G. If changes are in fact required or a delay in work occurs because of the material or equipment substitution which were not properly processed, the Contractor initiating the substitution shall be liable for all consequential effects and expenses to accommodate the change or delay.

END OF SECTION

## **20 10 00 BASIC MECHANICAL MATERIALS AND METHODS**

### **20 10 01 GENERAL**

- A. This Section describes and specifies basic mechanical materials and methods to be utilized in the Work included in other sections of Divisions 20 - 25.
- B. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 25 of the Specifications.
- C. Provisions and conditions cited in this Section shall apply, where and when relevant, to Work of other sections of Divisions 20 - 25 of these Specifications.

### **20 10 02 REGULATORY REQUIREMENTS**

- A. Work for this section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20.

### **20 10 03 RELATED SECTIONS OF THE SPECIFICATIONS**

- A. Requirements of the following Section(s) of the Specifications apply to Work of this Section:
- B. Division 20 - Basic Mechanical Conditions
- C. Requirements of this Section of the Specifications shall apply to Work of the following sections of Divisions 20 - 29:
  - 1. Division 20 - Insulation Work
  - 2. Division 21 - Fire Protection System
  - 3. Division 22 - Plumbing Work
  - 4. Division 23 - HVAC Piping and Equipment
  - 5. Division 24 - Air Distribution System
  - 6. Division 25 - Temperature Control System

### **20 10 04 WORK INCLUDED**

- A. Furnish material, labor and services necessary for and incidental to the installation of the following work where shown on the Plans and as hereinafter specified. Include all necessary work in related sections of the Specifications (sub-section 20 10 03) to perform the Work completely.
- B. Identification of piping and equipment for the work of Divisions 20 - 25.
- C. Testing, adjusting and balancing of systems for the work of Divisions 20 - 25.
- D. Cleaning of piping and equipment for the work of Divisions 20 - 25.
- E. Excavation, trenching and backfilling for the work of Divisions 20 - 25.
- F. Painting of piping and equipment for the work of Divisions 20 - 25.
- G. Concrete for the work of Divisions 20 - 25.

### **20 10 05 WORK NOT INCLUDED**

- A. Materials and methods are specified in this section for the work of Divisions 20 - 25. The Work, itself, is specified in the respective sections of Divisions 20 - 25 of the Specifications.

#### 20 10 06 SUBMITTALS

- A. The Contractor shall submit materials for the Work of Divisions 20 - 25 for approval in accordance with Section 20 00 43. The requirements are enumerated in the respective sections of Divisions 20 - 25 of the Specifications.
- B. Single and multiple manufacturers are cited in this Sub-section as acceptable sources of piping material. While "or equivalent" is not included, the intent of this Section is to permit substitution as defined in Sub-section 20 00 51, EQUIPMENT MANUFACTURERS, unless "no substitution allowed " is noted.
- C. The following shall be submitted under this section of the specification:
  - 1. Firestop schedule and product data, see Section 20 10 20 for specific requirements.
  - 2. Coordination drawings, see Section 20 10 53 for specific requirements.
  - 3. Testing and Balancing, see Section 20 10 80 for specific requirements.
  - 4. Identification, see Section 20 10 90 for specific requirements.

#### 20 10 07 SPECIAL REQUIREMENTS

- A. Special requirements for work shall be specified in the respective sections of Divisions 20 - 25 of the Specifications.

#### 20 10 08 ABOVE CEILING IDENTIFICATION

- A. All equipment items (i.e., pumps, fire dampers, duct access panels, VAV boxes, etc.) concealed above a ceiling shall be identified with ceiling marker tacks similar to Markserv Ceiling Markers, Equipment Locator Tacks. Provide serrated makers with retention disk. Color code equipment markers for each equipment item above ceiling. Coordinate color strategy with owner.

#### **20 10 10 BASIC PIPING MATERIALS**

- A. General:
  - 1. The intent of sub-sections 20 10 11, 20 10 12, and 20 10 13 is to identify materials that may be utilized for Divisions 20 - 25 Work as specified for each specific piping system.
  - 2. Respective piping materials shall be manufactured, fabricated and/or provided in accordance with the ANSI, ASTM, ASME or other accepted industry standard as specified herein.

#### 20 10 11 PIPE AND TUBE

- A. General:
  - 1. All pipe and tube material shall be uncoated, unless specified otherwise.
  - 2. Manufacturer's mill reports and applicable documents to certify the validity of procured piping materials shall be on file at the Contractor's office.
- B. Steel pipe:
  - 1. Steel pipe shall be specified by finish, size by nominal diameter, ASTM specification number, manufacturing process, wall thickness (by schedule number or decimal dimension) and end preparation as follows:
  - 2.

| ASTM<br>finish | mfr.<br>spec# | wall<br>method | size<br>thickness | end<br>range   | prep |
|----------------|---------------|----------------|-------------------|----------------|------|
| black          | A-53          | CW/ERW         | Sch 40, 80        | 2" and smaller | T&C  |
| black          | A-53          | SMLS           | Std, Sch 40,80    | all            |      |
|                |               | PE/T&C         |                   |                |      |
| black          | A-106         | SMLS Grade A   | Std, Sch 40,80    | all            |      |
|                |               | PE/T&C         |                   |                |      |
| galv           | A-53          | SMLS Grade A   | Std, Sch 40,80    | all            |      |
|                |               | PE/T&C         |                   |                |      |

- Per ANSI B36.10, schedule 40 is standard weight pipe for 10" pipe size and smaller.
- Schedule 80 in this pipe size range is extra strong pipe.
- Standard weight pipe for all sizes 12" and larger is 0.375" wall thickness and are generally not referred to by schedule number.
- Outside diameters of pipe sizes 14" and larger are even whole numbers (e.g. - 18" O.D., 20" O.D., etc.)

CW = continuous weld

ERW = electric resistance weld

SMLS = seamless

PE = plain end

T&C = threaded and coupled

- All steel pipe shall be mill coated and rust free.

C. Copper tube:

- Type K, L, and M copper tube shall be in accordance with ASTM B88. Tubing is available in various finished products and wall thickness, which must be called out as well as sizes being either "nominal" or "outside diameter" (O.D.) since there are overlaps in smaller sizes.

| type      | size<br>range | annealed |      | application                                        |
|-----------|---------------|----------|------|----------------------------------------------------|
|           |               | hard     | soft |                                                    |
| K         | 1/4"-2"       |          | x    | heaviest wall, underground water (ASTM B-88)       |
| L         | 1/4"-8"       | x        |      | general use, HVAC, refriger., plumbing (ASTM B-88) |
| M         | 1/4"-8"       | x        |      | lightest, gravity drains and vents (ASTM B-88)     |
| DWV       | 1-1/4"-6"     | x        |      | plumbing drains and vents (ASTM B-306)             |
| Refr./ACR | 1/8"-4-1/8"   | x        |      | O.D. tube, refrigeration (ASTM B-280)              |

D. Cast iron pipe:

- Hub and spigot soil pipe shall be in accordance with ASTM A-74. Available in service weight and extra heavy, both with coal tar coating, 5 foot and 10 foot lengths, single and double hub ends, range 2" - 15" diameter.
- No-hub soil pipe shall be in accordance with ASTM A-888, CISPI 301. Available with coal tar coating, 5 foot and 10 foot lengths, range 1-1/2" - 10" diameter.

E. Plastic pipe:

- PVC pressure rated schedule 40 (white) and schedule 80 (gray) pipe shall be in conformance with ASTM D-1785.
- CPVC pressure rated Schedule 40 and Schedule 80 pipe shall be in conformance with ASTM F-441.

3. PVC DWV pipe for non-pressure applications shall be schedule 40 pipe in conformance with ASTM D-1785.
4. SDR PVC sewer pipe outside of building shall be in conformance with ASTM D-3034 and ASTM F-477.
5. PVC AWWA C900 water distribution piping shall be in conformance with AWWA C900 and UL1285.

F. Ductile iron pipe:

1. Ductile iron pipe shall meet requirements of ANSI/AWWA C150/A21.5. Thickness class shall be in accordance to the pressure class, installed depth, and laying condition and meet requirements of ANSI/AWWA C151/A21.51.
2. Pipe shall be cement mortar lined with bituminous seal coat for ductile iron pipe and shall meet ANSI/AWWA C104/A21.4.
3. Pipe shall be exterior coated with bituminous for ductile iron pipe and shall meet ANSI/AWWA C106.

G. Polyethylene:

1. Material used for the manufacture of high density polyethylene pipe and fittings shall be categorized as extra high molecular weight and meet all requirements for a grade PE24. The high density polyethylene material shall be a cell class of 234343E per ASTM D3350 and shall be assigned a Plastics Pipe Institute (PPI) recommended designation of PE2406 and a 60°C Hydrostatic Design Basis (HDB). Pipe manufacturer shall be a member in good standing of the Plastic Pipe Institute.
2. Pipe and fittings shall be manufactured from material meeting the requirements of above, and all appropriate requirements of Part 192 of the Federal Minimum Safety Standards. The manufacturer shall certify that samples of the manufacturer's production product have been tested in-house in accordance with ASTM D2837, and validated in accordance with the latest revision of PPI TR-3. IPS dimensional, markings, and performance characteristics shall conform to the requirements of ASTM D2513.
3. Both pipe and fittings shall carry the same pressure rating. All fittings shall be pressure rated to match the system piping to which they are joined. Socket type fittings shall comply with ASTM D2683. Butt fusion fittings shall comply with ASTM D3261. The manufacturer of the pipe shall be the same manufacturer of the fabricated fittings and other fabrications. The manufacturer shall certify that the materials used to manufacture pipe and fittings meet the requirements of this specification.
4. The pipe shall have product traceability. This shall be accomplished by the inclusion of a product code into the printline of all products. This shall notate the manufacturer, the date of manufacture, the lot and supplier of raw material, the location of manufacturer, and the production shift on which the product was produced.
5. Pipe and fittings shall be butt fusible according to the manufacturer recommended procedures. The socket or sidewall fittings shall also be to manufacturer's recommended procedures. Pipe and fittings may also be joined with flanged adapters.
6. Testing shall be in accordance with the procedure in the Plastics Pipe Institute (PPI) Technical Report TR-3.
7. The pipe and fittings shall be PE2708 as manufactured by Isco Industries, JE Eagle, Performance Pipe or approved equivalent.

H. Corrugated, Stainless Steel Tubing (CSST):

1. Corrugated, Series 300 stainless steel tubing shall be in conformance with ASTM A 240/A 240M,



2. Flame retardant PE coating, with surface-buring characteristics of Flame Spread Index of 25 or less and Smoke Developed Index of 50 or less, as determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

## 20 10 12 FITTINGS

### A. Cast iron:

1. Screwed fittings and flange unions: 125# standard and 250# extra heavy threaded in accordance with ANSI B16.4 (except plugs and bushings which are ANSI B16.14). Available in black or galvanized, range 1/4" - 8".
2. Flanged fittings and flanges: 125# standard, flat faced in accordance with ANSI B16.1. 250# extra heavy, raised face in accordance with ANSI B16.2. Flange facing and drilling shall be in accordance with ANSI B16.5. Available black and limited galvanized, range 1-1/2" - 12".
3. Flanged elbows shall be long radius (1.5 x diameter), short radius elbow are not permitted, unless specifically noted.
4. Drainage fittings: recessed pitched threads for non-pressurized applications. Available in standard black uncoated, coated or galvanized, range 1-1/4" - 8".
5. Soil pipe hub and spigot and no-hub fittings shall be in accordance with ASTM A-74, ANSI A-112.5.1, CISPI std #301 and HS-82. Hub and spigot fittings available in service weight and extra heavy, coal tar coating, range 2" - 15" diameter. No-hub fittings with coal tar coating, range 1-1/2" - 10".

### B. Malleable iron:

1. Fittings: 150# Sat. steam (300 WOG), 300# Sat. steam (600 WOG), in accordance with ANSI B16.3. Available in black and galvanized, range 1/8" - 6".
2. Unions: 150# Sat. steam (300 WOG), 250# Sat. steam (500 WOG), 300# Sat. steam (600 WOG), threads in accordance to ANSI B2.1, hexagonal stock ASTM A197, ground joint type bronze-to-iron, range 1/8" - 3".

### C. Forged steel:

1. Fittings: 2000#, 3000# and 6000# threaded in accordance with MSS SP49 - SP50. 3000# and 6000# socket weld in accordance with ANSI B16.11/MSS SP79. Available black and electro zinc plated; socket weld for schedule 80 bore. Range 1/8" - 4".
2. Unions: 3000# threaded and socket weld, steel to steel and brass to steel; 6000# threaded and socket weld, steel to steel only all in accordance with MSS SP83. Available 3000# black and electro zinc plated, 6000# black only, range 1/8" - 4".
3. "Weldolets, Thredolets, Sockolets and Elbolets": In accordance with ANSI B36.10/ASTM A216, except Elbolets which are ANSI B16.11. Weldolets available standard and extra strong, black only, range 1/8" - 24". Others available 3000# and 6000#, black only, range 1/8" - 4" (limited). Source: Bonney Forge.

### D. Butt weld:

1. Butt welding fittings shall be in accordance with ASTM A-234 and ANSI B16.9. End preparation of butt welding fittings shall be in accordance with ANSI B16.25.
2. Elbows shall be long radius (1.5 x diameter), short radius elbows, and 180-degree returns are not permitted, unless specifically noted.

### E. Forged steel flanges:

1. 150# and 300# forged steel flanges shall be manufactured to the requirements of ASTM A-181 with dimension in accordance to ANSI B16.5. Flange faces shall be flat or raised face as required.
  2. Forged steel flanges shall be furnished as weld neck pattern. Slip-on, lightweight slip-on (drilled to 125# ANSI standards) and orifice flanges shall be provided only where specified and/or noted.
- F. Copper (alloy and bronze) shall be in conformance with the following ANSI specifications:
1. Cast bronze threaded fittings: ANSI B16.15
  2. Cast copper alloy solder fittings: ANSI B16.18
  3. Wrought copper pressure solder fittings: ANSI B16.22
  4. Cast copper DWV solder fittings: ANSI B16.23
  5. Cast bronze flanged fittings: ANSI B16.24
  6. Cast copper alloy for flared tubing: ANSI B16.26
  7. Wrought copper DWV solder fittings: ANSI B16.29
  8. Short radius 90 degrees elbows and 180 degree returns are not permitted, unless specified and/or specifically noted.
- G. Grooved:
1. All grooved components shall be of one manufacturer made in accordance with ANSI B-31.1, B-31.9. Fittings shall be ANSI 150#, 300# cast of ductile iron in accordance with ASTM A-536, Grade 65-45-12. Fittings shall have an enamel finish. Segmentally welded fittings are not acceptable.
  2. Only the following fittings will be accepted: Long radius (1.5 x diameter) 90° and 45° elbows, tee, reducing tee, concentric/eccentric reducers, and flange adapter nipples. Flange rings, reducing couplings, saddle/**mechanical/clamp branch** tee, and others not listed above are not acceptable.
- H. Ductile iron:
1. Ductile iron fittings shall meet requirements of ANSI/AWWA C110/A21.10 with thickness equal to Class 54 ductile iron pipe in accordance with ANSI/AWWA C151/A21.51.
  2. Ductile iron fittings shall be cement mortar lined with bituminous seal coat and shall meet the requirements of ANSI/AWWA C104/A21.4.
  3. Ductile iron fitting shall be exterior coated with bituminous and shall meet the requirements of ANSI/AWWA C106.
- I. Miscellaneous
1. Dielectric flanges and unions:
  2. Dielectric unions and flange unions shall be required in piping systems where an electrically insulated connection is needed to separate dissimilar metals from producing galvanic or electrolytic action. Unions shall be rated for 250#; flange unions for 175#. Range: unions ½" - 2"; flange unions 1-1/2" - 12".
  3. Steel threaded nipples:
  4. General use: Made from ASTM A-120 pipe in standard (schedule 40) and extra strong (schedule 80). Available black and galvanized, range 1/8" - 6" pipe diameters.
  5. High-pressure application: Made from ASTM A-53 seamless pipe and ASTM A106 seamless pressure tube in standard (schedule 40) and extra strong (schedule 80). Available black only, range 2" - 6" pipe diameters.
  6. Close nipples are not permitted.

## 20 10 13 VALVES

### A. General:

1. It is indented that valves specifications are for high quality HVAC / Plumbing applications, not lesser quality "Contractor / Value / Economy" series. Valves produced internationally shall be from the Manufacturer's owned facilities. Valves shall not be manufactured by third party OEM suppliers. Valve submittal shall indicate where the valve is assembled and tested.
2. When two or more valves of the same type are to be used in the same service, all valves of this type shall be of the same manufacturer.
3. Only general valve series are specified. Valves shall have all options, trim, seat material, and accessories as specified whether or not listed as a prefix, suffix or valve number.
4. All valve manufacturers and models listed shall be considered as "acceptable manufacturers" and may be submitted without concern from subsection 20 00 62
5. All valves for use in "cold" piping shall have stem or neck extensions allowing proper insulation and a continuous vapor barrier.
6. No asbestos packing allowed.

### B. Ball Valve:

1. 2" and smaller: Bronze ASTM B584 (or low lead bronze for lead-free), 2-piece body, 600 psi WOG, quarter turn lever handle, blow-out proof stem, stem extension (for "cold" applications), full port, virgin TFE seats, all stainless steel trim, threaded or soldered ends. Nibco S-585-70-66, Apollo 77-240, Watts Series B-6081, Hammond 8311 or approved equivalent. Full port valves 2 1/2" and 3" the same model numbers as the 2" and smaller valves are also acceptable.
2. 2-1/2" - 3": Bronze ASTM B584 (or low lead bronze for lead-free), 2-piece body, 600 psi WOG, quarter turn lever handle, blow-out proof stem, stem extension (for "cold" applications), standard port, virgin TFE seats, all stainless steel trim, threaded or soldered ends. Nibco S-585-66, Apollo 70-240, Watts Series B-6001, Hammond 8511 or approved equivalent. Full port valves 2 1/2" and 3" the same model numbers as the 2" and smaller valves are also acceptable.
3. Ball valves used for chilled water shall have insulated T-handle Nibco Nib-Seal, Apollo ThermaSeal, Hammond Valve Insulator/MS.
4. Gauge cocks where not specified or specifically identified shall be 1/4" bronze 2 piece body ball valves with lever handle and threaded ends per the above specification.
5. Drain valves and air vents shall be 3/4" bronze 2 piece body ball valves per the above specification, with 3/4" hose end adapter cap and chain. In 1/2" through 2" pipe, contractor may use Webstone model T-drain.

### C. Butterfly:

1. 2" - 24": Class 200 ASTM A395 ductile iron body, threaded lug type, 1/4 turn, extended neck, peroxide cured EPDM molded-in seat liner, aluminum bronze disc, 416 SS stem, lubersized bronze or Teflon bushings, and stem seals material matching the seat material. Conforms to MSS SP-67 & API 609. Bi-directional bubble tight dead end service with no downstream flange required rated at 200 psi for 2-12", or 150psi 14" and larger. Valve body shall an integrally cast top plate for direct flush mounting of manual or power actuators without the use of brackets or adapters.
  - a. Refer to subsequent paragraphs for operator type based on size and service.

- b. Valves shall be chemically compatible with: up to 4ppm of Chloramines (NH<sub>2</sub>Cl, NHCl<sub>2</sub>, NCl<sub>3</sub>) 40°F-200°F, propylene glycol 0°F-200°F; and NSF-61 rated 40°F-180°F.
    - c. Where used in potable water valve shall be "lead free" per 2011 Reduction of Lead in Drinking Water Act.
    - d. Valve submittal shall indicate where the valve is assembled and tested.
    - e. Valves shall be NIBCO figure LD 2000, Milwaukee ML-133E, Hammond 6411, Bray 31H, Apollo LD-145, Watts DBF-03, or approved equivalent. The following valves are **NOT** equivalent NIBCO N200, Milwaukee CL series, Hammond 5000 series, Apollo LC series, Watts BF series, or Crane 200 series.
  - 2. Service valves 6" and less shall have a 10-position lever handle; balance valves shall have infinitely adjustable lever handle with memory stop locking option. Service valves and balance valves 8" and larger shall have position indicating worm gear operators with handwheel operator. Control valves shall have actuators as specified in Division 25.
  - 3. Where valves are located above 15'-0" AFF provide gear operator with chain wheel and guide. Provide chain hoods where required, to prevent fouling of chains on equipment and to clear walkways. Terminate chains approximately 6'-3" above the floor.
- D. Balancing Valves:
- 1. General: Balance valves shall provide positive shut-off for service and shall have adjustable memory stops to allow returning to original balanced position after servicing.
  - 2. 3" and smaller: Body shall be bronze or Dezincification Resistant Brass rated to 300 psig. Valves shall be multi-turn, provide positive shut off; include: position indication, memory stops, integral pressure tap ports provided with "drip caps". Quarter turn valves are not acceptable. Balance valves shall be Nibco 1810, Tour and Anderson 786/787, Apollo 59A, Armstrong CBV, Macon Balancing STV/L Series or approved equivalent.
  - 3. 4" – 12": Body shall be iron body rated to 300psig with 150# flanges. Valves shall be multi-turn, provide positive shut off; include: position indication, memory stops, integral pressure tap ports provided with "drip caps". Quarter turn valves are not acceptable. Balance valves shall be Nibco F739, Tour & Anderson 788, Apollo 58A, Armstrong CBV, Macon Balancing STV, Watts CSM-91, or approved equivalent.
- E. Check:
- 1. Check valves installed at pump discharge size 2 ½ and larger shall be Silent type, size 2" and smaller may be swing type.
  - 2. 2" and smaller: Class 125 (125 psi at 400°F, 200 psi at 150°F), bronze, horizontal swing, vertical up-flow, Y pattern, teflon renewable seat and disc in conformance with MSS SP80. Nibco 413, Grinnell 3300, Watts 5000, Crane 1707, Hammond IB904, Stockham B320, or approved equivalent.
  - 3. 2" - 12": Class 125 (125 psi at 400°F, 200 psi at 150°F), iron body, flanged, horizontal swing, vertical up-flow, bolted bonnet, renewable seat and disc in conformance with MSS SP71, type 1. Nibco 918, Grinnell 6300A, Watts 511, Crane 373, Hammond IR1124, Jenkins 624C, Stockham G931, or approved equivalent.
  - 4. Silent Check Valve: 2-1/2" - 30", Class 125 (125 psi at 400°F, 200 psi at 150°F), flanged, ASTM A-126 Class B, cast iron body, bronze trim, resilient seat. Nibco F-910, Grinnell Series 500, Milwaukee 125 Class, Mueller 91-AP, or approved equivalent.
  - 5. Silent Check Valve: 2-1/2 – 30", Class 250 (500 psi at 150°F), flanged, ASTM A-126 Class B, cast iron body, bronze trim, resilient seat. Nibco F-960, Grinnell Series 550, Milwaukee 250 Class, or approved equivalent.
  - 6. Silent Check Valve: 2" and smaller, Class 300 (300 psi at 550°F, 600 psi at 150°F), ASTM B61 bronze body, horizontal swing, vertical upflow, regrinding type, Y pattern renewable

seat and disk in conformance with MSS SP80. Nibco T-473, Grinnell 3370, Milwaukee 507, Hammond IB949, or approved equivalent.

F. Polyethylene:

1. Ball valve: Valve shall be the same size as pipe polyethylene ball valve 150 psig, P.E. 2406 as manufactured by Nordstrom.
2. Valve box shall be plastic for a Nordstrom P.E. ball valve, gas lettering, heavy duty, arched base, 6@ ID shaft as manufactured by Handley Industries.

**20 10 14 STRAINERS**

A. General:

1. When two or more strainers of the same type are to be used in the same service, all strainers of this type shall be of the same manufacturer.
2. Only general strainer series are specified. Strainers shall have all options, trim, and accessories as specified whether or not listed as a prefix, suffix or the model number.
3. All manufacturers and models listed shall be considered as "acceptable manufacturers" and may be submitted without concern from subsection 150620.

B. "Y" Strainers:

1. 2" and smaller: ANSI 125 lb. (125 psi at 353°F, 200 psi at 150°F), ASTM B62 bronze body and straight thread cap, ASTM A240 304 stainless steel perforated sheetmetal with .033" openings for steam and 1/8" diameter for water service. Mueller 351M, Keckley F-150, Armstrong F4SC, Spirax/Sarco BT, Watts 777/777S, or approved equivalent.
2. 2-1/2" through 12": ANSI 125 lb. (125 psi at 353°F, 200 psi at 150°F), ASTM A126-B cast iron body and cover, ASTM A240 304 stainless steel perforated sheetmetal with .045" openings for steam and 1/4" diameter for water service. Mueller 751, Keckley A, Armstrong A-FL-125, Spirax/Sarco F-125, Watts 77F-D, or approved equivalent.

**20 10 20 MISCELLANEOUS MATERIALS**

**20 10 21 SLEEVES (NON-WATER PROOF, NON-FIRE RATED)**

- A. Piping passing through non-fire rated interior walls or floors shall be neatly field cut round holes with hole saws for non-masonry/concrete, and core drill for masonry/concrete. "Beating" an opening in a gypsum or masonry wall shall not be accepted.
- B. Install Schedule 40 pipe sleeves where pipes passing through floors of spaces where water could leak to the area below (i.e., mechanical rooms, janitor closets, kitchens, etc.). ID of pipe sleeve shall accommodate pipe insulation. Pipe sleeve shall extend a minimum of 4" above the finished floor, grout the annular space between the oversized core drill in the floor and the sleeve.
- C. In new construction, field formed walls or floors, the contractor shall install appropriate blocking or material or pipe sleeves.

**20 10 22 WATER SEALS**

- A. All penetrations through interior to exterior walls or floors shall be sealed water tight using the methods below.
- B. In new construction, sleeves shall be hot-dipped galvanized pipe fabrication with continuously welded water stop plate. GPT Industries "Century-Line" CS model (plastic), WS model (steel or SS model "Sleeve-Sec" (modular sections) sleeves may be used at the Contractor's option.

- C. The annular space between pipes/conduits and interior to exterior sleeves and sleeve penetrations for service temperatures below 250°F shall be sealed with GPT Industries "Link Seal" Model S-316 EPDM rubber with 316 stainless steel hardware. For service temperatures between 250°F-450°F and model "T" shall be used. Closure seals sizing shall be in accordance with manufacturer's data and application.
- D. The Contractor shall submit a schedule of sleeves and seals to the Architect/Engineer for approval indicating the following: carrier pipe size, location, type of sleeve - fabricated with dimensional details or purchased with manufacturer's support information, seal requirements - none, fire rated, non-fire rate or "Link Seal" with respective support data.
- E. Sleeves and seals manufactured by GPT Industries/PSI, Flexicraft Industries, Advance Products & Systems, Metraflex, or equivalent.

#### 20 10 23 FIRESTOPS AND SMOKESTOPS, FIRE RATED/SMOKE PARTITIONS

- A. All penetrations through rated assemblies, walls, shafts, floors, roofs, etc., shall be firestopped in accordance with Local Building Codes, NFPA, U.L. Fire Resistant Directory, and manufacturer's instructions.
- B. Provide a FIRESTOP PRODUCT SCHEDULE consisting of the following minimum information:
  - 1. Type – indicate the type of materials, or system.
  - 2. Manufacturer – manufacturer's name, product name and product number.
  - 3. Mechanical System – indicate which Divisions 20 - 25 items the product is utilized for.
  - 4. Rating – indicate the fire rating and UL detail numbers.
- C. Submit the following with the above FIRESTOP PRODUCT SCHEDULE:
  - 1. Manufacturer's specifications and technical data including installation instructions.
  - 2. Details of each proposed assembly.
  - 3. Manufacturer's representative who shall provide qualified engineering judgments and drawings for non-standard applications.
  - 4. Contractor's qualifications and related experience.
- D. Materials shall be stored per the manufacturer's recommendations and as specified for General Project storage in Division 20.

#### 20 10 24 SEALS, NON-FIRE RATED

- A. All penetrations through non-rated walls, floors, etc., shall be sealed for draft stopping with caulk, putty, etc., designed for this use.

#### 20 10 25 ESCUTCHEONS

- A. Wall, floor, and ceiling plates shall be spun brass, plain pattern, chrome plated, spring type or setscrew fastening. Provide escutcheons for all exposed piping in finished spaces.

#### 20 10 26 FLASHINGS, CURBS, AND EQUIPMENT SUPPORTS

- A. Piping and other roof penetrations shall be flashed and/or pitch pocketed by the Contractor in a manner approved by the roofing contractor and specified herein.

- B. Single pipe and other round penetrations less than 12" O.D. diameter shall be flashed with Pate Pipe Seal or equal product, which consists of a spun aluminum base, a stepped rubber boot, and stainless steel adjustable clamps.
- C. Multiple pipe and other round penetrations less than 12" O.D. diameter shall be flashed with Pate Pipe Curb or equal product, which consists of a galvanized roof curb, thermoplastic cover, rubber boots, and stainless steel adjustable clamps.
- D. Pate type PHA pipe hood assemblies or equivalent product can be used at contractors' option for multiple pipes, refrigerant line sets, or irregular shaped objects entering the assembly horizontally. The faceplate the items pass through shall be neatly trimmed to the size of the items with gap not to exceed 1/4". Faceplate can be fabricated with horizontal seam through the penetration with an overlap to shed water. Caulk penetration air and watertight.
- E. When an irregular shaped member extends above the roof, a pitch pocket fabricated of galvanized or copper sheet metal material shall be provided. The vertical box portion shall extend a minimum of 4" beyond the contained pipe or member, have a solid bottom cut for the penetration and extend at least 6" above the finished roof. The collar portion shall extend a minimum of 9" beyond the vertical box and be fastened to the roof deck. The open space on the inside of the pitch pocket shall be filled with oakum and topped with a minimum thickness of 2" of pitch or roofing cement.
- F. Supports for roof mounted equipment piping, and ductwork shall also meet the requirements listed above. All roof supports shall be anchored to the structure in a manner that will transmit all loads including seismic and wind loads from the equipment supports through the roofing to the building structure. Equipment supports shall be equal to Pate model ES-1. Pipe/duct supports shall be equal to Pate model PRS-1. Curbs not specified with the equipment shall be equal to Pate Curbs. The finished height of the roof curb shall be 10" – 12" above the finished roof. The Contractors shall coordinate the curbs with the roof insulation thickness.

#### 20 10 27 ACCESS DOORS

- A. Access to mechanical equipment and ductwork of Divisions 20 - 29 required for testing, adjusting, inspection, maintenance or servicing shall be the responsibility of the Contractor. Doors for manufactured equipment shall be an integral feature included with the respective equipment. Access openings in ductwork shall be included with the fabrication in accordance with SMACNA practices.
- B. Openings in building components for access to concealed mechanical work shall be furnished by the Contractor and installed with the building construction work. Access doors shall be located as indicated on the Plans or as strategically required for inspection, maintenance, and service. The model and style shall fit the building construction, fire rating requirements and provide adequate size and function.
- C. Access doors shall be sized as shown on the drawings or shall be a minimum size of 18" x 18" and otherwise shall be large enough for purpose intended and shall be fabricated of heavy gauge steel frames and door panels with double action concealed spring hinges, 1/4 turn flush screwdriver operated cam locks and prime coat paint finish. Access doors for various applications shall be as follows:

##### building construction:

flush door in dry wall construction (walls and ceilings)  
 flush door in masonry or tile walls with exposed frame  
 flange  
 flush door in plaster construction (walls and ceilings)  
 recessed door in acoustical plaster ceiling

##### Milcor access door:

style DW  
 style M (steel), Style MS  
 (stainless)  
 style K  
 style AP

|                                                              |                                     |
|--------------------------------------------------------------|-------------------------------------|
| recessed door in suspended drywall ceiling                   | style CT (aluminum - wet locations) |
| flush door in suspended drywall ceiling                      | style CF (aluminum - wet locations) |
| door in suspended drywall ceiling                            | style ATR (fire resistive door)     |
| fire rated separation (walls and ceilings) - fire rated door |                                     |

- D. Access doors are not required for Work above lay-in panel ceilings.
- E. Submittals shall indicate schedule of locations, sizes, types, adjacent building construction, finish, fire rating including thickness and type of insulation, conformance to UL requirements and associated labeling, metal and gauge of fabrication. Access door shall be as manufactured by Karp Associates, Milcor, or Higgins MfCO.

#### 20 10 28 RESTRICTIONS, GENERAL FOR ALL PIPING SYSTEMS

- A. Do not use gaskets or packing containing asbestos.
- B. Selections of material and equipment and options for substitution shall conform to the requirements of Sub-section 20 00 60, MATERIAL and EQUIPMENT.
- C. "Bull head" tee connections are not permitted, unless approved by the Engineer.
- D. Close nipples and bushing reducers are not permitted.
- E. Slip joints are permitted in sanitary drainage systems only, on the fixture side of traps.
- F. Mitered elbows are not permitted in welded pipe construction.
- G. Solder for use in joints of copper piping for domestic (sanitary) cold water, hot water, hot water recirculating and softened water shall not contain lead.
- H. Unprotected, non-smoke rated plastic piping material is not permitted in above-the-ceiling spaces used as return air plenums, or exposed in any occupied space.
- I. Black and galvanized pipe, fittings, nipples and specialties are not permitted in water piping systems where copper and/or brass are the basic materials.
- J. Cast iron fittings are not permitted for gaseous distribution applications.
- K. Cast brass/copper fittings are not permitted for gaseous applications including refrigerant lines.
- L. Short radius 90-degree elbows and 180-degree returns are not permitted, unless specified and/or specifically noted.
- M. The use of pipe hooks, chain and perforated band iron are not permitted for hanging or supporting piping.
- N. Power driven inserts and attachments are not permitted unless approved by the Architect/Engineer on express request by the Contractor.
- O. Welded attachments to the structural steel of the building are not permitted unless otherwise noted or approved by the Architect/Engineer on specific request of the Contractor.
- P. Plastic pipe, fittings, valves and specialties are not permitted for gaseous distribution applications.
- Q. Plastic and fiberglass piping systems shall not be tested pneumatically.



## **20 10 30 JOINTS AND CONNECTION METHODS**

### **20 10 31 THREADED**

- A. Threads for all screwed pipe systems shall be American National Standard taper threads in accordance with ANSI B-1.201.
- B. Threads shall be full, sharp, clean and free of fins and burrs. Pipe ends shall be reamed to remove internal burrs.
- C. Threaded connections shall be joined using teflon sealing tape applied to the male threads only.
- D. This sub-section does not apply to threads for compression, flare and sanitary drainage slip type drainage fittings.
- E. Threaded fittings for CSST shall be listed for use with CSST gas piping.

### **20 10 32 WELDED**

- A. Welded joints shall be "V" type butt welds in accordance with ANSI B31.1.
- B. The Contractor shall only use welders regularly engaged in the piping trades and certified by the National Certified Welding Bureau, using procedures set forth in ASME Boiler Construction Code, Section IX, "Welding Qualifications".
- C. Contractor shall keep a copy of welder's certification on file at Contractor's office. Upon request the Architect/Engineer may request Contractor to produce certifications. Any pipe installed by a non-certified welder shall be removed if requested by Architect/Engineer.
- D. All steel piping shall be cleaned of mill scale and rust before assembly. Welds shall be chipped and hammered after each pass and joints shall be built up to at least the same thickness as that of the pipe wall. All welding shall be done in accordance with the welding procedures of the National Certified Pipe Welding Bureau conforming to the requirements of the ASA Code for Pressure Piping.
- E. Architect/Engineer shall have the authority to accept or reject the welds and require random samples of installed welds to be removed, tested and inspected.

### **20 10 33 GROOVED**

- A. Grooved joints for grooved couplings and fittings shall be in accordance with accepted manufacturer's specifications and practices.
- B. Grooves may be cut or rolled in accordance with manufacturer's recommendations for type of pipe, sizes and thicknesses specified for respective systems.
- C. Gaskets shall be suitable for the temperature, pressure and compatibility with the fluid contained therein. Unless specifically specified otherwise or incompatibility with the system, gaskets shall be EPDM grade E.
- D. Grooved couplings shall be ASTM-A47 grooved malleable iron clamp type couplings as manufactured by Victaulic or equivalent.
- E. Grooved couplings for vibration isolation or as unions at equipment connections shall be similar to Victaulic Style 77; all others shall be similar to Victaulic Style 07.

#### 20 10 34 SOLDERED AND BRAZED

- A. Soldered and brazed connections shall be made in accordance with recommendations of the current edition of the Copper Tube Handbook of the Copper Development Association or as hereinafter specified.
- B. General criteria for soldered and brazed joints shall be as follows:
  - 1. Copper tubing shall be square-end cut by varied methods at the Contractor's option. The ends of the tubing shall be reamed to remove both internal and external burrs.
  - 2. Joints for copper piping for hydronic systems, domestic water, temperature controls, DWV systems and other applications of fluids below 250 degrees F. shall be soldered with 95-5 Tin Antimony. 50-50 Tin Lead solder shall not be used.
  - 3. Joints in copper piping for gases, refrigerant lines and other applications operating above 250 degrees F., or where otherwise specified shall be brazed with Copper Phosphorus (BCuP Series), Silver solder (BAg Series), or other approved high temperature brazing alloy.
  - 4. Cleaning of tubing and fittings, application of flux and heat, purging and cooling shall be in accordance with recommendations of solder and brazing alloy manufacturers for the joint type and material specified in the respective "PIPING MATERIAL SCHEDULE" in Section 230000.

#### 20 10 35 FLANGED

- A. Flanges shall be flat faced or raised faced as required for mating flanges of valves, specialties, equipment connections, etc.
- B. Carbon steel hex head machine bolts, ASTM A307, grade 2, with heavy hex nuts shall be used for joining 125 and 150# flanged joints, unless otherwise specified.
- C. Alloy steel machine bolts, studs and heavy hex nuts shall be used for joining of 250 and 300# flanged joints, unless otherwise specified.
- D. Lubricate the threads of bolts and studs with an acceptable commercial product. Include data with submittal for approval for piping material.
- E. Gaskets shall be 1/16" thick non-metallic type conforming to ANSI B16.21 and shall be suitable for the pressure and temperature of the fluid contained therein, shall be provided at all flange joints. Full-faced gaskets shall be used for flat face flanges; ring gaskets shall be used for raised face flanges.

#### 20 10 36 CAST IRON PIPE AND FITTINGS

- A. Joints for hub and spigot and no-hub cast iron soil pipe and fittings shall be installed in accordance with recommendations of the CISPI, unless noted otherwise.
- B. Do not use joint material which has deteriorated or which does not spread easily or smoothly.
- C. No-hub couplings shall be NSF Listed and conform to the requirements of CISPI 310, ASTM C1277, FM1680, IAPMO 35-89 and gaskets shall comply with ASTM C564.
  - 1. Band, screw housing, screw, and shield shall all be stainless steel.
  - 2. 1-1/2" through 4" couplings shall have a minimum of two clamps. 5" through 10" couplings shall have a minimum of four clamps. 12" through 15" coupling shall have a minimum of six clamps.

3. Extra Heavy duty couplings (80 in./lbs) shall be ASTM C1540 with shield thickness 0.015" or greater: Anaco/Husky SD-4000 or Clamp-All Hi-Torq 125.

#### 20 10 37 MECHANICAL JOINTS

- A. Mechanical joints and joining material shall meet the requirements of ANSI/AWWA C111/A21.11.
- B. Clean bell and plain end, and lubricate gasket as recommended by manufacturer. The joint area must be free of dirt.
- C. All bolts and tie rods shall be galvanized. Tighten bolt to 75-90 ft.-lbs. torque alternating from top to bottom maintaining equal distance between face and gland during tightening.
- D. Where flanged joints are used to interface with equipment or other piping materials they shall be flanged joints in accordance with ANSI B16.1. The gaskets shall be full forced, made of rubber and shall meet the requirements of ANSI B16.21.
- E. Joints shall be restrained with EBBA Megalug, Romac Industries Romagrip, or approved equivalent. Thrust blocks or other restrains are not acceptable.

#### 20 10 38 PLASTIC

- A. Solvent cement: Joints in PVC piping shall be made in accordance with manufacturer's guidelines and instructions for CPVC handling, joint preparation, type of primer and solvent/cement, curing time, temperature and testing.
  1. PVC pressure piping and DWV - solvent cement shall conform to ASTM D-2564 and primer shall conform to ASTM F-656.
  2. CPVC pressure piping - solvent cement shall conform to ASTM F-493.
  3. SDR sewer pipe - ASTM D-2855.
- B. Fusion welded: Joints for welding in polypropylene piping shall be made in accordance with the manufacturer's instructions.
- C. Gasket: Elastomeric seals (gaskets) for joining plastic piping shall conform to the following:
  1. PVC water distribution piping - AWWA C-900, ASTM D-2774 and ASTM D-3139.
  2. SDR sewer piping - ASTM D-2321 and ASTM D-3034.

#### 20 10 39 POLYETHYLENE

- A. Fusion welded: Joints for welding in polypropylene piping shall be made in accordance with the manufacturer's instructions, by a certified contractor.
- B. No person may make a joint in a plastic pipe unless that person has been qualified. Qualifications shall be in accordance with Section 6(H) of the MPSC 4CSR240-40.030 Pipeline Safety Regulations and the Manufacturers Qualification Procedure.

#### **20 10 40 HANGERS, SHIELDS, SUPPORTS AND ANCHORS**

- A. General:
  1. All hanger devices (e.g. - concrete inserts, expansion anchors, clamps, pipe hangers, strut, etc.) shall be UL approved for the intended service. Material shall be applied within the load

limitations prescribed by the respective manufacturer. Loads transmitted to the building shall be within the limitations of the structure.

2. Acceptable manufacturers of hanger material are Anvil International, B-Line Systems, Inc., Tolco, PHD Manufacturing, ERICO/Michigan Hanger Co., National Pipe Hanger Corp.
3. This section shall not apply to Division 21 Fire Protection.

#### 20 10 41 HANGERS

- A. Piping shall be supported from the building structure, walls, and floors. Piping shall not be supported from other piping, ductwork, conduits, etc. Loads shall be within the allowable load of building component that is connected to. Piping loads shall include, but not limited to, the weight of the piping, valves, specialties, insulation, pipe covering, pipe content, pressure test media content, wind, snow, seismic, etc.
- B. Where piping is indicated on common trapeze hangers, racks, stanchions or brackets, the various trade contractors involved shall agree to a mutually acceptable arrangement among themselves, but each shall be responsible for the correctness and compliance of their work.
- C. Pipe hangers, supports, etc. for "cold" piping systems shall have hangers sized for the outside diameter of the insulation in order to maintain a continuous vapor barrier.
- D. Pipe hangers for all "ambient" and "hot" piping systems shall be the same size as the pipe, except at roller hangers or supports where the treatment shall be the same as for "cold" piping systems.
- E. Hangers, and other supports, anchors, guides, etc. in direct contact with copper piping material shall be copper plated. All others shall be electro-plated for indoor use.
- F. The use of pipe hooks, chain, perforated band iron, wire, or cable are not permitted for hanging or supporting piping.
- G. Singular, horizontal, suspended piping above grade shall be hung with pipe hangers per the following schedule, unless noted otherwise:

| <u>pipe<br/>sizes</u> | <u>piping<br/>application</u>           | <u>Anvil International type and<br/>figure number</u> |
|-----------------------|-----------------------------------------|-------------------------------------------------------|
| 3" and smaller        | not subject to<br>expansion/contraction | adjustable ring, #69                                  |
| 4" and larger         | not subject to<br>expansion/contraction | adjustable clevis, #260                               |
| 2-1/2" and<br>larger  | systems with pipe guides<br>and anchors | adjustable steel yoke, #181 (2)                       |
| 4" and smaller        | copper pipe/tubing                      | adjustable ring, #CT-99                               |
| 5" and larger         | copper pipe                             | adjustable clevis, #260 (1)                           |
| all                   | vertical risers                         | riser clamps                                          |
|                       | steel                                   | #261                                                  |
|                       | copper                                  | #CT-121                                               |

1. hanger to be sized for outside diameter of insulation and to be used with insulation protection shield, figure 167.

2. hanger to be sized for outside diameter of insulation and to be used with insulation protection saddle, figure #160 through figure #165.
- H. Hangers, supports, etc. shall position the piping properly in the work, and provide for expansion and contraction.
- I. Vertical piping shall be supported at each floor level with riser clamps bearing on the building structure or pipe sleeve.
- J. Pipe stands shall be field fabricated to meet the anticipated loads. The base plate shall be spaced 1" minimum above the finished floor with concrete or grout.
- K. Wall brackets shall be field fabricated to meet the anticipated loads. The minimum brace angle shall be 45° from the horizontal.

#### 20 10 42 HANGER RODS AND HANGER SPACING

- A. Where "All-thread" rod is used it shall be galvanized, cadmium or zinc electro-plated. Where plain rod is used the threads shall be a minimum of 2" in length on each end.
- B. Hangers and hanger rod spacing for metallic piping shall be provided and installed in accordance with the Building Codes or the following schedule, whichever is more stringent:

| <u>pipe size</u> | <u>rod diameter</u> | <u>max. hanger spacing</u> |
|------------------|---------------------|----------------------------|
| 1-1/4" & smaller | 3/8" diameter       | 8' on centers              |
| 1-1/2" & 2"      | 3/8" "              | 10' oc                     |
| 2-1/2" & 3"      | 1/2" "              | 10' oc                     |
| 4" & 5"          | 5/8" "              | 12' oc*                    |
| 6" & 8"          | 3/4" "              | 12' oc*                    |

\* cast iron pipe shall have a maximum spacing of 10' oc center with the hangers located near the joint.

- C. Hangers for non-metallic piping shall be spaced in accordance with the Building Codes or the following schedule, whichever is more stringent:

| <u>pipe size</u> | <u>rod diameter</u> | <u>max. hanger spacing</u> |
|------------------|---------------------|----------------------------|
| 1" & smaller     | 3/8" diameter       | 4' oc                      |
| 1-1/4" - 2"      | 3/8" "              | 5' oc                      |
| 3"               | 1/2" "              | 6' oc                      |
| 4"               | 5/8" "              | 7' oc                      |
| 6" & larger      | 3/4" "              | 8' oc                      |

#### 20 10 43 ANCHORING

- A. Anchors for piping, ductwork, or equipment in new concrete construction may be suspended at the Contractor's option, or as shown on the plans, from inserts placed in the concrete as it is poured-in-place. Mechanical equipment rooms shall have inserts placed at a maximum of 4 ft. centers.

| <u>hanger rod size</u> | <u>Grinnell insert figure number</u> |
|------------------------|--------------------------------------|
| 7/8" or smaller        | single - CB universal, figure #282   |

7/8" or smaller multiple - 1-5/8" x 1" continuous strut, #PS 449

- B. Anchors for piping, ductwork, or equipment in new concrete construction, or new precast construction shall be suspended from epoxy resin set anchors, installed per the manufacturer's recommendations set into holes drilled into the concrete. Anchors shall be UL and/or FM approved, and applied within the allowable working load ratings for the respective size.

Cataloged load values shall be derated by one third for seismic allowances. Minimum embedment depth shall be 2/3 of concrete thickness. Field pullout test shall be performed when requested by the Engineer. Anchors shall be Hilti type HVA.

- C. Anchors for piping, ductwork, or equipment in steel structured buildings shall be attached to the steel by bolting directly through the void in the bar joist chord or by using the appropriate cataloged type C-clamp or beam clamp. The roof deck shall not be used for supporting the piping or ductwork.
- D. Welded attachments to the structural steel of the building are not permitted unless otherwise noted on the Construction Documents or where approved by the Architect/Engineer on specific request of the Contractor.
- E. Anchors for piping, ductwork or equipment in "flexicore" precast construction shall be suspended from inserts placed as the panels/planks are set in place. Where attachment to the "flexicore" is needed where the continuous strut is not available then, specifically designed "toggle bolt" anchors with oversized washers may be used provided that they are placed in the center of the hollow cores located 8" on center within the planks.
 

|                 |                                                              |
|-----------------|--------------------------------------------------------------|
| hanger rod size | Grinnell insert figure number                                |
| 7/8" or smaller | multiple - 1-5/8" x 1" continuous galvanized strut, #PS 400S |
- F. Power driven inserts and attachments are not permitted unless approved by the Architect/Engineer on express request by the Contractor.
- G. In all cases, anchor loading shall be based on hanger spacing, weight of the pipe to be supported when full and insulated, weight of any additional loads imposed upon the anchor, wind loading, seismic loading, quality of the material that the anchor is being installed in, etc. The Contractor shall verify in the field that the anchors used and the materials that they are being installed in are suitable for the load imposed and shall bring any problems to the attention of the Owner's Representative in writing immediately.

#### 20 10 44 SEISMIC RESTRAINT

- A. All materials and workmanship shall specifically comply with the above listed Building Code with respect to seismic requirements for the support and anchorage of all mechanical systems and equipment as installed on this project. Lateral forces to be restrained shall be as required by ASCE 7 Section 11 and 13 Architectural, Mechanical, and Electrical Components and Systems. Refer to structural drawings and/or Geotechnical Report for design values.

|                           |                                                      |
|---------------------------|------------------------------------------------------|
| - Seismic Use Group       | III                                                  |
| - Seismic Design Category | D                                                    |
| - Spectral Acceleration,  | Refer to ASCE or Building Code, Maps or online tools |
| Short period ( $S_{DS}$ ) |                                                      |

- B. All piping support and restraint details and practices shall conform to the publication "Seismic Restraint Manual Guidelines for Mechanical Systems" by SMACNA, 2008 Edition, and/or "Seismic Restraints" by B-Line systems, Inc.
- C. DELEGATED DESIGN: Design hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, herein referred to as Seismic engineer. Prepare drawings, calculations and details for any anchorage, bracing and/or sway bracing for seismic restraint as required by the local codes and Authority Having Jurisdiction.

Seismic engineer shall inspect the final installation for compliance with the approved Seismic shop drawings. Seismic engineer to identify items that need to be corrected or changed and provide contractor additional/revised drawings as required.

**D. SUBMITTALS:**

1. SHOP DRAWINGS: Submit drawings, calculations and details shall be signed and sealed by a Professional Engineer licensed in the State of the Project's location.
2. CLOSEOUT: As-built seismic drawings with Letter from Seismic engineer stating that the completed installation meets the design.

**E. INSTALLATION:** Contractor shall only use those materials submitted and approved. Contractor shall notify Seismic Engineer when actual installation differs from the approved Seismic shop drawing.

## **20 10 50 BASIC MECHANICAL METHODS - GENERAL**

### 20 10 51 INTENT OF PROJECT DOCUMENTS

- A. Install the Work in accordance with the Project Documentation and considerations enumerated in Subsection 20 00 01, GENERAL (Project Documents).

### 20 10 52 ARRANGEMENT OF WORK

- A. All Work shall be arranged so that hangers and supports for the mechanical equipment and materials shall be within the load limitations of the structure and the respective hanger and/or support.
- B. Contractor shall not scale from drawings to determine the exact locations for devices, piping, ductwork, etc., but shall follow the architectural drawings, the structural drawings and the actual building conditions, in establishing dimensions and lines of run. The work shall be adjusted to accommodate interferences anticipated and encountered. The Contractor shall verify the exact material quantities and lengths required.
- C. Piping that is required to pitch shall have priority over piping that does not pitch. Work which cannot be changed in elevation shall have priority over that which can be moved. Offsets, transitions and changes in direction shall be made in piping and ductwork to maintain headroom and pitch whether or not indicated on the Plans. The Contractor shall provide air vents, traps, dirt legs, drains, lifts, sanitary vents, mechanical vent lines, etc. as required to install the mechanical systems for proper operation and maintenance.
- D. Do not install work in the immediate proximity of electrical components (e.g. - panels, switches, controls, boxes, etc.) in equipment rooms. Drip pans above and/or around electrical equipment are not permitted.
- E. Aluminum and copper products shall not be encased in concrete.
- F. Work in "finished spaces" shall be concealed within walls, chases or above the ceiling unless specifically indicated otherwise. Install the Work to coordinate with other trades and to conform to the architectural reflected ceiling plan.
- G. The work shall be installed parallel with the building lines unless specifically shown or noted otherwise.

#### 20 10 53 COORDINATION

- A. **Each Contractor shall prepare and submit coordination drawings (at a scale equal to or larger than the project documents) to the Architect/Engineer for review prior to any fabrication or installation.**
- B. It shall be the Contractor's responsibility to coordinate their work with the work of other trades, and with the architectural and structural drawings. Where physical interferences cannot be resolved between the trades, or when encountered in the field, the Contractor shall prepare composite drawings at a scale of not less than  $3/8" = 1'-0"$  clearly showing the Work of Divisions 20 - 29 in relation to the Work of others to identify the conflict. Submit a proposed resolution to the Architect/Engineer for approval in accordance with Sub-sections 20 00 01, GENERAL (Project Documents) and 20 10 06, SUBMITTALS.
1. Do not proceed with Work in question until the matter is mutually resolved among the involved parties, and adequate information has been submitted to the Architect/Engineer for review. No additional compensation shall be granted for modifications and execution of the resolution(s). Modifications are to be incorporated in the "as-built" drawings.
- C. Contractor shall review the Project Documents, site conditions, and the requirements of other disciplines, and shall report any discrepancies between them to the Architect/Engineer and obtain from him written permission for changes necessary in the Mechanical Work. Subsequent clarification(s) by the Architect/Engineer will not be a change in scope of the Work. The Contractor at no addition in the contract price shall perform any such modifications required.
- D. Contractor shall verify tie-in locations to verify sizes, direction of flow (via pressure or physical tracing, not labels), materials, elevations, etc. prior to commencing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.
- E. The drawings shall not be scaled; obtain detailed information, shop drawings, installation and maintenance bulletins, etc. to determine exact requirements and to satisfactorily achieve the intent of the Project Documents.
- F. The Contractor shall furnish and properly install all sleeves, slots, chases, openings, recesses, supports, anchors and anchor bolts required for his Work in coordination with the other trades as the building is erected.
- G. The expenses for changes required by neglect in executing, coordinating or scheduling the Work properly or avoiding conflicts shall be borne by the Contractor precipitating the issue requiring the changes.

#### 20 10 54 DELIVERY, STORAGE AND HANDLING

- A. Delivery, storage and handling of equipment and material are the Contractor's responsibilities. The Contractor shall perform the Work in accordance with the following criteria:
1. Delivery shall be arranged by the Contractor (including Owner furnished items) for the expeditious and economical pursuit of the Work and to meet the scheduling requirements of the Contract.
2. The Contractor will be assigned a "lay-down" area at the job site and shall confine temporary storage to this area.
3. The Contractor may take delivery of equipment and material at his "shop" or an off-site location as suits the performance and schedule of the Work.



4. Regardless of where and how equipment and material are temporarily stored prior to installation, or if installed at the job site prior to acceptance, the Contractor is responsible for the following:
  - a. All equipment and material shall be accessible to the Architect/Engineer for inspection.
  - b. All equipment and material shall be protected adequately and properly from the weather, dirt and water, chemical, mechanical or comprehensive damages.
  - c. The Contractor shall be liable for the repair and/or replacement (including labor) of any equipment and material lost, damaged or defective prior to acceptance.
5. The Contractor shall arrange all labor, tools, services and scheduling to perform the handling of equipment and material for his Work.

#### 20 10 55 GENERAL CLEANING

- A. Each Contractor and Subcontractor shall be responsible for progress and final clean-up of his respective Work in accordance with the Contract Documents, requisite ordinances and regulations. Clean-up and legal disposal of debris from the Work, excess refuse and presence at the job site shall be performed in a timely and satisfactory manner. If not, the Contractor shall be notified of the unsatisfactory condition. If the matter persists, the Contractor will be back charged for the clean-up performed by others.
- B. Clean exposed exteriors and limited access interior surfaces of all equipment, piping and ductwork of foreign matter to provide an "as new" condition.

#### 20 10 56 CLEANING OF PIPING SYSTEMS

- A. The Contractor shall clean the respective piping system(s) that are included in his scope of work. All systems shall be flushed with water or air (depending on ultimate use) to relieve any congestion and internally cleanse the respective piping system. The Contractor shall provide all flushing media in sufficient quantity, inlet connections, discharge or drainage outlets and any temporary provisions to protect components, or remove it, to facilitate the flushing. Clean and replace all strainer screens and filters. Flush clean and drain all low points in the piping.
- B. Owner's representative shall be present for flushing, cleaning, and rinsing. Water treatment representative must check water after rinsing to insure all chemical cleaner has been removed and the Alkalinity of the rinse water is equal to that of the make-up water.
- C. All pipe systems for hydronic applications shall be flushed continuously with 100% city water make-up until the water runs clean from all drain locations. Each piping system shall be subsequently cleaned with recommended dosage of an approved pre-cleaning chemical designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials for a minimum period of twenty-four (24) hours then drained, refilled, and rinsed clean. Flushing before and rinsing after cleaning shall be supplying constant make-up water while draining at all system low points and drains.
- D. Condenser/tower water piping shall be flushed continuously with a surfactant cleaning chemical designed to remove deposition such as pipe dope and oils. This chemical shall not be alkaline or aggressive to the system metallurgy. Recommended dosages of a surfactant chemical product shall be added and circulated throughout the water system for a minimum period of twenty-four (24) hours then drained, refilled and rinsed clean.
- E. New or repaired potable water systems shall be purged of deleterious matter and disinfected prior to utilization. The method to be followed shall be that prescribed by the health authority having jurisdiction or, in the absence of a prescribed method, the procedure described in either AWWA C651 or AWWA C652, or as described in this section. This requirement shall apply to "on-site" or "in-plant" fabrication of a system or to a modular portion of a system.

1. The pipe system shall be flushed with clean, potable water until dirty water does not appear at the points of outlet.
2. The system or part thereof shall be filled with a water/chlorine solution containing at least 50 parts per million (50 mg/L) of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing at least 200 parts per million (200 mg/L) of chlorine and allowed to stand for 3 hours.
3. Following the required standing time, the system shall be flushed with clean potable water until the chlorine is purged from the system.
4. The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.
5. Water quality acceptance test(s) required shall include: Total Coliform, e-coli, pH, Alkalinity, Turbidity. Test potable water from nearby source as a reference sample.

#### 20 10 57 PRESSURE TESTING

- A. The Contractor shall submit a schedule at the beginning of the Work of the piping systems that are to be pressure tested, and indicate whether tests will be for an entire or partial system. Entire piping systems shall be pressure tested at one time unless it is not possible or practical.
- B. All piping to be insulated or concealed shall be pressure tested prior to the application of the insulation or concealment.
- C. A representative of the Architect/Engineer shall witness all pressure testing. The Contractor shall notify the Architect/Engineer at least three (3) days prior to the test date.
- D. Each piping system shall be tested per the method, test pressure, and test duration as specified in the Piping Material Schedules.
- E. The Contractor shall provide all test media, measuring devices, inlet connections, test measurement connections, and disposal of test media. The Contractor shall protect, isolate and/or remove piping system components that can not be subjected to test pressures.
- F. Hammer each joint in welded or soldered piping while under test. Leaks shall be repaired and the test(s) repeated until the respective piping system is tight.

#### 20 10 58 LEAK TESTING OF REFRIGERANT PIPING

- A. After the refrigerant piping connections have all been made, the entire refrigerant system shall be put under pressure and tested for leaks using dry nitrogen to develop the test pressure and the refrigerant charge as the tracer gas for leak testing.
  - B. A pressure regulator and a relief valve set at the test pressure (see Pipe Material Schedules) shall be used in the nitrogen test hookup.
  - C. The nitrogen shall be admitted to the system through the gage port on one of the refrigerant valves. All valves in the system shall be back seated so that holding charge refrigerant gas and nitrogen can diffuse throughout the piping.
  - D. If any leaks are discovered, the joint shall be broken and re-soldered. If possible, the section of piping containing the leaking joint should be isolated from the rest of the system. Dry nitrogen shall be passed through the joint being remade to prevent the formation of copper oxide.
1. Occasionally, a joint may be suspected of leaking, but the leak is so small that it is difficult to get a positive indication with the halide detector. When this happens, completely enclose

the joint with a small plastic bag. Tape the open ends of the bag securely to the piping to insure a gas tight seal. Leave the bag in place for several hours.

2. To test a leak, make a small hole in the bag at the lowest point and insert the exploring tube of your halide detector. Make another hole at the top of the bag to admit air. If the joint does have a slow leak, enough refrigerant gas will collect in the bag to give a positive indication.

#### **20 10 59 CHARGING REFRIGERATION SYSTEMS**

- A. Evacuation and Dehydration. The Contractor shall evacuate and dehydrate the refrigerant system to remove any air and moisture from the system. The manufacturer's literature shall be referred to for the evacuation procedure for each system installed.
  1. A vacuum pump capable of producing a vacuum of 1-mm Hg absolute is necessary for field evacuating. A single-stage pump having a free air displacement of 100 liters, or about 3 cubic feet/minute, is suitable. An accurate manometer type high vacuum gage, such as a Stokes or a Zimmerli gage, is also necessary.
  2. The vacuum pump shall be connected to the gage port of the suction line shutoff valve, so that moisture in the new refrigerant lines will not be drawn through the compressor when the system is evacuated. The vacuum gage shall be connected to the gage port of the liquid line shutoff valve. The pump shall be operated until the gage indicated a vacuum of 2.5 mm Hg or less.
  3. When the vacuum is sufficient, the refrigerant valves shall be back seated while the vacuum pump is running. The pump is then stopped. The system shall be allowed to stand under vacuum for at least 12 hours to allow all moisture to vaporize and to see if there is any in-leakage of air.
  4. After 12 hours, the Contractor shall break the vacuum with oil-pumped dry nitrogen or gaseous refrigerant and re-evacuate the system to 2.5 mm HG to further reduce the residual air and moisture to prevent compressor damage.
  5. The system can now be charged if the pressure has not risen noticeably.
- B. Charging. The Contractor shall determine the weight of a full charge of refrigerant and oil for the equipment plus refrigerant charge based on the length of refrigerant piping between the condensers and air conditioning units and in accordance with the unit manufacturer's literature.

The following charging procedure shall be used:

  1. The Contractor shall follow the manufacturer's installation instructions and/or industry standards in charging and start-up of equipment.

#### **20 10 60 BASIC MECHANICAL METHODS - INSTALLATION**

##### **20 10 61 GENERAL**

- A. The Contractor shall install all equipment and material as specified in the Project Documents. The Contractor shall review the installation requirements, and provide all of the appurtenances and accessories required for complete systems and a functioning installation. The Contractor shall be prepared to submit installation details and procedures where specified or requested for approval by the Architect/Engineer.
- B. The Contractor shall follow the manufacturer's instructions for the handling, temporary storage, protection and installation of the respective equipment and material. The Contractor shall promptly notify the Architect/Engineer in writing of any discrepancy or conflict between the Project Documents and the manufacturer's instructions, and request clarification. Unless there is a specific change in the scope of work, no additional compensation shall be granted for modification(s) and execution of the clarification.

- C. Work performed that does not comply with the manufacturer's instructions, any approval or instructions from the Architect/Engineer, or that causes a significant and/or unapproved deviation from the intent of the Project Documents shall not be grounds for additional compensation for costs to modify the Work in a manner directed by and to the satisfaction of the Architect/Engineer.
- D. All Work shall be installed to permit access and/or removal of components (e.g. - coils, fan wheels and shafts, filters, guards, bearings, motors, mechanical drives, etc.) that require periodic maintenance, servicing, repair and/or replacement. Equipment, piping, ductwork, conduit and raceways shall be arranged to permit access to valves, motors, motor and temperature controls, and to clear the opening of doors and access panels.
- E. Welded attachments to the building structure are not permitted.

#### 20 10 62 PIPING

- A. All piping shall be properly installed and supported with adequate provisions for clearance from other work, for expansion, contraction, slope, anchorage and prevention of transmission of vibration.
- B. Piping shall be generally installed parallel to building lines in the most expeditious and economical manner and to facilitate servicing. Piping shall be positioned and installed to provide noiseless circulation, and pitched to provide drainage and avoid air pockets. Valves and specialties shall be located to provide proper function and be readily accessible for servicing and maintenance.
- C. All piping connecting to equipment shall be installed without springing and any strain at final connections. The Contractor may be requested to disconnect piping to demonstrate that the piping has been so installed.
- D. Steel piping connections to equipment with rotating or reciprocating components shall be provided with a minimum of two grooved clamp type couplings per piping connection, which shall be Victaulic Style 77 couplings or equivalent. Copper piping connections to equipment with rotating or reciprocating components shall be provided with Mason Industries SafetyFlex model SFDEJ flexible joint. Air handling units with internal fan isolation are not included in the above.
- E. Changes in direction in the piping shall be made with manufactured fittings only. All elbows shall be long radius (1.5 x diameter) unless specifically noted otherwise. Bending may be permitted on submittal for approval of a satisfactory procedure to the Architect/Engineer for approval. Bending is to be accomplished with hydraulic type equipment producing no malformations in the piping.
- F. Full size branch connections and branch connections one size smaller in steel piping shall be made with manufactured fittings only. Branch connections two sizes and smaller than the main run may, in special cases with the Engineer's written permission, be made with manufactured fittings, weld-o-let or thread-o-let type fittings for welded piping construction, saddle type fittings for grooved piping construction or a pipe-to-pipe nozzle weld. Small branch connections for thermometers, pressure gauges, controls, etc. may be made with nozzle welded 3000# forged steel threaded couplings, thread-o-lets or saddle fittings. For insulated piping, provide branch connections with sufficient "neck" length to extend beyond the thickness of the insulation.
- G. Changes in direction in piping systems using hard temper copper tubing shall be made with manufactured and cataloged elbow fittings. Branch connections and reductions in all copper tubing systems shall be made with tee and reducer fittings. At the Contractor's option, utilizing a "Tee Turner" tool and corresponding procedure may provide branch connections. These joints shall be brazed and not soldered.

- H. Minimum slope for piping shall be provided in accordance with the following schedule, unless otherwise specified, noted or shown:

| Type of Piping<br>Fluid Conveyed | System<br>Component | Pitch     | Direction<br>of Fall |
|----------------------------------|---------------------|-----------|----------------------|
| Sewer, sanitary                  | main/branch         | 1/8"/Ft.  | w/flow               |
| Sewer, storm                     | main/branch         | 1"/40/Ft. | w/flow               |
| Chilled/heating water            | supply/return main  | 1"/40Ft.  | from vent            |
| Chilled/heating water            | runouts to risers   | 1/8"/Ft.  | back to mains        |
| Condensate drain                 |                     | 1"/20Ft.  | w/flow               |
| Refrigerant piping               |                     | 1"/20Ft.  | w/flow               |
| Domestic water                   |                     | 1"/40Ft.  | to drain             |

- I. All piping materials shall be physically cleaned internally and externally of mill scale, oxidation, grease, oil, dirt, mud, loose and foreign matter before fabrication and installation.
- J. All open ends of piping and equipment shall be closed during fabrication and installation to keep dirt and foreign matter out of the Work.

#### 20 10 63 VALVES

- A. Shut-off valves shall be provided at all inlet and outlet connections to equipment, at major branch connections to mains, where required for normal service, and where shown on the drawings, flow diagrams or details.
- B. Valves shall be the same size as the adjacent piping, except for control valves furnished in Division 25.
- C. Valves shall be accessible and free from interference when operated. Valves shall be installed with the stem on or above horizontal.
- D. Valves shall be packed and glands adjusted before final acceptance.
- E. Underground valves not installed in accessible manholes/vaults shall be provided with curb stop valve box.
1. Valve box shall be heavy duty cast iron, cast iron lid, 1.5 mills bituminous coated, two piece screw type, lettering matching the service of the valve (i.e. water, gas, etc.) , Equal to Tyler Union 29U 6850.
  2. Valve box shall be installed flush with final finished grade. Install with a 16" Sonotube around the valve box and the annular space filled with 3/4" clean rock up to 12" subgrade. Contractor shall ensure the valve box is plum and square as part of the installation. Owner's representative will witness valve operation and curb stop box installation for acceptance. Valve boxes that do not pass acceptance shall be corrected at the contractor's expense, until it does pass.

#### 20 10 64 EQUIPMENT

- A. The Contractor shall furnish and install the necessary frames, stands, brackets, stiff-legs, hangers, etc. to support or suspend the equipment and material that require this installation arrangement. The Contractor shall be responsible for the size, quantity, location and design of the supports and suspensions. The design shall permit no deflection of the support, the suspension arrangement or related building members, nor impart any vibration into the building structure. Loads transmitted to the building shall be within the limitations of and distributed satisfactorily to the structure. Designs for supports and suspensions shall be submitted for approval to the Architect/Engineer. Any attachment to the floor shall be provided with a

minimum of 1" thick concrete or grout between the base and the floor. All associated ferrous metal parts shall be painted or galvanized. Painting shall consist of one (1) coat of base primer on properly prepared surfaces and one (1) coat of rust inhibiting enamel, color selected by the Architect/Engineer.

- B. Each exposed mechanical drive and rotating shaft shall be provided with a protective guard. The guards may be provided with the respective equipment or may be field fabricated. The guard shall be constructed to comply with the appropriate safety requirements of the National Institute of Safety and Health and OSHA. Provide adequate and proper access for speed measurements for all rotating shafts. Guards shall not interfere with the lubrication of equipment nor restrict the airflow into fan inlets. The design for field fabricated guards shall be submitted for approval to the Architect/Engineer.
- C. All equipment, except pumps, having rotating or reciprocating components shall be provided with captive spring type vibration isolation mounts for seismic and restrained service. Mounts shall be selected at a maximum transmissibility of 0.03 (isolation efficiency of 97%) at the lowest anticipated operating speed of the equipment.
- D. Grease fittings for bearings shall be extended to accessible locations.
- E. Installation Instruction
  - 1. Equipment shall be set level, plumb, properly oriented, aligned and secured in the location shown on the drawings.
  - 2. Shims used for leveling shall be of size sufficient to cover the entire bearing surface except where shims are used to level preparatory to grouting. Shims used in conjunction with grouting shall be located to properly support equipment at load points to prevent any distortion.
  - 3. Assembly and installation of the equipment shall be in strict compliance with the equipment vendor's instructions.
  - 4. Where specified, equipment shall be assembled, installed, inspected and adjusted under the supervision of the Vendor's representative.
  - 5. Lugs, saddles, supports, covers or similar components which have been shipped separately or loose shall be located and attached by the Contractor by means of welds or bolting.
  - 6. Holes in structural steel required for installation of equipment shall be drilled as required.
  - 7. Contractor shall supply and install self-anchoring anchors.
  - 8. The Contractor shall grout under the equipment to effect a firm permanent setting as required.
  - 9. Upon completion of installation the Contractor shall remove all staging, blocking and construction debris from the equipment.
  - 10. The Contractor shall check all packaged or pre-assembled equipment to make sure that all packing shims and blocking is removed before rotating, running or testing the equipment.
- F. Equipment Alignment
  - 1. The Contractor shall do a cold final alignment of all rotating equipment shafts and coupling assemblies even when they were factory aligned. The reverse dial indicator method of alignment is preferred whenever possible. The following requirements apply to alignment:
    - a. Initial Alignment shall be checked with all piping larger than NPS 1" disconnected from the equipment. Maximum misalignment readings shall be 0.05-in. total indicator reading (TIR) on the rim and on the face of the coupling hub for all equipment unless otherwise noted in the Equipment Data Sheet instructions. Equipment shall rotate freely, all bolts shall be tight, all bearings and couplings shall be lubricated, and all safety guards shall be in place.

- b. Soft Foot. Equipment will be checked for “soft foot”. If the dial indicator indicates more than 0.05 in. (TIR) when any equipment to baseplate bolt is loosened, the equipment will be reshimed.
  - c. Final Alignment. The Architect/Engineer will witness the final alignment check on each piece of rotating equipment. Connecting pipe shall fit up to the equipment without the use of mechanical force. Connecting piping greater than NPS 1” will be bolted to the equipment one at a time, with the dial indicator attached. If the alignment changes by more than 0.05 inches (TIR), the piping will be revised until the alignment change is acceptable.
2. Shims used for aligning the equipment shall be stainless steel and shall be stamped with the shim thickness. The shim shall be large enough to cover the complete load bearing area and the total height shall be a maximum of 1/8 inch and shall be installed between the equipment's foot and the equipment's baseplate.

#### 20 10 65 MISCELLANEOUS

##### A. Sleeves, inserts, etc.

- 1. The Contractor shall furnish and properly install sleeves, inserts, supports, anchors and anchor bolts required for his Work. The size, quantity and location of chases, openings and recesses in the building structure shall be the responsibility of the Contractor performing the Work that requires these considerations. Patching of oversized openings and finishing thereof shall be the responsibility of the trade or Contractor requiring the opening. Material and labor for openings in new construction requiring structural framing including lintels and angles shall be furnished by the trade requiring the opening and installed by the General Contractor. Lintels shall be structural steel angles, channels, or tees of proper size and sections for the load supported.
- 2. Sleeves shall be provided for all penetrations through the building structure. Sleeves through floors shall extend 1” above the finished floor except where otherwise noted; sleeves through walls, partitions or structural members shall be flush with the exterior surface on both sides. Sleeves shall sized to include the pipe/duct insulation.
- 3. The space between the sleeve (or opening in the structure) and the pipe/duct or outside of the insulation of penetrations through fire rated components of the building shall be fire stopped, see Section 20 10 20 Miscellaneous Piping Materials. Penetrations through non-rated components of the building shall be draft stopped, see Section 20 10 20 Miscellaneous Piping Materials.

##### B. Unions and flanges:

- 1. A ground joint type union shall be provided in threaded and sweat joint piping, 2” and smaller pipe or tube size, down-stream of each branch shut-off valve, control valve and specialty item, the inlet and outlet connections of each piece of equipment, and where shown on the drawings.
- 2. Flanged connections shall be provided in piping 2-1/2” and larger at each manual valve, control valve, specialty item and the inlet and outlet of each piece of equipment.

##### C. Interconnections between dissimilar piping material systems shall be made with fittings manufactured for the specific application.

#### **20 10 70 BASIC MECHANICAL METHODS - RELATED WORK**

#### 20 10 71 CUTTING AND PATCHING

- A. The basic premise of this Sub-section in “new” construction, the premise is that the building component is already in place.

- B. The Contractor requiring the penetration of or the access way in the building structure to fulfill the intent of the Project Documents for his Work shall be responsible for the cutting and the subsequent patching in accordance with the following criteria:
  - 1. No structural component of the building shall be cut or violated without express approval of the Architect/Engineer.
  - 2. The Contractor shall verify the presence of any concealed utility or service within the structure (walls, roof, floor, etc.) in question, and shall be responsible for maintaining continuity and/or replacing it.
- C. Cutting of work-in-place in "new" construction because of error, neglect or damage inflicted shall be the responsibility of the Contractor precipitating the issue.
- D. "Patching" shall be construed as the repairing or replacing of the building structure to return it to an original or new condition, in the opinion of the Owner and/or Architect/Engineer, as existed prior to the cutting.
- E. Patching and finishing work shall be the responsibility of the Contractor requiring the cutting. The patching shall match all the substantive and visual aspects of the structure and adjacent surfaces. Restoration and finishes shall be as specified and executed in the respective sections, schedules and/or details of the Project Documents for the general construction work. Completed work and any special requirements shall be subject to approval by and satisfaction of the Architect/Engineer.

## 20 10 72 EXCAVATION, TRENCHING AND BACKFILLING

### A. General:

- 1. This sub-section shall supplement Section 31 00 00 – Earthwork for excavation, trenching, and backfilling required to install the work of Divisions 20 - 29.
- 2. In the event of a conflict between this sub-section and Section 31 00 00, the more stringent shall apply.

### B. Definitions:

- 1. Topsoil: shall be friable, free from clay lumps, grass, brush, roots, stumps, toxic substances, litter, gravel, stains greater than 1 ½" diameter, or other foreign material. Topsoil shall not contain plant parts of Nutsedge, Johnson Grass, Nimblewill, Bermuda Grass, Bindweed, or other noxious weeds. Topsoil shall have the following composition by percent volume: sand (9% - 30%), silt (30% - 70%), clay (10% - 27%), organic matter (1.5% minimum) with a P.H. between 5.5 and 7.0.
- 2. Unsuitable Soil Materials: are defined as those complying with ASTM D2487, soil classification groups GC, SC, ML, MH, CL, CH, O, OH, and PT.
- 3. Suitable Soil Materials: are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 2" diameter, debris, waste, frozen materials, vegetation and other deleterious matter.
- 4. Subsoil: Earth, clay, loose stone, hard pan, abandoned piping, concrete and masonry rubble, broken paving and other materials capable of being removed with standard power driven excavating equipment.
- 5. Rock: Solid, natural mineral material with a volume of over 1 cubic foot and other matter (e.g.- abandoned foundations, broken paving and rubble) that cannot be removed with standard 100 HP power driven excavating equipment without drilling.
- 6. Common Fill: Suitable soil as determined by geotechnical testing and/or as approved by the Architect/Engineer; free from wood, debris, organic matter or other deleterious materials.



7. Granular Fill: Naturally or artificially graded mixture of natural or crushed stone, and natural or crushed sand, ASTM D2940; except with 100 percent passing a 1" sieve and not more than 8 percent passing a No. 200 sieve.
  8. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse aggregate size 57; with 100 percent passing a 1 ½ sieve and 0 to 5 percent passing a No. 8 sieve.
  9. Flowable Fill: Lean concrete mixture with fine aggregate of sand and fly ash.
  10. Bedding: Natural or crushed sand.
- C. The Contractor shall include the following Work:
1. Contractor shall become familiar with location of underground utilities and structures which may be encountered or affected by Work.
  2. Locations of underground utilities and structures shown on Drawings are based upon available owner's records such underground facilities or by others, and were used by engineer to prepare Contract Documents, but are not guaranteed to be complete or correct, and are given only to assist in making determination of location of underground utilities and structures.
  3. Contractor shall contact the state's One Call System for public utilities and the Owner with 72 hours notice for all private underground utility locates.
  4. Where there are active utilities within 8 feet of excavation the Contractor shall locate utilities using a hydrovac. Where the excavation is parallel or near parallel with the active utility perform hydrovac location at 100 feet intervals.
  5. Excavate or trench "subsoil" material in accordance with the Project Documents to depths required for the installation of underground equipment and/or piping in his respective scope of work.
  6. Establish the location, routing, invert elevations, slope percentages, trench contours and perform the necessary surveying work for the excavation and trenching of his respective requirements.
  7. Be responsible of protecting excavations and trenching as necessary with shoring, bracing, sheathing, sheet piling, underpinning or other methods required to prevent cave-ins, damage to adjacent improvements and injury to personnel. The requirements of OSHA shall be met.
  8. Maintain the excavation and/or trenching during the progress of the Work to keep it free from water and to provide for the uninterrupted flow of surface water adjacent to and around the open ground.
  9. Provide "bedding" material for uniform support of the equipment/piping in the bottom of the excavation/trench to an elevation as hereinafter specified.
  10. Identification of underground utilities with marker tape, refer to Section 20 10 96
  11. Backfill and compact the excavation and trenching with "common fill", "granular fill", and "topsoil" in a manner hereinafter specified or as otherwise noted in the respective section of the Specifications of Divisions 20 - 29.
  12. Remove any existing and functioning surface improvements necessary to perform the excavation and/or trenching work, and replace to a condition equal to that prior to the removal, unless noted otherwise.
  13. Protect and maintain any existing or uncovered functioning piping and/or utility services in the excavation/trenching. Any damage caused by the activity of this Contractor shall be corrected or repaired at no additional compensation.
  14. Remove excess and/or "unsuitable soil materials" and backfill materials determined by the Architect/Engineer, and leave the site in a condition not imposing on subsequent work.
- D. Work Not Included:

1. The Contractor shall not be responsible for removal of material defined as "rock". In the event this requirement occurs, a change order shall be issued based on a unit price, if so requested in the proposal, or shall be negotiated. Payments for rock removal shall be limited to 8" below the invert elevation of the pipe and 18" wider than the pipe diameter.

E. Trenching, Bedding and Backfilling:

1. Trenching shall be open cut from the surface. The bottom of the trench shall be not less than 8" or more than 16" wider than the outside diameter of the pipe to be laid therein. The bottom elevation shall be clean of loose matter and shall provide for a bedding 4" deep below the piping (or conduit).
2. The "bedding" material shall extend the full width of the trench and to a height of 4" above the piping. The pipe and/or conduit shall be supported uniformly by the compacted bedding. Place and shape the bedding to support the piping over the entire length and to allow for making-up joints properly. Thoroughly compact (95% modified proctor) the bedding material along the sides of the piping for the full height of the bedding while maintaining the alignment of the pipe.
3. After pressure testing and acceptance of the underground installation by the Architect/Engineer, continue to backfill and compact (95% modified proctor) the trench as follows:
  - a. For piping inside the building backfill material shall be "granular fill" in layers of 6" and compact (95% modified proctor) between layers.
  - b. For piping under sidewalks, under parking lots, or under roadways backfill material shall be "granular fill" in layers of 6" and compact (95% modified proctor) between layers.
  - c. For piping outside the building and not listed above then the backfill material may be "common fill" or "granular fill" placed and compacted (95% modified proctor) from the aforementioned elevation to 12" below finish grade in layers not exceeding 8". The final 12" shall be backfilled with "topsoil".

F. Miscellaneous:

1. Trenching shall not interfere with normal 45 degree bearing splay of foundations.
2. Exterior trenches (to the building) for utility services and pipes containing water shall provide for a depth of burial of not less than (insert local frost depth) from the top of the pipe to finished grade, unless noted otherwise.
3. Provide adequately designed and sized concrete anchor/thrust blocks at all changes in direction and end points.
4. The underground piping shall be identified with marking tape laid in the trench in accordance with Subsection 20 00 19.

G. AS-BUILT Drawings:

1. Before backfilling is commenced, the Contractor shall measure and record vertical elevations and horizontal locations of all underground equipment and piping. This information shall be recorded on "record" drawings and submitted to the Architect/Engineer as part of the "As-Built" drawings for the Project, and shall be a requisite for final payment.

20 10 73 CONCRETE WORK (CAST-IN-PLACE)

A. General:

1. This sub-section shall supplement Section 03300 – Concrete Work for the concrete work required to install the work of Divisions 20 - 25.
2. In the event of a conflict between this sub-section and Section 03300, the more stringent shall apply.

B. The Contractor shall include the following Work:

1. Provide concrete foundations, bases and/or housekeeping pads for mechanical equipment furnished in his respective scope of work where such are not indicated on the architectural or structural drawings. Concrete work shall include requisite excavation, formwork, reinforcing and contained hardware.
2. Submit for approval to the Architect/Engineer detailed and dimensioned drawings of size, location, reinforcing and hardware contained therein of concrete work to be provided.

C. Housekeeping Pads:

1. All equipment setting on concrete or other type of pave flooring shall be set upon a raised "housekeeping" pad, unless noted otherwise.
2. The Contractor shall be responsible for this size, location, and any required anchor bolts. In general, housekeeping pads shall be a minimum of 3 ½" high, a ¾" chamfer on exposed corners and edges, and a minimum of 3" beyond the equipment on all sides or as required for anchor bolt edge distance.
3. Housekeeping pads shall be 3000 psi 28-day compressive strength concrete. Pads shall be reinforced and doweled to the floor slab. Refer to ASHRAE-A Practical Guide to Seismic Restraint 1999, Chapter 6 – Housekeeping Pads for size and spacing of reinforcing and dowels.
4. Specifically designed vibration isolation/inertia concrete bases for equipment will be specified and shown separately.

D. Thrust Blocks:

1. Thrust blocks shall be installed at all changes in direction and end points in unrestrained underground piping systems.
2. Thrust blocks shall only contact the backside of the fittings and shall not cover any joints. All thrust blocks will be inspected by the Owner's Representative prior to backfilling, provide a minimum of 3 days notice.

20 10 74 PAINTING

A. General:

1. This sub-section shall supplement Section 09900 – Painting for the painting work required for the work installed by Divisions 20 - 25.
2. In the event of a conflict between this sub-section and Section 09900, the more stringent shall apply.

B. Painting of the following shall be included in the scope of work of this sub-section:

1. All mechanical equipment including housings, fans, etc., not factory painted shall have prime coat and finish painting.
2. All plain steel hanger rods, plain steel pipe hangers, field fabricated or prefabricated steel supports and braces, and other ferrous metal. Prime coat only for all interior work, both exposed and concealed. Prime coat and finish painting of all exterior work.
3. Touch-up, as required, of factory finished equipment to original condition.
4. Interior surface of air ducts, cabinets, enclosures, covers and air dampers where visible from a finished space through grilles and louvers with one coat of flat black paint.
5. All above grade exterior uninsulated piping systems shall have a prime coat and finish painting.
6. All piping systems exposed in mechanical rooms, both insulated and uninsulated, shall have a color coded finish painting. Uninsulated piping shall receive a prime coat.

C. Painting of the following shall not be included in the scope of work of this Sub-section, unless noted otherwise:

1. Surfaces to receive special finishes specified elsewhere.
2. Building construction surfaces - floors, ceilings, interior and exterior walls, exposed concrete work, special finishes, etc.
3. All stainless steel, brass, copper, aluminum, plastic, electro-plated and galvanized surfaces.
4. Caulking, sealers, fire stops, etc.
5. Valves, controls, specialties.
6. Nameplates of equipment. Replace nameplate if painted.
7. .Light fixtures.
8. Equipment (mechanical and electrical) which has been finished in a factory.
9. Black steel surfaces over 250 degrees F. (e.g. - breechings, kitchen hood exhaust ducts, etc.).

D. General Requirements:

1. The Contractor shall provide all labor, coating materials, accessory materials (e.g.- turpentine, painting thinners, etc.), tools and services necessary and reasonably incidental to the scope of work of Sub-section 20 10 75.
2. .Coatings shall be factory prepared and mixed; ready for application upon delivery; have good flow and brushing properties and be capable of drying and curing free of streaks or sags.
3. Materials for each application shall be compatible with one another and with other specified materials with which contact may be made.
4. Products shall meet the following UL fire hazard classifications when tested in accordance with ASTM E84: Flame spread, 0; Fuel contributed, 5; Smoke developed, 15.
5. Coatings shall be applied in accordance with the paint manufacturer's recommendations with the surfaces well illuminated. In general, coatings shall not be applied when the relative humidity is above 60% nor the ambient temperature below 45 degrees F.
6. The Architect/Engineer shall make color selections, when required.

E. Acceptable Manufacturers

1. Benjamin Moore & Co.
2. Porter International
3. Pratt & Lambert, Inc.
4. Sherwin Williams Co.
5. Glidden
6. Pittsburgh

F. The Contractor shall submit the following to the Architect/Engineer for review and approval:

1. Statement of qualification that the company specializes in commercial painting and finishing with a minimum of five (5) years experience.
2. Product data describing the following:
  - a. Instructions for substrate preparation including priming.
  - b. Instructions for product preparation, application procedures, clean-up and maintenance.

- c. Recommended ambient temperature and relative humidity range, substrate temperature, moisture content and alkalinity at the time of application.
    - d. Manufacturer's list of trademarked products for each coat of each system. For each product, state vehicle type, percent solids by volume, method of application, drying time, recommended rate of coverage and dry film thickness for each coat. Coordinate with the Schedule in Sub-section in 20 10 75.84.
    - e. Advise any recommendations which differ from the specified or scheduled requirements.
  - 3. Material Safety Data Sheet (MSDS) for each coating and painting product, and maintain a file of it at the job site for reference and emergency use.
  - 4. Certificates and/or test reports demonstrating that the painting products specified meet regulatory requirements.
  - 5. Color charts and available sheens of finish, when required, for selection by the Architect/Engineer.
  - 6. Samples of painting products when requested for inspection by the Architect/Engineer.
- G. Painting:
- 1. The Contractor shall be responsible for delivery, handling and storage of all coating and painting materials for the pursuit of his work.
    - a. All painting products shall be delivered in sealed containers.
    - b. All painting product containers shall be labeled to show the manufacturer's name, type of coating, brand name, coverage, surface preparation, drying time, clean-up, color designation and instructions for mixing and reducing.
    - c. All painting products shall be handled and stored in accordance with the respective manufacturer's recommendations. In the absence of specific instructions, products shall stored in well-ventilated areas at a minimum ambient temperature of 45 degrees F. and a maximum temperature of 90 degrees F.
    - d. Precautions shall be exercised to prevent fire hazards and spontaneous combustion. Provide adequate type and quantity of fire extinguisher at the job site.
  - 2. The Contractor shall perform the following in preparation of the painting application:
    - a. Verify that surfaces and substrate conditions are ready to receive the application of coatings as specified or in accordance with manufacturer's recommendations. Commencement of application is acceptance of existing conditions.
    - b. Provide drop clothes and other protective measures to prevent coatings on other work not included in the scope of work of this sub-section.
    - c. Where required by Architect/Engineer, post "WET PAINT" signs.
    - d. Solvent or power tool clean surfaces, as required or as deemed appropriate, to remove grease, scale, dirt, rust, mill scale, weld splatter and burrs. Apply primer immediately after cleaning.
  - 3. Application:
    - a. Coating products shall be prepared and applied in accordance with the respective manufacturer's instructions and reviewed submittals. Dry mil thickness of each coat shall be as scheduled or as recommended by the manufacturer. Finish coat shall not be less than 5.0 mils in thickness, and sufficient to cover completely substrates and undercoats.
    - b. Where shop prime coat finishes are specified elsewhere, primer may be omitted, except as otherwise scheduled, specified or recommended by the coating manufacturer. Damaged shop prime coats shall be touched-up, using a primer compatible with or same as original primer.

- c. Each coat shall be applied to provide a uniform finish, without sags, laps, brush marks or other defects. Allow applied coat to dry before next coat is applied.
- 4. Schedule - Latex, General Painting Materials:
  - a. Steel - unprimed, located indoors or outdoors:
    - 1. One (1) coat lead and chromate free alkyd primer. Two (2) coats latex, semi-gloss.
  - b. Steel - shop primed, located indoors or outdoors:
    - Touch-up with lead and chromate free alkyd primer.
    - Two (2) coats latex, semi-gloss.
  - c. Insulation on mechanical equipment, located indoors:
    - One (1) coat latex primer sealer.
    - Two (2) coats latex, flat.
  - d. Schedule - Epoxy, General Painting Materials:

#### **20 10 75 LUBRICATION**

- A. Provide all oil and grease for the operation of all equipment until acceptance. The Mechanical Contractor and Subcontractors shall be held responsible for all damage to bearing while the equipment is being operated by them up to the date of acceptance of the equipment. Protect all bearings during installation and thoroughly grease steel shafts and other unpainted steel surfaces to prevent corrosion. All motors and other equipment shall be provided with covers as required for proper protection during construction. For equipment that is received void (dry) of lubrication the Contractor shall lubricate the equipment before storing to prevent internal damage to the equipment.

#### **20 10 76 DRAINING, FILLING AND VENTING SYSTEMS**

- A. The Contractor shall provide all required labor for draining, filling and venting of new systems as many times as required during construction.

#### **20 10 80 TESTING, ADJUSTING AND BALANCING**

##### **20 10 81 GENERAL**

- A. At the completion of the installation work, the Contractor shall execute tests and make adjustments to qualify and quantify that all mechanical systems and subsystems installed under this project function to their respective specified performance and the intent of the Project Documents. All systems shall be operated and tested systematically for capacity, calibration, balancing and sequence as close to design conditions as possible with maximum attainable internal load. Adjustment to system components shall be made including replacing motor drives, if necessary, to achieve specified performance.
- B. Work shall be conducted under the supervision of an individual certified by NEBB or AABC and trained technicians. All test results shall be documented per the previously approved procedure and transmitted to the Architect/Engineer for review as a requisite for final acceptance and payment. Final inspection shall follow completion and acceptance of the test results.
- C. The balancing contractor shall review plans and specifications for balancing dampers, balancing valves, gauge connections, airflow/pitot sections. The Contractor shall notify the Engineer if the Contractor cannot perform the Work because of inadequate provisions so that the inadequacy can be corrected by change order during project construction without any cost over and above the device itself. No excuses during the testing and balancing procedure will be accepted for Contractor's lack of performance, and the Contractor shall be responsible for the additional cost of adding the required device(s) into the completed systems.

- D. Employment of a Balancing Subcontractor by the Contractor shall not relieve him of obligations to perform Work in accordance with the Project Documents.

#### 20 10 82 REFERENCES

- A. National Standards for Total System Balance, by the Associated Air Balance Council (AABC), latest edition.
- B. Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems, by the National Environmental Balancing Bureau (NEBB), latest edition.
- C. 2019 Application Handbook, Chapter 39, Testing, Adjusting and Balancing by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

#### 20 10 83 WORK INCLUDED

- A. Testing and adjusting each air handling unit and relief fan to achieve the design airflow rates as scheduled.
- B. Testing and adjusting each VAV box to achieve design minimum and maximum airflows, water flows, and heating capacity as scheduled.
- C. Testing and adjusting each pump to achieve design water flow rate as scheduled.
- D. Testing and adjusting each coil to achieve design flow rate and capacity as scheduled.
- E. Testing and adjusting each unit heater and fan coil unit water flow rate and/or airflow rate to achieve design flows and capacities.
- F. Testing and adjusting each exhaust fan to achieve design airflow rate as scheduled.
- G. Testing and adjusting each air device to achieve design airflow rate as indicated on the plans.
- H. Provide sufficient labor and resources required to assist in the commissioning process, refer to commissioning specification section.
- I. Testing and adjusting the domestic cold and hot water system, including but not limited to, balance valves, expansion tanks, pressure regulator, etc.

#### 20 10 84 SUBMITTALS

- A. The Contractor shall submit to the Architect/Engineer for approval the following within thirty (30) days of his notice to proceed:
  - 1. Name and address of the proposed Balancing Contractor and their credentials.
  - 2. Name of the Mechanical Contractor's representative responsible for the balancing work.
  - 3. The Contractor shall certify that each system is installed in accordance with the Project Documents, is operable and is prepared for testing and balancing; and that products and systems meet or exceed specified requirements.
- B. The Contractor shall submit the following prior to commencing any testing, adjusting and balancing work:
  - 1. Name of Balancing Contractor's representative for coordination with the Mechanical Contractor.
  - 2. The Contractor shall certify that: all instruments, measuring devices, meters, etc. to be used for his Work have been calibrated to NIST standards including Mechanical Contractor

provided permanently installed and portable devices; that supervisor is certified by a recognized national organization; and that personnel are qualified technicians.

3. At least 60 days prior to the beginning of testing the work, the Contractor shall submit to the Architect/Engineer for approval:
  - a. Written proposed procedures of testing, adjusting, balancing and documentation including techniques, methods and responsibilities.
  - b. List of each instrument to be used and latest date and method of calibration to verify accuracy. If more than one (1) year old or accuracy is in question, instrument shall be recalibrated.
  - c. Sample forms for all pieces of equipment to be tested.

#### 20 10 85 RESPONSIBILITIES AND COORDINATION

- A. Work by Contractor, which installed the respective system to be tested, shall include the following:
  1. Schedule, coordinate and sequence the testing, adjusting and balancing of the respective systems. Prepare and distribute a schedule.
  2. Verify that the respective equipment, ductwork, piping and temperature control systems have been provided, each is operable and apparently functioning all in accordance with and to the intent of the Project Documents. In particular, the following shall be checked and noted as having been accomplished prior to the testing, adjusting and balancing:
    - Initial checkout and start-up of all equipment.
    - Pressure and leak testing, and cleaning of all systems.
    - Alignment and adjustment of motor drives, and lubrication of bearings.
    - All dampers, manual line valves, control valves and balancing valves are in the "open" position.
  3. Verify that all instruments, measuring devices, meters, immersion wells, taps, valves, specialties, dampers, measuring and sensing elements, access openings, etc. have been provided in correct quantities and locations to permit commencement of the testing, adjusting and balancing of the Work. Correct deficiencies and/or modify the Work, as required.
  4. Provide the Balancing Contractor with all pertinent shop drawings on equipment to be tested, adjusted and balanced.
  5. Provide the Balancing Contractor with a set of "as-built" drawings or the Mechanical Contractor's marked-up "record" set showing all changes to the mechanical systems.
- B. Work by Balancing Contractor shall include the following:
  1. Perform a total system balance in accordance with NEBB or AABC National Standards for Field Measurement and Instrumentation, Total System Balance.
  2. Direct measurement of temperatures, pressures, air and fluid quantitative flow rates and any other values necessary to establish the status of each system in comparison with the Project Documents.
  3. Adjust components and devices to achieve design operating conditions within acceptable tolerances for each system. Do not use shut-off devices for balancing unless indexed. Lock memory stops or mark set points of balancing devices. Replace all system components removed temporarily during the testing and balancing effort, set all temperature controls properly and generally leave the systems in working order and "as-new" condition.



4. Report to the Architect/Engineer any existing installed or operating condition that deviates from the design or intent of the Project Documents, and that the Balancing Subcontractor believes to be beyond the scope of his work.
5. Furnish fixed sheaves to the Owner, upon acceptance of the balancing report, for fans furnished with adjustable sheaves where the balancing contractor was able to make the required speed adjustments with the factory sheave.
6. Furnish and install fixed sheaves for fans furnished with adjustable sheaves where a speed change, beyond that obtainable with the adjustable sheave, is required to obtain design airflow. The system shall be proportionally balanced, then the required fan speed shall be calculated based upon the fan laws. Contractor shall also calculate the required brake horsepower at the design airflow, if this exceeds the nameplate horsepower the Architect/Engineer shall be notified.
7. Furnish and install fixed sheaves for fans furnished with fixed sheaves where a speed change is required to obtain design airflow. The system shall be proportionally balanced, then the required fan speed shall be calculated based upon the fan laws. Contractor shall also calculate the required brake horsepower at the design airflow, if this exceeds the nameplate horsepower the Architect/Engineer shall be notified.

#### 20 10 86 REPORTS

- A. Reports shall be submitted in 9" x 12" binder complete with cover identification, index page, and indexing tabs. Reports shall not contain footnotes explaining why the system was not balanced to the required performance.
- B. The form of the testing and the report shall be submitted and approved prior to testing work. Reports shall be submitted on pre-approved forms.
- C. Diagrams, as required, to clarify locations of measurements and/or reading shall be included in the report.
- D. Final acceptance and payment of the contract shall not be issued before final report is approved.
- E. Air handling unit forms shall contain the following minimum information:
  - Unit Name.
  - Make/Model.
  - Type/Size.
  - Serial Number.
  - Fan Arrangement/Class/Rotation
  - Discharge Location.
  - No. Belts/Make/Size.
  - Motor Make/Frame.
  - Motor Horsepower.
  - Motor Volts/Phase/Amps.
  - Motor Full Load Amps/S.F.
  - Design and Actual Supply CFM.
  - Design and Actual Total S.P.
  - Design and Actual Fan RPM.
  - Design and Actual Motor Volts (each phase).
  - Design and Actual Motor Amps (each phase).
  - Design and Actual Discharge S.P.
  - Design and Actual Suction S.P.
  - Design and Actual Pressure Drops Across Components.
  - Design and Actual Minimum Outside Air CFM.
  - Design and Actual Return Air CFM.
  - Coil Condition Wet/Dry.

Filter Condition Clean/Dirty.

Minimum Outside Air Damper Position (degrees 90° open; 0° closed)

Maximum Outside Air Damper Position (degrees 90° open; 0° closed)

Return Air Damper Position (degrees 90° open; 0° closed) for Positive Pressure on Upstream Side and Negative Pressure on Downstream Side

F. Terminal unit forms shall contain the following minimum information:

VAV Box No.

VAV Box Make/Size.

Room Number of Area(s) Served.

Design and Actual Maximum Cooling CFM.

Design and Actual Minimum Cooling CFM.

Design and Actual Minimum Heating CFM.

Minimum static pressure required at duct static pressure sensor to provide design CFM with box air valve fully open.

Flow Factor Variable for DDC Calibration

For Fan Powered Terminal Boxes:

Motor Horsepower.

Motor Volts/Phase/Amps.

Motor Full Load Amps/S.F.

Motor Speed H/M/L.

Filter Size and Quantity.

G. Air Outlet forms shall contain the following minimum information:

Area Served.

Grille Type.

Grille Size.

Design, Preliminary and Final CFM.

Damper Position (degrees 90° open - 0° closed).

H. Pump forms shall contain the following minimum information:

Pump No.

Service.

Make/Model.

Type/Size.

Serial Number.

Seal Type.

Design Impeller Size.

Required NPSH.

Motor Manufacturer/Frame Size.

Motor HP/RPM.

Volts/Phase/Amps.

Full Load Amps.S.F.

System Pressure (Pump off).

Shut-off Pressure.

Actual Impeller Size.

Design, Preliminary, and Final Flow.

Design, Preliminary, and Suction, Discharge, and Differential Pressure.

Design, Preliminary, and Voltage, each phase.

Design, Preliminary, and Amps, each phase.

I. Air handling unit coil forms shall contain the following minimum information:

System No.

Location.

Service (Preheat, Cooling, Reheat).

Coil Type.

No. Rows/Fins per inch.  
 Manufacturer.  
 Model No.  
 Face Area (Sq. Ft.).  
 Design and Actual Air Quantity.  
 Design and Actual Air Velocity.  
 Design and Actual Air Pressure Drop (in. w.c.).  
 Design and Actual Outside Air DB/WB.  
 Design and Actual Return Air DB/WB.  
 Design and Actual Entering Air DB/WB.  
 Design and Actual Leaving Air DB/WB.  
 Design and Actual Air  $\Delta T$ .  
 Design and Actual Water Flow.  
 Design and Actual Water Pressure Drop (ft.).  
 Design and Actual Entering Water Temperature.  
 Design and Actual Leaving Water Temperature.  
 Design and Actual Water  $\Delta T$ .  
 Design and Actual Inlet Steam Pressure.  
 Design and Actual Control Valve Pressure Drop.  
 Design and Actual Expansion Valve.  
 Design and Actual Refrigerant Suction Pressure.  
 Design and Actual Refrigerant Suction Temperature.

J. Exhaust, return/relief fan forms shall contain the following minimum information:

Unit Name.  
 Make/Model.  
 Type/Size.  
 Serial Number.  
 Fan Arrangement/Class/Rotation  
 Discharge Location.  
 Motor Make/Frame.  
 Motor Horsepower.  
 Motor Volts/Phase/Amps.  
 Motor Full Load Amps/S.F.  
 Design and Actual CFM.  
 Design and Actual Total S.P.  
 Design and Actual Fan RPM.  
 Design and Actual Motor Volts (each phase).  
 Design and Actual Motor Amps (each phase).  
 Design and Actual Discharge S.P.  
 Design and Actual Suction S.P.

K. Cooling Tower forms shall contain the following minimum information:

Unit Name.  
 Manufacturer.  
 Model Number.  
 Serial Number.  
 Capacity Rating.  
 No. of Fan Motors.  
 Motor Make/Frame.  
 Design and Actual Motor HP/RPM.  
 Design and Actual Motor Voltage (each phase).  
 Design and Actual Motor Amps (each phase).  
 Design and Actual Fan RPM/CFM.  
 Design and Actual Air Entering W.B.  
 Design and Actual Air Leaving W.B.

Design and Actual Water Entering/Leaving Water Pressure.  
Design and Actual Water  $\Delta P$ .  
Design and Actual Water Entering/Leaving Water Temperature.  
Design and Actual Water  $\Delta T$ .  
Design and Actual Water Flow Rate (gpm).

L. Heat Exchanger forms shall contain the following minimum information:

Unit Name.  
Service.  
Rating (Btu/hr).  
Circuiting.  
Manufacturer.  
Model Number.  
Serial Number.  
Design and Actual Steam Pressure.  
Design and Actual Flow Rate (#/hr).  
Primary Water Design and Actual Entering/Leaving Temperature.  
Primary Water Design and Actual  $\Delta T$ .  
Primary Water Design and Actual Air Entering/Leaving Pressure.  
Primary Water Design and Actual Water  $\Delta P$ .  
Primary Water Design and Actual Flow Rate (gpm).  
Secondary Water Design and Actual Water Entering/Leaving Temperature.  
Secondary Water Design and Actual Water  $\Delta T$ .  
Secondary Water Design and Actual Entering/Leaving Pressure.  
Secondary Water Design and Actual Water  $\Delta P$ .  
Secondary Water Design and Actual Flow Rate (gpm).  
Secondary Water Design and Actual Control Setpoint.

M. Chiller forms shall contain the following minimum information:

Unit Name.  
Manufacturer.  
Model Number.  
Serial Number.  
Capacity Rating.  
Refrigerant Type.  
Starter Type.  
Heater/Overload Settings.  
Evaporator Design and Actual Entering/Leaving Water Temperature  
Evaporator Design and Actual Water  $\Delta T$ .  
Evaporator Design and Actual Entering/Leaving Water Temperature.  
Evaporator Design and Actual Water  $\Delta P$ .  
Evaporator Design and Actual Water Flow Rate (gpm)  
Condenser Design and Actual Entering/Leaving Water Temperature  
Condenser Design and Actual Entering/Leaving Water Temperature.  
Condenser Design and Actual Water  $\Delta P$ .  
Condenser Design and Actual Water Flow Rate (gpm)  
Compressor Design and Actual Suction Pressure/Temperature.  
Compressor Design and Actual Discharge Pressure/Temperature.  
Compressor Design and Actual Oil Pressure/Temperature.  
Compressor Design and Actual Voltage (each phase).  
Compressor Design and Actual Amps (each phase).  
Compressor Design and Actual Kw.  
Compressor Design and Actual Chilled Water Setpoint.

N. Terminal Unit or VAV Coil forms shall contain the following minimum information:

Room No./VAV Box No.

Size.  
Design and Actual Air Flow Rate (CFM).  
Design and Actual Water Flow Rate (gpm).  
Design and Actual Entering Water Temperature (nominal).  
Design and Actual Entering Air Temperature.  
Design and Actual Leaving Air Temperature  
Design and Actual Capacity (Btu/hr).

O. Packaged Rooftop Unit forms shall contain the following information:

Unit Name.  
Make/Model.  
Type/Size.  
Serial Number.  
Output  
Motor Volts/Phase/Hertz  
Motor Horsepower  
Motor Full Load Amps/S.F.  
Motor Drive Data  
Design and Actual CFM.  
Design and Actual Supply CFM at Minimum Outside Air Setting.  
Design and Actual Return CFM at Minimum Outside Air Setting.  
Design and Actual Outside Air CFM at Minimum Setting.  
Design and Actual Supply CFM in Economizer Mode.  
Design and Actual Return CFM in Economizer Mode.  
Design and Actual Outside Air Setting in Economizer Mode.  
Design and Actual Entering and Leaving Air Temperature.  
Design and Actual CFM Air Temperature  $\Delta T$ .  
Design and Actual Entering and Leaving Air Pressure.  
Design and Actual Air Pressure  $\Delta P$ .  
Design and Actual Low Fire Input.  
Design and Actual High Fire Input.  
Design and Actual Manifold Pressure/CFH.  
Design and Actual High Limit Setting.  
Design and Actual Operating Setpoint.  
Coil Condition Wet/Dry.  
Filter Condition Clean/Dirty.

P. Boiler Water Heater Test forms shall contain the following information:

Unit Name.  
Make/Model.  
Serial Number.  
Location.  
Type/Size.  
Fuel/Input.  
Number of Passes.  
Ignition Type.  
Burner Control.  
Volts/Phase/Hertz.  
Design and Actual Operating Pressure and Temperature.  
Design and Actual Entering and Leaving Temperature.  
Design and Actual Number of Safety Valves/Size.  
Design and Actual Safety Valve Setting.  
Design and Actual High Limit Setting.  
Design and Actual Operating Control Setting.  
Design and Actual High Fire Setpoint.  
Design and Actual Low Fire Setpoint.

Design and Actual Voltage (T1-T2, T1-T3, T2-T3).  
Design and Actual Amperage (T1, T2, T3).  
Design and Actual Draft Fan/Volts/Amps.  
Design and Actual Manifold Pressure.  
Design and Actual Output-MBH.  
Design and Actual Safety Controls – Check.

## 20 10 87 PROCEDURES

- A. The procedures listed herein are presented to enhance the procedures of the referenced agencies and the lack of a procedure being presented herein does not relieve the Contractor from following the procedures of the referenced agencies.
- B. In general, balancing dampers shall not be used to adjust the cfm quantity of fans but rather only to adjust the proportion of the airflow within the system. The fan speed shall be adjusted, with all of the dampers open, to a cfm slightly greater than design cfm. Then the dampers shall be adjusted to move more air towards the end of the system. The balancing damper at the furthest points of the system should be nearly full open. If these furthest dampers are not open then the fan speed shall be reduced and the process repeated until a satisfactory result is achieved.
- C. Prior to testing and adjusting VAV boxes the Balancing Contractor shall verify that the controllers are functioning properly and with the proper sequence of operation. If any inadequacies are encountered they shall be reported for correction prior to testing and adjusting.
- D. Pitot tube traverses shall be taken at all branch ducts serving more than three (3) VAV boxes, more than six (6) air devices, or more than 10% of the system total airflow, and at all places indicated on the plans. The static pressure shall be recorded at each pitot tube traverse.
- E. VAV box airflow shall be measured by a pitot tube traverse in the inlet duct and measurement of the individual air device outlets, these measurements shall be used to calibrate the maximum and minimum airflows of the VAV box controller. The VAV box airflow measuring device shall not be used in the testing and balancing procedure for measuring air quantities.
- F. Systems with diversity shall be tested in accordance to a method agreed upon by Engineer and is to be established when the Contractor submits his procedures to the Engineer for approval. Typically this may be: to force the East zones to operate design capacity while west zones are left to operate at their given load; or that some air handling units would be forced to operate at design capacity while other units may be off or left to operate at their given load.
- G. Systems with air economizer cycles shall be adjusted to provide near linear flow as the amount of outdoor varies. Three (3) conditions to be tested are minimum outdoor air, 50% outdoor air, and 100% outdoor air. Record the values of total supply, return, relief, and building differential pressure at each of these conditions. Systems with return fans shall have the return damper adjusted to provide a change from positive to negative gauge pressure to provide a negative mixed air plenum pressure.
- H. When the Contractor has any questions regarding how the systems operate or cannot obtain design performance, they should contact the Engineer for clarifications or further instruction. The work shall not be considered complete until all systems and components achieve design performance unless the Engineer issues written direction otherwise.
- I. All systems shall be adjusted between 10% above the design value as a maximum, to the design value as a minimum.
- J. Domestic hot water recirculating system shall be adjusted to provide equal flow in each branch or as otherwise indicated on the drawings.

- K. Domestic hot water heating system shall be adjusted to the heater flow rate indicated on the drawings.

## **20 10 90 BASIC MECHANICAL METHODS - IDENTIFICATION**

### **20 10 91 GENERAL**

- A. This Sub-section specifies basic materials and methods for identification that shall apply to systems specified in other sections of Divisions 20 - 29 of the Specifications.
- B. The Contractor shall submit schedules and listings of Work to be identified indicating color code, material, name plate information and method of application for approval prior to performing the Work.

### **20 10 92 REFERENCES**

- A. All provisions and conditions cited in this Sub-section shall apply to Work of all other sections of Divisions 20 - 29 of these Specifications, where and when relevant.
- B. Applicable requirements of the current and accepted edition of the following codes and standards shall apply to the Work of this Sub-section:
  - 1. ANSI/ASME A 13.1 - "Scheme for the Identification of Piping Systems".

### **20 10 93 WORK INCLUDED**

- A. Each respective Contractor and Subcontractor shall identify the applicable components of his Work in accordance with specifications hereinafter enumerated or where required by other sections of Divisions 20 - 29 of the Specifications.
  - 1. All equipment items (i.e., chillers, air handling units, fans, pumps, boilers, etc.).
  - 2. All chilled water, condenser water, heating water, steam and condensate, plumbing, and fire protection valves.
  - 3. All piping systems identifying the system type and direction of flow.
  - 4. All underground utilities (i.e., chilled water, steam and condensate, condenser water, natural gas, etc.).
  - 5. All control devices and panels.

### **20 10 94 SUBMITTALS**

- A. Contractor shall submit shop drawings for approval in accordance with Section 20 00 43 submittals.
- B. Provide an Identification Product Schedule consisting of the following minimum information:
  - Material - type of identification product.
  - System - indicate which system or equipment materials will be used for.
  - Manufacturer - Manufacturer's name, product name and model numbers.
  - Accessories - Miscellaneous materials used in affixing identification.
- C. Provide manufacturer's technical product sheet and recommended installation instructions.
- D. Provide color list/schedule and lettering sizes for pipe markers, valve tags, and equipment nameplates.
- E. Provide a valve tag list for approval prior to ordering or making valve tags.

## 20 10 95 GENERAL METHODS FOR IDENTIFICATION

- A. All surfaces to receive identification nameplates or markers shall be clean, degreased, dry, free of oxidation and prepared per manufacturer's recommendations.
- B. Plastic nameplates shall be installed with corrosion-resistant mechanical fasteners. Do not use adhesives.
- C. Tags shall be installed with corrosion-resistant chain and end fasteners.
- D. Pipe and duct markers shall be installed in accordance with the manufacturer's recommendations.
- E. Valve tag list for each separate trade (i.e., mechanical, plumbing, fire protection, and temperature control) shall each provide a valve tag list in electronic format or under glass in a suitable frame located in a location approved by Architect/Engineer.
- F. Valve tag information is required on "as-built" drawing submittals.
- G. Acceptable Manufacturers:
  - 1. Products of the following manufacturers may be considered
    - a. Seton Nameplate Corp.
    - b. Brady Signmark Division
    - c. Craftmark Identification Systems
    - d. D & G Sign and Label

## 20 10 96 PIPING IDENTIFICATION

- A. All piping, bare pipe or insulated, exposed or concealed, shall be identified by one of the methods specified herein.
- B. Markers shall be installed in clear view; aligned with axis of pipe; located at not more than twenty-five foot (25') intervals on straight runs, risers and drops; located adjacent to each valve, control device and tee fitting; and located on each side of penetrations of the building structure and non-accessible enclosures.
- C. The following schedule shall govern label types for each application:

| <u>Location</u>       | <u>Type</u> |
|-----------------------|-------------|
| Mechanical Rooms      | II          |
| Above Lay-in Ceilings | I           |
| Exterior/Outdoors     | III         |

- 1. Pressure Sensitive Tape (Type I): Vinyl pressure sensitive tape color coded and lettered in accordance with ANSI A13.1 for label of service. Flow direction shall be separately labeled with 2" wide pressure sensitive tape. The flow arrow band shall overlap the service label to secure it in place and shall not be less than two complete wraps around the pipe.
- 2. Plastic Pipe Markers (Type II): Manufactured in accordance with ANSI A13.1 requirements, semi-rigid plastic, pre-formed to fit curvature of pipe or pipe insulation, color coded and imprinted with media identification and flow direction. Available in varied sizes for pipe diameter, wording and inclusion of arrow.
- 3. Outdoor Pipe Markers (Type III): Non-vinyl chloride markers specifically design for outdoor use. Color coded and lettered in accordance with ANSI A13.1 for label of service with direction of flow arrows.



4. Stencil Lettering (Type IV):

| Outside diameter of bare pipe<br>or insulated pipe | Size of letters | Length of color field |
|----------------------------------------------------|-----------------|-----------------------|
| 3/4" - 1-1/4"                                      | 1/2"            | 8"                    |
| 1-1/2" - 2"                                        | 3/4"            | 8"                    |
| 2-1/2" - 6"                                        | 1-1/4"          | 12"                   |
| 8" - 10"                                           | 2-1/2"          | 24"                   |
| -10" and larger                                    | 3-1/2"          | 32"                   |

D. All underground metallic piping shall be identified with continuous 6" wide x 0.004" polyethylene film, color coded, and imprinted for type of utility buried below located in the same trench as the piping and/or utility and positioned approximately 6" to 12" below finished grade.

E. All underground non-metallic piping shall be identified with continuous 6" wide x 0.035 metallic detection tape, color coded and imprinted for type of utility buried below located in the same trench as the piping and/or utility and positioned approximately 6" to 12" below finished grade.

F. The following legend, color, and lettering shall be used:

| Service and Legend              | Color of Field | Letters |
|---------------------------------|----------------|---------|
| Materials Inherently Hazardous: |                |         |
| Natural Gas                     | Yellow         | Black   |
| Boiler Blowdown                 | Yellow         | Black   |
| Boiler Feedwater                | Yellow         | Black   |
| Hot Water Supply                | Yellow         | Black   |
| Hot Water Return                | Yellow         | Black   |
| Refrigerant                     | Yellow         | Black   |
| Domestic Hot Water              | Yellow         | Black   |
| Domestic Hot Water Return       | Yellow         | Black   |
| Waste                           | Yellow         | Black   |
| Vent                            | Yellow         | Black   |

Materials of Inherently Low Hazard:

|                        |       |       |
|------------------------|-------|-------|
| Chilled Water Supply   | Green | White |
| Chilled Water Return   | Green | White |
| Cold Water             | Green | White |
| Condenser Water Supply | Green | White |
| Condenser Water Return | Green | White |
| Drain                  | Green | White |
| Roof Drain             | Green | White |

Fire Quenching Materials:

|                  |     |       |
|------------------|-----|-------|
| Sprinkler – Fire | Red | White |
|------------------|-----|-------|

The following legend, color, and lettering shall be used for below ground piping:

| Service         | Color  | Legend                               |
|-----------------|--------|--------------------------------------|
| Electric 4160 V | Red    | Caution Buried High Voltage Electric |
| Electric        | Red    | Caution Buried Electric              |
| Fiber Optic     | Orange | Caution Buried Fiber Optic           |
| Telephone       | Orange | Caution Buried Communication         |
| CATV            | Orange | Caution Buried CATV                  |
| Sewer           | Green  | Caution Buried Sewer                 |
| Potable Water   | Blue   | Caution Buried Water                 |

|                  |        |                                |
|------------------|--------|--------------------------------|
| Non-potable Fire | Purple | Caution Buried Reclaimed Water |
| Natural Gas      | Yellow | Caution Buried Gas             |
| Fuel Oil         | Yellow | Caution Buried Fuel            |
| Steam            | Yellow | Caution Buried Utility Line    |
| Chilled Water    | Purple | Caution Buried Reclaimed Water |
| Condenser Water  | Purple | Caution Buried Reclaimed Water |
| Heating Water    | Purple | Caution Buried Reclaimed Water |
| Condensate       | Purple | Caution Buried Reclaimed Water |
| Irrigation Water | Purple | Caution Buried Reclaimed Water |

#### 20 10 97 VALVE IDENTIFICATION

- A. All valves exposed or concealed shall be identified with brass valve tags indicating the service of system the valve is in and the number of the valve.
- B. Valve tags shall be minimum 1-1/2" diameter brass stock with 1/4" legend identifying and 1/2" valve number both shall be black enamel filled. Legends shall be HVAC, PLBG, SPR, and GAS.
- C. Valve tags shall be secured in place with a No. 6 brass bead chain or No. 16 brass jack chain. Chains shall be attached to the valve lever handle or around the valve stem.
- D. An additional 10 consecutively numbered tags for each service shall be provided to the Owner for future use.
- E. Service valves and isolation valves shall be labeled consecutively with supply being odd and return even (i.e., chilled water pump service valves shall be No. 1 on pump discharge and No. 2 on pump suction). Where a valve does not have a match skip the next number. All single valves for make-up water, expansion tanks, etc. can be numbered consecutively and shall be last in the sequence.
- F. Balance valves that are not used as a combination balance/service valve are not required to be labeled.
- G. Temperature control valves shall be identified with a 1/4" "T.C." legend and shall be numbered consecutively starting with major equipment and then terminal units (i.e., AHU-1 preheat, cooling, reheat control valves shall be numbered 1, 2, 3 respectively).

#### 20 10 98 EQUIPMENT IDENTIFICATION

- A. All major equipment items (i.e., chillers, air handling units, fans, terminal units, pumps, boilers, etc.) shall be identified with appropriately sized nameplates permanently attached to the respective equipment.
- B. Small equipment items (i.e., in-line pumps, pot feeders, etc.) shall be identified with brass valve tags, see requirements for valve tags and chains.
- C. Equipment that is controlled by the Building Automation Control System shall be labeled with a 2" x 5" yellow label with black letters:  

**"CAUTION – THIS EQUIPMENT IS UNDER COMPUTER CONTROL AND MAY CYCLE AT ANY TIME."**
- D. Interior equipment nameplates shall be 1/16" thick two-ply acrylic plastic 2-1/2" x 1" size minimum with white letters on a black background. Tag size shall be appropriate for equipment name, letters shall be a minimum of 1/2" high.
- E. Exterior equipment shall be identified with nameplates suitable for exterior use or shall be engraved aluminum plates .020" thick, minimum size shall be 4" x 1-1/2" plates.

- F. Nameplates shall be attached with corrosion-resistant No. 3 round head or No. 4 sheetmetal screws.

#### 20 10 99 DUCTWORK IDENTIFICATION

- A. Supply, return and exhaust ductwork uninsulated or insulated, exposed or concealed, shall be identified as specified herein, except for exposed ductwork in finished areas.
- B. Markers shall be installed in clear view; installed on both sides of the duct; run parallel to the ductwork; located at not more than twenty-five foot (25') intervals on straight runs at all branch locations; and located on each side of penetrations of the building structure and non-accessible enclosures.
- C. Markers shall be pressure sensitive vinyl tape labeled for service and direction of airflow. Minimum size shall be 2" high x 8" long.
- D. Supply, return, exhaust and outdoor air ductwork labels shall be blue with white letters. Hazardous exhaust air ductwork labels shall be yellow. Outdoor air labels shall have an "air" legend.

#### 20 10 100 CONTROL DEVICES IDENTIFICATION

- A. The materials specified herein Section 20 10 90 shall apply to Division 25 Temperature Control Systems. Additional identification work is specified in Division 25.

### **20 20 10 ELECTRICAL REQUIREMENTS**

#### 20 20 11 GENERAL

- A. This Subsection specifies the basic requirements for electrical components which are an integral part of "packaged" mechanical equipment. These components include, but are not limited to, factory installed motors, starters, disconnect switches, control panels and related prewiring of power and control wiring for a single external electrical service connection. All material and equipment shall be provided for the application and service intended.
- B. Specific electrical requirements (e.g. horsepower, electric characteristics, etc.) for mechanical equipment shall be specified within the respective equipment specifications or shall be scheduled on the Plans.
- C. The Contractor shall verify that electrical characteristics of material and equipment furnished for Divisions 20 - 25 equipment are in accordance with the electric service and comply with the specifications and requirements of Division 26 - 29.
- D. Unless otherwise specified as an integral part of packaged mechanical equipment, motor control centers, motor starters and disconnect switches and the power wiring from power source to motor starting equipment (including variable frequency drive packages) and wiring from that equipment to the respective motors including final connections shall be performed as Electrical Work of Division 26 - 29.
- E. The field installation of electrical components, not included in Division 26 - 29, that are specified to be provided with the mechanical equipment and are shipped separately shall be the responsibility of the Contractor furnishing the base equipment.
- F. All electrical components and material shall be UL labeled.

- G. Submittals for the applicable electrical equipment shall include the following: identification of the equipment which the electrical material is to serve, application, voltage, phases, full load amperage, wattage and NEMA enclosure. For motors: horsepower, RPM, full load power factor and efficiency, frame size and service factor.
- H. Identification of electrical components of mechanical equipment shall be in accordance with Subsection 20 10 90, "Basic Mechanical Methods - Identification".

## 20 20 12 REFERENCES

- A. Electrical material and equipment provided for Divisions 20 - 29 shall meet the applicable requirements of the latest accepted edition of the following codes and standards:

|      |                                                  |
|------|--------------------------------------------------|
| ANSI | American National Standards Institute            |
| EEL  | Edison Electrical Institute                      |
| IEEE | Institute of Electrical and Electronic Engineers |
| NEC  | National Electrical Code                         |
| NEMA | National Electrical Manufacturers Association    |
| UL   | Underwriter's Laboratories, Inc.                 |

## 20 20 13 MOTORS

- A. The following are basic minimum requirements for all motors. Additional motors, more detailed and specific requirements may be specified with the respective equipment.
- B. Single-phase motors shall be provided for all motors 1/2 HP or less, except as specified or scheduled otherwise and shall be of the permanent split capacitor (PSC) type.
- C. Polyphase motors shall be provided for all motors 3/4 HP or larger, except as specified or scheduled otherwise with a minimum power factor of .85 at 65% of full load or shall be power factor corrected.
- D. Multi-speed motors shall have dual windings wound to the speeds scheduled or specified.
- E. Torque characteristics shall be sufficient to satisfactorily accelerate the driven load(s) with low in rush current.
- F. Motor horsepower sizes shall be large enough so that the driven load shall not require the motor to operate in the service factor range.
- G. Temperature rating: Rated for 40 deg. C environment with maximum temperature rise for continuous duty at full load of 40°C for open dripproof motors, 50°C for splash proof motors, and 55°C for totally enclosed motors (Class B insulation). Motors used with variable frequency drives/inverters shall be NEMA MG1, Part 31 Compliant and have a Class B temperature rise with Class F insulation design to resist transient spikes, high frequencies, and short rise time pulses produced by inverters.
- H. Starting capability: Frequency of starts as specified by the automatic control system. For manually controlled motors, not less than five (5) evenly time spaced starts per hour.
- I. Service factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- J. Motor construction:
  - 1. NEMA standard frame sizes, general-purpose open dripproof (unless otherwise specified), continuous duty, Design "B" (unless "C" is required for high starting torque). Motor frame, end bells and conduit box shall be cast iron; stator windings shall be copper. Aluminum is unacceptable for any parts. Provide grounding lug in motor terminal box.

2. Motors located outdoors or otherwise exposed to water, dust, etc where an open motor would not be suited, shall be totally enclosed fan-cooled (TEFC).
  3. Bearings: Ball or roller bearings with inner and outer shaft seals. Externally accessible inlet/outlet grease fittings. Where motors are enclosed within equipment, extend grease tubing to exterior of the enclosure. Bearings designed to resist thrust loading for drives producing lateral or axial thrust. Fractional horsepower, light duty motors may have sleeve bearings.
  4. Overload protection: Built-in thermal overload protection.
  5. Noise rating: Motors shall meet IEEE, Standard 85.
  6. Efficiency: Motors shall be NEMA Premium Efficiency per NEMA Standards Publication MG 1-2003, Table 12-12 and 12-13.
  7. Nameplate: Indicate full identification of manufacturer's name, model number, serial number, horsepower, speed, voltage, characteristics, construction, special features, etc. Nameplates in harsh environments such as for cooling towers, or in pool equipment rooms, etc. shall be suited to the specific application.
- K. Acceptable manufacturers: Baldor, General Electric, Gould, Marathon, Magnetek, Reliance, Siemens, Toshiba, and U.S. motors.

#### 20 20 14 MOTOR CONTROLS

- A. Motor Starters: NEMA 1, general-purpose enclosures with padlock ears, unless specified other wise. Type, size and duty shall be as specified or as recommended by the motor manufacturer and the requirements of the driven equipment for applicable protection and start-up conditions.
- B. Manual Starters: Pilot light and extra positions for multi-speed motors. Melting alloy type thermal overload relay protection.
- C. Magnetic Starters: Hand-off-Auto selector switches, pilot lights, interlock contacts, switches and other devices as required for control requirements. Trip-free thermal overload relays for each phase. Built-in 120 volt control circuit transformer, fused from line side, where power service exceeds 240 volts. Externally operated manual reset; under-voltage release of protection.
- D. Acceptable Manufacturers: Allen-Bradley, Cutler-Hammer, General Electric, Square D.

#### 20 20 15 DISCONNECT SWITCHES

- A. Fusible: For 3/4 horsepower and larger. Disconnect switch shall be horsepower rated, heavy duty, spring reinforced fuse clips each phase, quick-make/quick-break mechanism with arc quenchers, dead front line side shield, solderless lugs, silver electroplated current carrying parts, lockable hinged door, capacity and electric characteristics as specified.
- B. Non-fusible: For 1/2 horsepower motor and smaller. Disconnect switch shall be horsepower rated, toggle switch type, quantity of poles and voltage rating as specified.

#### 20 20 16 MULTI-SPEED MOTORS AND CONTROLS

- A. Multi-speed motors, when required, shall be specified under the heading of the respective equipment to be driven.
- B. Motor controls for multi-speed applications shall be specified, also, under the heading of the respective equipment, if said equipment is a "packaged" type unit.
- C. Otherwise, multi-speed motor controls shall be specified in Division 26.

#### 20 20 17 VARIABLE SPEED DRIVES

- A. Motor controls for variable speed drives shall be specified under the heading of the respective equipment, if said equipment is a "packaged" type unit.
- B. Otherwise, variable speed drives shall be specified in Division 26.

#### 20 20 18 CONTROL PANEL

- A. NEMA 1 general-purpose enclosure for indoor application; NEMA 3R weather resistant enclosure for exterior location.
- B. Factory mount panel(s) and internal power and control devices. Pre-wire all devices for the operation of the related equipment so that only one main power connection shall be required in the field.
- C. Provide internal protection for each circuit, maximum 120-volt secondary control transformer(s), terminal strips for wiring terminations, identification of components and wiring diagram inside the cover.

### **20 20 20 DRIVES AND GUARDS**

#### 20 20 21 GENERAL

- A. This Subsection covers V-belt, sprocket-chain, gear and direct coupled drives.
- B. All drives shall be selected for 150% of specified motor nameplate horsepower.
- C. All drives shall be installed, balanced and aligned in accordance with the respective manufacturer's instructions and recommendations.

#### 20 20 23 DIRECT DRIVES

- A. Wherever available, motors and related direct driven equipment shall be mounted on a common base.

#### 20 20 24 GUARDS

- A. All belts, chains, pulleys, shafts, sheaves, sprockets, gears, couplings, projecting setscrews, keys and any other rotating parts shall be provided with guards by the Contractor furnishing the base equipment.
- B. Guards shall be designed and arranged in accordance with OSHA requirements.
- C. Guards shall completely enclose the drive, shall be secured to the respective equipment and shall be removable for servicing. Wherever available from the manufacturer, guards shall be provided with the equipment. If not, these shall be field fabricated.
- D. Provide reinforced openings with removable coverplates for access to motor and driven shafts for speed measurement.
- E. Extend tubing for grease fittings inside the guard to accessible locations outside the guard.

20 20 25    INSTALLATION AND OPERATION

- A. Install, balance and align all drives in accordance with the respective manufacturer's instructions and recommendations.
- B. The balancing and alignment of drives including pinning, doweling and grouting shall be the responsibility of the Contractor furnishing the equipment. Any adversities arising from executing the Work shall be resolved/remedied by the Contractor.
- C. Verify all electrical characteristics prior to running electric motor driven equipment. Check motor amperage draw and rotation for proper operation.

END OF SECTION

## **20 25 00 INSULATION**

### **20 25 01 GENERAL**

- A. This Section specifies mechanical insulation of piping, equipment and ductwork.
- B. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 29 of the Specifications.
- C. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 20 - 29 of these Specifications.

### **20 25 02 REFERENCES, REGULATORY REQUIREMENTS**

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20 in addition to the following:
  - 1. State and local Air Pollution Codes and Regulations.
  - 2. NFPA 255/UL 723/ASTM E-84 Surface Burning Characteristics of Building Materials.
  - 3. UL 1479/ASTM E-814 Fire Test of Through-Penetration Firestops.
  - 4. ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation.
  - 5. ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
  - 6. ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
  - 7. ASTM C1290 Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
  - 8. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
  - 9. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - 10. NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
  - 11. North American Commercial and Industrial Insulation Standards. 9th Edition or Latest Edition. Published by Midwest Insulation Contractors Association (MICA).

### **20 25 03 RELATED SECTIONS OF THE SPECIFICATIONS**

- A. Requirements of the following Sections of the Specifications apply to Work for this Section:
  - .1 Division 20 - Basic Mechanical Conditions
  - .2 Division 20 - Basic Mechanical Materials and Methods
  - .3 Division 22 - Plumbing Work
  - .4 Division 23 - HVAC Piping and Equipment
  - .5 Division 24 - Air Distribution

### **20 25 04 DEFINITIONS**

- A. The term **“fitting”** where used in this Section of the Specifications shall be construed as an elbow, tee or reducer. Unions, flanges and valves shall not be considered as fittings.
- B. The term **“cold”** shall be defined as the temperature of a surface that may result in the formation of condensation.
- C. The term **“accessory”** shall include staples, bands, wire, mesh, clips, pins, studs, tape, anchors, corner angles, cements, adhesives, coatings, sealers, mastics, finishes, etc.



- D. The term “**ASJ**” where used in this Section of the Specifications shall mean a reinforced vapor retarding All Service Jacket.
- E. The term “**SSL**” where used in this Section of the Specifications shall mean Self-sealing Lap Joint closure system for longitudinal jacket joints.
- F. The term “**supply air**” where used in this Section of the Specifications shall mean downstream of a coil.
- G. The term “**outdoor air**” where used in this Section of the Specifications shall mean ambient air that has not been conditioned.
- H. The term “**return air**” where used in this Section of the Specifications shall mean conditioned air that is returned from the space.
- I. The term “**mixed air**” where used in this Section of the Specifications shall mean air streams that are a mixture of “outdoor air” and “return air”.
- J. The term “**relief air**” where used in this Section of the Specifications shall mean excess return air that is relieved from the building.
- K. The term “**exhaust air**” where used in this Section of the Specifications shall mean air that is removed due to contaminants, odors, or heat.

#### 20 25 05 WORK INCLUDED

- A. Furnish material, labor and services necessary for and incidental to the insulation of the following systems where shown on the Plans and as hereinafter specified. Include all necessary considerations in the related sections of the Specifications (Subsection 20 25 03) to perform the Work completely.
  - 1. Chilled water piping (including chilled glycol and brine).
  - 2. Heating water piping.
  - 3. Combination chilled/hot (heating) water piping.
  - 4. Refrigerant piping (suction, hot gas/discharge).
  - 5. Condensate drain piping.
  - 6. Waste piping and floor drains located above grade serving condensate drains.
  - 7. Make-up cold water piping.
  - 8. Chilled water pumps, equipment and specialties.
  - 9. Reheat coils and return bends of uncased coils, including VAV boxes.
  - 10. Heat exchangers and other heating equipment.
  - 11. Ductwork/sheetmetal systems.
  - 12. Fire wrapping kitchen exhaust duct.
  - 13. Boiler and water heater flues.
  - 14. Domestic hot, hot recirculating and cold-water piping.
  - 15. Domestic hot water storage tanks and other equipment.
  - 16. Storm water drainage.
  - 17. Heat traced piping (above grade).
  - 18. Chiller water boxes and miscellaneous chiller specialties.

- B. Providing appropriate size calcium silicate/cellular glass/pipe shield manufactured inserts to the trade contractor for installation between the pipes and oversized hangers as specified in this section.
- C. Fire wrapping piping system located in occupied spaces or plenum spaces that do not meet flame spread 25 and smoke development 50.

#### 20 25 06 SUBMITTALS

- A. The Contractor shall submit shop drawings for approval in accordance with Subsection 20 00 43, Duties of Contractor - Submittals.
- B. Provide an INSULATION PRODUCT SCHEDULE consisting of the following minimum information:
  - Material - type of insulation material, jackets, or covers.
  - Manufacturer - manufacturers name, product name, and K-value where applicable.
  - Accessories - tapes, staples, coatings, adhesives including manufacturer's name and product name.
  - Systems - indicate systems where product is used.
- C. Provide an INSULATION THICKNESS SCHEDULE consisting of the following minimum information:
  - System - indicate which system insulation is installed.
  - Location - inside, outside, concealed, exposed, etc.
  - Size - indicate size range of pipe, insulation type used.
  - Thickness - indicate insulation thickness in inches.
- D. Provide manufacturer's technical product data of each material and accessory item with engineering support information and recommended installation procedure. Indicate product number, "K" value, thickness and required accessories for each application.
- E. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

#### 20 25 07 SPECIAL REQUIREMENTS

- A. Contractor's Qualifications: Contracting company shall be one specializing in insulation application and have a minimum of three (3) years experience in this work.

### **20 25 10 INSULATION MATERIALS**

#### 20 25 11 GENERAL

- A. Materials and accessories furnished for this Section of the Specifications shall be standard cataloged products, new, commercially available and suitable for the service specified.
- B. Insulations materials shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or polybrominated diphenyl ether fire retardants.
- C. Fiberglass insulations shall be constructed of bio-soluble fiber, certified by EUCB.
- D. Fiberglass insulations shall have a minimum of 50 percent recycled glass content; certified and validated in accordance with UL 2809.
- E. Fiberglass insulations shall have a bio-based, formaldehyde-free binder.

## 20 25 12 FIRE SAFETY STANDARDS

- A. All insulation material shall have composite fire and smoke hazard ratings in accordance with NFPA 255 and UL 723 not exceeding the following values as tested by the latest procedures of ASTM E-84: flame spread of 25; smoke developed of 50.
- B. Accessories such as adhesives, mastics, cements, tapes and cloths for seams, joints and fittings shall have the same ratings as hereinbefore listed. All products and their respective shipping cartons shall have indications that flame and smoke ratings meet the aforementioned requirements. Any treatment of jackets or facings to impart acceptable flame and smoke safety values shall be permanent; water-soluble applications are prohibited. The Insulation Contractor shall bear responsibility that all products to be used meet the foregoing criteria.

## 20 25 13 TYPES OF INSULATION MATERIALS

The following types of insulation material are enumerated in the respective INSULATION MATERIAL SCHEDULE. K values listed are in units of (Btu in/hr ft.<sup>2</sup> °F) and are based on specific products and are to be met or exceed. ANSI/ASTM types or class shall not provide relief for any K value specified.

- A. Type CS: Hydrous calcium silicate, molded pipe or block form, asbestos free, ANSI/ASTM C533, Type I, "k" value of 0.41 at 200 degrees F for pipe, "k" value of 0.39 at 200 degrees F for block, density of 15#/cubic foot. Owens-Corning Calcium Silicate or equivalent by Knauf, Johns Manville or Pabco.
- B. Type GF1: Glass fiber, non-combustible, preformed for pipe and tube application, ANSI/ASTM C547, Grade A, "k" value of 0.23 at 75 degrees F. Owens-Corning type ASJ with SSL-II vapor retarder jacket or equivalent by Knauf, Manson, or Johns Manville.
- C. Type GF2: Glass fiber, non-combustible, rigid board with vapor retarder facing, ANSI/ASTM C612, "k" value of 0.24 at 75 degrees F, density of 3#/cubic foot. Owens-Corning type 703 with ASJ 25 jacket or equivalent by CertainTeed, Knauf, Manson or Johns Manville.
- D. Type GF3: Glass fiber, flexible blanket, laminated to reinforced kraft vapor retarder facing, ANSI/ASTM C553, Type II, "k" value of 0.27 at 75 degrees F, density of 1#/cubic foot. Owens-Corning type 100 All-Service faced duct wrap or equivalent by CertainTeed, Knauf, Manson or Johns Manville.
- E. Type F1: Flexible elastomeric foamplastic with smooth exterior surface, preformed for pipe and tube application, ASTM C534, Type I, "k" value of 0.28 at 75 deg. F. Armacell AP Armaflex pipe insulation, K-Flex LS tube, AeroFlex EDPM tube.
- F. Type F2: Flexible elastomeric foamplastic with smooth exterior surface, sheet material, ASTM C534, type II, "k" value of 0.28 at 75 degrees F. Armacell AP Armaflex sheet material, K-Flex LS sheet, AeroFlex EDPM sheet.
- G. Type FG: Rigid foamglass preformed for pipe applications ASTM C552, K value of 0.33 at 75°F with all-purpose vapor retarder jacket. Owens Corning Foamglas.
- H. Type PI: Polyisocyanurate preformed for pipe applications ASTM C591, aged "k" value of 0.19 at 75 degrees F, density of 2#/cubic foot. Shall be ASTM E84 less than 25/50 rated. Saran 560 vapor barrier.
- I. Type PH: Phenolic preformed for pipe applications ASTM C1126, Type III, grade 1. ASTM E84 less than 25/50 rated, Saran 560 vapor varrier, 0.15@75°F.

## 20 25 14 TYPES OF PIPING JACKET MATERIALS

A. Field-applied Protective Finish Jackets - 0.016" aluminum or 0.010" stainless steel jackets with moisture barrier shall be cut and fitted to size required. Fold a ½" safety edge on exposed side, roll to diameter required and secure with ½" x 0.020" aluminum or ½" x 0.015" stainless steel bands respectively on 9" centers (4 bands per 3 foot section of jacketing). Provide appropriate seals, and shed water toward low end of pitched piping. Install lap on top quadrant (2 or 10 o'clock position) of outside diameter of insulation and line up bands and seals to present neat and workmanlike appearance. Fitting covers shall be consistent with piping insulation jacketing. Secure in place with SS screws or banding. Seal with approved caulking. Sharp edges shall be turned under or otherwise protected.

B. PVC jacketing 0.030" thick for pipe insulation and PVC fitting covers shall be applied over the insulation and vapor barrier system where indicated below for aesthetics or mild abuse areas.

C. Outdoor refrigeration linesets shall be jacketed as follows:

1. Exterior refrigerant piping shall be insulated and covered with high performance jacketing product that performs well over a wide temperature range; -30°F to +300°F (-34°C to +149°C) service temperature. Cold weather acrylic adhesive shall apply easily at temperatures as cold as -10°F (-23°C). Zero permeability, absolute vapor barrier. High puncture and tear resistance. Shall contain tested and approved mold inhibiting agents. Shall be UL 723 10/20 Flame Spread/Smoke Rating approved. Shall meet requirements of FSIS Directive 5000.1, 9 CFR, Part 416 for USDA and FDA facilities and Department of Health and Human Services Construction Guide for Food Facilities. Covering shall be VentureCLAD 1577CW Natural Aluminum Finish, or equivalent.

D. Finish piping insulation with factory or field application for respective locations as follows:

Dry, low abuse:  
(indoor)

Concealed, not exposed to view.  
Mechanical equipment room.  
Exposed, finish space.

Pipe:  
Fittings:

ASJ or ASJ+ jacket.  
Pre-molded PVC covers.

High abuse area:

Exposed vertical risers in all Storage Rooms, Janitor Closets.  
Exposed, unfinished space.

Pipe:

Stainless steel jacket with seam away from abusive force.  
Apply to height of 8 feet.

Fittings:

Formed stainless steel covers.

Outdoors:

All

Pipe:

Smooth aluminum jacket with seam on topside at 2 or 10 o'clock position of horizontal runs.

Fittings:

Formed aluminum covers.

## 20 25 15 DELIVERY AND STORAGE OF MATERIALS

A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

- B. The Contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the Contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance and provide the Architect/Engineer with a copy of manufacturer's recommendation for approval.

#### 20 25 16 ACCEPTABLE MANUFACTURERS

The following are acceptable manufacturers for products specified in this section of the specification.

- A. Metal jackets:
  - 1. RPR Products, Inc.
  - 2. Ideal Products
  - 3. Johns Manville
  - 4. Shur-Fit Products
- B. PVC covers:
  - 1. Proto Corp. (Lo Smoke)
  - 2. Speedline PVC Corp. (Smoke Safe)
  - 3. Johns Manville (Zeston)
  - 4. Shur-Fit Products
  - 5. P.I.C. Plastics
- C. Mastics, Coatings, Sealants & Adhesives:
  - 1. Miracle Adhesives
  - 2. Vimasco Corporation
  - 3. Childers Products / H.B. Fuller Construction Products
  - 4. Foster Products / H.B. Fuller Construction Products
  - 5. Mon-Eco Industries
- D. Fasteners
  - 1. ACS Industries
  - 2. GEMCO
  - 3. Midwest Fasteners
- E. Fire Stop
  - 1. 3M
  - 2. Metacaulk
  - 3. Specified Technologies, Inc.
  - 4. USG Interior, Inc.

5. Alkegen Unifrax
  6. Morgan Advanced Materials – Thermal Ceramics
- F. Glass Fiber Insulation (aka Fiberglass):
1. Knauf Insulation
  2. Manson Insulation
  3. Owens Corning
  4. Johns Manville
  5. CertainTeed (does not make pipe insulation)
- G. Elastomeric Foam Insulation:
1. Armacell North America
  2. Aeroflex USA
  3. K-Flex USA
- H. Phenolic Foam Insulation:
1. Polyguarde (PolyPhen)
  2. Johns Manville (Trymer Supercel Phenolic)
- I. Polyisocyanurate Foam Insulation:
1. Johns Manville (Trymer PIR)
  2. HiTherm LLC
  3. Kingspan
- J. Cellular Glass Insulation:
1. Owens Corning (Rigid Foamglas)

**20 25 20 INSULATION MATERIAL SCHEDULES:**

20 25 21 INSULATION MATERIAL SCHEDULE I-1

| A. | Service: Hot and cold piping                                                                                                                                                                              | thickness  | insulation material                       |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------------------------------|
| B. | Chilled water supply and return piping<br>2" and smaller                                                                                                                                                  | 3/4"       | Type PI*, PH, F1                          |
|    | 2-1/2" through 5"                                                                                                                                                                                         | 1"         | Type PI*, PH, F1<br>(Contractor's option) |
|    | 6" and larger                                                                                                                                                                                             | 1-1/2"     | Type PI, PH                               |
|    | Condenser Water Piping to be Heat Traced                                                                                                                                                                  | 1-1/2"     | Type PI                                   |
| C. | Hot water (140°F and less) supply and return<br>1-1/4" and smaller<br>1-1/2" and larger                                                                                                                   | 1"         | Type GF1, F1<br>(Contractor's option)     |
| D. | Electrically heat traced piping,<br>all sizes.                                                                                                                                                            | 1-1/2"     | Type as specified<br>for the system.      |
| E. | Domestic water- hot, hot recirc.<br>2" and smaller                                                                                                                                                        | 1"         | Type GF1, F1<br>(Contractor's option)     |
|    | 2-1/2" and larger                                                                                                                                                                                         | 1-1/2"     | Type GF1                                  |
| F. | Domestic water-cold                                                                                                                                                                                       | 1/2"       | Type F1, GF1<br>(Contractor's option)     |
| G. | Storm water from the roof drain to the first<br>floor level below the roof. Thereafter, all<br>horizontal piping only and related elbows to<br>vertical. Insulate drain body with 1/2" sheet<br>Armaflex. | 1"         | Type GF1                                  |
| H. | Refrigeration Piping:                                                                                                                                                                                     |            | Type F1                                   |
|    | Suction - 2" and smaller<br>2-1/2" and larger                                                                                                                                                             | 3/4"<br>1" |                                           |
|    | Hot gas/discharge - All sizes<br>where piping is 8'-0" or less AFF                                                                                                                                        | 3/4"       |                                           |
| I. | Condensate Drain Lines:                                                                                                                                                                                   | 1/2"       | Type F1                                   |
|    | All - except air handling units in Mechanical<br>Rooms where drain line is 2'-0" or less in<br>total length and located at the Mechanical<br>Room floor.                                                  |            |                                           |
| J. | Waste Piping and Floor Drains:                                                                                                                                                                            | 1/2"       | Type F1                                   |
|    | Piping above grade serving floor drains,<br>hub drains, indirect cabinets, etc., that receive<br>condensate from cooling coils. Insulate piping<br>to where it connects to main waste pipe.               |            |                                           |

|    |                                           |                                                                                                                                                                             |
|----|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| K. | Fittings (hot and cold):                  | Molded/preformed fittings, secured in place with twine or tape, seal all "cold" applications prior to installing jacket material.                                           |
| L. | Unions, flanges:<br>Valves: (cold piping) | Type F1, same thickness as adjacent piping.<br>Form external collar, minimum 1" overlap on adjacent insulation. Use adhesive to secure in place and maintain vapor barrier. |
| M. | Unions, flanges:<br>(hot piping)          | No insulation.                                                                                                                                                              |
| N. | Valves (hot piping):                      | Insulate valve body only.                                                                                                                                                   |
| O. | Joints:                                   | Lines subject to condensation: seal longitudinal laps of jacket with adhesive and wrap butt joints between sections with 2" wide tape.                                      |



20 25 22 INSULATION MATERIAL SCHEDULE I-2

|    |                                                                                                                                                                                         |                                                    |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| A. | Service: "Cold" equipment                                                                                                                                                               | <u>Thickness</u>                                   |
| B. | Chilled (cold) surfaces, not factory insulated, interior application                                                                                                                    | 3/4"                                               |
| C. | Air separator                                                                                                                                                                           | 1"                                                 |
| D. | Pump impeller housing                                                                                                                                                                   | 1"                                                 |
| E. | Water boxes of chilled water heat exchangers                                                                                                                                            | 1"                                                 |
| F. | Insulation material:                                                                                                                                                                    | Type F2                                            |
| G. | Fittings:                                                                                                                                                                               | Type F1                                            |
| H. | Unions, flanges:<br>Valves:                                                                                                                                                             | Same requirements as "Fittings"<br>or use Type F2. |
| I. | Joints and seams:                                                                                                                                                                       | Seal with Armstrong 520 adhesive.                  |
| J. | Finish, interior:                                                                                                                                                                       | No additional finish required.                     |
| K. | Finish, exterior:                                                                                                                                                                       | Seal with (2) coats of WB Armaflex.                |
| K. | Hangers, supports:                                                                                                                                                                      |                                                    |
| 1. | Outside insulation with continuous vapor barrier. If hanger or support is in direct contact with equipment, insulate immediate support and connecting member(s) for length of 12" away. |                                                    |

20 25 23 INSULATION MATERIAL SCHEDULE I-3

|    |                                  |                                                                                                                                                                                                        |
|----|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A. | Service: "Hot" equipment         | <u>thickness</u>                                                                                                                                                                                       |
| B. | Heat exchangers                  | 2"                                                                                                                                                                                                     |
| D. | Hot water pump impeller housings | 2"                                                                                                                                                                                                     |
| E. | Air separator                    | 2"                                                                                                                                                                                                     |
| G. | Insulation Material:             | Type GF2                                                                                                                                                                                               |
|    | Option #1:                       | Owens-Corning type ASJ w/ SSL jacket for round surfaces                                                                                                                                                |
|    | Option #2:                       | Owens-Corning Pipe & Tank Insulation for round surfaces                                                                                                                                                |
| H. | Flanges:                         | No insulation.                                                                                                                                                                                         |
| I. | Attachment:                      | Secure rigid board with welded pins on 12" centers.<br>Secure with ¾" x 0.020" SS bands on 12" centers. Fit ends of tanks and irregular surfaces by segmenting or scoring board and wiring into place. |
| J. | Joints:                          | Point and fill-in all joints and voids with insulating cement or fill-in all joints and voids by stuffing with mineral wool.                                                                           |
| K. | Finish:                          | 0.016" smooth aluminum jacket with moisture barrier, secured with ½" x 0.015" SS bands on 9" centers and SS sheet metal screws.                                                                        |

20 25 23 INSULATION MATERIAL SCHEDULE I-3

|                                                                                                                                                                                          | <u>thickness</u>                         | <u>insulation material</u> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|----------------------------|
| A. VAV box coil return bends                                                                                                                                                             | 1-1/2"                                   | Type GF3                   |
| B. Insulation Material (Refer to Acoustical Liner Schedule in Division 24)                                                                                                               |                                          |                            |
| 1. Rectangular ducts unless otherwise noted                                                                                                                                              | 1" Acoustical Liner                      |                            |
| 2. Round ducts (concealed)                                                                                                                                                               | 1-1/2" Type GF3                          |                            |
| 3. Round ducts (exposed in space)                                                                                                                                                        | 1" Acoustical Liner (Spiroacoustic Plus) |                            |
| 4. Kitchen Hood Exhaust                                                                                                                                                                  | See Div 24 for product requirements      |                            |
| 5. Transfer Air Ducts                                                                                                                                                                    | 1" Acoustical Liner                      |                            |
| C. Plenum Boxes                                                                                                                                                                          | 1"                                       | GF2                        |
| 1. OA intake plenum boxes are to be externally wrapped until 6" beyond isolation damper location. Liner is forbidden in untreated airstreams.                                            |                                          |                            |
| 2. RA plenum boxes may have 1" internal liner with 18 ga sheet metal work surface installed on top of plenum box floor.                                                                  |                                          |                            |
| D. Storm Shelter Duct                                                                                                                                                                    |                                          |                            |
| 1. All duct in the RTU-4 Storm Shelter ventilation system is to be externally wrapped duct. All exposed ductwork to be K-27 double wall duct or equivalent.                              |                                          |                            |
| E. Exterior Duct                                                                                                                                                                         |                                          |                            |
| 1. Exterior duct shall be pre-manufactured duct by Thermaduct or submitted pre-approved equal. Product substitution requests shall be made prior to the shop drawing phase per 20 00 52. |                                          |                            |

## **20 25 30 INSULATION APPLICATION**

### **20 25 31 INSULATION APPLICATION - GENERAL**

- A. Respective piping system, duct system and/or equipment shall be pressure tested, proved tight and accepted, as specified in section for installation of such, before insulation is applied. Sheet metal ductwork joints shall be sealed prior to insulating. Coordination among the respective contractors is essential.
- B. To ensure that it will achieve its highest possible performance and serve its intended purpose, install all insulation materials and accessories in accordance with manufacturer's published instructions (latest edition) and industry practices detailed by the North American Commercial and Industrial Insulation Standards (latest edition). All surfaces to receive insulation shall be clean, dry, free of oxidation and prepared as required.
- C. The insulation work shall be subject to inspection during the various applications and construction phases. Material, accessories, finishes, methods and workmanship that are not in compliance with these Specifications and/or approved submittals may lead to rejection of the Work and replacement at the Contractor's expense.
- D. Where heat tracing is utilized for piping and/or equipment shall be installed, tested and accepted before insulation is applied.
- E. Painting of piping for corrosion protection, where specified, shall be performed before insulation is applied.
- F. Painting of piping for color coding, where specified, shall be performed after insulation is applied.

### **20 25 32 INSULATION APPLICATION - PIPING**

- A. Insulate each piping section with single thickness full-length units of insulation, with a single cut piece to complete the run where a fitting is encountered. Do not use cut pieces or scraps abutting each other.
- B. Extend piping insulation without interruptions through walls, floors, and similar piping penetrations, except where otherwise specified.
- C. Insulation on unions, flanges, valves, strainers, expansion joints, pump impeller housings and other equipment requiring accessible servicing shall be removable and reusable without damage. Items requiring periodic attention shall have covers and/or casings to contain the insulation.
- D. All "cold" piping systems shall be insulated with type and thickness of material herein specified and shall have a continuous vapor retarder through all fittings, hangers, supports and sleeves.
- E. In cold systems flanges, unions, valves, etc., shall be covered with an oversized pipe insulation section sized to provide the same thickness as on the main piping section. An oversized insulation section shall be used to form a collar between two insulation sections with low-density blanket insulation being used to fill gaps. Jacketing shall match that used on main piping system. Rough cut ends shall be coated with suitable weather and/or vapor resistant mastic as required by the system location and service. All valve stems must be sealed with caulking that allows free movement of the stem but provides a seal against moisture incursion.
- F. In hot system flanges, unions, valves, etc., shall be left exposed; insulation ends shall be tapered and sealed to allow bolts to be removed or other required access.

- G. The installation of cold piping systems shall use oversize (outside the thickness of the insulation) pipe hangers.
1. Piping systems 3" and smaller, the Insulation Contractor shall replace temporary wood blocking with insulation of thickness as scheduled in this section of the specification. Metal pipe shields shall be placed between the pipe hanger and the insulation.
  2. Piping systems 4" and larger, the Insulation Contractor shall replace the temporary wood blocking with high density pre-formed insulation (i.e. calcium silicate, cellular glass) inserts with suitable characteristics for the weight, temperature and application and insulation protection shields at each hanger. The specified insulation should stop and start at the insert at the hanger locations. The insert shall be wrapped with vapor barrier jacketing. Circumferential joints shall be taped with vapor barrier tape and coated with vapor barrier sealant. B-Line, or equivalent, figure B-3380 through B-3384, 360 deg. calcium silicate insert/shields and figure B-3153 protection shields may be used or equivalent may be field fabricated per details submitted for approval.
  3. If in the event pipe hangers are not oversized, this Contractor shall notify the Engineer and the Contractor(s) who provided and/or installed hangers. Hangers shall be corrected before pipe is insulated.
  4. Where size on size hangers have been approved by the Engineer in writing for use in special situations, the insulator shall insulate the hanger and hanger rod with ½" Type F insulation. Pipe insulation shall terminate at each side of the hanger and have vapor barrier end joint butt strips. Hanger insulation shall overlap pipe insulation a minimum of 4" on each side of the hanger and secured to the pipe insulation with contact adhesive. Hanger rods shall be insulated for a minimum of 12" secured to the rod with contact adhesive and the end sealed with a bead of caulk.
  5. The Contractor shall adjust hangers after the insulation and pipe shields have been installed to provide an evenly supported piping system. No hanger shall bear the entire weight or not carry any weight of piping system.
- H. For piping systems using elastomeric foamplastic insulation, joints and seams shall be sealed with manufacturer's recommended contact adhesive. Fittings shall be insulated from segments fabricated from pipe insulation or sheet material, secured and sealed with contact adhesive. Termination points and ends shall be sealed to the pipe to prevent backflow of condensation on the inside of the insulation. Any piping outdoors or otherwise exposed to UV or ozone provide VentureClad.

#### 20 25 33 INSULATION APPLICATION - EQUIPMENT

- A. Manufactured equipment (i.e. air handling equipment, terminal units, air device plenums, etc.) requiring insulation shall be specified in the respective equipment specifications to be factory insulated with internally applied liner or double wall casing.

#### 20 25 34 INSULATION APPLICATION - DUCTWORK

- A. Ductwork systems shall be insulated in accordance with the insulation schedules. Insulate each duct section with single thickness full length pieces. Do not use scraps abutting each other.
- B. Extend insulation without interruptions through walls, floors, and similar penetration, except where otherwise specified.
- C. "Cold" duct systems shall have insulation with a continuous vapor retarder through all fittings, hangers, supports, air devices, fire dampers, duct mounted coils, dampers, and other devices in the ductwork system, etc.
- D. In "cold" duct systems, using rigid board or sheet elastomeric foam insulation, support angles, stiffener angles, ductmate flanges, etc. they shall be covered with an oversized insulation strip

sized to provide the same insulation thickness as on the duct. Provide a minimum of 2" of overlap on each side of the obstruction.

- E. Board insulation shall be properly cut and dry fitted to the surface to be insulated. Edges shall be neat and clean cut. No intermediate cut pieces shall be allowed on the bottom and sides of the ductwork. Insulation board shall be secured in place using mechanical fasteners such as welded pins or speed clips. Locate not less than 3" from each edge or corner and approximately 12" on centers on all sides. There shall be a minimum of two (2) rows of pins on the bottom of the duct and one (1) on the sides. Additional pins may be needed on the bottom to prevent sagging. All seams, joints, penetrations and breaks in the vapor retarder jacket shall be sealed with pressure sensitive tape matching insulation facing. Edges shall be provided with 28 ga. 1" x 1" aluminum corner beading properly secured and shall have the same facing material as the insulation board.
- F. Flexible duct wrap insulation shall be cut properly and fitted to "stretchout" dimensions and a 2" piece of insulation removed from the facing at the end of the piece to form an overlapping staple and tape flap. Insulation shall be installed with facing outside so tape flap overlaps facing at the other end. Insulation shall be butted tightly. Seams shall be stapled on 6" centers with outward clinching staples. Adjacent sections of duct wrap insulation shall be butted tightly with the 2" tape flap overlapping and stapled. For horizontal oval ducts over 30" wide, duct wrap insulation shall be secured additionally to the bottom of the duct with mechanical fasteners such as pins and speed clip washers spaced on 18" centers to prevent sagging. All seams, joints, tears, punctures and other penetrations in the vapor retarder jacket shall be sealed with FRK backing pressure sensitive tape.
- G. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation.
- H. Where a duct run changes from interior lining to exterior application (or vice versa), there shall be a 6" overlap of insulation.
- I. In "cold" duct system with internal duct insulation, with 1 1/2 " thickness flexible duct wrap, insulate air devices, fire dampers, duct mounted coils, dampers, and other devices in the ductwork system that are not internally insulated.

END OF SECTION  
104313.000

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## **22 00 00 PLUMBING WORK**

### **22 00 01 GENERAL**

- A. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 22 of the Specifications.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 22 of these Specifications.
- C. Each plumbing fixture, accessory, equipment item and specialty shall be installed in accordance with the respective manufacturer's recommendations.
- D. Plumbing fixtures, equipment and specialties shall be protected against damage in the period between installation and acceptance. Any item damaged shall be removed, repaired and/or replaced at no additional compensation.
- E. All operable devices and features of plumbing fixtures, accessories, equipment and specialties provided for in the Scope of Work of this Section shall be operated and proved to function satisfactorily for a period of eight (8) hours. Adjust, balance, lubricate as required, and instruct the Owner in the proper operation and maintenance of each device.
- F. The plumbing system shall comply with the 2011 Reduction of Lead in Drinking Water Act. Components shall be "lead free" equivalent of model number specified regardless if manufacturer's prefix and suffix have been included.

### **22 00 02 REFERENCES, REGULATORY REQUIREMENTS**

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20.

### **22 00 03 RELATED SECTIONS OF THE SPECIFICATIONS**

The following sections of the Specifications apply to Work under this Section:

Division 20 - Basic Mechanical Conditions and Basic Mechanical Material and Methods

Division 25 - Temperature Control (for monitoring domestic water temperature)

### **22 00 04 DEFINITIONS**

Refer to section 20 00 05.

### **22 00 05 WORK INCLUDED**

- A. Furnish material, labor and services necessary for and incidental to providing the following Plumbing Work where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications (Subsection 20 00 43) to perform the Work completely.
  - 1. Sanitary waste system, including but not limited to, sanitary piping, vent piping, plumbing fixtures, floor drains, and cleanouts.
  - 2. Storm water drainage system, including but not limited to, storm water piping, roof drains, overflow drains, area drains, subsoil drain, and cleanouts.

3. Potable domestic water system, including but not limited to, backflow preventers, pressure regulators, water meter, cold water piping, hot water piping, hot water return piping, and connection to all plumbing fixtures, equipment or specialties.
4. Domestic hot water system, including but not limited to, gas fired hot water heater, storage tank, circulator pump, and expansion tank. Refer to Division 23 for heat exchanger scope.
5. Valved branches in the potable domestic water system with backflow preventers for extension under other sections of the specification for make-up water usage.
6. Water softener system including, but not limited to mineral tank, brine tank, automatic controls, unsoftened and softened water piping.
7. Contractor shall coordinate his work with the work of other trades, and with the architectural and structural drawings.
8. Draining, filling, and venting of all modified systems as required for the above work. This includes scheduling shutdowns with the Owner. (Refer to Section 20 10 70).
9. Provide sufficient labor and resources required for the testing and balancing (Refer to Section 20 10 80) and for the commissioning process.
10. Smoke stopping of all penetrations of pipes and firestopping of the same through fire rated partitions as shown on the architectural drawings including, but not limited to stairways, shafts, corridors, floors, roofs, and required exits. (Refer to Section 20 10 20).
11. Cleaning and pressure testing equipment, piping, and accessories installed under this section of the specification. (Refer to Section 20 10 50)
12. All seismic restraints for the above work. (Refer to Section 20 10 40).
13. Installing accessories specified under other sections of the specification referenced in subsection 20 00 05.

#### 22 00 06 SUBMITTALS (SEE SUBSECTION 20 00 43)

- A. The Contractor shall submit the following shop drawings for approval in accordance with Subsection 20 00 43 - Submittals.
  1. Piping materials and valves as specified in Piping Material Schedule(s) in subsection 22 20 00.
  2. All specified drains and overflows in subsection 22 30 00.
  3. All specified plumbing fixtures in subsection 22 40 00.
  4. All specified plumbing equipment in subsection 22 60 00.
  5. All specified plumbing specialties in subsection 22 80 00.
  6. All general items specified under Division 20 utilized in the installation of work required by this section of the specification.
- B. Provide manufacturer's technical product data of each material and accessory item with engineering support information and recommended installation procedure. Data shall be specific to product specified and clearly identified on all data sheets, which contains multiple models or sizes.
- C. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.
- D. Contractor shall submit coordination drawings to the Engineer for review prior to any fabrication or installation. (Refer to Section 20 10 50).

#### 22 00 07 SPECIAL REQUIREMENTS

- A. Where lines installed under this section of the specification tie-in to existing lines Contractor shall verify all existing lines, their elevations and directions of flow before running any new lines.
  1. Contractor shall notify Architect/Engineer upon discovery if the new line cannot tie-in to the existing line due to location, elevation, size, or direction of flow.

- B. Prior to excavation, best efforts shall be made to locate lines with cameras, locating sondes, ground penetrating radar, etc.
- C. Protection:
  - 1. Protect drains during entire construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
  - 2. Place plugs in the ends of uncompleted piping at the end of each day or when work stops.

#### **22 00 08 CLOSE-OUT REQUIREMENTS**

- A. Refer to General Conditions and Division 20.
- B. As-built drawings of underground plumbing shall include dimensions from walls/columns and invert elevations.
- C. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping are smoke or fire stopped as required by the Code.

#### **22 20 00 PLUMBING PIPING SYSTEMS**

- A. General
  - 1. Furnish and install the piping systems shown on the Plans and as hereinafter specified in the respective PIPING MATERIAL SCHEDULE. Include all necessary considerations in the related sections of the Specifications (subsection 22 00 05) to provide for complete systems.
- B. All drainage lines shall be flushed clean at the completion of the Work. Rod out any obstructions encountered.
- C. All domestic water lines shall be flushed clean at the completion of the Work. Refer to Section 20 10 56 – Cleaning of Piping Systems.
- D. Pressure test each respective piping system for tightness to the test pressure indicated without loss. Repair any leaks and retest, as required. If test pressure is not indicated, hydrostatically test to 1.5 times the system operating pressure.
- E. The Plans indicate the approximate location and arrangement of roughing-in for waste, vent and domestic water piping to serve the respective plumbing fixture, equipment and specialties. Final locations and arrangements shall be determined from approved shop drawings of the respective item.
- F. Provide approved backflow preventers in all branch lines in the domestic water system for connections to non-domestic applications.
- G. Main vents shall be the same size as waste lines and shall extend 12" minimum above the roof. Minimum vent thru the roof (VTR) shall be 3" size.
- H. Vent through storm shelter roof shall be Cyclone Vault CVTR2004 by Roof Penetration Housings LLC.
- I. Install all piping with pitch to vent or drain. Provide drain valves at low points and air vents at high points. Drain valves and air vents shall be ¾" bronze, 2 piece body ball valves with ¾"

hose end adapter, cap, and chain. In ½" through 2" pipe, contractor may use Webstone model T-drain.

- J. The plumbing system shall comply with the 2011 Reduction of Lead in Drinking Water Act. Components shall be "lead free" equivalent of model number specified regardless if manufacturer's prefix and suffix have been included.

22 20 01 PIPING MATERIAL SCHEDULE P-1

- A. Service: Potable and non-potable water service mains below grade.
- B. Design: 150 psig at 60°F.
- C. Pipe: Pre-insulated SDR-11 High Density Polyethylene 4710
- 4" and larger: DIPS HDPE 4710, AWWA C906
  - Smaller than 4": IPS HDPE 4710, NSF-61, AWWA C901
- D. Fittings: Molded High Density Polyethylene 4710
- E. Joints: Butt Fusion
- F. Valves: Iron body gate valve, flanged, non-rising stem, indicator post pattern, 175psig, with curb box.
- G. Trace Wire: #12 copper wire.
- H. Pressure Test: Hydrostatic test at 200 psi for four (4) hours minimum.
- I. Transition at Building Entry: Transitions from indoors to outdoors will be with HDPE to stainless steel transition piece similar to Poly-cam model 815. The underground stainless steel will be protected with a 17# magnesium anode with a cathodic test station at grade.

22 20 02 PIPING MATERIAL SCHEDULE P-2

- A. Service: Grease waste, below grade.  
Piping within the building perimeter to 5' beyond the building limit.
- B. Design: Pressure: gravity vented.  
Temperature: 140 degrees F.
- C. Pipe: Service weight cast iron, bell and spigot.
- D. Fittings: Cast iron bell and spigot.
- E. Joints: Neoprene rubber compression type gasket.
- F. Test: Pressure test at not less than 15 feet static head of water for two (2) hours minimum.

22 20 03 PIPING MATERIAL SCHEDULE P-3

- A. Service: Storm water drainage (ST), below grade.  
Sanitary waste (SAN), and Vent (V), below grade.  
Piping within the building perimeter to 5' beyond the building limit.
- B. Design: Pressure: gravity vented.  
Temperature: 140 degrees F.
- C. Pipe: Schedule 40 PVC solid core.
- D. Fittings: Schedule 40 PVC DWV.
- E. Joints: Solvent.
- F. Test: Pressure test at not less than 15 feet static head of water for two (2) hours minimum.

22 20 04 PIPING MATERIAL SCHEDULE P-4

- A. Service: Storm water drainage (ST), above grade.  
Sanitary waste (SAN) and Vent (V), above grade.  
Piping within the building perimeter.
- B. Design: Pressure: gravity vented.  
Temperature: 140 degrees F.
- C. Pipe: Cast iron soil pipe, no-hub.
- D. Fittings: Cast iron, no-hub.
- E. Joints: No-hub stainless steel coupling assembly, with neoprene rubber gasket.
- F. Test: Pressure test at not less than 15 feet static head of water for two (2) hours minimum.

22 20 05 PIPING MATERIAL SCHEDULE P-5

- A. Service: Domestic water, above grade.  
Includes cold water (CW), hot water (HW), hot water circulating (HWC) and softened water (SW), tempered water.
- B. Design: Pressure: 100 psig.  
Temperature: 180 degrees F. max. for hot water only.
- C. Pipe: Copper, hard drawn, seamless, type L.
  - 1. Fittings: Wrought copper, solder ends.
  - 2. Dielectric Isolation union/union flanges between Fittings: water piping and non-copper connections and at all equipment connections.
- D. Flanges: Cast bronze, 125 psi.
- E. Joints:

All 95/5 Solder

F. Valves (refer to Section 20 00 13):

1. Shut-off/Service:

3" and smaller Ball valve, bronze body, two piece, full port, stainless steel ball and trim.  
4" and larger Gate valve, Class 125 cast iron body, bolted bonnet, non-rising stem, resilient wedge.

2. Balancing/Throttling:

All sizes Multi-turn calibrated balance valve

3. Recirculation (end of runs): Thermostatic recirculation balance valve (refer to Section 22 80 00)

4. Check Valve:

3" and smaller Class 125 bronze, horizontal swing, Y-pattern, regrinding type, renewable seat and disc, solder ends.  
4" and larger Class 125-iron body, bolted bonnet, horizontal swing, renewable seat and disc, bronze mounted, flanged ends.

5. Hose End Valve: Interior: ¾" hose thread outlet x copper sweat inlet with integral vacuum breaker. Nibco figure 63-VB.

6. Hose End Valve: Interior: ¾" hose thread outlet x copper sweat inlet with integral vacuum breaker. Nibco figure 63-VB.

7. Test: Hydrostatically pressure test at 150 psi for four (4) hours minimum.

22 20 07 PIPING MATERIAL SCHEDULE P-6

A. Service: Potable water, below grade – outside the building.

B. Rating: Pressure: 250 psig at 150°F

C. Pipe:

1. 3" and larger: Ductile iron pressure pipe, bituminous-coated Exterior. Cement lined interior.

2. 2" and smaller: Copper, annealed "soft", seamless, type K.

3. 2" – 4": Copper, drawn "hard", type K.

D. Fitting:

1. Ductile iron, mechanical joint, bituminous coated exterior. Cement lined interior.

2. Wrought copper, solder ends.
- E. Joints:
1. Ductile Iron: EBAA Iron Megalug or equivalent restraints at all joints.
  2. Copper: 95-5 solder
- F. Valves: Gate valve, Class 125 cast iron body, bolted bonnet, non-rising stem, resilient wedge, stem nut, and curb box.
- G. Test: Hydrostatically pressure test at 200 psi for four (4) hours minimum.
- H. Note #1: Provide retainer glands where flanged ductile iron pipe is installed at point of building entry.

22 20 08 PIPING MATERIAL SCHEDULE P-7

- A. Service: Subsoil drainage, 3" and larger below grade.
- B. Design: Pressure: gravity vented.  
Temperature: 80°F
- C. Pipe: Schedule 40 PVC perforated subsoil pipe.
- D. Fittings: Schedule 40 PVC DWV.
- E. Joints: Solvent.
- F. The trenches for the drain tile shall be excavated to allow at least 6" of filler material to be placed in the trench before laying the pipe and a backfill of at least 8" of filter material on both sides. Fill over the pipe shall extend to 18" above the pipe where located around the exterior of the building.
1. The filler material shall be washed, uniformly graded mixture of crushed stone, or uncrushed gravel, with 100% passing 1" sieve, 90 to 100% passing ¾" sieve, 15 to 40% passing ¾" sieve, and 0 to 5% passing No. 5 sieve.
  2. A filter fabric shall be placed in the trench between the earth and filter material and shall completely enclose the filler material. The fabric shall be equal to Mirafi 140N; .5 oz. nonwoven fabric composed of strong rotproof polymeric fibers. The fabric shall be nonbiodegradeable and resistant to acids and alkali solutions within the pH range of 3 to 12. The fabric shall have the following physical properties.

|               |                                |
|---------------|--------------------------------|
| <u>E.O.S.</u> | <u>#80 U.S. Standard Sieve</u> |
|---------------|--------------------------------|

|                    |                            |
|--------------------|----------------------------|
| Water Permeability | 0.07 cm/sec                |
| Coefficient (k)    |                            |
| Water Flow Rate    | 48 ga./min/ft <sup>2</sup> |
| Thickness          | 30 mils                    |
| Burst Strength     | 125 psi                    |

## 22 20 09 PIPING MATERIAL SCHEDULE P-8

- A. Service: Natural Gas Piping, appliance connector.
- B. Design: Pressure: 14 in. w.c.
- C. Pipe: Corrugated, Stainless Steel Tubing (CSST), ASTM A 240, stainless steel with yellow flame retardant PE coating.
- D. Fittings:

Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing. Fittings shall be approved for use with CSST.
- Note: All piping methods and materials shall be in accordance with NFPA 54, National Gas Code.
- E. Pressure Test: New piping shall be installed, capped, and pressure tested with Nitrogen at 50 psi for two (2) hours. After the piping has passed the above pressure test the final tie-ins shall be made, then the system will be filled with natural gas and the final joints will be checked with soap.

## **22 30 00 DRAINS AND CLEANOUTS**

- A. General
  - 1. Furnish and install the following drains and cleanouts where shown on the Plans and as hereinafter specified. Drains and cleanouts shall have all options, body material, top size, top style, top material, and accessories as specified whether or not listed as a prefix, suffix, or catalog number.
  - 2. All floor drains to be provided with trap guard.
- B. Drain and cleanout outlets shall be compatible with respective piping material and size. Outlets below grade shall be push type. Outlets above grade may be no-hub or push type at the Contractor's option. Tops shall be compatible with the flooring system.
- C. Provide deep seal P-traps for all floor drains.
- D. Provide full size cleanouts up to 4" size above the lowest floor line in all drainage risers, and where total of the fittings exceed 120 degrees and at changes in direction greater than 45 degrees in horizontal drainage lines, and at intervals of not greater than fifty (50) feet in straight piping runs 4" diameter and smaller, and one hundred (100) feet for piping over 4" diameter.
- E. Do not install cleanouts in electrical equipment rooms. Extend the cleanout to outside the room limits.
- F. Where cleanout is located in open ground, extend the cleanout to finished grade elevation and install a 16" x 16" x 8" deep concrete pad at grade to secure the cleanout.
- G. Submit with products, a room by room schedule indicating floor drains and cleanouts to be used including top size, shape, floor finish material, and setting height with respect to concrete slabs. Any drain body set prior to approval shall be performed with block-outs to allow correct tops and finished heights to be adjusted.



#### 22 30 01 TRAP GUARDS

- A. Trap guard shall be provided for all floor drains. Trap guards shall be constructed of UV and Ozone resistant ABS plastic housing with rubber or elastomeric PVC diaphragm and sealing gasket. Unit shall meet floor rating ASSE – 1072 AF-GW. Size appropriately to match each specific floor drain. Unit shall be ProSet Trap Guard, Rectorseal SureSeal, MIFAB MI-GUARD or approved equivalent.

#### 22 30 02 CLEANOUTS

- A. Cleanout: interior finished floor (FCO):

Cast iron body, threaded adjustable housing, flanged ferrule with straight tread gasketed bronze plug and square secured satin nickel bronze scoriated top, vandal proof fasteners, tops shall be for tile, carpet, ceramic tile, terrazzo tile as required. Wade W-8000-S-75-VP, Zurn ZN-1400-T-BP-VP, J.R. Smith 4041-U, MIFAB C1100-S-1-6, Sioux Chief 834-4DNQV, or Josam 55000-1-SQ-22-VP.

- B. Cleanout: interior unfinished floor (FCO):

Cast iron body, threaded adjustable housing, flanged ferrule with straight tread gasketed plug and round secured satin nickel bronze scoriated top, vandal proof fasteners. Wade W-8000-1-75-VP, Zurn Z-1400-BP-VP, J.R. Smith 4021-U, MIFAB C1100-R-1-6, Sioux Chief 834-4DNRV, or Josam 55000-1-22-VP.

- C. Cleanout: wall type for concealed riser in finished spaces (WCO):

Provide cleanout fitting with screwed plug opening and countersunk bronze plug. Provide 8" x 8" square access covers with polished nickel bronze beveled edge frame with anchor lugs for over the wall installation, smooth stainless steel cover, and vandal proof fasteners. Wade 8303-85-75-VP, Zurn ZANB-1460-9-VP, J.R. Smith 4730-U-NB, MIFAB C1460-S-3-6, or approved equivalent.

- D. Cleanout: wall type for concealed riser in unfinished spaces (WCO):

Provide cleanout fitting with screwed plug opening and countersunk bronze plug. Provide round access covers with smooth stainless steel cover, and vandal proof center screw. Wade, Zurn, J.R. Smith, MIFAB, Sioux Chief, Josam, or approved equivalent.

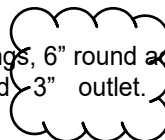
- E. Cleanout: exterior location (YCO):

Cast iron body, threaded adjustable housing, flanged ferrule with straight tread gasketed plug and round secured cast iron or ductile iron top. Wade W-8000-12-75-BP, Zurn Z-1400-BP-VP, J.R. Smith 4221-U, MIFAB C1100-XR-4-6, Sioux Chief 834-4DiRV, or Josam 55000-22-VP.

#### 22 30 03 FLOOR DRAINS

- A. Floor Drain: interior finished floor (FD-A):

Cast iron body with flashing flange, seepage openings, 6" round adjustable satin nickel bronze, strainer top with vandal proof fasteners, and 3" outlet. Wade W-1103-G6-1-VP,



Zurn ZN-415-6S-VP, J.R. Smith 2005-B06NB-U, MIFAB F1100-S6-1-6, Sioux Chief 832-235NQV, or Josam 30000-6S-VP.

B. Floor Drain: mechanical equipment room (FD-B):

Cast iron body with flashing flange, seepage openings, 7" cast iron loose set tractor strainer and 3" outlet. Wade W-1103-TS7-12, Zurn Z-415-7N, J.R. Smith 2000-D-CI, MIFAB F1100C-7N, Sioux Chief 833-23DiR, or Josam 30000 7E-93.

C. Floor Drain: interior unfinished floor (FD-C):

Cast iron body with flashing flange, seepage openings, 6" round adjustable satin bronze round strainer top, with vandal proof fasteners and 3" outlet. Wade W-1100-A6-VP, Zurn ZN-415-6B-VP, J.R. Smith 2000-A06NB-U, MIFAB F1340-Y-Q-1-6, Sioux Chief 833-235DNRV or Josam 30000-6A-VP.

22 30 04 FLOOR SINKS

A. Floor Sink (FS-A):

Cast iron 12" square floor sink with 8" sump, A.R.E. interior, aluminum dome strainer, and nickel bronze hinged top. Field cut grate as required for drain terminations. Wade W-9140, Zurn ZN-1901-K, J.R. Smith 3150, MIFAB FS1730-1, or Josam 49340A-LF-NB.

B. Floor Sink (FS-B):

Same as floor sink FS-A, except with sediment bucket. Wade W-9140-27, Zurn ZN-1901-K-23, J.R. Smith 3151, MIFAB FS1730-1-5, or Josam 49340A-LF-NB-33.

C. Floor Sink (FS-C):

All Duco cast iron receptor and grate, dome strainer, 12" square floor sink with 8" sump with sediment bucket, all components shall be acid resistance coated, A.R.C. Provide with ½ grate. J.R. Smith 3430 or equivalent by Wade, Zurn, or MIFAB.

22 30 05 ROOF DRAINS

A. Roof Drain: (RD-A):

Cast iron body with flange, flashing collar and gravel stop, removable cast iron dome and under deck clamp, sump receiver pan, adjustable extension. Provide extension, as required, to suit thickness of roof construction. Wade W-3000-AE-42-52-53, J.R. Smith 1015-R-C-CID, MIFAB R1200-EU-B-M-U, or Josam 21500-AE-1-2-22, or high performance roof drain with funnel-shaped body: Zurn Z-100-C-EA-R.

A. Overflow Drain: (OFD-A):

Same specification as subsection 22 30 02, except add 2" high dam. Wade W-3000-AE-D-42-52-53, Zurn ZC-100-C-EA-R-89. J.R. Smith 1045-R-C-CID, MIFAB R1200-EU-B-M-U-W2, or Josam 21500-16-AE-3-22.

B. Overflow Drain Nozzle (OFN-A):

Overflow drain downspout cover to be located at each discharge location. Downspout cover shall be fabricated of 304 stainless steel and provide with hinged perforated cover and vandal proof construction. Overflow drain cover shall be Josam 25020-Z-VP, J.R. Smith 1775-U, MIFAB R1960, Wade 3941-VP, Watts RD-950-6, Zurn Z199-DC-VP or approved equal.

**22 30 06 TRENCH DRAIN**

A. Trench Drain: (TD-A) (SHOWERS):

Minimum 14 ga. Type 304 stainless-steel body, ADA slotted grate with vandal-proof fasteners, 2" no-hub bottom outlets (review plan for quantity of outlets) and flashing flange clamp. Provide custom unit at length specified with quantity of drain outlets specified on drawings. Base of drain shall slope to each drain outlet. JR Smith 9666 or approved equivalent by Zurn, MIFAB or Wade.

See Architectural Drawings for length.

B. Trench Drain: (TD-C) (LAUNDRY DRAIN)

1. Provide trough recessed in floor.
2. Trough shall be 1/4" polypropylene body, 3/8" polypropylene lid, lint filter with 3/8" diameter holes. Units shall be chemical resistant. Lid shall be secured with stainless steel screw. Unit shall be 36" long, 18" wide, and 12" deep with end 3" waste discharge and 3" top inlet from washer. Unit shall be manufactured by H-M Company or approved equivalent.
3. Locations: Custodial Rm 300 and Alcove 309.

**22 40 00 PLUMBING FIXTURES**

A. General

1. Furnish and install the following plumbing fixtures where shown on the Plans and as hereinafter specified. Plumbing fixtures shall be institutional/commercial grade fixtures, no residential or "trade" grade fixtures are acceptable. Plumbing fixtures and accessories shall have all options, body material, water consumption, and accessories as specified where or not listed as a prefix, suffix, or catalog number. Include all necessary work in the related sections of the Specifications (subsection 22 00 03) and accessories to provide for complete installation and operation of the respective fixture.
2. All plumbing fixtures and non-metal accessories shall be white color, except where shown or specified otherwise.
3. Vitreous china fixtures, where specified, shall be best quality, non-absorbent. Warped or imperfect fixtures shall not be accepted. Enameled cast iron fixtures, where specified, shall be thoroughly fused and bonded to body without discoloration, chips, flaws or cracks. Finish all exposed surfaces.
4. Fixture trim shall be cast brass with polished chrome-plated finish on exposed surfaces, except where shown or specified otherwise.
5. Fixture traps shall be tubular wall type, minimum 17 gauge with integral cleanout plugs, polished chrome plated finish, except where shown or specified otherwise. Size to suit fixture tailpiece. Comply with local plumbing code.

6. All water closets, and urinals shall be from the same manufacturer. All faucets for lavatories, janitor sinks, and sinks shall be from the same manufacturer. All supplies and stops for lavatories and sinks shall be from the same manufacturer. All fixture carrier shall be from the same manufacturer.
7. Furnish accessories for fixtures requiring trim, carriers, brackets, back-up plates, specialties, etc. for respective complete installation.
8. Install all designated fixtures to respective ADA Standards requirements per Federal Register 28 CFR part 36, July 26, 1991.
9. Provide stops (valves) in all water supplies to all fixtures.
10. Provide escutcheon plates for all wall penetrations for exposed connections to fixtures.
11. Division 22 shall provide templates of openings required for countertop mounted fixtures to the General Contractor.
12. Connections between plumbing fixture outlets and respective waste piping shall be gas and watertight. Use suitable and approved setting compound or gasket; rubber gaskets or putty are not acceptable.
13. Acceptable manufacturers:
  - a. Vitreous China Fixtures - American Standard, Kohler, Mansfield, Zurn, Sloan, Toto
  - b. Stainless Steel Sinks – Elkay, Just, Advance Tabco
  - c. Carriers – Josam, J.R. Smith, MIFAB, Wade, Watts, Zurn
  - d. Flush Valve – Sloan Royal, no substitutions allowed.
  - e. Supplies, Strainer, Traps – McGuire, Chicago Faucets, Dearborn, Brass Craft, Engineered Brass, American Standard, Kohler, Elkay.
  - f. Faucets: Chicago Faucets, or Sloan, no substitutions allowed.

#### 22 40 01 WATER CLOSETS (WC-A AND WC-B)

##### A. Wall Hung:

Vitreous china elongated bowl, 1.28-1.6 gal/flush, siphon-jet, wall-mounted with 1-1/2" (top) inlet spud, High Efficiency Toilet (HET). Conforms to ASME Standard A112.19.2 fixture dimensions. American Standard "AFWALL Millennium FloWise" model 2257.101, Kohler "Kingston" model K-84325-0, Mansfield "Erie" model 1301, Sloan model ST-2459, Toto CT708E, or Zurn model Z5615-BWL. Mount at ADA height where scheduled on drawings. Mount at ADA height where scheduled on drawings.

#### 22 40 02 WATER CLOSET: SEATS

- A. Provide seats for each water closet furnished.
- B. Standard Seat: Heavy duty commercial, solid plastic, open front less cover for elongated bowl, integral bumpers, self-sustain hinges and external check hinges with stainless steel hinge pins and mounting bolts. American Standard model 5901.100SS, Bemis model 1955SSCT, Church model 295SSCT, or Zurn model Z5955SS-EL-STs.

#### 22 40 03 WATER CLOSET: FLUSH VALVES

A. Provide flush valves for each water closet furnished, as scheduled.

B. Automatic, Hardwired – Wall Mounted, 1.6 GPF

Diaphragm type, 1.6 gallons per flush closet flushometer, ADA compliant, hard wired low voltage powered automatic “no hands” operation, chrome plated infrared sensor housing, angled sensor window, manual override flush button. 1” I.P.S. screwdriver angle stop with vandal resistant stop cap, adjustable tailpiece, vacuum breaker flush connection, spud coupling and spud flange for 1½” top spud. Valve shall be in compliance with the applicable sections of ANSI/ASME A112.19.2. Sensor to be mounted flush with the wall.

Furnish transformer(s) as required for a group application of water closets, urinals, and faucets.

1. Sloan model Royal Optima 111 ES-S TMO-HW, no substitutions.

#### 22 40 04 WATER CLOSET: CARRIERS

A. Provide carriers for each wall hung water closet furnished.

Arrangements shall be per the application.

Carrier: Adjustable anchor foot type for above-the-floor no-hub piping connection for wall hung toilet. Cast iron factory painted adjustable faceplate with corrosion-resistant adjustable waste coupling with neoprene seal and integral test cap. Zinc plated steel fixture studs with vandal proof chrome plated fixture cap nuts and fiber fixture washers. Josam 12674/12684/12694-VP, J.R. Smith series 0200, MIFAB series MC-10, Wade series W-311, Watts series ISCA-101, or Zurn series Z-1203-N-VP.

#### 22 41 01 URINALS (UR-A AND UR-B)

A. Urinal (1.0 GPF):

Vitreous china water saver (1.0 gallons per flush) siphon-jet, wall hung and with ¾” (top) inlet spud, 2”IPS female threaded outlet (rear) connection and wall hanger. Conforms to ASME Standard A112.19.2 fixture dimensions. American Standard “Trimbrook”, model 6561.017, Kohler “Freshman” model K-4989-T, or Zurn Z5730.

#### 22 41 02 URINAL: FLUSH VALVES

A. Provide flush valve for each urinal furnished.

B. Automatic, Hardwired – Valve Mounted, 1.0 GPF

1. Diaphragm type, 1.0 gallons per flush urinal flushometer, hard wired low voltage powered automatic “no hands” operation, chrome plated infrared sensor housing, ¾” I.P.S. screwdriver angle stop with vandal resistant stop cap, adjustable tailpiece, vacuum breaker flush connection, spud coupling and spud flange for ¾” top spud. Valve shall be in compliance with the applicable sections of ANSI/ASME A112.19.2. Sensor to be mounted on side of valve.
2. Furnish transformer(s) as required for a group application of water closets, urinals, and faucets.
3. Sloan model Royal 186 SMOOTH 186-HW-1.0, no substitutions allowed.

#### 22 41 03 URINAL CARRIERS

- A. Provide carrier for each urinal furnished.

Adjustable height universal plate hanger carrier with rectangular steel uprights, block base anchor feet, upper and lower support plates, and vandal proof cap nuts. Josam 17550-UR, J.R. Smith 0636, MIFAB MC-32, Wade W-401-AM1-M3, Watts CA-321, or Zurn model Z1222-58.

#### 22 42 01 LAVATORIES

- A. Wall Hung Lavatory (L-A & LA-B)

Vitreous china with front overflow, faucet ledge, concealed carrier arms, self-draining deck area with contoured back and side splash shields. Nominal size: 20-1/2" x 18-1/4" with "D" shaped bowl. Single faucet hole. Conforms to ASME Standard A112.19.2 for fixture dimensions. American Standard model "LUCERNE" 0356.015, Kohler "Kingston" model K-2006-0, Sloan model SS-3803, or Zurn model Z5348.

Refer to architectural drawings for mounting height.

- B. Undercounter Lavatory (L-C):

Vitreous china with front overflow, unglazed rim for undercounter mounting. Nominal size: 19 1/4" x 17" with oval shaped bowl. Conforms to ASME Standard A112.19.2 for fixture dimensions. American Standard model "Ovalyn" 0496.221, Kohler model "Caxton" K-2210-0, Mansfield "Maple" model 217, Sloan model SS-3001, or Zurn model Z5220.

#### 22 42 02 LAVATORY FAUCETS

- A. Automatic Faucet, Hard Wired, Small Gooseneck:

1. Single hole, 4-1/2" spout, single supply for tempered water, vandal proof 0.5 GPM non-aerating spray outlet, infrared sensor operated, serviceable strainer, single 24 VAC solenoid valve, metal jacketed hard wired automatic faucet.
2. Thermostatic temperature mixing valve that conforms to ASSE 1070, Sloan Model BDT.
3. Furnish transformer(s) as required for a group application of water closets, urinals, and faucets, equal to Chicago Faucets 243.260.00.1.
4. Sloan model ETF-600, no substitutions allowed.

#### 22 42 03 LAVATORY ACCESSORIES

- A. Standard Strainer:

1-1/4" x 17 gauge cast brass grid strainer, integral spud and tailpiece.  
McGuire Mfg. model 155A, Dearborn Brass model 760-1, Just J-15-FS, or approved equivalent.

- B. ADA Strainer:

1-1/4" x 5" offset x 17 gauge cast brass grid strainer, integral spud and tailpiece.

McGuire Mfg. model 155WC, Dearborn Brass model 760W-1, Just J-ADA-15-FS, or approved equivalent.

C. Supplies:

Loose keyed ball valve angle stops with lock shield caps and 1/2" (nominal) copper solder (5/8" ODS) inlet x 3/8" OD outlet x 12" long flexible risers. Provide cast brass escutcheons. Chicago Faucets model STB-41-11-AB, approved equivalent by McGuire, Dearborn, Brass Craft, Engineered Brass, or Kohler.

D. Trap:

1-1/2" x 1-1/4" x 17 gauge tubular P-trap with clean-out, plug and wall escutcheon. McGuire Mfg. model 8902, Dearborn Brass model 510, Just model JT-150, or approved equivalent.

E. Insulation Kit:

Conforms to 28CFR Part 36, Article 4.19.4 (7/26/91). Truebro model LavGuard2, Dearborn Brass model ADA100, Just model J-ADA-150, or approved equivalent.

F. Standard Wall Hung Carrier:

Adjustable concealed arm lavatory carrier with rectangular steel uprights, block base anchor feet. Josam 17100, J.R. Smith 700-M31, MIFAB MC-41, Wade model W-520-M36, Watts WCA-411 or Zurn Z1231.

G. Wheel Chair Wall Hung Carrier:

Adjustable concealed arm lavatory carrier with rectangular steel uprights, block base anchor feet and extended arm supports. Josam 17100-67, J.R. Smith 0700-27-M31, MIFAB MC-42, Wade catalog no. W-520-M24-M36, Watts CA-411-WC or Zurn Z-1231-79.

22 43 01 SINKS

A. Single Compartment, Countertop Size 1 (SK-A1 & SK-B & SK-D)

18 gauge, type 304 stainless steel, self-rim single bowl sink. Inside bowl dimensions: 21" L x 15 1/2" W x 5 1/2" D. Faucet deck with 3 holes (per the Faucet schedule) on 4" centers. Elkay model LRAD-252260.

B. Single Compartment, Countertop Size 2 (SK-C)

18 gauge, type 304 stainless steel, self-rim single bowl sink. Inside bowl dimensions: 16" L x 16" W x 6" D. Faucet deck with 3 holes on 4" centers. Elkay model LRADQ202260.

C. Double Compartment, Countertop (SK-A2)

18 gauge, type 302 stainless steel, self-rim double bowl sink. Overall dimensions 43" L x 22" W X 12" D. Inside bowl dimensions: 19" L x 16" W x 12" D. Faucet deck with single hole. Elkay model DLR-432212.

D. Oval, Countertop Size 2 (SK-D)

~~18 gauge, type 304 stainless steel, self-rim single oval bowl sink. Inside bowl dimensions: 15 1/2" L x 11 1/2" W x 6" D. Elkay model ELUH1511.~~

22 43 02 SINKS ACCESSORIES

A. Strainer:

Provide stainless steel crumb basket with rubber stop for 3-1/2" drain opening and 1-1/2" OD brass tailpiece for each sink bowl, that does not have a disposal. Elkay model No. LK-35, Just J-35, or Advance Tabco K-310.

B. Supplies:

Loose keyed ball valve angle stops with lock shield caps and 1/2" (nominal) copper solder (5/8" ODS) inlet x 3/8" OD outlet x 12" long flexible risers. Provide cast brass escutcheons. Chicago Faucets model STB-41-11-AB, or approved equivalent by McGuire, Dearborn, Brass Craft, Engineered Brass, or Kohler.

C. Trap:

1-1/2" x 17 gauge tubular P-trap with cleanout plug and wall escutcheon. McGuire Mfg. model 8912, Dearborn Brass model 710-1, Just model JT-150, or approved equivalent.

22 43 03 SINK FAUCETS

A. Large Gooseneck, Wristblade Handles

8" centers, 8" 360 degree swing gooseneck spout, vandal proof 2.2 GPM aerator, and vandal proof metal wristblade handles. Complies with ANSI A112.18.1. Chicago Faucets model 1100-GN8AE35-317AB .

B. Large Gooseneck, Lever Handles with Integral Sprayer

9 1/2" swing gooseneck spout and spray valve with 44" flexible stainless steel hose, vandal proof 2.2 GPM aerator, vandal proof metal lever handles, and pipe strap and hook assembly. Complies with ANSI A112.18.1. Chicago Faucets model 919-613XKCAB.

22 45 01 MOP SINK BASIN (MSB)

A. Receptor (basin):

24" x 36" x 12" high, precast terrazzo one-piece basin, ground smooth, grouted and sealed to resist stains. Top edge capped with 20-gauge type 302 stainless steel cast integrally on all four sides. Acorn model TSH-24-KF24

A. Faucet:

Vacuum breaker rigid spout with 3/4" hose thread outlet, polished chrome finish, wall brace and pail hook, 1/2" F union inlets on exposed valves on 6" centers, lever handles, indexed and tabbed for "HOT" and "COLD". Chicago Faucets model 835 for overhead supplies. Chicago Faucets model 897-CCP for supplies thru-the-wall.



B. Strainer:

Cast brass outlet with stainless steel strainer cast integrally into bottom of basin to provide for an inside caulk connection for a 3" waste pipe.

C. Splash Panels:

Provide 20 gauge 302 stainless steel sheet splash catcher panels on one or two sides as required.

22 45 02 ELECTRIC WATER COOLER: SINGLE, NON-FILTERED, BOTTLE FILLER (EWC-A)

- A. Wall mounted, refrigerated for general public and handicapped usage. Refer to architectural elevation drawings for mounting heights. Bubbler shall be activated by mechanical push-bar and have built-in pressure regulator for supply pressure range from 20 to 125 psi. All exposed surfaces shall be satin-finish type 304 stainless steel. All waterway components shall be copper construction with lead-free connections. Refrigeration system shall be air-cooled; chill the drinking water in a storage tank type heat exchanger; have an adjustable thermostatic control; be rated to cool 8 gph from 80 deg. F to 50 deg. F at 90 deg. F room temperature; be certified by ARI, UL and CSA and comply with all local building codes and ADA Requirements. Provide Halsey Taylor Model HTHBHVR8-NF with louver screens, no substitutions.
- D. For masonry construction applications, Plumbing Contractor will mount water cooler directly to wall using factory supplied mounting box. For non-masonry applications, provide and mount using Wade W-440-A11-M36, Zurn 1225-BL, J.R. Smith 0830, or Watts CA-421-HFH.

22 45 01 ELECTRIC WATER COOLER: SINGLE, NON-FILTERED (EWC-B)

- A. Wall mounted, refrigerated for general public and handicapped usage. Refer to architectural elevation drawings for mounting heights. Bubbler shall be activated by mechanical push-bar and have built-in pressure regulator for supply pressure range from 20 to 125 psi. All exposed surfaces shall be satin-finish type 304 stainless steel. All waterway components shall be copper construction with lead-free connections. Refrigeration system shall be air-cooled; chill the drinking water in a storage tank type heat exchanger; have an adjustable thermostatic you control; be rated to cool 8 gph from 80 deg. F to 50 deg. F at 90 deg. F room temperature; be certified by ARI, UL and CSA and comply with all local building codes and ADA Requirements. Provide Halsey Taylor Model HVR8-NF with louver screens, no substitutions.
- B. For masonry construction applications, Plumbing Contractor will mount water cooler directly to wall using factory supplied mounting box. For non-masonry applications, provide and mount using Wade W-440-A11-M36, Zurn 1225-BL, J.R. Smith 0830, or Watts CA-421-HFH.

22 47 01 SHOWER: ADA DUAL OUTLET: INDIVIDUAL STALL (SH-A)

- A. Heavy duty, pressure balancing mixing valve with integral screwdriver service stops and adjustable stop screw to limit handle turn.  
Heavy duty, diverter valve for operation on either hand or fixed head operation (not both simultaneously)  
Hand shower with non-positive shutoff, 60 inch. flexible hose, in-line vacuum breaker. The shower spray unit shall have an on/off control with a non-positive shut-off.  
30" adjusting bar with slide bracket.  
Attached soap dish.  
Matching sloped horizontal supply covers.  
All fittings for direct connection to 1/2" copper horizontal supplies.  
Stainless steel covering to be 18 gauge with #4 brush finish and extend to ceiling.

Vandalproof.

Symmons Hydapipe H902S custom shower system, less fixed head punchout on shroud. No substitutions.

Super, adjustable spray showerhead, vandal resistant, with ball joint mounted to institutional type head bracket shall be provided for remote install (not on hydapipe shroud) with this unit. Contractor shall be responsible for piping from diverter valve to fixed head in adjacent CMU or metal stud wall (Refer to Architectural drawings for more information on fixture locations). Piping shrouds are not required at the fixed head location. Head shall be by Symmons, no substitutions.

- B. Contractor shall provide all accessory fittings as necessary to complete shower fitting assembly.

**22 47 02 EMERGENCY SHOWER (ES-A)**

- A. Combination drench shower/eye/face wash station shall comply with ANSI Z358.1. 10" diameter stainless steel shower head. 1" stay-open ball valve operated by stainless steel pull rod with triangular handle. 20 gpm flow control for shower head. 10" diameter stainless steel eyewash bowl. ½" stay-open ball valve with hand operated paddle push handle. 8 gpm flow control for eye/face wash. Unit shall be floor mounted and wall anchored. Acorn S2340-BF-AS, Bradley S19314BFSS, Guardian Equipment model GBF1994, or Stingray model S5515-SS-EP-NFT-SSSS.

**22 60 00 PLUMBING EQUIPMENT**

A. General

1. Furnish and install the following plumbing equipment where shown on the Plans and as hereinafter specified. Include all necessary considerations in the related sections of the specifications (subsection 22 00 02) and accessories to provide for complete installation and operation of the respective equipment item.

**22 60 01 CONDENSING DOMESTIC WATER HEATER (DWH-1,2)**

- A. Heater shall be gas-fired equipped to burn natural gas with gas controls to totally regulate gas input pressure between 7"-14" water column to the required burner/pilot operating pressures as controlled by the heater's controls to maintain setpoint temperature adjustable between 100°F - 160°F. The American Gas Association shall certify the design to meet the latest ANSI Standard.
- B. Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
- C. Tank shall be steel, rated for 150 psi working pressure, all internal surfaces exposed to water shall be glass lined, insulated with foam insulation, exceeding ASHRAE 90.1., covered with a minimum 16 ga. outer jacket, and have baked enamel finish.
- D. Heater shall have an ASME pressure/temperature relief valve, replaceable magnesium anode rods, high temperature safety gas shutoff, draft hood/diverter, non-metallic dip tube, and drain valve with hose end and cap.

- E. Where applicable, comply with and submit application to State of Missouri Authority for ASME-CSD-1-1998 certification and reporting. (2021 is latest version of CSD-1).
1. Application or report shall list: (1) each device installed in accordance with ASME-CSD-1-1998; (2) name of the manufacturer and model number of each control and safety device; (3) operational test performed.
  2. Copy of this report shall be (1) submitted to the Chief Inspector, (2) provided to the owner/user, and (3) hung by chain at each boiler or pressure vessel to be made available to the authorized inspection agency or inspector.
  3. It is the responsibility of the installing contractor to deliver these instructions, together with complete wiring and piping diagrams, and a written precaution that the operating, testing, and servicing only be performed by qualified personnel, to the owner/user and to obtain a receipt for the instructions. The receipt shall be filed with the installation report.
- F. Water heater shall meet or exceed the capacity scheduled. PVI Conquest A.O. Smith Cyclone Mxi , Bradford-White F Series, Heat Transfer Products Pheonix, Lochinvar Armour, or equivalent model by Rheem/Ruud.

22 60 02 DOMESTIC WATER CIRCULATING PUMP (DWCP-1,2)

- A. Domestic hot water circulating pump shall be stainless steel with impact modified PPE impeller, line mounted, with capacities as scheduled. Bell & Gossett model ecocirc XL or 20-18, or approved equivalent by Armstrong or Grundfos.

22 60 04 WATER SOFTENER

- B. Furnish and install a vertical pressure type water softener system complete with pressure vessel, softening resin, control valve, brine maker and electronic controller. The system will be of an approved design as fabricated by a manufacturer regularly engaged in the production of water treatment equipment. All equipment and material will be supplied in compliance with the specifications as intended for a complete and operational system.
- C. The system specifications are based on Culligan International model CSM 750-3-DF 42in Duplex Non-Code Tank with Prog. Flow configured with a Water Meter and an Aqua Sensor device.
- D. The system specifications are based on Culligan International model CSM 750-3-DF 42in Duplex Non-Code Tank with Alt. Flow configured with either a Timeclock, Water Meter or Aqua Sensor device.
- E. The purpose of the Culligan International Series CSM automatic water softener will be to remove mineral hardness from a known water supply to a level not to exceed 17.1 mg/l, as determined by an accepted ASTM or EDTA test method, when the system is operated at 174 gpm and in accordance with the operating instructions. The system will be capable of supplying 84230 gallons of softened water between regenerations based on the influent water analysis listed in Section 3.1 of this equipment specification.
- F. The systems performance is rated at a design flow rate of 174 gpm with a rated pressure drop of 10.6 psi and will be capable of a peak flow rate of 267 gpm for sustained periods of 90 minutes with a pressure drop of 25 psi.
- G. There shall be a quantity of 1 of the above-described systems.
- H. Softener Tanks: Each system shall include (2) tanks. Each softener tank shall be 42 in. in diameter. The overall tank height (less base) shall be 60 in., sufficient to allow for a proper freeboard space above the resin bed for adequate expansion of the resin during backwashing. Tanks shall be electrical welded pressure vessel, low carbon steel construction rated for 100.0 psi working pressure and a minimum design pressure of 1.2 times the working pressure amount. Additionally, the tanks shall be capable of withstanding testing with pressure fluctuations from 0 to 120 psi for a minimum of 30,000 cycles

- I. Main Operating Valve: The main operating valve shall be a fully automatic multiport diaphragm type. The multiport design shall incorporate all valves necessary for complete control of the softener service and regeneration steps. The diaphragm valves shall be slow opening and closing, free of water hammer. The diaphragm assembly shall be fully guided on its perimeter to assure a smooth reliable shut off without sticking. There shall be no dissimilar metals within the valve and no special tools shall be required to service the valve. The main operating valve shall include a valve mounted automatic self-adjusting brine injector to draw brine and control rinse at a constant rate regardless of water pressure in the range of 30.0 and 100.0 psi. The main operating valve shall be protected externally and internally against corrosion with an application of NSF-61 listed electrodeposition coating. The valve shall have a soft water sampling cock. The unit shall be supplied so that the valve will allow automatic bypass of untreated water during regeneration. The bypass shall be integral to the main operating valve body and be capable of being easily modified to prevent untreated water bypass.
- J. Flow Control: The backwash flow controller shall be a pressure-compensating orifice capable of providing and maintaining proper backwash flows over the entire listed operating pressure range of the system. The backwash flow controller shall be easily serviced without special tools and design so that service to the flow controller can be performed without disassembly of the valve body or the sequencing controller and without disconnecting existing inlet and outlet piping connections.
- K. Controls:
  - 1. A fully integrated programmable microprocessor driven electronic controller shall be provided to automatically cycle the main operating valve through the regeneration sequence. The electronic controller shall be designed and manufactured by the same manufacturer as the water treatment equipment.
  - 2. The controller shall be capable of initiating a regeneration by accepting an internal signal from the controller time keeping device; an external Hall-Effect flow sensor, a Culligan Aqua-Sensor®, an external device such as a remote start push-button or any combination of these methods. The controller shall sequence all steps of an automatic regeneration and automatically return the softener to a service or stand-by mode. The initiating time and/or volume setpoints shall automatically reset upon completion of the regeneration sequence.
  - 3. The controller shall include a sealed keypad, capable of programming all controller functions, located on the face of the controller. The controller display shall be a multi-line OLED display capable of full text readouts of operating status and codes.
  - 4. An audible alarm beeper capable of emitting a tone of ~70 dBA shall be available but capable of being disabled if so desired.
  - 5. The controller shall allow for a manual initiation of the automatic regeneration sequence by utilizing a regeneration selection from the controller menu.
  - 6. The controller shall operate on a low voltage electrical system. The system shall include a UL/CUL listed transformer. The entire electronic control package and its associated inputs/outputs shall require not more than 24 VAC @ 50VA.
  - 7. The controller shall utilize EEPROM to save pertinent programmed data and statistical functions. The controller must retain all functionality for power interruptions of less than 72 hours. A battery backup shall be installed and capable of maintaining the time of day for a minimum of 5 years.
- L. Exchange Resin: The ion exchange resin shall be virgin high capacity "standard mesh" of sulfonated polystyrene type stable over the entire pH range with good resistance to bead fracture from attrition or osmotic shock. Each cubic foot of resin will be capable of removing 30000.0 grains of hardness as calcium carbonate when regenerated with 15.0 lbs of salt. The resin shall be solid, of the proper particle size of 16x40 mesh, U.S. standard screen and will contain no agglomerates, shells, plates or other shapes that might interfere with the normal function of the water softener. The resin shall be manufactured to comply with the food additive regulation 21 CFR 173.25 as set forth by the USFDA. The system shall include 20ft<sup>3</sup> of exchange resin per vessel and a total of 60ft<sup>3</sup> of resin for the system.
- M. Brine System

1. Provide a complete brine system consisting of a plastic tank, cover, salt platform, brine well, an automatic brine valve and all necessary fittings for operation with the water softening system. The system shall consist of a combined brine measuring and salt storage tank with salt platform. The recommended tank will be sized 24.0 in. x 50.0 in.; the system will include a total of one (1) brine tank. This brine tank can hold 2700 of salt which provides for 16 per salt fill.
2. The brine tank will be equipped with a float operated non-corrosive field serviceable brine float valve for automatic control of brine withdrawal and freshwater refill.
3. The brine valve will automatically open to admit brine to the resin tank during eduction and close automatically providing positive shut-off to prevent air from entering the system. The brine valve will also regulate the flow of soft water into the brine tank during refill. The brine valve works with the timed fill feature of the main operating valve controls to admit the correct volume of fresh water to the brine tank in accordance with the refill time setting in the control program. The brine valve will include a float operated safety shut-off valve as a back up to the timed refill from the main operating valve control to prevent brine tank overflow.
4. Contractor shall provide and install adequate salt for startup and testing of the system. At substantial completion, fill the brine tank and provide the owner with an additional pallet of salt (~2,700 lbs) for brine tank refills.

## **22 80 00 PLUMBING SPECIALTIES**

### **A. General**

1. Furnish and install the following plumbing specialties where shown on the Plans and as hereinafter specified. Include all necessary considerations in the related sections of the specifications (subsection 22 00 02) and accessories to provide for complete installation and operation of the respective item.
2. Specialties shall comply with the 2011 Reduction of Lead in Drinking Water Act. Components shall be "lead free" equivalent of model number specified regardless if manufacturer's prefix and suffix have been included.

### **22 80 01 BACKFLOW PREVENTER – REDUCED PRESSURE**

- A. Furnish and install reduced pressure backflow preventer at water service entrance and at cross connection locations.
- B. Assembly shall include shut off valves, strainer, test cocks, and pressure relief valve with ASME A112.1.2 air-gap fitting located between two positive seating check valves. Construction shall be all bronze with quarter-turn, full port, resilient seated ball valve shut offs for sizes 2" and smaller. 2-1/2" and larger shall be bronze, cast-iron, steel or stainless steel body and interior coating according to AWWA C550 or FDA approved epoxy coating with OS&Y resilient seated gate valve shut offs.
- C. Discharge from air gap shall be piped to a floor drain.
- D. Backflow preventer shall be Watts model LF909 or approved equivalent unless otherwise specified. See backflow preventer schedule for exact model numbers and sizes.

### **22 80 02 BACKFLOW DUAL CHECK DEVICE (ICE MACHINES)**

- A. Backflow dual check valves with atmospheric vent port & strainer. ASSE 1022. Watts model SD-3.

### **22 80 03 CAST IRON DOWNSPOUT BOOTS**

- A. Refer to architectural drawings and details for product and location.

#### 22 80 04 COMBINATION TEMPERATURE AND PRESSURE RELIEF VALVES

- A. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank. Products shall be by Watt, Cash Acme, Spence, Kunkle or approved equal.

#### 22 80 05 EXPANSION TANK

- A. Expansion tank shall be a steel hydro-pneumatic tank rated for a working pressure of 125 psig at 200°F. All internal wetted parts shall comply with FDA regulations and approvals. Capacity shall be as scheduled on the plans.
- B. Expansion tank shall be Amtrol Therm-X-Trol, or approved equal.
- C. INSTALLATION:
  - 1. Floor mounted tanks shall be installed on a 3-1/2" concrete housekeeping pad, refer to Section 20 00 00.
  - 2. Support and anchoring of tanks is delegated design by the Contractor. Design operating weight shall be based on tank full of water.
  - 3. Prior to opening the expansion tank to the system, the tanks shall be field charged by the Contractor and witnessed by the Engineer. Refer to expansion tank schedule and flow diagrams for charge pressure, if not indicated confirm with the Engineer.

#### 22 80 06 GREASE INTERCEPTOR HYDROMECHANICAL BELOW GROUND

- A. Rotational molded polyethylene grease interceptor. Interceptor shall be certified to ASME A112.14.3 (Type C) and CSA B481.1, built-in flow control and three outlet options. Interceptor is to have a capacity of 5495 lbs. and a flow rate of 100 gpm. Schier model GB-1000, Zurn Green Turtle, or approved equal.
- B. Sampling port shall be lifetime guaranteed and made in USA of seamless, rotationally-molded polyethylene. Sampling port shall be furnished for above or below grade installation with adjustable cover adapter and Safety Star® access restrictor built into cover adapter. Cover shall provide water/gas-tight seal and have minimum 16,000 lbs. load capacity. Sampling port shall be furnished with field cut riser to enable access for below grade installation.
- C. Sampling port shall be Schier Products Sewer Viewer model SV10. Contractor shall provide appropriate quantity of risers to extend covers to grade (exterior-located) or floor (interior-located).

#### 22 80 07 HOSE BIBB (HB-A): INTERIOR UNFINISHED SPACES (COLD WATER ONLY)

- A. 3/4" hose outlet x copper sweat inlet with integral vacuum breaker. J.R. Smith 5673, MIFAB MHY-9200-NPB, Wade 8605, Woodford 26 or Zurn Z1341XL.
- B. For exposed locations: Woodford 26V or approved equivalent.

#### 22 80 08 ICE MAKER OULTET BOX (OB-A)

- A. Furnish and install stainless steel wall mounted ice maker shut-off valve box equal to IPS Corporation model SSIB1AB, or equivalent by Acorn, MIFAB, or Oatey.
- B. Provide bronze body dual check backflow preventer at ice maker box for connection to equipment, equivalent to Watts Series 7.

#### 22 80 10 PRESSURE REDUCING VALVES

- A. 3" and larger: automatic, pressure piloted, flanged cast iron body with interior coating according to AWWA C550, bronze or stainless steel trim, low flow bypass pressure control, pressure gauge connections, position indicator, and means for discharge pressure adjustment. Watts model LFF115-74, Zurn Wilkins model ZW209BP, Cla-Val model 90-48, or MIFAB ACV x.xx HF-PR.
- B. 2-1/2" and smaller: automatic, internal diaphragm sensing, lead free bronze body, stainless steel seat, sealed spring cage, integral pressure by-pass, , cleanable stainless steel strainer. Watts model LFN223B/LFU5B-Z3, Cla-Val CRD-L or Zurn Wilkins model 500XL/600XL.

#### 22 80 11 ROOF HYDRANT: EXTERIOR FREE STANDING ROOF MOUNTED PEDASTAL (RH-A)

- A. 3/4" hose outlet x 3/4" (nominal) copper sweat straight inlet, non-freeze, drain down design with stainless steel reservoir, fully insulated with stainless steel shroud, approved ASSE 1019 integral backflow preventer.
- B. Roof hydrants shall be MAPA Products model MPH-24FP:24/9
- C. Installation – Contractor to install in accordance with manufacturer's instructions. Provide service valve on inlet to allow isolation for service, provide support below the roof to anchor the unit to the building structure.

#### 22 80 12 SEDIMENT INTERCEPTOR (SI-A)

- A. 2" inlet/outlet fabricated stainless steel body, perforated stainless steel sediment bucket and fine mesh screen bucket liner. Sediment Interceptor shall be J. R. Smith model 8714-SS or approved equal.

#### 22 80 13 TEMPERATURE RELIEF VALVES

- A. Temperature relief valves on domestic hot water system shall be a self-contained, reverse acting, with adjustable setpoint as manufactured by Spence, 3/4", 2020 TDGQF or equivalent.

#### 22 80 14 THERMOSTATIC MIXING VALVES - ELECTRONIC: PRIMARY (TMV-1 & TMV-2)

- B. Furnish and install shut off valves, check valves, thermometers and accessories per the flow diagram and the manufacturer's installation instructions. ASSE 1017 Certified.
- B. Central thermostatic mixing station shall be used to temper domestic hot water supply to the building. System shall consist of a thermostatic mixing valve designed specifically to be installed as the primary control valve within a pumped recirculation system. Valves shall be Leonard Valve Company Nucleus Proton, Acorn model ABMV, Armstrong Brain, or Lawler.
- C. See Schedule on Drawings for exact type and quantities.
- D. Mixing valves shall be provided with BACNET connection capability.

#### 22 80 15 THERMOSTATIC MIXING VALVES: EMERGENCY (TMV-3)

- A. Furnish and install thermostatic tempering valves with integral check valves, removable cartridge strainers, stainless steel pistons, and thermal bellows – rough bronze finish. ASSE 1071 Certified.
- B. Emergency thermostatic mixing station shall be used to temper domestic water supply to emergency fixtures. System shall consist of a thermostatic mixing valve designed specifically to be installed as a control valve for emergency fixture usage. Provide with cold water by-pass. Valves shall be Leonard Valve Company Eco-Mix, Armstrong, Lawler or Acorn.
- C. See Schedule on Drawings for exact type and quantities.

22 80 16 WALL HYDRANT: EXTERIOR WITH BOX (WH-A)

- A. 3/4" hose outlet x 3/4" (nominal) copper sweat straight inlet, non-freeze, anti-siphon wall hydrant with bronze casing, approved ASSE 1019 integral vacuum breaker and polished nickel bronze, stainless steel, or chrome-plated box. Josam 71300, J.R. Smith 5519, MIFAB MHY-26, Wade W-8700, Watts HY-330, Woodford B65, or Zurn Z1300.

22 80 17 WALL HYDRANT: INTERIOR WITH BOX (WH-B)

- A. 3/4" hose outlet x 3/4" (nominal) copper sweat straight inlet, anti-siphon wall hydrant with bronze casing, integral backflow preventer and polished nickel bronze or chrome plated box. J.R. Smith 5509QT-SAP-NB, MIFAB MHY-35, Wade W-8708, Watts HY-330, Woodford B76, or Zurn Z1330-XL.

22 80 18 WASHING MACHINE BOX (WMB-A)

- A. Furnish and install recessed stainless steel washing machine box with 1/2" sweat valves for cold and hot water inlets and a 2" center drain outlet. Washing machine box shall be IPS Corporation, Guy Gray model SSWB2, or equivalent by Acorn, MIFAB, or Oatey.

22 80 19 WATER HAMMER ARRESTOR

- A. Furnish and install all stainless steel shock absorbers at all solenoid, remote operated or quick closing valves such as restroom devices for each battery of fixtures. Install on both domestic hot and cold water branch lines in an upright position. Install where shown on the drawings and as required by code, provide access door when not accessible. J.R. Smith Hydrotrol models 5005 to 5050, Josam 75000 series, MIFAB WHB, Precision Plumbing Products SBHA, or Zurn Z1700, sized according to manufacturer's recommended sizing.
- B. Access door when not accessible shall be 8" x 8" square access covers with polished nickel bronze beveled edge frame with anchor lugs for over the wall installation, smooth stainless steel cover, and vandal proof fasteners. Wade 8303-85-75-VP, Zurn ZANB-1460-9-VP, J.R. Smith 4730-U-NB, MIFAB C1460-S-3-6, or approved equivalent.

22 80 20 WATER METERS

- A. Water meter 1 1/4" through 10" shall be a totalizing magnetic turbine meter indicating in U.S. Gallons meeting AWWA Standard C-701 latest edition. Meters shall be in-line horizontal-axis type per AWWA Class II, flanged cast bronze body, permanently roll-sealed register, turbine measuring chamber, stainless steel spindle, and graphite bearings. Meters shall be Badger Recordall Turbo Series, Hersey MTX/WTX, Kent T-3000, Neptune HP Turbine, Niagara WPX, or approved equivalent.

END OF SECTION  
104313.000



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## **23 00 00 HVAC PIPING AND EQUIPMENT**

### **23 00 01 GENERAL**

- A. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Division 20 of the Specifications.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Division 20 of these Specifications.

### **23 00 02 REFERENCES, REGULATORY REQUIREMENTS**

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc., as identified in Division 20.

### **23 00 03 REFERENCES, RELATED SECTIONS OF THE SPECIFICATIONS**

Requirements of the following Sections of the Specifications apply to Work for this Section:

- 1. Division 20 - Basic Mechanical Conditions and Basic Mechanical Materials and Methods
- 2. Division 24 – Air Distribution
- 3. Division 25 - Temperature Controls

### **23 00 04 DEFINITIONS**

(none)

### **23 00 05 WORK INCLUDED**

- A. Furnish material, labor and services necessary for, and incidental to, installing the following systems where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications (Sub-section 23 00 03 to provide for complete systems.
  - 1. Cooling system including, but not limited to, chillers, cooling tower, piping specialties, pumps, chemical water treatment system, chemical pot feeder, relief valves, air separator, and expansion tank.
  - 2. All chiller and refrigeration related specialties including, but not limited to, refrigerant monitor, self-contained breathing apparatus, refrigerant pump out unit and storage vessel.
  - 3. Heating system including, but not limited to, factory assembled/field assembled packaged hot water boilers, heat exchangers, piping, chemical pot feeder, piping specialties, pumps, unit heaters, convectors, relief valves, chemical pot feeder, air separator and expansion tank.
  - 4. Air handling equipment including, but not limited to, custom rooftop air handling units, packaged DX rooftop air handling units, terminal units, relief, supply, and exhaust fans.
  - 5. Make-up water connections including, but not limited to, piping, backflow preventers, pressure regulators, water meters, and electronic level sensors.
  - 6. Natural gas piping, service valves, seismic valve, and gas pressure regulators.
  - 7. Chemical water treatment of chilled water, heating water, condenser water.
  - 8. Draining, filling, and venting of all systems as required for the above work.

9. All seismic restraints for the above work (Refer to Section 20 10 40).
10. Smoke stopping of all penetrations of pipes and ductwork, and firestopping of the same through fire rated partitions as shown on the Architectural drawings including, but not limited to stairways, shafts, corridors, floors, roofs, and required exits (Refer to Section 20 10 20).
11. Cleaning and pressure testing equipment, piping, and accessories installed under this section of the specification. (Refer to Section 20 10 50).
12. Leak testing and charging of field piped refrigerant systems (Refer to Section 20 10 50).
13. Provide sufficient labor and resources required for the testing and balancing (Refer to Section 20 10 80) and for the commissioning process (Refer to Section 152300).
14. Installing accessories specified under other sections of the specification referenced in Sub-section 23 00 05, including but not limited to, flow meters, control valves, thermowells, and taps for pressure sensors.

**23 00 06 SUBMITTALS:**

- A. The Contractor shall submit the following for approval in accordance with Subsection 20 00 43, Duties of the Contractor - Submittals.
  1. Piping materials, valves, and accessories as specified in Piping Materials Schedule(s) in this section of the specification.
  2. All specialties including, but not limited to, thermometers, gauges, relief valves, pressure regulators, backflow preventers, flow switches, and vacuum breakers.
  3. All HVAC equipment specified in this Division 23 including, but not limited to, chillers, boilers, boiler vent, heat exchangers, pumps, packaged equipment, air handling units, fans, terminal units.
  4. All general items specified under Division 20 utilized in the installation of work required by this section of the specification.
- B. Provide manufacturer's technical product data of each material and accessory item with engineering support information, installation manual, operation and maintenance manual. Data shall be specific to product specified and clearly identified on all data sheets, which contains multiple models or sizes.
- C. At the point where the mechanical system has been installed and checked by the Contractor and the systems are ready for testing and adjusting, submit a letter to the Architect/Engineer stating such. Refer to Section 20 10 85.
- D. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.
- E. **Contractor shall submit coordination drawings to the Engineer for review prior to any fabrication or installation (Refer to Section 20 10 50).**

**23 10 00 HYDRONIC PIPING**

- A. Itemization of the piping materials for specific system application are enumerated in the following sub-sections for the respective PIPING MATERIAL SCHEDULE. Specific requirements for materials shall be as listed in Division 20 Basic Materials and Methods.
- B. Manufacturer's mill reports and applicable documents to certify the validity of the procured piping materials shall be on file at the Contractor's office.

- C. Install all piping with pitch to vent or drain. Provide drain valves at low points and air vents at high points. Drain valves and air vents shall be  $\frac{3}{4}$ " bronze 2 piece body ball valves with  $\frac{3}{4}$ " hose end adapter, cap and chain. In  $\frac{1}{2}$ " through 2" pipe, contractor may use Webstone model T-drain. Use eccentric reducing fittings (installed top level) as required to avoid air pockets.
- D. Gaskets and packings containing asbestos are not acceptable.
- E. Where Pipe and accessories installed under this section of the specification tie-in to existing systems, Contractor shall verify existing for: sizes, direction of flow (via pressure or physical tracing of piping, not labels), materials, and elevations before installing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.

#### 23 10 01 PIPING MATERIAL SCHEDULE, M-1

- A. Service: Chilled water supply and return for HVAC.  
Hot water (heating) supply and return for HVAC.  
Condenser water supply and return (interior to building envelope).
- B. Rating: 125 psig at 350°F  
175 psig at 150°F
- C. Pipe: (Refer to Section 20 10 11)
  - 1. 3" and smaller Copper, type L.
  - 2. 10" and smaller Black carbon steel, schedule 40, ASTM-A53, ERW.
  - 3. 12" and larger Black carbon steel, standard (0.375" wall thickness), ASTM-A53, ERW.
  - 4. Contractor has the option on piping 3" and smaller to use either copper or black carbon steel. Fittings shall be as scheduled below for the piping material chosen.
- D. Fittings: (Refer to Section 20 10 10)
  - 1. 3" and smaller Wrought copper, solder ends.
  - 2. 2-1/2" and smaller Cast iron, screwed.
  - 3. 3" and larger Black carbon steel, buttweld. Elbow fittings shall be long radius. See Division 20 for acceptable branch arrangement in lieu of tee fitting. Wall thickness consistent with connecting pipe.
  - 4. 3" and larger Contractor's option at vertical branch drops to equipment located within mechanical rooms: Painted ductile iron, smooth (segmented or welded fittings are not acceptable), grooved ends. Wall thickness consistent with connecting pipe. To be used in conjunction with compatible rigid mechanical couplings designed specifically for this application.
- E. Joints in Steel Piping: (Refer to Section 20 10 12)
  - 1. 2-1/2" and smaller Screwed

2. 3" and larger Welded  
or

Contractor's option at vertical branch drops to equipment located within mechanical rooms: Victaulic Style 107 couplings except at connections to rotating equipment where (2) Style 177 couplings shall be used at each inlet and outlet connection.

3. All sizes where  
concealed in chases  
or walls, or above  
gyp/plaster  
ceilings Welded

F. Joints in Copper Piping:

1. All 95/5 solder

G. Valves: (Refer to Section 20 10 13)

1. Shut-off/service:

11. 3" and smaller Ball valve: two piece bronze body, stainless steel ball and trim.
12. 2 1/2" and larger Butterfly valve, cast iron body.

2. Balancing/Throttling:

21. 12" and smaller Multi-turn calibrated balance valve.
22. 14" and larger Butterfly valve with memory stops.

3. Check valve – General Duty:

31. All Class 125, swing check.

4. Check Valve – Pump Discharge:

41. 2-1/2" and smaller Class 125, swing check
42. 3" and larger Class 125, cast iron body, silent check

5. Strainers (Refer to Section 20 10 14)

51. 4" and smaller Class 125, cast iron body, Y-pattern
52. 5" and larger Class 125, cast iron body, basket type

6. Unions:

61. 3" and smaller Wrought copper, solder ends.

7. Flanges:
71. 4" and smaller Cast copper companion type, solder end, class 125 ASME standard or class 150.
72. 2-1/2" and larger 150 lb, Black forged carbon steel, weld neck pattern (for welded pipe)  
150 lb. ANSI Class flange equal to Victaulic 45 (for grooved pipe).
73. Pressure Test: Hydrostatic test at 200 psi for two (2) hours minimum.

#### 23 10 02 PIPING MATERIAL SCHEDULE M-2

- A. Service: Make-up water for hydronic systems.
- B. Rating: 175 psig at 150°F
- C. Pipe: Type L copper
- D. Fittings: Wrought copper, solder ends.
- E. Shutoff/Service
- Valves: Ball valve: two piece, bronze body stainless steel ball and trim.
- F. Pressure Test: Hydrostatic test at 200 psi for two (2) hours minimum.

#### 23 10 03 PIPING MATERIAL SCHEDULE M-3

- A. Service: Condenser Water System (All exterior and through-roof piping)
- B. Rating: 175 psig at 150°F.
- C. Pipe: Stainless Steel, Schedule 10S
- D. Fittings: Welded  
Flanged at valves, strainers, and equipment  
Stainless Steel, Schedule 10S
- E. Valves: Butterfly valve, Stainless Steel body
1. Shut-off/service: Butterfly valve
2. Balancing/Throttling: Butterfly valve with memory stops
3. Drain Valve: Ball valve with vented port
- F. Pressure Test: Hydrostatic test at 200 psig for two (2) hours minimum.
- G. All exterior condenser water piping to be heat traced. Provided by Division 26.

#### 23 10 04 PIPING MATERIAL SCHEDULE M-4

- A. Service: Condensate drain piping.
- B. Design: Atmospheric

- C. Pipe: Type L copper
- D. Fittings: Wrought copper, solder ends. 90° elbows are not permitted, use (2) 45° elbows or 'Y' provided with cap in unconnected straight run.
- E. Valves: Two piece bronze body, stainless steel ball and trim.
- F. Extend piping from all cooling coil drain pans to the location of discharging indirectly to the building drain system. Pipe size shall be unit connection size unless indicated larger on the plans.
- G. Connections to the drain pans shall be made through a water seal trap with the downstream side vented to atmosphere.

#### 23 10 05 HYDRONIC SPECIALTIES

- A. Provide complete (2) year warranty covering parts and labor for any defect in materials and workmanship for all Hydronic Specialties.

##### B. Air Separator

1. Furnish and install centrifugal type or coalescing type air separator where shown on the plans or flow diagrams. Air separator shall be designed, constructed, and stamped for 125 psig at 350°F in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code. Centrifugal type air separator shall have tangential or bottom outlet, tangential inlet, stainless steel collector tube without strainer. Coalescing type air separator shall have internal copper coalescing medium. Air separator shall have flanged inlet and outlet with a threaded drain connection. Drain connection to be routed to nearest floor sink.
2. Air separator shall be Bell & Gossett Rolairtrol, Amtrol, Taco, Armstrong VA, Thrush, Spirovent model HV or equivalent.

##### C. Automatic Air Vent

1. Automatic air vents shall be furnished and installed for all centrifugal air separators. Automatic air vents shall be high capacity, float actuated, cast iron or cast brass body, stainless steel/brass trim and rated for 150 psi at 250°F.
2. Automatic air vents shall have their discharges piped to a drain.
3. Automatic air vents shall be Amtrol Model 720, Armstrong AAE-750, Bell & Gossett 107A, Spirotherm model Spirotop, Thrush model 720 or equivalent.

##### D. Safety Valves, Relief Valves, Safety Relief Valves

1. Pressure relief valves shall be furnished and installed for all chillers and where shown on the plans, flow diagram, or details in all hydronic systems not containing boilers. Valves shall be factory set and field verified for 125 psi, bronze body, stainless steel trim and test/lift lever. Pressure relief valves shall be a minimum of ¾" Bell and Gossett Model 790, Watts 174A, Kunkle or equivalent.
2. Discharges from valves shall be piped to floor drains.

##### E. Pump Flowline Fitting (Suction diffuser)

1. At all inlets to vertical inline pumps furnish and install a flowline fitting with strainer. Fitting shall be coordinated with pump inlet size and system piping, where largest system size available is smaller than the system piping, provide piping reducer at inlet of flowline fitting.

2. Fitting shall be 90° angle cast iron body with exit vane, 304 stainless steel strainer with ¼" openings, fine mesh start-up strainer, adjustable support foot, and drain connection.
3. Fitting for VIL pumps shall be Bell & Gossett, Armstrong, Taco or equivalent.

F. Make-up Water Connection

1. At all make-up water locations to hydronic systems provide a line size reduced pressure backflow preventer, pressure reducing valve, water meter, and a pressure relief valve.
2. Backflow preventer shall be of reduced pressure type. Assembly shall include shut off valves, strainer and air gap connection. Backflow preventer shall be Watts Series 909 or equivalent.
3. Pressure reducing valves shall be furnished and installed for each system and field adjusted for each system to provide 10 psi at the highest point in the system with all pumps off for positive venting. Pressure reducing valves shall be Watts U5, Bell and Gossett #7, Taco 335, Armstrong HRD70 or equivalent.
4. Water meter 1" and smaller shall be a totalizing positive displacement meter indicating in U.S. Gallons meeting AWWA Standard C-700 latest edition. Meters shall be Neptune T-10, Kent C-700, or Hersey MTX 123, or equivalent.
5. Water meter 1 ¼" and larger shall be a totalizing magnetic turbine meter indicating in U.S. Gallons meeting AWWA Standard C-701 latest edition. Meters shall be in-line horizontal-axis type per AWWA Class II, flanged cast bronze body, permanently roll-sealed register, turbine measuring chamber, stainless steel spindle, and graphite bearings. Meters shall be furnished with pulse transmitters for remote monitoring. Meters shall be Neptune HP Turbine, Kent T-3000, Hersey MTX/WTX, or equivalent.

G. Thermometers

1. Thermometer wells and thermometers shall be provided at the inlet and outlet of all air handling unit coils, chillers, etc. and where shown on the plans, piping isometrics, flow diagrams and details.
2. Thermometers shall be organic spirit filled in a 9" polyester or aluminum case, magnified lens, glass or acrylic front, black divisions and numbers. Accuracy shall be  $\pm$  one scale division. Stem shall be tapered aluminum installed in a brass thermowell. Stem length and lagging length shall be coordinated with the piping and the insulation. A minimum 2" insertion length shall be in the moving fluid.
3. Thermometers for use in chilled water having 1°F increments are preferred with a minimum range of 30°F - 100°F, in no case shall the range be greater than 0°F - 160°F having 2°F increments.
4. Thermometers for use in heating water systems shall have 2°F increments with a range of 30-240°F.
5. The submittal data shall clearly identify the range and the service the thermometers are used for.
6. Thermometers shall be Weksler AS5, Trerice model Adjustable Angle, Weiss Vari-angle, MILJOCO 935, or equivalent.
7. Where thermometer wells are installed below 5 feet they shall be installed on the side of vertical piping or on the top of horizontal piping so that they can be angled back beyond vertical to allow easy reading. Where thermometer wells are installed above 6 feet they can be installed on the face or the side of vertical piping and for horizontal piping it should be installed between 9 and 12 o'clock to allow the thermometers to be angled less than vertical without the pipe blocking the view of the thermometer.
8. Prior to installing the thermometer wells, the contractor shall have the thermometers at the jobsite and shall demonstrate to the Architect/Engineer where they intends to install



them where they will be easy to read. If the Contractor fails to perform the above, any thermometers which are unreadable, in the opinion of the Architect/Engineer, it shall be modified at the Contractor's expense.

#### H. Test Ports

1. Provide pressure and temperature test plugs at locations shown on the plans, flow diagrams and details. Test ports shall be pressure and temperature test plugs. Plugs shall be self-sealing plugs. EPDM seals rated for the temperature, pressure and fluid associated with the application and shall be capable of accepting a needle type temperature or pressure probe and reclosing when the probe is removed. Furnish extensions for test ports installed in insulated piping. Plugs shall be provided with threaded protective caps. One temperature and pressure test kit suitable for the plugs used on the job shall be provided to the Owner on all installations where the plugs are used. Acceptable manufacturers and models are as follows:

| Manufacturer         | Model                          |
|----------------------|--------------------------------|
| Peterson Engineering | Pete's Plug                    |
| Terice               | Pressure/Temperature Test Plug |
| Sisco                | P/T Plugs                      |
| Bell and Gossett     | Read-out Valve RV-125A         |

2. Alternatively, access fittings may be provided in place of the Pete's Plugs. In this case, the fittings shall be provided with a retained cap and shall be Mueller Brass A-17130 or equivalent.

#### I. Gauges

1. Provide 1/4" ball valves gauge cocks at all inlet and outlet of air handling units and across control valves of air handling units and at the inlet and outlets of chillers, boilers, heat exchangers, pumps, etc. and where shown on piping isometrics, flow diagrams and details. Provide gauges where shown on piping isometrics, flow diagrams, and details.
2. Gauges shall be 4-1/2" diameter, flangeless aluminum/stainless steel safety case with removable ring, bottom connection, with a recalibrator, and have stainless steel tube and stainless steel movement calibrated to 1/2% accuracy, ANSI B40.1 Grade 2A with a pressure range appropriate for each system. Open water condenser systems shall have compound gauges. Gauges located at pumps shall be provided with a porous stone/metal type pressure snubber.
3. Gauges shall be Weiss Instruments UG2, Terice 500XSS Series, Weksler AA44Y or equivalent by Marsh, or Marshalltown. Accessories from the same manufacturer shall be acceptable.
4. At pump locations utilizing factory taps in the casing or other locations where steel pipe is utilized, provide 1/4" brass screwed pipe and 1/4" 2-piece bronze threaded ball valve with lever handle for a gauge cock.
5. At locations where copper pipe is utilized, provide a 1/2" tee by line size connection in the piping and a 1/2" 2-piece bronze threaded ball valve, and 1/4" NPT bushing with lever handle for a gauge cock.
6. Gauges shall be installed as follows: 3" straight piping/nipple, service valve/gauge cock, tee with P/T plug in the run of the tee, and the gauge installed on the branch of the tee. There shall be no change in direction between the valve and the process pipe to allow cleaning an obstruction. The 3" is to create a dead leg to minimize sweating without insulating the valve.

7. All gauges shall be positioned where their view is unobstructed and can be easily read. If any gauge is unreadable, in the opinion of the Architect/Engineer, it shall be modified at the Contractor's expense.

#### 23 10 06 EXPANSION TANKS

- A. Furnish, install, and charge expansion tanks as indicated on the plans, flow diagrams, and schedules. The tanks shall be field charged by the Contractor to provide 10 psig at the high point of the system with all pumps not operating for positive venting.
- B. Expansion tanks shall be constructed in accordance with Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code and stamped for a minimum working pressure of 125 psi at 200°F. The tanks shall have a standard schrader charging valve (.302" – 32) connection for on-site adjustment of the system pressure. The tanks shall be provided with mounting hardware for either vertical base mount or saddles for horizontal mounting in the configuration shown or scheduled on the drawings.
- C. Diaphragm type tanks shall have a non-replaceable heavy duty butyl rubber diaphragm to separate the air charge and the system water. The minimum system connection size shall be ½" NPT. Diaphragm type tanks shall only be used when scheduled as such, otherwise expansion tanks shall be bladder type tanks. Diaphragm tanks shall meet or exceed both the minimum acceptance volume and total volume as scheduled.
  1. Diaphragm type expansion tanks shall be Amtrol AX Series, Bell and Gossett Series D, Taco CAX series, Thrush AX series or approved equivalent.
- D. Bladder type tanks shall have replaceable bladder constructed of heavy duty butyl rubber. The water shall be in bladder, and the air shall be in the tank. The minimum system connection size shall be 1" NPT. The tank shall have a ¾" NPT drain to allow draining water from the tank in the event of a bladder failure. The tank shall have both vertical and horizontal lifting rings. Bladder tanks shall meet or exceed the total volume as scheduled.
  1. Bladder type expansion tanks shall be Amtrol L series, Bell and Gossett Series B, Taco CA series, Thrush L series or approved equivalent.

#### 23 10 07 CHEMICAL FEEDERS

- A. Chemical feeders for the closed water systems shall be installed at locations as shown on the drawings and as indicated below. Feeders shall be cast iron bulk type feeders complete with connections for water in, treated water outlet, drain, isolation and drain valves, and removable covers. Feeders shall be Ball feeder type, rated for continuous operation at 200 psi and 250°F, Dearborn Type AV, J.L. Wingert Co., Neptune VTF or equivalent.

Chilled Water: 5 gallon pot feeder  
Heating Water: 5 gallon pot feeder
- B. Corrosion test three (3) sample coupon racks shall be installed at the following location(s):
  1. Chilled Water: PVC rack
  2. Heating Water: Steel rack
  3. Condenser Water: PVC rack
- C. Chemical supplies and services of a qualified Water Treatment Representative shall be provided by the Contractor.

1. The Water Treatment Representative shall provide chemicals and be present for filling, flushing, and cleaning of piping systems. The systems shall each be filled through a meter and the system volume recorded and included on the record drawings. Refer to Section 20 10 56 - Cleaning of Piping System.
2. The Water Treatment Representative shall provide chemicals and be present for treatment of closed loop systems. The system shall be tested and coupon samples weighed quarterly for the first year of operation. The chemistry shall be adjusted to control corrosion, scale, and biological growth. Submit to Owner and Engineer reports and lab test from each visit.

## **23 21 40 PUMPS**

### **A. General**

1. Furnish and install circulating pumps for water service of the base mounted or in-line configuration as scheduled on the drawings. Pumps shall be factory tested, aligned, painted, and shipped complete for installation. Electrical characteristics shall be as scheduled on the plans.
2. Piping at pumps shall be arranged to facilitate pump maintenance. Piping shall be arranged so that the service valves can be closed and the piping and specialties between the service valves and pump removed for servicing and to allow clear access to the pump for removal as required. Where pump connection sizes are smaller than the line sizes associated with the suction and discharge piping, concentric reducers or increasers shall be installed immediately at the pump flanges to adapt to the indicated line size. All specialties and service valves associated with the pump such as strainers, check valves, etc., shall be line size, and not pump connection size.
3. Where pumps are from manufacturers not scheduled the following criteria shall apply: Pumps shall be picked at scheduled flow and head with working fluid of the system which the pump is in, pump impeller shall not be within 1/2" of the smallest or largest size for the pump body, pump efficiency shall not be more than 5% less efficient than scheduled pump, operation point shall not exceed nameplate horsepower, pump motor size shall not be larger than scheduled motor (Contractor can pursue equipment substitution as required in Subsection 20 00 51 for pumps with larger motors), pumps which are used in parallel installations shall be sized such that the brake horsepower does not exceed the motor horsepower when only one pump is running. This operating point shall not be off of the manufacturers published pump curve.
4. All pump assemblies shall be warranted against any failure caused by defects in materials and workmanship for no less than two (2) years following the date of Owner acceptance.

## **23 21 41 IN-LINE PUMPS**

- B. General: In-line pumps and circulators shall be suitable for mounting in either vertical or horizontal piping with the motor mounted as specified below. Pumps shall be flanged and provided with a companion flange having NPT tappings or shall be ANSI Standard B16.1 flanges. Pumps shall have factory taps, shipped with plugs installed, for measuring suction and discharge pressure, and at the low point in the volute to allow draining. Where in-line pumps are installed in horizontal or vertical piping, the pump shall be rigidly mounted to the piping with pipe hangers on each side of pump, but the motor shall not be supported. Where in-line pumps are supported from the floor using a pipe stand/column then two flexible mechanical couplings shall be used on each side of the pump for vibration isolation.
- C. Cartridge type circulators shall be bronze or iron construction as scheduled. Pumps shall be maintenance free, horizontal (motor and shaft installed position) in-line, single stage, wet rotor type with the motor mounted directly to the pump volute rated for 125 psi, 230°F operation.

The integral motor shall be cooled and lubricated by the pump fluid. The motor stator shall be isolated from the circulated fluid through use of a stainless steel rotor can. The pump shaft shall be ceramic supported by ceramic/carbon bearings. Pumps shall be Bell and Gossett Fox series, Taco "00" series, Armstrong Astro series, Grundfos series UP, or approved equivalent.

- D. Circulators shall be bronze or iron construction as scheduled. Pumps shall be horizontal (motor and shaft installed position) in-line, oil lubricated, one-piece dynamically balanced impeller, and flexible coupling. Pumps shall be rated for 125 psi at 225°F. Mechanical seals shall be two piece with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Motors shall be open drip-proof type with sleeve bearings, quite operating, rubber mounted, with built-in thermal overloads. Pumps shall be Bell and Gossett Booster pump, Taco Red Baron Circulator, Armstrong series S & H, or approved equivalent.
- E. Horizontal in-line pumps shall be bronze or iron construction as scheduled. Pumps shall be horizontal (motor and shaft installed position) in-line type, oil lubricated, one-piece cast bronze impeller dynamically balanced, and flexible coupled. Pumps shall be rated for a maximum working pressure of 175 psi at 150°F and 150 psi at 250°F. Mechanical seals shall be two piece design with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Pump shall be of a three-piece design consisting of: the volute, bearing module, and the motor; with each section bolted to the next. The bearing module shall have oil lubricated bronze journal and thrust bearings. The motor shall be joined to the pump shaft through a flexible coupling. Motors shall be NEMA B letter design with a 1.15 service factor, open drip-proof, premium efficiency. Pumps shall be Bell and Gossett series 60, Taco 1600 series, Armstrong series 1060, or approved equivalent.
- F. In-line pumps shall be bronze fitted Class 30 cast iron body designed for either horizontal or vertical (motor and shaft installed position) in-line mounting, oil lubricated, one piece cast bronze dynamically balanced impeller, replaceable bronze wear rings, steel pump shaft with replaceable bronze shaft sleeve, close/split coupled. Pumps shall be rated for a maximum working pressure of 175 psi at 150°F and 150 psi at 250°F (125# ANSI flange). Mechanical seals shall be flushed two piece design with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Motors shall be NEMA JM, with a 1.15 service factor regreaseable ball bearings, vertical shaft, drip-proof enclosure, premium efficiency. Provide factory wired, motor mounted variable frequency drive. Drive shall meet the requirements of specification section 26 29 23 VARIABLE FREQUENCY DRIVES or be an approved equal. Pumps shall be Bell and Gossett series e80-ITSC, Taco SKS model, Armstrong 4380/4300 series, or approved equivalent.

## **23 23 00 MISCELLANEOUS PIPING**

- A. Itemization of the piping materials for specific system application are enumerated in the following sub-sections for the respective PIPING MATERIAL SCHEDULE. Specific requirements for materials shall be as listed in Division 20 10 00 Basic Materials and Methods.
- B. Manufacturer's mill reports and applicable documents to certify the validity of the procured piping materials shall be on file at the Contractor's office.
- C. Gaskets and packings containing asbestos are not acceptable.

### **23 23 01 PIPING MATERIAL SCHEDULE M-5**

- A. Service: Natural Gas Piping, above grade.
- B. Design: Pressure: 2 psig.
- C. Pipe: Black carbon steel, Schedule 40, ASTM-53, ERW.

D. Fittings:

1. 2" and smaller Malleable iron, screwed
2. 2-1/2" and larger Black carbon steel, buttwelded

E. Joints:

1. 2" and smaller Threaded
2. 2-1/2" and larger Welded
3. All sizes concealed in chases or walls or above gyp/plaster ceilings Welded

F. Valves: Relubable plug type U.L. listed for natural gas service installed where shown and within 6 feet of the equipment served.

G. Note: All piping methods and materials shall be in accordance with NFPA 54, National Gas Code.

H. Pressure Test: New piping shall be install, capped, and pressure tested with Nitrogen at 50 psi for two (2) hours. After the piping has passed the above pressure test the final tie-ins shall be made, then the system will filled with natural gas and the final joints will be checked with soap.

23 23 02 PIPE MATERIAL SCHEDULE M-6

- A. Service: Refrigerant - liquid, suction
- B. Design: Pressure: 300 psig  
Maximum temperature: 300°F
- C. Pipe: Type ACR copper pipe
- D. Fittings: Wrought copper, brazed
- E. Pressure Test: Refer to Section 20 10 60.

23 23 03 PIPING MATERIAL SCHEDULE M-7

- A. Service: Natural Gas Piping, below grade.
- B. Design: Pressure: 50 psig.
- C. Pipe: SDR-11 Polyethylene 2708
- D. Fittings: Fabricated or Molded Polyethylene 2708
- E. Joints: Butt Fusion
- F. Valves: Polyethylene ball valve

- G. Trace Wire: #12 copper wire.
- H. Pressure Test: New piping shall be install, capped, and pressure tested with Nitrogen at 50 psi for two (2) hours. After the piping has passed the above pressure test the final tie-ins shall be made, then the system will filled with natural gas and the final joints will be checked with soap.
- I. Purging: Prior to being placed in service, all piping shall be purged with gas until completely air free. A moderately rapid and continuous flow of gas shall be introduced at the one end of the gas line and air vented at the other end. The gas flow shall be continued without interruption until vented gas is free from air.

#### 23 23 04 MISCELLANEOUS SPECIALTIES

##### A. Natural Gas Specialties

1. Pressure Regulators: Furnish and install Maxitrol, Schlumberger, Fisher or equivalent "pounds to inches" gas pressure regulators with changeable springs for outlet pressure adjustment.
  - a. Furnish and install pressure gauges and gauge cocks on both the high pressure and low pressure side of the gas service entrance.
2. Gas vales 2" and smaller: threaded end, two piece bronze body, UL listed natural gas, ball valve, Nibco 580/5-70-UL or equivalent.
3. Gas valves 2-1/2" and larger: flanged end, class 125, short pattern cast iron body, lubricated plug, UL listed natural gas, Milliken 171M, Nordstrom 143, Resun R-1431
4. Meter shall be Roots series B3 as manufactured by DMD Dresser with a Mercury Instruments model Mini-Max volume corrector.

#### **23 50 00 BOILERS**

- A. Comply with and submit application to State of Missouri Authority for ASME-CSD-1-1998 certification and reporting. *(2021 is latest version of CSD-1)*
1. Application or report shall list: (1) each device installed in accordance with ASME-CSD-1-1998; (2) name of the manufacturer and model number of each control and safety device; (3) operational test performed.
  2. Copy of this report shall be (1) submitted to the Chief Inspector, (2) provided to the owner/user, and (3) hung by chain at each boiler or pressure vessel to be made available to the authorized inspection agency or inspector.
  3. It is the responsibility of the installing contractor to deliver these instructions, together with complete wiring and piping diagrams, and a written precaution that the operating, testing, and servicing only be performed by qualified personnel, to the owner/user and to obtain a receipt for the instructions. The receipt shall be filed with the installation report.

#### 23 50 01 MODULATING CONDENSING WATER BOILER

- A. Boilers shall be of a low pressure, high efficiency, pulse combustion or forced draft combustion, direct vented, stainless steel firetube/combustor type capable of developing full I=B=R gross output capacity at one hundred percent firing rate. The boilers shall have stainless steel firetube for self-aspirating and self-venting pulse combustion. The boilers shall be constructed in accordance with the provisions of Section IV of the ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code and shall be stamped with the required official

ASME symbol. The boiler rated working pressure shall be 150 PSIG or greater. The boilers shall be tested in accordance with the requirements of the Hydronics Institute (Institute of Boiler and Radiator Manufacturer's) and shall have the capacities as scheduled on the drawings. Boiler shall also comply with CSD-1 code requirements. The boiler shall have no minimum flow requirements and shall be capable of operating with a minimum return water temperature of 40°F.

- B. The boilers shall be completely factory packaged with jacket, igniter, controls and trim mounted and wired. The packaged boiler-burner units shall be factory fire-tested before shipment to assure proper function. Adequate openings shall be provided for access to the water side of the boiler. Boilers shall include full modulating control package. "Modulating control package" shall be inclusive of two-position water flow isolation valves and modulating boiler control panel. Boilers shall be enabled or disabled and monitored by the Temperature Controls Contractor.
- C. The combustor and the exhaust pipes shall be constructed of SA-312 Grade 316-L stainless steel. The vessel shell shall be SA-53B ERW pipe or SA-285 Grade C plate. The heads shall be SA-516 Grade 70 plate. (Fulton Pulse Boiler). The combustion chamber and fire tubes shall be constructed of 316-L stainless steel (Aerco Boiler). The pressure vessel shall be fully insulated with 2" of high temperature insulation. Accessories shall include mounting on closed captioned spring isolators, vibration isolation and intake and exhaust silencers for the pulse type boiler. The combustor or combustion chamber location shall be within water backed areas.
- D. Boilers shall be A.G.A./C.G.A. approved as a Direct Vent Boiler, with conventional chimney or stack not required. Boilers shall have combustion air intake supply ducted in from the outside. Exhaust venting shall be constructed of AL-29-4C. The boiler manufacturer's representative shall furnish exhaust-venting material.
- E. Combination pressure-temperature gauge shall be provided with the boiler. The boilers shall be furnished with an A.S.M.E. certified pressure relief valve(s) and the valve(s) shall be set to relieve at the rated boiler A.S.M.E. working pressure as specified above. The relief valve(s) shall be of the side outlet discharge type. The relief valve outlet(s) shall be piped to a floor drain.
- F. Each boiler shall be equipped for modulated gas input. Fuel flow and air flow shall be controlled by valves operated from a single controller. Turn down shall be at least 5:1.
- G. Boiler controls shall include:
  - Operating Temperature Controller for automatic start and stop, valve regulation, and sequencing control of the installed boilers.
  - High Limit Temperature Controller (manual reset). The high temperature limit control should be set at least 20°F higher than the low limit control setting.
  - Low Water Cutoff Probe in each boiler shell.
  - Air Safety Switch to prevent operation until sufficient prepurge air is assured.
  - Blocked combustion air intake switch (manual reset) (Fulton only)
  - Proof of Flame Switch to prove combustion (manual reset).
  - Remote setpoint adjustment from building management system (50 to 200°F range, 4-20 mA input signal)
  - Single point fault alarm output signal (dry contact closure).
  - Enable/Disable input from building control system.
- H. All controls are to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired according to A.G.A./C.G.A. and UL requirements. Electric power supply 120 volts, 60 cycle single phase (Fulton Pulse Boiler) or 208 volts, 60 cycle single phase (Aerco Boiler).

- I. Instructions for installation, operation, and maintenance of the boiler shall be contained in a manual provided with each boiler unit. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.
- J. The pressure vessel shall be guaranteed against thermal shock for at least seven (7) years when utilized in a closed loop hydronic heating system with a temperature differential of 170°F or less. The pressure vessel and exhaust assembly shall be covered by a five (5) year non-prorated warranty against flue gas corrosion.
- K. The manufacturer shall guarantee that the equipment will meet specified/schedule performance when the equipment is installed according to the Project Documents. The manufacturer shall provide the services of a technical representative of the manufacturer to review the Project Documents for correctness of the installation including, but not limited to, flow rates, piping connections, electric connections, and safety interlocks, boiler flue sizing and flue type. The manufacturer shall notify the Engineer, in writing, of any and all items, which are contradictory to the manufacturer's installation instructions. The manufacturer shall furnish a specific remedy for each problem, furnishing a copy of manufacturer's installation instructions will not remove the burden and responsibility from the manufacturer. In the event that units are installed per the approved Project Documents and/or specific modifications provided by the manufacturer and the start-up representative of the manufacturer requires any modifications or changes to the installation then the manufacturer shall pay the contractor(s) for such changes.
- L. After installation, the manufacturer shall provide the services of a technical representative of the manufacturer to inspect the completed installation including all piping, wiring and control connections, and auxiliary apparatus. The manufacturer's technician shall work with the installing contractor in adjusting the equipment.
- M. The manufacturer shall provide the Owner with four (4) sets of detailed operating, maintenance, and service instruction publications. They shall further include a total of two (2) days instruction by a qualified service engineer describing service, operation, and maintenance of the equipment provided. Also, included in the cost will be two (2) inspection visits by a qualified field service engineer of the manufacturer during the first year of operation of the machinery to be scheduled with the Owner during periods of normal equipment operation.
- N. Boilers shall be Aerco Benchmark or Fulton Endura+ Series.

## **23 51 00 CHIMNEY AND VENT CONNECTOR**

### **23 51 01 DOUBLE WALL AL-4C**

- O. Furnish and install U.L. listed double wall AL-4C stainless steel flue system for all high efficiency, condensing, gas fired equipment with combustion gas temperatures below 550°F.
- P. Flue shall have AL-4C stainless steel inner wall and Type 430 stainless steel outer jacket with an air space separating the two walls.
- Q. Flue shall be suitable for ANSI Category I, II, III, or IV Appliances rated for operating pressures from negative to 3" w.c. positive pressure. The system is to be installed and sealed per manufacturer's instructions so all joints are gas tight preventing leakage of combustion products into the building. Vents shall terminate as required by code.
- R. This section applies to all gas water heaters, electric kilns and boilers. Coordinate water heater flue size with plumbing contractor.
- S. All flues shall extend to a minimum 8'-0" above roof deck. Provide guy wires or deck plate with Heat Fab system for support.



- T. Flue shall be Heat Fab or equivalent.

#### **23 51 02 COMBUSTION AIR INTAKES**

- A. All combustion air intake material shall be 304 stainless steel at an equivalent 22 gauge or heavier.
- B. Terminate all combustion air intakes a minimum of 24" above roof deck with a goose neck and birdscreen.
- C. This section applies to all boilers and water heaters.

#### **23 57 00 HEAT EXCHANGERS**

- A. General
  - 1. Furnish and install heat exchanger of the type, size, and arrangement as specified herein and as scheduled on the drawings.
  - 2. Provide mounting hardware and steel frame as necessary for installation.

#### **23 57 01 SHELL AND TUBE – COOLING TOWER FREEZE PROTECTION**

- A. Water to water heat exchanger shall be constructed according to ASME Section VIII, Division 1 and rated for a minimum of 150-psi condenser water in the shell and 150 psi heating water in the tubes.
- B. Heat exchanger shall have steel shell, 125 psi removable cast iron bonnet head, removable tube bundle,; brass tube sheet, 3/4" copper tubes; brass tube supports; and brass baffle plates.
- C. Heat exchanger shall be Bell and Gossett type WU, Armstrong type W, Taco GL, or approved equivalent.

#### **23 60 00 CHILLERS**

#### **23 60 01 ELECTRIC WATER CHILLER**

- A. The water chillers shall be a magnetic bearing water-cooled centrifugal type chiller. Each chiller shall have the capacity to cool 400 gpm of water from 57 to 45 F, when supplied with 500 gpm of condenser water at 85 F. Compressor KW rating shall not be greater than 0.561 KW per ton. Evaporator and condenser pressure drop shall not exceed 15 feet. Voltage source shall be 480 volts, 3 phase, 60 cycle.
- B. All exposed surfaces shall be painted with an air enamel prior to shipment. Each unit shall have a full operating charge of refrigerant. Molded neoprene isolation pads shall be supplied for placement under all support points. Start-up and operator instruction by factory trained service personnel shall be included.
- C. Compressor Motor shall be a semihermetic, accessible direct-drive, 3600 rpm, rotary compressor with capacity control. Motor shall be refrigerant cooled, hermetically sealed induction motor.
- D. Evaporator Condenser shells are carbon steel plates. Evaporator and condenser shall be designed, tested and stamped in accordance with ASME Code for refrigerant side working pressure of 300 psig. Evaporator and condenser tubes shall be individually replaceable copper

with tubes that are mechanically expanded into tube sheets. Waterside is hydrostatically tested at 1 1/2 times design working pressure, but not less than 225 psig.

- E. Unit shall be complete with factory mounted microprocessor-based control panel. Automatic shutdown protection with manual reset for low evaporator refrigerant temperature and pressure, high condenser refrigerant pressure, high compressor discharge temperature, high motor temperature, motor current overload, phase reversal and low oil flow. Automatic shutdown protection with automatic reset when condition is corrected is provided for low line voltage, loss of chilled water flow and loss of condenser water flow. The unit control module automatically takes action to prevent automatic shutdown in the event of low evaporator refrigerant temperature, high condenser refrigerant pressure, motor current overload and prevents motor current from exceeding setpoint current limit. A solid-state chilled water temperature sensor is for precision and accuracy in control. A selector switch allows the machine to load, unload, hold, or to allow automatic operation. A menu driven display shall indicate the operating code, the last diagnostic code, chilled water setpoint, current limit setpoint, and leaving chilled water temperature. Control panel mounted gauges shall display suction and discharge refrigerant pressure and include shutoff valves. Chillers shall be furnished with a separate control panel to provide the sequencing indicated in Division 25, Temperature Controls.
- F. Starter shall be NEMA 1 enclosure with top power wiring access, starter door designed to accommodate padlock and three-phase solid-state overload protection. Starter shall be unit mounted VFD. Provide a factory installed and wired control power transformer at 120 volt. Ammeter and voltmeter set, three each, shall be mounted on starter door.
- G. All low temperature surfaces shall be covered with 3/4" Armaflex II or equivalent (K = 0.28), including the evaporator, water boxes and economizer lines.
- H. Provide for Victaulic style water connections.
- I. Install chillers on neoprene vibration isolation pads designed for 1/4" deflection at each foot.
- J. Provide complete (2) year warranty covering parts, refrigerant quality, and labor for any defect in materials and workmanship. Additionally, the motor and compressor parts shall be provided with a 10-year warranty.
- K. Units shall be as manufactured by Trane Agility HDWA or pre-approved chiller by Daikin, model Magnitude or York model YZ.

## **23 61 00 CHILLER ACCESSORIES**

### **23 61 01 REFRIGERANT MONITOR**

- A. Furnish and install gas detector at location(s) indicated on the drawings. Gas detector shall be installed in a NEMA 1 cabinet and shall be UL listed. Gas detector shall be capable of detecting presence of refrigerant used within chillers submitted. System shall indicate, alarm, and shutdown/start-up equipment as specified below and in governing regulations. Oxygen deficiency monitoring shall not be acceptable in lieu of TLX-TWA monitoring for human safety exposure.
- B. Analyzer shall be microprocessor based and shall use solid state, ceramic metal oxide semiconductor (CMDs), or infrared (IR) sensor technology. No field calibration is acceptable at the time of installation. Response time shall be 30 seconds, or less, to 90% of the reading.
- C. The gas detector shall have a minimum of six (6) sampling points remotely mounted. Microprocessor shall monitor multiple remote sampling locations. Dry contact relays shall

activate when any sensor reaches an alarm condition. It is not required that the zone in alarm be distinguished. The gas detector shall have either a plain English display or LED indication for status, diagnostics, and each alarm condition.

- D. Unit shall have a minimum of 2 independent sets of formed-C SPDT alarm contacts, each having a separate programmable setpoint. Unit shall have self-diagnostics and a malfunction/fault contact for remote monitoring. The unit shall have a factory installed and wired combination alarm horn and visual beacon which activates on the second alarm or on a self-diagnostic malfunction. A second remote horn and beacon shall be provided for field installation.
- E. The first level of alarm shall be set at 100 ppm for early leak warning. The high alarm level shall be set at the TLA-TWA level of 1000 ppm. Set points shall be factory set to the above values and factory tested to  $\pm 10\%$
- F. The unit shall be warranted two years from acceptance. The representative is encouraged to contact the Owner on an annual basis for verification and recalibration.
- G. Gas detectors shall be Thermal Gas Systems series Haloguard, MSA model Chillguard, Armstrong series AMC, or approved equivalent.

#### **23 61 02 SEISMIC SNUBBER**

- A. Furnish and install seismic snubbers on chiller corners including all anchors, plates and supports required.
- B. Seismic snubber shall be an all-directional type with replaceable neoprene element. Snubber shall provide  $\frac{1}{4}$ " deflection for vibration isolation. Seismic snubber shall be Mason Industries model Z-1011, or approved equivalent.

#### **23 65 00 COOLING TOWERS**

##### **23 65 01 INDUCED DRAFT, CROSSFLOW**

- A. Furnish and install cooling tower(s) with the capacity and number of cells as scheduled on the plans. The performance shall be certified in accordance with CTI Certification Standard STD-201. CTI Certification notwithstanding, the cooling tower manufacturer shall guarantee that the tower supplied will meet the specified performance conditions when the tower is installed according to Plan. If, because of a suspected thermal performance deficiency, the Owner chooses to conduct an on-site thermal performance test under the supervision of a qualified, disinterested third party in accordance with CTI or ASME standards during the first year of operation; and if the tower fails to perform within the limits of test tolerance; then the cooling tower manufacturer will pay for the cost of the test and will make such corrections as are appropriate and agreeable to the Owner to compensate for the performance deficiency.
- B. Cooling Towers shall be factory-assembled of induced-draft, cross-flow propeller-fan design with vertical air discharge. All components shall be Series 300 stainless steel, except as otherwise specified. Since the space for the cooling towers is limited, the cooling tower shall not exceed 20' wide, 20'-1" long, and 12' high to the top fan guard.
- C. The cold water basins shall be constructed of Series 300 stainless steel. All steel items, which project into the basin, shall also be made of the same material as the cold basins. Basin shall include a depressed center section with drain/clean-out connection, large area, lift-out, steel strainers with perforated openings sized smaller than water distribution nozzle orifices; an integral anti-vortexing hood to prevent air entrainment; and a side outlet deep sump. Inlet louvers shall be fiberglass reinforced polyester (FRP) spaced to minimize air resistance and

prevent water splash- out. Hot water distribution basins shall be Series 300 stainless steel and shall be open gravity type with basin covers suitable for use as a work platform. Distribution weirs and plastic metering orifices shall be provided to assure even distribution of water over the wet deck surface.

- D. Water inlet shall be bottom with integral flow balancing valves shall be factory-installed in the hot water basin inlet(s) to distribute flow evenly between the distribution basins. The wet deck surface and integral drift eliminators shall be formed from polyvinyl chloride,. They shall be impervious to rot, decay, and fungus or biological attack. The wet deck surface shall be manufactured and performance tested by the cooling tower manufacturer to provide single source responsibility and assure control of the final product. The PVC fill shall be self-extinguishable for fire resistant flamespread rating of 5 per ASTM E84. The drift rate shall not exceed 0.005% at design conditions.
- E. Fans shall be adjustable pitch with the pitch factory set for specified performance, cast aluminum propeller type, axial flow. Fans shall discharge through a Series 300 stainless steel or FRP fan cylinder designed for streamlined air entry and minimum tip clearances for maximum fan efficiency. Heavy gauge, stainless steel wire fan guard shall be provided over each fan cylinder. The fan deck shall be galvanized metal to be used as a work platform. Access doors shall be provided on both end walls of the tower for access to eliminators and fan plenum section.
- F. Fans shall be driven by a right angle, industrial-duty, oil lubricated gear speed reducer that requires no maintenance for the first five-(5) years. The motor shall be located outside the airstream supported by a rigid, galvanized steel structural support that prevents misalignment between the motor and gear reducer. The tower manufacturer's representative shall assist the contractor in aligning the motor/shaft/drive assembly. The motor shall be a premium efficiency, inverter duty, totally enclosed fan cooled (TEFC), rpm as required to meet specified performance metrics, 1.15 service factor, squirrel cage, ball bearing type, variable torque, mill and chemical severe duty. The motor characteristics shall be as scheduled on the plans. The nameplate horsepower shall not be exceeded at any operating condition.
- G. The top of the tower shall be equipped with a handrail, complete with kneerail and toeboard, ladder, ladder safety cage, ladder extension, and access door platform designed according to OSHA guidelines. A vibration limit switch shall be installed on the mechanical equipment support assembly, it shall be adjustable, and shall require manual reset. Lubrication lines for the fan bearings shall be extended to the outside of the tower. On larger towers where the fan, drive or motor are not accessible from the plenum walkway an intermediate platform shall be furnished. The intermediate platform shall have toeboard, kneerail, handrail, and ladder.
- H. Provide make-up water level controller system utilizing electronic immersion probe assemblies. Probes shall be individually adjustable with a minimum of four (4) probes with isolated dry contacts for low alarm, fill, and high alarm. Make-up water control shall include a slow opening electric make-up water valve the size as indicated on the flow diagram.
- I. The towers will operate from a variable frequency drive furnished and installed by Division 26. The tower manufacturer shall assist in start-up to program/lockout of tower natural frequencies.
- J. The mechanical equipment assembly shall be warranted against any failure caused by defects in materials and workmanship for no less than five (5) years following the date of Owner acceptance. This warranty shall cover the fan(s), speed reducer(s), drive shaft(s) and couplings, and the mechanical equipment support(s). The electric motor shall carry a manufacturer's warranty of at least two years.
- K. The cooling tower shall be Marley NC Diamond Series, Baltimore Aircoil JE Premier Series.

## **23 66 00 CONDENSER WATER TREATMENT**

### **23 66 01 OPEN AND CLOSED WATER SYSTEM**

- A. This section shall apply to condenser water, chilled water, and heating water systems.
1. Furnish and install condenser, chilled water, and heating water chemical treatment systems as required by this section and indicated on drawings includes necessary equipment, chemicals and service to inhibit development of scale, corrosion, and biological growth in the following systems:
    - Condenser Water System
    - Chilled Water System
    - Heating Water System
  2. Contractor shall provide chemicals and bi-weekly service program for period of at least one (1) year but up to 16 months from start-up date of equipment through July 15, 2022 and shall include the following:
    - Initial water analysis and recommendations.
    - Systems start-up assistance. (Field location of components and connections).
    - Training of operating personnel.
    - Bi-weekly field service, consultation, and testing.
    - Customer report charts and log sheets.
    - Laboratory technical assistance.
  3. Coordinate installation with Division 26. Power supply wiring from power source to receptacles for water treatment equipment will be furnished by Division 26. Contractor shall provide for control wiring between field-installed controls, indicating devices, and unit control panels as required by the contractor.
  4. The water treatment company shall provide the following:
    - Installation and system start-up procedure recommendations
    - Pre-operation system cleanout procedure supervision
    - Initial water analysis and recommendations
    - Training of operating personnel on proper feeding and control techniques
    - Bi-weekly field service and consultation meetings
    - Any necessary log sheets and record forms
    - Any required laboratory and technical assistance
  5. Furnish one year to 16 months supply of a Phosphonate/Polymer-based formula for control of scale and corrosion in the Open Recirculating System. Provide a solid or liquid Bio-Dispersant to be added daily and two separate solid or liquid Biocides for prevention of microbiological growth in the same system. Biocide products recommended shall be properly registered with the Environmental Protection Agency and EPA registration numbers shall be, clearly shown on all product literature and container label. Chromates and sulfuric acid formulas shall not be used in the standard Treatment Program.
  6. Furnish complete submittals of the proposed system including but not limited to the following:
    - a. Product Data: Submit manufacturer's technical product data including rated capacities of selected equipment clearly indicated.
    - b. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to water treatment equipment. Submit manufacturer's external wiring diagrams for interlock and control wiring.

7. Furnish and install an open condenser, (cooling tower) treatment controller. Controller shall be Megatron series controllers, Model XS-C-F4-E3-H1 with internet connectivity as manufactured by Advantage Controls with the following features:
- a. Shall be housed in a NEMA 4X Type thermoplastic enclosure with dimensions being W 10" (28.4 cm) x H 12" (30.5 cm) x D 7.25" (18.4 cm) complete with:  
Hinged, gasketed Lexan viewing door.  
Padlockable door.  
An 8-ft., 3 wire input power cord with molded plug.  
Prewired 11" receptacle cords with molded female plugs for connection of electrical devices to be controlled.
  - b. Controller shall have an externally mounted flow sample stream assembly that is easily removable from the side of the enclosure and will include:  
  
Flow switch that will disable the control outputs if there is no flow in the sample stream.  
  
Provides a sample water port.  
  
Electrode will be secured in the sample stream piping with a threaded hand nut with O-ring seal that requires no tools for assembly.
  - c. Controller shall have complete keypad control and shall consist of:  
  
Unit shall be 100% adjustable through keypad, no mechanical adjustment will be required.  
  
Keypad shall have 20 keys that are tactile dome sealed style.  
  
Shall have override control of all relays through the keypad.
  - d. The controller shall utilize microprocessor technology including:  
  
High-resolution 12-bit A/O converter.  
Real time clock.  
Menu driven program for ease of operation.
  - e. Display on controller shall be 240 X 128 Graphic LCD.
  - f. Conductivity monitor and control:  
  
Shall provide linear measurements of the full controller range.  
  
Readings will be in increments of 1 MicroSiemen/cm with an adjustable deadband or hysteresis.  
  
Temperature compensated conductivity readings will be displayed after active measurement of the conductivity and the temperature.  
  
Bleed off shall be controlled in the following manner. The controller activates a blowdown valve whenever conductivity exceeds the control level set.
  - g. Chemical feed controls for inhibitor feed modes shall be provided and the unit shall be capable of operating in one of the following field programmable modes.

1. Counter timer – chemical feed proportional to make up water added.
    - a. Controller shall operate a feed relay or closure of a dry contact.
    - b. Controller shall count contacts or switch closures from a contacting head water meter with a range of 0-999 counts. Upon completion of programmable counts will start the feed timer for a selected time then reset automatically for the next cycle.
    - c. Contacts made shall be totalized and count capable of being reset.
  2. Percentage timer – chemical feed can be set to feed based on adjustable percentage of time.

Post blow down percentage timer. Controller tracks the amount of time that the bleed off is activated and turns on a chemical pump for a percentage of that time following the completion of the Bleed-Off.
  3. Feed Limit Timer – chemical feed can be limited to a pre set amount of time for each cycle blown down.
8. Provide (2) 28-day programmable Biocide timers for the automatic addition of two separate biocides on a user selectable basis. Each timer shall provide two on and off programs for each of two biocides:

Each of the two timers shall be programmable to run every day, every other day, once per week, once every other week, or on even or odd weeks or on a four-week (28 day) cycle.

Pump run times shall be programmable from 1 minute to 6 hours in one-minute increments.

A programmable conductivity pre-bleed timer shall be included to open the bleed valve for a user programmed time period prior to any biocide addition by either timer. This pre-bleed timer shall have a run time from one minute to six hours programmable in one-minute increments.

A post-feed bleed lock out timer shall be provided. This programmable time function allows the operator to prevent the bleed valve from opening for a programmable length of time following the addition of biocide from either timer. This timer shall be programmable from one minute to six hours, in one-minute increments.

A test switch shall be provided to allow a relay output test of both timers. This test switch shall be front panel mounted on the controller and provides for an automatic shut off after a three-minute maximum run time. The test function can be disabled at any time during the three-minute run period by pushing the front panel button again.

Controller shall include the following auxiliary features:

- Have an LED display for each output relay.
- Have security code to prevent unauthorized operation.
- Have an alarm dry contact relay output for connection to building automation system.

- a. Furnish three (3) Gemini Multiple Chemical Units by American Water Treatment. The tanks must double walled polyethylene tanks. Tanks shall be configured for three different liquids with tank capacities of 12-gallon/6-gallon/6-gallon.
  - b. Chemical delivery shall be by highly concentrated liquid from heavy duty dual wall containers
  - c. Electrical Connections
    - Must have (1) quad, 4-position, 110 volt electrical outlet at feed point for both Cooling System operations TDS Controller & Pumps.
9. Furnish and install Advantage XS-C-F4-E3, chemical pumps and sample stream piping assembly shall be mounted on a Pre Fab Polyboard. All components on the polyboard shall be pre-plumbed and pre-wired to form an operational and ready to use system. The pre-packaged system shall include:
- One (1) sample stream piping assembly consisting of:
    - A. Two (2) 3/4" inlet/outlet shut off valves rated for 125 PSI service.
    - B. One (1) flow switch rated for 125 PSI service.
    - C. Four (4) injection tees.
    - D. Conductivity probe of PVC construction, temperature compensated elements, mounted in a tee with probe fitting. The conductivity probe shall be easily removed from the probe fittings. No tools shall be required for probe removal.
10. Furnish and install three (3) chemical feed pumps by Advantage Controls of the positive displacement type, with Ball-type check valves and necessary polyethylene discharge tubing for the feed of corrosion inhibitor and two biocides. Pump materials of construction shall be compatible with chemicals being used. Pump quantities and capacities shall be three (3) at 55 GPD. Model B-155
11. Furnish and install two (2) water meters complete sized to meter twice the volume of the maximum makeup and bleed-off water rates of the system. The tower make-up water meter shall have an electric contacting register which will be connected to the tower conductivity controller. The minor scale of the meter shall be 1 gallon maximum.
12. Provide one (1) prepiped bleed-off piping assembly consisting of inlet shut-off valve, wye strainer, and motorized ball valve with capacitor return. Bleed-off piping assembly shall be 1 inch sized to bleed twice the maximum bleed-off rate of the system.
13. Furnish for installation by the mechanical contractor for each Chilled and Hot Water System, a One-Shot Feeder Model FA-1000 w/ Internal Filter Kit VF-1000. The Feeder will have legs and be a 5-gallon capacity designed to meet the temperature & pressure requirements of the system.
- a. Furnish one year's supply of a Nitrite Based treatment formula for scale and corrosion protection of Closed Recirculating Systems Treatment Levels shall be 1100-1400 ppm Sodium Nitrite. Formulation shall not contain any ingredients that are harmful to system materials of construction.
  - b. Furnish (24) replacement filter cartridges for the pot feeder filter systems. The filter should be capable of handling water temps of 180 degrees. Filter cartridges should be 100 micron size and compatible with the pot feeder system listed above.
15. Furnish water test equipment (1) Handtron Conductivity Meter by Advantage Controls as specified herein for proper system testing.



- a. Furnish (3) Prefabricated Coupon bypass Assemblies to monitor program effectiveness in the Condenser Water, Chilled Water, and Heating Water systems. This prefabricated assembly shall be a Model #ACR 21B7-J for Condenser and Chilled Water systems and ACR 28-B2 for Heating Water system. Systems include:
    - 1 inch inlet and outlet shut-off valve.
    - 1 inch line strainer with screen.
    - One (1) mild steel corrosion coupons with holders
    - One (1) copper corrosion coupon with holder
    - Two (2) corrosion coupon tees.
    - Adjustable Flow Control Valve.
    - Clear Plastic PVC over the Corrosion Coupon
  - b. Corrosion coupons will be analyzed by a regional laboratory every 90 days and test reports provided at recommended intervals. Provide coupon tests 4 times throughout the first year of operation.
16. Preoperational system cleanout shall be executed as follows. Cleaning shall be coordinated with the mechanical contractor and shall be supervised by the water treatment specialist.
- a. Heating and Chilled Systems:

All chilled and heating water lines and related equipment shall be thoroughly flushed out with pre-cleaning chemicals designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials prior to the addition of any chemical products. Water Treatment Specialist recommended dosages of pre-cleaner chemical products shall be added and circulated throughout the water system. The water system will then be drained, refilled and flushed thoroughly until no foreign matter is observed and total alkalinity of the rinse water is equal to that of the make-up water. This process may require longer than 24 hours of bleed and feed.
  - b. Condenser / Tower Water:

Condenser water lines and related equipment shall be thoroughly flushed out with a Surfactant type pre-cleaning chemical designed to remove deposition such as pipe dope, oils. This chemical shall not be Alkaline or aggressive to the system metallurgy. Recommended dosages of a Surfactant chemical product shall be added and circulated throughout the water system. The water system will then be drained, refilled and flushed thoroughly until no foreign matter is observed and total alkalinity of the rinse water is equal to that of the make-up water.
  - c. Water Treatment Representative shall be present for flushing and cleaning to inspect system discuss procedure and check water characteristics. American Water Treatment Representative must check water after 24 hours to insure all chemical cleaner has been removed and the Alkalinity of the rinse water is equal to that of the make-up water. American Water Treatment Representative must sign off on completion of cleaning & flushing.
17. Water treatment provided shall be American Water Treatment, Inc. No substitutions.

## **23 70 00 PACKAGED EQUIPMENT**

### **23 70 01 DUCTLESS SPLIT SYSTEMS**

- A. Furnish and install ductless split system DX air conditioning/heat pump units as specified herein and as shown on the drawings. System shall consist of wall or ceiling mounted ductless indoor fan coil unit, remote air cooled condenser, controls, refrigerant pipe sets, and all accessories.
- B. Indoor unit shall feature crossflow supply air fan, aluminum fin/copper tube cooling coil, housing and mounting bracket, integral condensate pump.
- C. Exterior unit shall feature Rotary-Hermetic compressor with crankcase heater, propeller fan, fan guard, and all refrigerant accessories. Refrigerant shall be R-410A. System shall be designed for up to 50 foot refrigerant tube length. Unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
- D. Unit shall have a single point power connection. Power shall be 208/230 volts, 1 phase, 60 hertz.
- E. Units shall be manufactured by Daikin, Hitachi, Mitsubishi, Trane or LG.

## **23 73 00 AIR HANDLING UNITS**

### **23 73 01 CUSTOM DOUBLE WALL ROOFTOP UNITS**

- A. ACCEPTABLE MANUFACTURERS
  - 1. Provide custom outdoor air handling units as manufactured by Temtrol as the basis-of-design. York Custom and Trane Custom are approved alternates if the included criteria is met. Where a specific product from a manufacturer is listed, along with the words "approved alternate" and a list of manufacturers, this equal product may be submitted.
- B. GENERAL
  - 1. Furnish and install where shown on the plans, mechanical frame style air handling units specifically designed for outdoor roof mount application with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.
- C. Factory Testing and Quality Control
  - 1. Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment.
- D. UNIT CONSTRUCTION DESCRIPTION
  - 1. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory

assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and AHRI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Units shall comply with NFPA 70, "National Electrical Code," as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.

2. Rigging Provision – Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.
3. Unit Base - Floor: Unit perimeter base rail shall be fabricated using heavy gauge steel. C-Channel cross supports shall be welded to perimeter base steel and located on maximum 24" centers to provide support for internal components. Base rails shall include lifting lugs at the corner of the unit or each section if de-mounted. Internal walk-on floor shall be 16 gauge galvanized steel. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel. The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors with glued and pinned insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.
4. Unit Casing – The construction of the air handling unit shall consist of a (1" x 2") steel frame with formed 16 gauge exterior casing panels. The exterior casing panels shall be attached to the gasketed (1 x 2) steel frame with corrosion resistant fasteners. All casing panels shall be completely removable from the unit exterior without affecting the unit's structural integrity. (Units without framed type of construction shall be considered, provided the exterior casing panels are made from 20 gauge galvanized steel, maximum panel center lines are less than 20 inches and deflection is less than L/200 @ 8" positive pressure). The air handling unit casing shall be of the "no-through-metal" design. The casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there's no path of continuous unbroken metal to metal conduction from inner to outer surfaces. All panel seams shall be caulked and sealed for an airtight unit.
5. The exterior panel finish shall be painted with a polyester resin coating designed for long term corrosion resistance meeting or exceeding (ASTM B-117) Salt Spray Resistance at 95 degrees F. 2,500 hrs. and (ASTM D-2247) Humidity Resistance at 95 degrees F. 2,500 hrs. The color shall be sandstone.
6. Note: If manufacturer cannot provide thermal break (no through metal) and or removable exterior panel construction it must be noted as an exception on the bid.
7. Double Wall/Roof Liner - Each unit shall have double wall construction with:
  - a. 16 gauge solid galvanized liner in the:
    - i. Outdoor Air Section
    - ii. Exhaust Air Section, downstream of exhaust fans
    - iii. Return Air Section, downstream of return fans
    - iv. Supply Air Section, upstream of supply fans
    - v. Heating Water Coil Casing

- b. 16 gauge solid stainless steel liner in the:
    - i. Chilled Water Coil Casing
  - c. 22 gauge perforated galvanized liner in the:
    - i. Exhaust Air Section, upstream of exhaust fans
    - ii. Return Air Section, upstream of return fans
    - iii. Supply Air Section, downstream of supply fans
  - d. The double wall interior panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.
- 8. Fiberglass Insulation – Perforated liner sections to be insulated with a full 3" thick non-compressed fiberglass insulation. The insulation shall have an effective thermal conductivity (C) of .24 (BTU in. /sq. ft. F°) and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). The coefficients shall meet or exceed a 3.0 P.C.F. density material rating. Insulation shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88) and meet NFPA 90A and 90B. All insulation edges shall be encapsulated within the panel. All perforated sections shall have Micromat® or equal insulation with non-woven mat facing, 5000 fpm rating and non-hygroscopic fibers as manufactured by Johns Manville or approved equal.
- 9. Foam Injected Insulation – Solid steel liner sections to be insulated with a full 3" thick closed cell foam insulation. Foam shall be ecomate 0-, 0-, (Non VOC) UL 94HF1 rated. All insulation edges shall be encapsulated within the panel. All field penetrations must be completely sealed by installing contractor. Non UL 94HF1 rated foam is not allowed.
- 10. Roofs shall have a minimum slope of 1/4" per foot.
- 11. Access Doors – 18" minimum width. The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
- 12. Note: If manufacturer cannot provide thermal break door design it must be noted as an exception on the bid.
- 13. Pipe cabinets and electrical compartment shall be constructed similar to the unit base and casing specification listed within.
- 14. All base/floor penetrations for supply, return and exhaust air shall have a walkable protective grate. Piping penetrations through base of unit shall be open to return air plenum below for freeze protection. Provide protective grate for continuous walking surface.
- 15. All chilled and heating water piping, and freeze protection pump must be supported from unit base rails. Do not hang piping from roof or walls. Supports must be anchored to the unit base rails, do not secure to flooring without base rail support.

#### E. UNIT COMPONENT DESCRIPTION

- 1. Fans and Fan Arrays
  - a. Fan Wheel
  - b. Fans shall be polymer airfoil wheel, direct drive arrangement and shall be individually housed. Fans shall tested in accordance with AMCA 210 for air performance and AMCA 300 for sound performance. Fan shall be housed in a "cell".
  - c. Fan housing or "cell" shall be constructed of aluminum or stainless steel with perforated inner liner, melamine insulation, with either solid or perforated outer panels as required by application.

- d. Fan/motor assembly shall be mounted within the housing on an adjustable slide rail base. Fan/motor assembly must be capable of either horizontal or vertical application.
  - e. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, for fan application class BV-5, to meet or exceed a rotational imbalance Grade G1.0, producing a maximum rotational imbalance of 0.04 inches per second peak, filter in. "Filter in" measurement indicates that the specified balance grade must be achieved at the submitted design operating speed for the fan(s).
  - f. Fan assemblies shall be dynamically balanced to meet AMCA standard 204-96, for fan application class BV-4, to meet or exceed a rotational imbalance Grade G2.5, producing a maximum rotational imbalance of 0.10 inches per second peak, filter in. "Filter in" measurement indicates that the specified balance grade must be achieved at the submitted design operating speed for the fan(s).
  - g. Fan and motor assemblies shall be designed for application in multiple fan arrays.
2. Fan Backdraft Dampers
- a. Each fan applied in multiple fan applications shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan, or multiple fans, becomes disabled. The system effect for the submitted back flow prevention device shall be included in the calculation to determine the fan TSP for fan selection purposes and shall be indicated as a separate line item SP loss in the submitted fan selection data. Manufacturers other than the basis of design being submitted must provide independent lab certification of fan testing that indicates the system effects attributed to the submitted back flow prevention device in the submitted close coupled mounting arrangement at the inlet of the fan. Fans submitted with discharge dampers will not be approved.
  - b. Back Draft Damper performance data that is based on an AMCA ducted inlet and ducted discharge mounting configuration will not be accepted. Submitted Back flow prevention device data must be reflective of close coupled mounting at the intake of the fan(s) per the project design documents. Motorized dampers or other motorized devices submitted for back flow prevention are not acceptable.
  - c. AHU Manufacturers that do not manufacture the fans being submitted must provide tested and certified performance data for fans as installed in the AHU unit including the back draft damper system effects introduced by close coupled back draft dampers at the fan inlet.
3. Fan Airflow Monitoring
- a. Fans shall have non evasive, zero pressure drop flow a/o pressure sensing taps installed in the fan inlet cone for airflow monitoring capability as specified.
4. Motors
- a. Electronically Commutated Permanent magnet motors (ECM)
    - i. All EC motors shall be UL listed with brushless permanent magnet motors.
    - ii. All bearings shall be permanently lubricated
    - iii. Motors shall have a design life of L10 100,000 hours
    - iv. Motors shall have a means of shaft isolation to prevent electrical arcing across bearings
    - v. Motors shall be complete with electronic motor overload protection, locked rotor protection and thermal management
    - vi. Motors shall meet IP54 protection and thermal class THCL 155
5. Multiple Fan Arrays
- a. The fan array shall consist of multiple housed fans or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air tunnel cross section and components contained therein.
  - b. Each fan and motor assembly shall be removable through a 24" wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor.

- c. All fans in the multiple fan arrays shall be AMCA certified for performance per AMCA arrangement "A" testing configuration. The submitted fan performance shall be inclusive of system effects attributed to the fan mounting arrangement, fan enclosures, back draft dampers, and other fan appurtenances not considered when AMCA certified performance per AMCA arr. "A" is determined. Submitted AHU/fan performance that does not indicate allowances for system effects for the backflow prevention device(s), wheel enclosures, safety screens, bearing pedestals, belt guards, or the fan and motor enclosure in which each fan is mounted, will be returned to the contractor disapproved and will need to be resubmitted with all the requested information included for approval. Added system effects for other devices required to meet specified fan performance and sound levels must be indicated in the submitted fan selection data.
  - d. Fan system power requirements or sound power levels that fail to meet specified performance levels shall be corrected to meet specified performance levels at no additional cost to the owner. Any proposed corrections for power or sound deviations from specified values must be submitted to the engineer for approval prior to implementation of any proposed corrective procedure.
  - e. Submittals for units providing less than the scheduled quantity of fans and/or spacing of the fans for multiple fan arrays shall submit CFD modeling of the air flow profile for approval that indicates uniform velocity and flow across all internal components without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.
  - f. Manufacturers that do not manufacture their own fans for the specific purpose of use in multiple fan arrays, shall provide a letter guaranteeing submitted AHU performance for flow, pressure, and acoustics at the perimeter boundary of the unit signed by an officer of the OEM fan manufacturer being submitted. Any corrective acoustical treatment, added airway tunnel lengths, increased electrical service, and any structural modifications necessary to meet specified and scheduled performance shall be provided at no additional cost to the owner to meet the specified performance criteria. All proposed corrective actions, when required, must be submitted for approval and shall include a guarantee of performance, as listed above, at no additional cost to the owner.
6. Acoustical Performance
- a. The AHU unit shall provide the specified acoustical performance as scheduled for the unit supply discharge opening(s), RA opening(s), and the Outside air and Exhaust air opening(s).
  - b. Coplanar silencer(s) and/or sound attenuator(s) shall be provided to meet specified acoustical requirements. Sound attenuator cross sectional area shall be selected to not exceed 500 fpm. Losses from sound attenuating devices must be included in the fan performance selection.
  - c. Listed or alternate manufacturers, other than the basis of design, providing fan arrays that incorporate fans which are not manufactured by the AHU manufacturer, must provide modeled acoustical performance of the AHU unit.
  - d. Sound and performance data for approval showing only single fan performance for multiple fan array application will be returned without review.
  - e. Any proposed remedy for deviations in submitted sound power levels shall be approved by a registered acoustical consultant as selected by the owner or architect. Costs for review of proposed changes shall be borne by the contractor.
7. Heat Transfer Coils – Water Coil
- a. All coil assemblies shall be leak tested under water at 315 PSIG and PERFORMANCE is to be CERTIFIED under AHRI Standard 410. Coils exceeding the range of AHRI standard rating conditions shall be noted.
  - b. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a

copper downspout. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins are die formed Plate type.

- c. Headers are to be seamless copper with die formed tube holes.
  - d. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided on coil header for coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.
  - e. Water coils shall have the following construction:
    - f. 5/8" o.d. x .020" wall copper tube with .028 return bends.
    - g. .008" aluminum fins
    - h. 16 gauge galvanized steel casing on heating coils
8. Condensate / Drain Pans - IAQ style drain pans shall be provided under preheat, cooling and reheat coils as shown on the drawings. The drain pan shall be fabricated from 16 gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4" MPT drain connection extended to the exterior of the unit base rail. Units in excess of 159 inches shall have drain connections on both sides. All cooling coil drain connections shall be piped and trapped separately for proper drainage. All drain pans at heating coils shall be capped at base rail.
9. Filters - Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by AAF, FARR or equal. Side service filter sections shall include hinged access doors on both sides of the unit. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters. The filters shall be as manufactured by Farr, Purolator, AAF or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.
10. Filter Gauge: Each Filter bank shall be furnished with: (Magnehelic / Photohelic) filter gauge with a 4 3/4" OD white static pressure dial with black figures and zero pointer adjustment. Dwyer Series 2000 Air filter gauge, Dwyer Mark 25 Inclined manometer (DWYER 250 AF).
11. Flat Racks - Filter racks shall be completely factory assembled and designed for industrial applications. Filter racks shall be fabricated from no less than 16 gauge galvanized steel. Filter racks shall be applied in low efficiency filter applications and will be either upstream or side accessible. Side accessible filter racks shall have an oversized access door on the exterior of the air handler, centered on the filter rack for easy filter removal. Upstream access filter racks shall have one central access cover per row of filters centered in the unit for easy access. Filter racks over 72" in length shall require an angle center reinforcement support. Filter racks shall be designed for a maximum of 500 fpm, or meet or exceed the area specified in the mechanical schedule.
12. Medium Efficiency Pleated Filters - Filters shall be 2" thick, 30% efficient. Filter media shall be 100% synthetic. The filter shall have an average efficiency of 25-30% and an average resistance of 90-92%. The filters shall be listed as Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52-76. The effective media shall not be less than 4.6 square feet of media per 1.0 square foot of filter face area, and shall contain not less than 15 pleats per linear foot. Initial arrestance at 500 fpm approach shall not exceed 0.28" wg.
13. High Efficiency Bag Filters - Filters shall be a high performance extended area disposable type. Each filter shall consist of high density glass fibers, reinforced to form a lofted filter blanket. Filters shall be furnished with individual dust holding compartments

and a corrosion resistant galvanized steel enclosing frame. Dust holding compartments shall consist of glass fibers bonded to a reinforced backing. The configuration of the dust holding compartments shall be controlled by means of progressive link stitching. The stitching shall be such that it forms a supported compartment resulting in uniform velocities in the passages of the entering air and exit air side of the filter. The dust holding compartment shall be equipped with a minimum of 48 support points per square foot of the filter media. All stitching points shall be sealed with a hot melt adhesive or equivalent. The dust holding compartment shall be equipped with a galvanized entry faceplate which becomes an integral part of the enclosing frame. The filter unit shall be completely factory assembled and shall be classified by UL as Class II under UL Standard 900. The filter efficiency shall be Merv14 meeting the efficiency specified by the mechanical schedule. The filter efficiency and arrestance shall be in accordance with ASHRAE Standard 52.1-1996.

F. Dampers

1. Dampers shall be constructed from minimum 12 gauge extruded aluminum blades and frames. Blades shall be locked to the blade shaft by a positive means other than setscrews. Such means include ribs extruded into the blade that fit slots in the damper shaft and hexagonal shafts that fit tightly in hexagonal holes extruded into the blades.
2. Shafts shall be provided with bearings at all support locations.
3. Dampers shall be equipped with blade and jamb seals and shall have a leakage rate less than .1% of maximum flow.
4. Linkage shall be concealed in the jamb out of the air stream where such an arrangement will be accessible for maintenance and lubrication without removal of the unit from the duct system or fan system that it is installed in. In all other cases the linkage shall not be concealed in the frame.
5. Dampers with vertically oriented blades shall be provided with thrust bearings to support the vertical blades.
  - a. Mixed Air Section Damper and Outdoor Air Section Dampers shall be vertical blade to promote air mixing.
6. Dampers shall be Ruskin Model CD-50 or approved equal.

- G. Rain Hoods - Rain hoods shall be fabricated from same material as unit casing with 1/4" wire mesh inlet screen. Hoods sized to minimize moisture carry over.

H. Louvers:

1. Exhaust/Relief Air applications - Provide extruded aluminum stationary louvers, drainable type with built in downspouts and birdscreen. Blades shall be housed inside a 16 ga. galvanized steel frame mounted to the unit exterior. Louver finish to match exterior unit finish.
2. Outside Air applications - RUSKIN EME6625D extruded aluminum louvers shall be used at O/A location. Louvers shall be stationary, drainable type with built in downspouts and furnished with birdscreen. Blades shall be vertical and housed inside an aluminum frame mounted to the unit exterior. Louver finish to match exterior unit finish.

I. ELECTRICAL POWER AND CONTROLS

1. All electrical and automatic control devices not previously called out or listed below are to be furnished and installed in the field by OTHERS.
2. All wiring shall be (75°C) Insulated copper wires.
3. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.
4. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquidtight flexible metal conduit may be used outside the air tunnel for wet locations. All



electrical wiring shall be installed in EMT conduit where possible. Flexible conduit use shall be limited.

5. Provide two (2) 1-inch EMT conduits empty for field installed temperature controls low voltage wiring. Provide conduits in each supply and return air tunnels the entire length of the unit.
6. The unit shall feature a main non-fused disconnect of the proper amp rating to allow shutoff of all electrical motors and control items. This disconnect shall be located in the electrical compartment.
7. A compartment shall be furnished on the end or side of the unit. The compartment shall be ventilated with supply air from the unit to provide adequate cooling of electrical components mounted within. Access doors(s) shall be furnished on the unit exterior to provide service to all components.
8. All EC fan motors shall be wired to a junction box mounted in the electrical compartment.

#### J. UNIT CONVENIENCE FEATURES

1. All fan motors, energy recovery wheel motors shall be wired to a single electrical panel in the electrical compartment for an external 480Volt, 3 Phase source.
2. Each section shall be equipped with a vapor- proof LED strip light equal to a minimum of 100 watt with guard.
3. Lights shall be controlled by one light switch mounted in the electrical compartment.
4. Furnish a 120 volt GFI duplex convenience outlet in the electrical compartment.
5. All lights, switches and outlets shall be wired to a non-fused disconnect for a separate 120 volt external source.
6. Furnish 120 volt junction box for installation of temperature controls panel.
7. All shipping splits shall have electrical connections clearly labeled for field installation. The mechanical contractor shall coordinate field connection with electrical contractor.

#### K. Roof Curbs shall be galvanized steel with a two-inch by four-inch nailer strip. All openings air openings shall be gasketed. Curb shall be provided with knocked down for easy assembly. Curb shall be manufactured to National Roofing Contractors Associated guidelines. Curbs shall be a minimum of 18-inches in height and be fully insulated.

1. Units with piping routed through the base of the return air section shall include an isolated piping curb frame to allow for air tight seal.
2. Contractor shall coordinate curbs with structural steel.
3. Roof curbs shall be sloped to match the roof structure slope to minimize blocking.

#### L. Rooftop Unit Noise Reduction System

1. The noise reduction system shall be a multi-layered acoustical composite for placement inside the rooftop equipment curbs. The overall installed thickness of the composite panels shall be 7". All materials shall meet Class "A" flame spread and smoke develop as per the inside the curb. Decking shall be maintained inside the RTU curb to a clearance of 1/4" maximum. The manufacturer or their local authorized agent shall inspect the in-curb deck system work on site prior to installation of the RTUs on the roof curbs and issue a letter of certification to the engineer. The system shall be provided by the rooftop unit manufacturer as a turnkey package.
2. The in-curb acoustical treatment performance shall be tested in accordance with ASTM E-90-10, The assembly shall be rated at not less than STC-52 with 1/3 octave performance values as listed below for sound radiation throughout the deck inside the curb.

| In-Curb Composite - (Transmission Loss) in accordance with ASTM E-90-10 |    |     |       |     |     |     |       |     |     |     |     |      |       |      |      |      |       |      |      |      |
|-------------------------------------------------------------------------|----|-----|-------|-----|-----|-----|-------|-----|-----|-----|-----|------|-------|------|------|------|-------|------|------|------|
| Freq. (Hz)                                                              | 80 | 100 | 125   | 160 | 200 | 250 | 315   | 400 | 500 | 630 | 800 | 1K   | 1.25K | 1.6K | 2K   | 2.5K | 3.15K | 4K   | 5K   | 6.3K |
| Transmission Loss (dB)                                                  | 26 | 27  | 33    | 32  | 35  | 42  | 45    | 45  | 50  | 56  | 59  | 60   | 62    | 63   | 64   | 65   | 67    | 71   | 74   | 78   |
|                                                                         | 8K | 10K | 12.5K | 16K | 20K | 25K | 31.5K | 40K | 50K | 63K | 80K | 100K | 125K  | 160K | 200K | 250K | 315K  | 400K | 500K | 630K |
|                                                                         | 80 | 82  | 85    | 88  | 90  | 93  | 95    | 97  | 100 | 103 | 106 | 108  | 110   | 112  | 115  | 118  | 120   | 123  | 126  | 129  |

3. System shall be by manufacturer BRD Noise and Vibration Control, Inc. model Hushcore Deck System model DS-52 or approved equal.

O. Energy Recovery Wheel

1. General

- a. Refer to unit schedules to identify units that require wheels.
- b. Furnish and install the I3 energy recovery wheel, to be manufactured by Innergy tech Inc. or equal by Thermotech Inc. or approved equal.
- c. The energy recovery wheel shall transfer both sensible and latent energies between outgoing and incoming air streams in a counter flow arrangement.
- d. The energy recovery wheel shall be labeled for rotation direction and airflows (Outdoor air & Exhaust air).
- e. The energy recovery wheel manufacturer must have at least ten (10) years of experience in the manufacturing of energy recovery components.
- f. The energy recovery wheel shall carry a full parts and labor 5 years warranty from the date of shipment. An optional 10 years warranty shall be available as a separate option.

2. Quality Assurance

- a. The wheel shall bear the AHRI 1060 certified label. Wheels tested in independent laboratories, whether according to AHRI Standard 1060 or not, are not acceptable unless actually certified by AHRI. Wheel manufacturer membership in AHRI is not an acceptable substitute for AHRI certified performance.
- b. The energy recovery wheel shall be a UR recognized component and bear the UR label.
- c. The energy recovery wheel shall comply with the requirements of UL723. The media shall have a flame spread of less than 25 and a smoke developed of less than 50 when rated in accordance with ASTM E87.
- d. The energy recovery wheel shall comply with the IBC Certification and OSHPD Seismic Qualifications.
- e. The manufacturer's quality procedures shall be ISO 9001-2008 certified.

3. Performances (Effectiveness, Pressure drop, EATR & OACF)

- a. Sensible, latent and total effectiveness along with pressure drop, EATR and OACF ratings, shall be clearly documented in the AHRI 1060 Certified Product Directory.
- b. The energy recovery wheel, without purge, shall achieve an EATR rating of 0% (no cross-leakage) at 5" WC pressure differential. The result shall be clearly shown in the AHRI 1060 directory.
- c. To reduce fan operating costs, the energy recovery wheel shall not exceed an OACF of 1.15 for rotors of up to 70" (1778mm) and 1.08 for rotors of up 120" (3048mm) at 5" WC pressure differential when no purge is used. The results shall be clearly shown in the AHRI 1060 directory.

4. Rotor Media & desiccant

- a. The rotor media shall be made of 2 mils minimum thickness aluminum. The media shall be coated to prohibit corrosion and shall be suitable for seacoast application. Non-metallic substrates made from paper, plastic, synthetic or glass fiber media are not acceptable.
- b. All surfaces shall be coated with a non-migrating desiccant specifically developed for water transfer in vapor phase. Etched or oxidized surfaces are not acceptable.
- c. Desiccant must be a polymer hygroscopic or 3 angstroms molecular sieve (3A).
- d. Desiccant shall be bactericide and non-corrosive.

- e. The rotor shall be constructed of equal width, alternate layers of corrugated and flat aluminum sheet material to create a flat and smooth surface and insure laminar flow thus preventing any dust or particles accumulation inside the rotor.
  - f. Corrugation pattern shall be of closed triangular shape to prevent any cross-leakage between airstreams. Open type corrugations or embossments, since they increase fan operating costs, are not acceptable.
  - g. Dry particles up to 800 microns shall freely pass through the media to minimize air pressure drops and pre-filtering requirements.
5. Seals
- a. The rotor shall be supplied with labyrinth seals facing the media, polymer contact seal along the depth of the wheel and "S" type labyrinth seal along the wheel's periphery. Wheel using less effective seals like brush seals or standard 4 pass labyrinth seals are not acceptable.
  - b. The labyrinth seals shall be installed with no gap between the seal and media. Labyrinth seals that require an installation gap or seals that will damage the media if they come in contact with it are not acceptable.
  - c. All seals shall be designed to withstand pressure differentials of up to 10"WC.
  - d. The labyrinth seals shall be factory adjusted. Field adjustments shall be possible using common tools.
6. Bearings and center shaft
- a. The rotor shall be supported by two pillow block bearings which can be maintained or replaced without removal of the rotor from its casing or the media from its spoke system. Inboard type bearings are not acceptable. Grease fittings shall be easily accessible.
  - b. Bearings shall be rated for a minimum L10 life of 220,000 hours.
  - c. The center shaft shall be machined as to provide a shoulder against the bearing and prevent any axial movement of the rotor.
  - d. The center shaft shall use black oxide and oil coating to prevent rust. Center shafts using oil only are not acceptable.
7. Purge & Cassette Assembly
- a. The unit shall be provided with a factory set & field adjustable purge section to prevent any cross-leakage (0% EATR) starting for pressure differentials as low as 0.5"WC.
  - b. The rotor shall be provided with a structural frame which limits the deflection of the rotor due to air pressure drops to less than 1/32".
  - c. The framing shall be made of a heavy-duty welded tubular steel assembly.
  - d. Framing shall be primed with a rust inhibitor phenolic primer and painted with a high durability synthetic industrial paint.
  - e. The cover panels shall be made of galvanized steel (minimum thickness of 1/16") to prevent corrosion.
  - f. When the top/bottom & side plate option is selected, the cassette shall be equipped with removable cover panels for side service access to the motor assembly.
  - g. For easier parts inspection and maintenance, all major components (motor assembly, driving belt, seals) shall be easily accessible from at least one side of the wheel within the airstream. The components shall not require the removal of sheet metal for a visual inspection. Wheels with face plates on both sides are not acceptable.
  - h. The wheel shall be supplied with removable corner bracings (bolted) for easy replacement of media sections from both faces of the wheel if ever required.
8. Rotor assembly
- a. Rotor spoke system shall be of segmented design to allow for field erection or replacement of one section at a time without requiring side access. Wheels up to 62" in diameter shall be made of 4 sections and wheels larger than 62" shall be made of 8 sections.
  - b. The rotor spoke system shall be made of strong aluminum material providing the structural integrity required at design pressure differentials.

- c. The rotor hub shall be made of machined, extruded aluminum (no welding), for reduced tolerance and increased stiffness.
  - d. All rotor parts shall be made of aluminum or stainless steel. Galvanized steel parts are not acceptable.
9. Drive system
- a. The rotor shall be perimeter driven with a multilink V-belt made of high-tech polyurethane/polyester composite material for easier installation and replacement.
  - b. V-belt shall be easily adjustable without the use of tools.
  - c. The belt shall be tensioned with a heavy-duty belt tensioner. Gravity tensioned assemblies are not acceptable.
  - d. An A/C inverter duty motor shall drive the rotor.
  - e. The wheel shall be supplied with a speed reducer resulting in a rotation speed of 20RPM without the use of a VFD. Wheels with rotation speed higher than 20RPM are not acceptable due to increased fan energy consumption.
  - f. Speed reducer and belt tensioner shall be permanently lubricated and maintenance free.
10. Controls
- a. The VFD shall be supplied with a NEMA 1 enclosure and located in the electrical compartment. The VFD shall be by ABB, no exceptions.
  - b. The VFD standard communication protocol shall be: S-422/485 MEMOBUS/Modbus at 115.2 kbps (BACnet™ optional).
  - c. VFD to be supplied with LCD display screen for easy monitoring of VFD parameters, inputs and outputs.
  - d. Communication Capabilities: VFD software to enable building automation system (BAS) to monitor temperatures, control discharge set point, wheel rotation speed and display alarms.

#### 23 73 02 PACKAGED DOUBLE WALL ROOFTOP UNIT

- A. Units shall be electric cooling/hot water heat as scheduled packaged rooftop equipment as scheduled on the drawings and specified herein. Units shall be fully factory assembled UL Standard 465 listed and labeled package consisting of an insulated weathertight casing, compressor(s), air cooled condenser coil, condenser fans and motors, evaporator coil, filters, supply fan, fan motors and drives, heater, and unit controls.
- B. Cooling performance shall be tested and certified to ARI Standard 210/240-89 or 360-85. Units shall be factory charged and 100% factory run tested for proper operation of all standard and optional items including: fans, compressors, expansion valves, heater, safeties, and controls. A copy of a run test report indicating the date, time, tested refrigerant temperatures/pressures, amperages, voltages, etc. shall be shipped with the unit.
- C. Unit casing shall be a minimum of 18 ga. G90 galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a baked enamel finish to meet a 500 hour salt spray test in accordance with ASTM B117. Roof panels shall be cross broken and/or sloped to provide positive drainage. The interior airside of the cabinet shall be entirely insulated on all exterior panel with a minimum of 1 inch thick, 1 pound density, neoprene coated fiberglass insulation. The unit shall have a minimum of 20 ga. G90 galvanized steel solid or perforated interior liner. Access door shall be double wall construction with stainless steel piano hinges, quarter-turn camlocks (door fastening screws are not acceptable), fully gasketed with rain breaks. Access doors shall be provided for ready access to bearings, motors, drives, coils, piping devices and connections, and points required for maintenance service or inspection. Condensate drain pans shall be insulated with full thickness, non-compressed, insulation between the drain pan and the unit casing and shall drain both the coil and the fan; units with multiple vertically stacked coils shall have an intermediate drain pan. The pans shall be continuously welded seams, Series 300 stainless steel, 'V' shaped and/or sloping to the drain connection, flat pans will not be acceptable. Drain pans shall be located in the coil section and in the fan section.

- D. Compressor shall be isolator mounted, high efficient, hermetically sealed, refrigerant cooled, inverter scroll type with high starting torque. Motor shall be capable of operating at plus/minus 10 percent of nameplate voltage. Motor shall have internal temperature and current sensors for motor protection. Compressor shall have an automatic resetting low pressure safety and a manual reset high pressure safety. Refrigeration filter-drier, sight glass, liquid service valve, suction service valve, and gauge ports shall be factory furnished and installed.
- E. Condenser coils shall be 3/8" smooth bore copper tubes with aluminum fins mechanically bonded to the tubes. Fins shall not be spaced closer than 12 fins per inch. Provide subcooling circuits integral with the condenser coils for a minimum of 10°F subcooling. Coils shall be factory pressure tested to 425 psig. Coil guards shall be a minimum of 20 ga. galvanized steel louver type to protect the coil from hail or other damage, wireguards are not acceptable. Condenser fan(s) shall be aluminum or galvanized steel blades with non-corrosive hubs. Fan motors shall be direct connected, totally enclosed, permanent split capacitor type, with built-in thermal overload protection.
- F. Fans shall have capacities as indicated on the schedules. Each fan shall be of the non-overloading airfoil or backward inclined centrifugal type with deep drawn inlet rings, streamlined housing and scroll, with blades continuously welded to the flange, solid backplate, full curved shroud, and flanged discharge collar. Where Class II construction is required, wheels shall be reinforced with a welded intermediate ring. Fan bearings shall be heavy duty, self-aligning, grease lubricated, antifriction type with double row rollers and labyrinth grease seals. Provide drain openings at the bottom of each fan scroll. Each fan shall be equipped with an adjustable pitch V-belt drive selected for 1.5 times the motor horsepower, motor sliderail base and premium efficiency open dripproof motor. Fans and motors shall be resiliently mounted on a single structural base, internally mounted with resilient mounts on the unit structural frame. Internal resilient mounting shall be spring type with minimum 1-1/2" static deflection and provided with seismic restraints.
  - 1. Manufacturer shall allow for using the most energy efficient fan option within the manufacturer's line for the unit size. The Engineer reserves the right to choose the final fan size from the manufacturer's line.
- G. The units shall be provided with coils of the types and capacities scheduled. Cooling coil casing shall be galvanized steel. Coils shall be constructed with no less than 1/2" diameter x .020" wall thickness copper tubes and .0075" aluminum or copper fins spaced not closer than 10 per inch. Fins shall be permanently secured to the tubes by mechanical bonding or soldering and shall be plate type. Frame shall include intermediate tube supports to prevent sagging of the tubes. The coil shall be removable with removing casing panels (i.e., casing shall have its own internal frame and shall not use the coil for support).
  - 1. Refrigerant coils shall be row split or interlaced type with equalizing distributors. Coils shall be tested to 300 psig and shipped with a holding charge of dry nitrogen. Tube diameters, wall thickness, and fins shall be the same as above.
- H. Air filters shall mount integral within the unit casing on slide channels. The channel shall incorporate a positive sealing gasket material to seal the top and bottom of the filter to prevent bypass. Access door(s) with the same construction as specified previously, and shall be located to allow easy replacement of the filters. Filters shall be minimum 2" pleated 30% throw-away MERV 8. Filters that are 24" x 24" size are preferred to reduce the required inventory, thus facilitating better maintenance.
- I. Units shall have a factory furnished and wired non-fused single point power disconnect switch and fused 24 volt control power transformer. The disconnect switch handle shall be accessible without opening any unit access doors. The unit shall be provided with a factory furnished and wired GFI 120V outlet that the transformer (460 models) is powered from the line side of the incoming three phase power, so that the outlet can remain powered when the three phase

disconnect is off. The receptacle shall be fused and have disconnects, overload protection, etc., per the NEC.

- J. Units shall be completely factory wired with terminal block connections for all customer wiring interfaces. A wiring diagram specific to the unit ordered (with only the options actually provided) shall be shipped with the unit. Factory controls shall include: anti-short circuit time delay relay(s), low ambient temperature start-up and control down to 0°F, pump down cycle, and coil frost control. A customer terminal strip shall be provided to enable control of the following functions: start/stop, fan proof of operation, heater control (each stage), economizer damper control (4-20 mA), cooling control (each stage), dirty filter switch, fan speed control (4-20 mA), and safety shutdown indication (N.O. contact).
- K. Units shall have a complete two year warranty and a five year warranty on the compressor.
- L. Unit shall be Daikin Rebel, or approved equal by Trane or York.

## **23 82 00 TERMINAL UNITS**

### **23 82 01 UNIT HEATERS**

- A. Furnish and install unit heaters of types, arrangements, and capacities as indicated on the drawings.
- B. Cabinet type units shall include a 16 gauge furniture steel casing, inclined blade type inlet and discharge grilles, removable panels, 120/1/60 fan motors, quiet operating centrifugal fans, non-ferrous hot water heating coils, throwaway filters, vandal proof fasteners, and air vent tappings. The heaters shall be arranged for mounting as indicated. Heater casings shall be finished in baked enamel with colors as selected by the Architect/Engineer.
- C. Field mounted controller with remote DDC temperature sensor. Provide with factory mounted disconnect switch and EC motor with dial for balancing.
- D. The units shall be IEC DBY or equivalent by Trane, Sterling, Airtherm, McQuay, Engineered Air.

### **23 82 02 VARIABLE VOLUME UNIT WITH HOT WATER HEAT**

- A. Unit casing shall be welded, galvanized steel. Leak rate shall be not more than 1% of rated capacity at 4" wg. Interior surface of unit casing shall be acoustically and thermally lined with 1/2 inch thick, minimum of 1.5 lb./cu. ft. density glass fiber with high density facing. Insulation shall be UL listed and meets NFPA-90A and UL 181. Factory mounted, removable panel on bottom of unit providing access to air valve and entering airside of coil. Straight flange or slip and drive rectangular discharge duct connection.
- B. Factory mounted two row coil with maximum of 12 fins per inch. Full fin collars for accurate fin spacing and maximum tube-fin contact, 5/8 inch O.D. seamless copper tubes mechanically expanded into the fin collars, leak tested at 300 psig.
- C. Air valve shall be a 90° rotational damper flow control device with factory installed direct digital controls (DDC). All controls shall be furnished, mounted, and wired in the factory by unit manufacturer. Manufacturer shall provide multiple point averaging flow sensing ring with high and low pressure pneumatic tubes compatible with DDC velocity pressure sensor. A calibration chart shall be provided on each unit.
- D. Factory mounted low voltage transformer for DDC controls.

- E. At the Contractor's option Division 25 may field mount controls at no additional cost to the Owner.
- F. Units shall be as manufactured by Titus, Anemostat, Carnes, Enviro-Tech, Krueger Metal Aire, Nailor, Price, Tuttle and Bailey.

#### 23 82 03 FAN COIL UNITS

- A. Furnish and install fan coil units as specified and as shown and scheduled on the drawings. Capacities shall be certified in accordance with ARI Standard 440-latest edition.
- B. The basic unit shall be constructed of galvanized steel and insulated to meet the ARI Fan-Coil Industry test standard for insulation efficiency. Coils, motor speed control, electric junction box, primary and auxiliary drain pans, motor board, motor(s), and fan(s) shall be included in the basic unit.

Exposed wiring shall be in flexible conduit. Unit mounted electrical devices shall be prewired to a junction box. Units shall comply with Underwriters' Laboratories' standard No. 883 for Room Fan Coil Units. All unit/cabinet styles: shall have a factory installed and wired disconnect switch. Disconnect switch shall be Hubbell model HBL-1221 or equivalent.

Unit shall have an externally insulated stainless steel condensate drain pan/trough. An auxiliary drain pan located in end pocket shall be molded plastic. Drain surfaces shall be separate from the motor board assembly.

Insulation shall be 1/2" thick, 2 lb. density, foil faced fiberglass with no exposed fiberglass to the air stream.

Motors and fans shall be mounted on a removable galvanized steel motor board assembly. Wiring shall have a modular plug to allow removal of the motor board from the unit without tools.

Fan wheels shall be metal centrifugal forward curve type, dynamically balanced. Fan housing shall be constructed of galvanized steel with streamlined air inlets.

- C. Cooling coils shall be constructed of 1/2" O.D. seamless copper tubes mechanically bonded to aluminum fins. The entire coil assembly shall be factory tested with 300 psig air pressure when the coil is submerged in warm water. It shall have a maximum working pressure of 200 psig. Each coil shall be provided with a manual air vent.

Auxiliary heating coils shall be constructed of 1/2" O.D. seamless copper tubes mechanically bonded to aluminum fins. The coils shall be tested at 300 psig air pressure under warm water, and shall have a maximum working pressure of 200 psig. Each coil shall be provided with a manual air vent.

- D. Motors shall be resilient mounted, electronically commutated with balance dial, totally enclosed, with integral thermal overload protection and automatic reset. Minimum power factor shall be .96. Motors shall be permanently lubricated with provision for re-oiling. High static motors shall be provided as scheduled or as need to meet the scheduled performance.

- E. Exposed horizontal cabinets and Ceiling Recessed Units:

Cabinets shall be constructed with 16 gauge steel panels. Fronts, backs, sides, and top panels forming the air flow path shall be insulated for maximum thermal and acoustical performance. Cabinet parts shall be cleaned and phosphatized before painting.

The finish shall be baked enamel with color selected by Architect, from the manufacturer's standard colors.

Cabinets shall have extended 9" end pockets on both sides. Bottom panels shall be one piece, hinged, with tamper proof fasteners.

Units shall have stamped angled louvers, both for inlet and outlet.

- F. Concealed Units

Casing shall be constructed of 18 gauge panels. Units shall be furnished with inlet and outlet duct collars, and vibration isolation grommets.

- G. Filters shall be 1" pleated fiberglass media 30% (MERV 8) throw-away filters. Furnish and install one complete set of filters for start-up and one complete set of filters following substantial completion and acceptance.
- H. Div 25 to provide and install controller and remote temperature sensor.
- I. Factory Valve Packages will be accepted provided that every component meets the piping and valve specifications listed in Div 20 and Div 23. Any valve packages that include components that do not meet the requirements of the piping specifications will be rejected.
- J. Fan coil units shall be IEC, Trane, Engineered Air, Superior Rex, or approved equivalent.

#### 23 82 04 TERMINAL UNIT COIL HOOK UP

- A. Contractor to provide valves and specialties specified herein and in section 20 10 13 Valves (not valves from a HVAC hose kit manufacturer). Two service valves and a manual balance valve are required regardless of memory function of balance valves.
- B. One of the following piping and specialty configurations is acceptable (piping components installed in the order listed):
  - 1. Supply service valve, balance valve, tee with integral drain, hard pipe or hose to coil, hard pipe or hose from the coil, tee with integral vent, control valve, service valve.
  - 2. Supply service valve with integral drain (on coil side), balance valve, hard pipe or hose to coil, hard pipe or hose from the coil, control valve, service valve with integral vent (on coil side).
- C. When hoses are used at the contractor's option they shall meet the following:
  - 1. Internal diameter of the hose shall be not less than 90% of the ID of copper pipe, for the pipe size on the drawings feeding the unit. Hose inner liner shall be EDPM rubber and shall be covered with stainless steel braid. Pressure rating shall not be less than 200 psig.
  - 2. Hoses shall have one fixed end male NPT connection and one swivel end. The swivel shall be a gasket-less JIC 37°F flared female connection, with companion flare x NPT fitting. Connections shall be stainless steel or brass. Hose kits shall be 24" long. Hoses using gaskets or o-rings are not acceptable. Hoses shall be Twin City Hose, ACE Hose, Hosecraft USA, Chamflex, or approved equivalent meeting the above specifications.
- D. Specialty Valves incorporating auxiliary ports for p/t, drain, vent, etc. may be utilized provided the arrangement meets the flow diagram and the products do not contain unions, gaskets, or o-rings. Valves shall be dezincification resistant brass and shall be rated for 200psig minimum at 200°F.
  - 1. Service valve with integral drain /vent – Webstone Ball Drain, Cimberio Valve model 630B less strainer basket, or approved equivalent.
  - 2. Service valve with NPT tapping, plus separate drain cocks – Apollo 7B-100, Cimberio 200MC, or approved equivalent.
  - 3. Tee with integral drain /vent – Webstone T-drain, or approved equivalent.



END OF SECTION  
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## **25 00 00 TEMPERATURE CONTROL SYSTEMS**

### **25 00 01 GENERAL**

- A. This Section specifies an Automation/Energy Management System to control and monitor HVAC systems.
- B. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 29 of the Specifications.
- C. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 20 - 29 of these Specifications.

### **25 00 02 REFERENCES, REGULATORY REQUIREMENTS**

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20 in addition to the following:
  - 1. N.E.C., NFPA 70 – 1996
  - 2. FCC rules, Part 15, Subpart J, regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
  - 3. UL 916 Underwriters Laboratories Standard for Energy Management Equipment.
  - 4. ASHRAE Standard 135-2016, BACnet – A Data Communication Protocol for Building Automation and Control Networks.

### **25 00 03 REFERENCES, RELATED SECTIONS OF THE SPECIFICATIONS**

Requirements of the following Sections of the Specifications apply to Work for this Section:

- A. Section 01 91 13 – Commissioning of Building Systems
- B. Division 20 - Basic Mechanical Conditions and Basic Mechanical Materials and Methods
- C. Division 23 - HVAC Piping and Equipment
- D. Division 24 - Air Distribution
- E. Division 26 - Electrical Power and Lighting

### **25 00 04 DEFINITIONS**

- A. The term “DDC” or “Direct Digital Control” where used in this Section of the Specifications shall be defined as a control technique through which the process variable is continuously monitored by a digital computer which accomplishes loop control by calculating a control solution for output to a control device.
- B. The terms “EMS” Energy Management System, “BAS” Building Automation System, may be used interchangeably in this Section of the Specifications to mean a system to control mechanical equipment using DDC. This definition includes both hardware and software components that are integrated to form a working system.
- C. The term “Control Wiring” where used in this Section of the Specifications shall be defined as all wiring, 120 VAC line voltage or lower other than power wiring, required for the proper operation of the mechanical system and the BAS. This includes applications where line voltage serves as the control circuit such as a line voltage thermostat or involves interlocking with a damper.
- D. The term “Power Wiring” where used in this Section of the Specifications shall be defined as all line voltage wiring to the mechanical and BAS equipment that is required for proper

operation of the equipment. Typically, this wiring will support voltage at or above 120 VAC and is connected to the equipment for the purpose of providing motive power.

#### 25 00 05 WORK INCLUDED

- A. Furnish material, labor and services necessary for and reasonably incidental to the installation of the following work where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications (section 25 00 03) to perform the Work completely.
- B. All engineering, labor, material, components, tubing, wiring, software, data base generation, graphics development, etc., as required for a complete operational control system as described on the drawings, in the specification, and as required by good practice.
- C. Furnishing of sensor wells, calibration wells, valve bodies, control dampers, smoke dampers, air flow measuring stations, etc. for installation, by the respective trade contractors, under other sections of the specification.
- D. Coordination as required with Divisions 26, 27 and 28 for proper interlocking, control wiring, and start-up. Furnish and supervise the installation of all control equipment required by Divisions 26, 27 and 28 for interlocks as indicated on the drawings and specified herein.
- E. Coordination with other Divisions 20 - 29 sections as required to assure proper equipment interlocking and installation including, but not limited to, damper installations, mixing box arrangements, terminal unit controls, and adjustment required by the testing and balancing work.
- F. Provide technicians to assist the balancer, and to adjust the economizer dampers to maintain design cfm during economizer modulation with no greater than a 10% variation.
- G. The work included in this contract involves the expansion of and integration to an existing system already present at the Owner site. In addition to the scope of services set forth in these plans and specifications, contractor shall comply with all site standards (documented or undocumented) for seamless integration with existing system. Any existing systems modified under this contract shall have those modifications documented in the Submittal and Record Drawing process.

#### 25 00 06 WORK NOT INCLUDED

- A. The following considerations are not included in the Scope of Work for the proposal for this Section of the Specifications:
  - 1. Installation of sensor wells, calibration wells, valve bodies, control dampers, and smoke dampers furnished under this section of the specification for installation under other sections of the specification.
  - 2. Power wiring and relays shown on the electrical drawings furnished and installed under Division 26.

#### 25 00 07 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Section 25 00 00 Temperature Control Systems
  - 1. 25 20 05 Automatic control dampers
  - 2. 25 30 01 Temperature sensor wells and sockets
  - 3. 25 30 03 Control Valves
  - 4. 25 30 04 Hydronic flow measurement
  - 5. 25 30 06 Electronic Flow Switch

25 00 08 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Section 23 60 00 Chillers
  - 1. Evaporator flow switch
  - 2. Condenser flow switch
  - 3. Evaporator pump interlock
  - 4. Condenser pump interlock
  - 5. Evaporator isolation valve
  - 6. Condenser isolation valve
- B. Section 23 50 00 Boilers
  - 1. Inter-boiler communication wiring
  - 2. System supply temperature sensor wiring
  - 3. System tank temperature sensor wiring
  - 4. Isolation valve wiring
  - 5. Emergency shutdown switch wiring
- C. Section 23 61 00 Chiller Accessories
  - 1. Refrigerant monitor interlock wiring
- D. Section 23 70 00 Packaged Equipment
  - 1. Rooftop unit zone temperature sensor
  - 2. Rooftop unit duct static pressure sensor

25 00 09 PRODUCTS NOT FURNISHED OR INSTALLED UNDER BUT INTEGRATED WITH THE WORK OF THIS SECTION

- A. Section 23 50 00 Boilers – Boiler Controller
- B. Section 23 60 00 Chillers – Chiller Controller
- C. Section 23 70 00 Packaged Equipment – Rooftop Unit Controller
- D. Section 26 29 23 Variable Frequency Drives – Drive Controller

25 00 10 SUBMITTAL

- A. The Contractor shall submit the following for approval in accordance with Section 20 00 40, Duties of Contractor, sub-section 20 00 43.
- B. Schematic diagrams for each system, identifying by make and model number, size, capacity, performance, range, accuracy, etc., of each device. Each device shall have an identifying number unique to that device.
- C. Detailed sequence of operation of each system or device including specific references to each of the components in the system describing specifically how the component affects system operation in the various operating modes. This detailed sequence shall be preceded by a generalized overview of the sequence describing in broad terms how the system functions.
- D. Complete engineering data and descriptive literature for each component.
- E. Complete wiring diagrams including: the system riser diagram showing the network architecture; floor diagrams showing sensor locations, panel locations, and equipment locations; point to point wiring diagrams for each electrical and electronic device showing all

internal wiring and all interlock wiring required to complete the intent of the sequence of operations of the systems described in this section of the specifications.

- F. Control panel layout drawings showing internal and external component arrangements, entry and exit points for wiring and tubing, and a list of all cover mounted labels indicating label size and inscription.
- G. Startup report outline to be used at completion of installation.
- H. After the shop drawings have been approved and system startup is complete, the Contractor shall prepare and submit four (4) copies of Catalog Data per Section 20 00 47, four (4) copies of Operations and Maintenance Manuals per Section 20 00 46, and two (2) copies of Software Manuals.
- I. After the installation is complete the Contractor shall prepare and submit Operations and Maintenance Manuals and Record Drawings for the Owner's records in accordance with Division 20.
- J. At each control panel, include one (1) copy of the panel's Record Drawing inside the panel. Record drawings shall contain the actual field point names and numbers as determined by the Control Contractor and the Owner, and plans shall show all cable routing and all device locations, panel locations, and equipment locations.

#### 25 00 11 SPECIAL REQUIREMENTS

##### A. START-UP

- 1. At completion of the installation, and before final acceptance by the Owner, the temperature control subcontractor shall test all control devices in a systematic manner. A complete report showing each device by identification number (T-41, V-20, etc.) shall be listed, its use or function identified (discharge air controller, damper motor, etc.), system (S-1, P-8, etc.), test result, date of test, and initial of technician. The format of this calibration report shall be included with the submittal drawings.
- 2. Upon completion of the installation, the Contractor shall start up the system and perform all necessary testing and run diagnostics to ensure proper operation. A start-up test in the presence of the Owner's representative and the Engineer shall be performed. When the system performance is deemed satisfactory the system will be placed into operation.

##### B. TESTS AND ADJUSTMENTS

- 1. This subcontractor shall adjust and regulate all control devices relating to the work contained herein and shall instruct the Owner's representative in the proper operation and care of the control system. The subcontractor shall test and operate each component of the control system under actual performance conditions to assure proper function of all devices.
- 2. Proportional plus integral plus derivative (PID) control loops shall be tuned for minimum error and no hunting under all load conditions. The control contractor shall simulate various load conditions at the time of initial calibration and demonstrate that upsetting the control loop results in a typical PID response with stable control reestablished following two or three oscillations of decreasing amplitude around set point.
- 3. During the first year of operation, the control subcontractor shall be available upon request to answer questions regarding the system, and shall assist the Owner in diagnosing any problems or difficulty encountered in the operation or care of same, in addition to the scheduled visits outline in the preceding paragraphs.

##### C. TRAINING

- 1. The contractor shall provide a representative from the company used as the source for the electronic controllers used in the systems installed under this contract. The

representative shall conduct the training class on the project site at a time scheduled in advance with the Owner and shall occur during or immediately following system start up. These instructions are to be conducted during normal working hours. The instruction shall consist of two (2) days of training with each day consisting of 4 hours of classroom instruction and 4 hours of hands on training. All pertinent costs shall be included in this contract.

#### D. COORDINATION WITH OTHER TRADES

1. Control contractor shall cooperate with unit manufacturers to assure proper arrangement of control items. Control valves, dampers, thermostat wells, and other control devices that are to be built into the field assembled ductwork or piping systems shall be furnished by the temperature control subcontractor and installed by the Mechanical or Electrical Contractor as directed by the supplier and indicated in other portions of the specifications and drawings.
2. The control contractor shall provide coordination as required for a properly functioning system and as specified in this section via shop drawings, coordination drawings, site visits, etc. Final responsibility for proper application, installation, and operation of all control system components falls under this section of the specification including equipment provided for installation by others.
3. Where it is specifically mentioned that design and engineering work associated with equipment provided under this section of the specification is by others, then the responsibility for only the performance and application of the equipment provided to the defined interface point falls under this section of the specification. Responsibility for proper application of the equipment and proper performance of the system controlled by the equipment from the interface point is the responsibility of the designer, installer and equipment supplier.

#### E. INTERFACES TO EQUIPMENT PROVIDED BY OTHERS

1. All equipment and control panels provided under this section of the specification and under other sections of the specification shall be provided with terminal strips. These terminal strips shall serve as the contract boundary between sections of the specification for trouble shooting purposes and bidding purposes. All wiring and connections external to the device shall be the responsibility of the section responsible for field wiring of the device. All internal wiring, connections, and internal components shall be the responsibility of the section providing the piece of equipment. The requirements of this section are intended to apply to but are not limited to motor starters, motor control centers, unit mounted control panels by the unit manufacturer, and control panels.

#### 25 00 12 ACCEPTANCE TESTING AND WARRANTEE

- A. Acceptance testing shall consist of demonstrating to the Owner's Representative at their request that the complete system has been available for operation and operating satisfactorily for at least 99% of the time during a continuous 60 day period. The Contractor shall provide the Owner's Representative with acceptable records and logs of operations to substantiate the availability of the system at their request. Failure of one or more DDC panels, or software, or the main CPU, or the Network shall constitute system unavailability.
- B. The building control system, including all hardware and software components shall be warranted for a period of two years following the date of acceptance. Any manufacturing or installation defects arising during this period shall be corrected without cost to the Owner.
- C. During the warrantee period the Contractor will be permitted to monitor and make adjustments to the automatic system via a remote VPN connection. The Contractor shall advise the Owner prior to making any changes to the system and shall follow up, immediately after making the modifications, with the Owner, informing the Owner of what changes were made.



1. On a non-emergency warrantee call from the Owner/Engineer the Contractor shall respond remotely within two (2) hours of the time the problem was reported. If the problem cannot be resolved with on-line support, the Contractor shall dispatch the appropriate personnel to the job site before the end of the next business day.

## **25 10 00 CONTROL SYSTEM REQUIREMENTS**

### **25 10 01 GENERAL**

- A. This specification defines the minimum equipment and performance requirements for a direct digital control building control system.
- B. This project includes the creation of a new DDC system infrastructure in a new building that does not have an existing control infrastructure in place to be integrated with. Under these drawings and specifications, Contractor shall provide all hardware and software necessary to establish a fully functional DDC system.
- C. The control system shall consist of a high-speed network of DDC controllers, a control system server, and a graphical user interface.
- D. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the Owner's local area network, and remotely over the Internet (through the Owner's LAN).
- E. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, trends, configure trends, configure points and controllers, or to edit programming.
- F. All products will be as specified in the following portions of the specification. Equivalent devices will not be substituted or accepted without review and approval by the Engineer prior to the bid date. Not all of the items presented in the products paragraphs will be required for the specified sequence of operation, depending on the specific design selected by the successful contractor. However, all items used in a design by the contractor must be from the list or approved by the engineer prior to the bid date.
- G. Model numbers specified are based on information currently available. The Bidders are responsible for confirming that the equipment they are supplying will conform to the specifications presented. Deviations from the specifications should be brought to the attention of the Engineer.
- H. In addition, suppliers should feel free to present to the Engineer for approval, equipment that meets the specifications or could meet the specifications if minor adjustments were made to the specification but is not listed as acceptable. The intention of the specifications is not to exclude manufacturers or equipment but rather to provide an opportunity for various suppliers to bid the job while at the same time retain control over the level of quality.
- I. All materials and equipment used shall be standard components, regularly manufactured for this system and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use. The building control system shall possess a fully modular architecture, permitting expansion through the addition of more stand-alone control units, sensors, actuators, operator terminals, and/or a general purpose CPU.
- J. The general design concept for the control systems to be provided under this section of the specification includes the use of non-proprietary equipment used throughout the field sensing system and the field actuation system to allow the Owner more than one source of supply for field devices associated with the control system.

- K. Input and output to all control loops shall reside in the field panel in which the control loop algorithm is operating. Communication trunks shall not be a part of any control loop.
- L. The building control system specified herein shall be a direct digital control system, which can, without additional equipment, perform all of the automatic temperature control and energy management functions as required in this specification. The system, as specified, shall independently control the building's HVAC and auxiliary equipment to maintain a comfortable environment in an energy efficient manner. Stand-alone control units shall be capable of performing all specified control functions in a completely independent manner.
- M. Control systems installed under this section of the specification shall be directly engineered, designed, and installed; or directly engineered, designed and installed under the direct supervision of companies or their authorized branch offices or distributors. These companies, and/or their branch offices or distributors shall have been in the control contracting business for a minimum of 8 years unless otherwise approved by the Engineer prior to the bid date.
- N. All controllers provided under this section shall be certified by the BACnet Testing Lab, and shall be listed in their online listing database at the time of submittal.
- O. **Acceptable manufacturers: Automated Logic provided by Automatic Controls Equipment Systems (ACES), Inc. (no exceptions).**
- P. The Contractor shall provide a list of no less than ten similar projects which have building control systems as specified. These projects must be on-line and functional such that the Owner's Representative would observe a direct digital control system in full operation.

## 25 10 02 NETWORK ARCHITECTURE AND WIRING

- A. General. The network shall utilize a three-tier architecture model as shown in Figure 25 10 02-1 below.

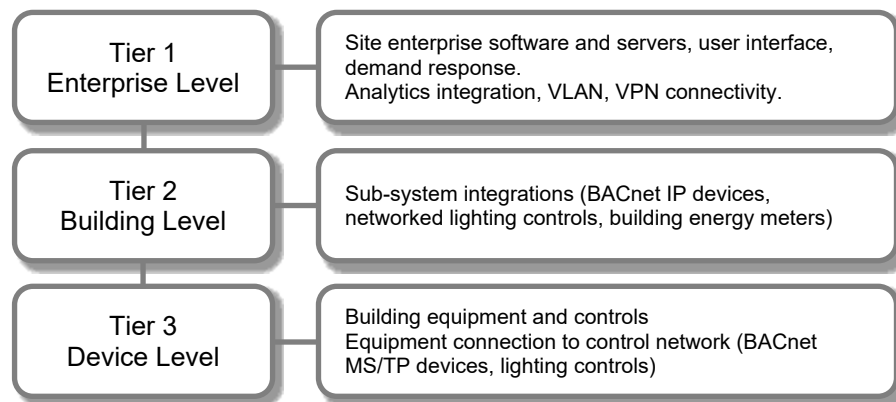


Figure 25 10 02 – 1: Three-Tier Network Architecture

- B. BAS Three-Tier Architecture. Control systems have the following main components.
  - 1. Tier 1 – Enterprise Level
    - a. This tier includes devices directly connected to the Owner's enterprise network, including the enterprise server, graphical user interface, web-client devices, and other enterprise-level third party integration servers.
    - b. Remote access to Tier 1 devices shall utilize a Virtual Private Network (VPN) connection administered by the Owner.
    - c. All Tier 1 connected devices shall be clearly identified in the Shop Drawing submittal, and connection requirements to the Owner's enterprise network shall be coordinated with the Owner.

- d. Tier 1 lower level communications shall be Ethernet Category 6 23 gauge MPP/CMP plenum rated 100 ohm UTP cables using T-568B wiring scheme termination.
  - e. Coordinate with Owner to furnish and install Ethernet hubs, switches and network drops as required by the final system architecture where multiple segments must be interfaced at one location. Tier 1 Ethernet devices are all provided by the Owner as a part of their Enterprise IT network. All appliances must meet the installation, security, and maintenance requirements of their network.
    - 1. One connection for each enterprise system will be provided by the Owner to support the project.
    - 2. Additional network connections will be at the contractor's expense, but must be contracted for installation in accordance with the Owner's IT infrastructure practices. This may include subcontracting the installation to a sole-sourced provider utilized by the Owner.
2. Tier 2 – Facility-, Building-, or Floor- Level
- a. This tier includes IP devices that connect to the Owner's enterprise network via a switch and/or subnet dedicated to the BAS device network. Based on the size of the facility and installed system, this level may segregate individual facilities, buildings, or floors within buildings at the Owner's site.
  - b. For Tier 2 devices that act as a communication supervisor or gateway, the upper level network connection will be Ethernet IP, and the lower level network connection will be as dictated by the Tier 1 protocol requirement.
  - c. All Tier 2 connected devices shall be clearly identified in the Shop Drawing submittal, and connection requirements to the Owner's enterprise network shall be coordinated with the Owner. Building Controllers shall reside on the Tier 2 network as their upper level communication.
  - d. Tier 2 upper level communications shall be Ethernet Category 6 23 gauge MPP/CMP plenum rated 100 ohm UTP cables using T-568B wiring scheme termination.
  - e. Coordinate with Owner to furnish and install Ethernet hubs, switches and network drops as required by the final system architecture where multiple segments must be interfaced at one location. Tier 2 Ethernet devices are all provided by the Owner as a part of their Enterprise IT network. All appliances must meet the installation, security, and maintenance requirements of their network.
    - 1. One connection for each Building Controller will be provided by the Owner to support the project.
    - 2. One connection for each third party integration device via BACnet IP as designated in this Specification, the Sequence of Operations, or the Points List will be provided by the Owner to support the project.
    - 3. Additional network connections will be at the contractor's expense, but must be contracted for installation in accordance with the Owner's IT infrastructure practices. This may include subcontracting the installation to a sole-sourced provider utilized by the Owner.
3. Tier 3 – Device Level
- a. This tier includes devices and actuators that are not IP based. These devices are networked using BACnet MS/TP, Modbus, or other approved media types.
  - b. Tier 3 communication shall support a family of Application Specific Controllers and Custom Application Controllers to allow communication with the Building Controllers.

1. Provide network repeaters of the type specific to the manufacturers requirements for isolation of different Tier 2 communication protocols, as required to support node counts under a BC, or as required by network wire length restrictions.
  2. Contractor is responsible for all Tier 3 hardware required to deliver a fully operational system compliant with the system described in the Contract Documents and to fulfill the approved Network Architecture.
  3. For vendors that utilize Ethernet IP connectivity for Tier 3 communication, the Owner will furnish one Ethernet IP address and connection for every 50 controllers provided by this contractor. If these connections are required, they must be clearly identified on the Shop Drawing submittal for coordination with the Owner.
- c. Tier 3 communication shall be RS-485 twisted pair. Cable construction, including wire gauge, shielding, number of conductors, and EOL terminators shall be consistent with the published wiring standards of the manufacturer's equipment requirements.

#### 25 10 03 BUILDING CONTROLLERS

- A. Building Controllers (BC) shall be capable of being networked on a peer to peer network with other Building Controllers as well as being networked to a campus Ethernet LAN as standard or through an additional communication module. The supporting firmware and hardware shall be configured and arranged so that a dedicated LAN is not required for networking of the system controllers. In other words, the system shall be capable of interfacing with an existing Ethernet LAN which is on line and handling communications between other data systems, and using this LAN for handling its own inter controller communications without interference from or interference to the original communications occurring on the network. Having only a proprietary communications bus available at this level will be unacceptable. The files and data transferred on the network may be proprietary and use proprietary file and data string structures. The minimum communication rate shall be 100 Mbps.
- B. Building Controllers shall function as communications/network controllers supporting both communications to other Building Controllers on a high level, high speed bus as well as communications to Custom Application Controllers (CAC) and Application Specific Controllers (ASC) on lower level Local Area Networks (LANs). The following specific functions shall be required.
1. Provide an adequate number of BC to achieve the performance specified in "BAS PERFORMANCE."
  2. The BC shall have sufficient memory to support its operating system, database, and programming requirements.
  3. Controllers that perform scheduling shall have a real-time clock.
  4. Support for a high level communications using Ethernet, or other high-speed protocol. The files and data transferred on the network may be proprietary and use proprietary file and data string structures. The minimum communication rate shall be 100 Mbps. High level communications will reside on Tier 2 communications.
  5. Support for a low-level communications bus or busses for communications between lower level controllers such as Custom Application Controllers, Application Specific Controllers, and Third Party Devices. Low level communications will be Tier 3 communications.
    - a. Custom Application Controllers are stand-alone controllers that are fully custom programmable.
    - b. Application Specific Controllers are small, low point density, low memory stand-alone controllers with pre-programmed sequences geared to a very specific application

lacking in the ability to do custom control sequences but providing “fill in the blank” programming simplicity. Controllers are suitable for use in controlling terminal equipment such as reheat coils, constant volume regulators, variable volume boxes, fan coil units, fan terminal units, etc.

- c. Third Party Devices include Variable Frequency Drives, Chillers, Boiler Control Panels, Lighting Control Systems, and other devices included in the specifications that share information with the DDC system. At the contractor’s option, Third Party Devices may be isolated by a BACnet MS/TP router. In that instance, the router and all configuration shall be provided by this contractor.
  - d. The low level communications bus shall be BACnet MS/TP utilizing TIA-485. Minimum communications speed shall be 19,200 baud. Low level communications bus networks utilizing LonWorks, Modbus, or proprietary protocols shall be clearly identified in the submittal process and are subject to review and acceptance.
6. Each Building Controller shall perform the following energy management routines as a minimum:
- a. Event based programming
  - b. Time of day programming
  - c. Optimized time of day programming
  - d. Demand control
  - e. Duty Cycling
  - f. Global data sharing (one point used by multiple controllers)
  - g. Programmable schedule overrides
  - h. Scheduling
  - i. Hours of operation accumulation
  - j. Reporting
  - k. Trending
  - l. Alarming
  - m. Time synchronization of controllers
  - n. Customized start-up on power failure
7. Each Building Controller shall perform customized control strategies based upon arithmetic, Boolean or time delay logic. The arithmetic functions shall permit simple relationships between variables as well more complex relationships (i.e., square root, exponential). The system shall permit the generation of job-specific control strategies that can be activated in any of the following ways:
- a. Continuously
  - b. At a particular time-of-day
  - c. On a pre-defined date
  - d. When a specific measured or controlled variable reads a selected value or state
  - e. When a piece of equipment has run for a certain period of time
- C. Upon a loss of commercial power to any Building Controller, the other units within the network shall not be affected, and the loss of operation of that unit shall be reported at the designated operator’s terminal. All control strategies and energy management routines defined for the BC shall be retained during a power failure with the unit. Upon resumption of commercial power,

the control unit shall resume full operation without operator intervention including updating all monitored functions, resume operation based on synchronized time and status, and custom start-up strategies.

1. Each Building Controller shall contain an uninterruptible hardware real time clock accurate to ten (10) minutes per year. The clock shall contain the time of day, day, month, year, and day of the week. The system shall automatically correct for daylight savings time and leap years.
- D. The BC shall contain self-diagnostics that continuously monitor the proper operation of the unit. A malfunction of the unit will be reported, and will inform the operator of the nature of the malfunction, and the control unit affected. It shall be possible to annunciate malfunctions as well as other control unit alarms at a selected central operator's terminal.
- E. Building Controllers shall be sized to meet the requirements of the number of distributed and networked Custom Application Controllers, Application Specific Controllers, and Third Party Devices. Those requirements shall include, but not be limited to, the number of devices, the complexity of control sequences, the number of global points, the number of trends (and size of trends considering number of samples required), the number alarms, and the physical distances between subordinate networked nodes.

#### 25 10 04 CUSTOM APPLICATION CONTROLLERS

##### A. General

1. Each Custom Application Controller (CAC) shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each unit shall be a microprocessor-based, multi-tasking, real-time digital control processor. Custom Application Controllers shall be fully programmable controllers capable of supporting and executing user defined programs in addition to firmware based routines. Programming in the modules shall function independently of the Building Controller and shall not depend on a functional communications network for execution. Loss of communications with other Custom Application Controllers, or Building Controller, shall result in the programming either continuing to execute in its most recent state or returning to some user defined default routine based on the detection of the communications failure by the Custom Application Controllers firmware or software. The ability to detect and respond to a communications failure will be required.
2. Custom Application Controllers shall be native Tier 3 communication devices.
3. Custom Application Controllers shall be applied to Air Handling Units as well as system level control (Chilled Water System, Condenser Water System, Hot Water System, for example).
4. Each controller shall support its own real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in the event communication with its Building Controller is lost and to ensure protection during power outages.
5. Provide each unit with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM or a minimum of 72-hour battery backup shall be provided. All programs shall be field-customized to meet the user's exact control strategy requirements. Controllers utilizing pre-packaged or canned programs are not acceptable.
6. Local alarming and trending capabilities shall be provided for convenient troubleshooting and system diagnostics. Alarm limits and trend data information shall be user-definable for any point.
7. Each controller shall have connection provisions for a portable laptop PC. It shall allow the user to display, generate or modify all point databases and operating programs.

8. The unit shall be capable of direct interface to a variety of industry standard sensors and input devices. It shall be possible for each unit to monitor the following types of inputs:
    - a. Analog inputs: 4-20 mA, 0-10 VDC, Thermistors, RTDs.
    - b. Digital inputs: Dry contact closure, Pulse accumulator.
  9. The unit shall directly control electronic actuators and control devices. Each unit shall be capable of providing the following control outputs:
    - a. Analog outputs: 4-20 mA, 0-10 VDC.
    - b. Digital outputs: Dry contact closure (pilot duty).
  10. Each CAC within the building control system shall perform control functions as defined by the operator. All control functions shall be executed within the CAC unit. Loop control shall be executed via direct digital control algorithms.
- B. It shall be possible to fully create, modify or remove control algorithms within a specific CAC unit while it is operating and performing other control functions. Changes shall be made either through a direct connection of the CAC and a laptop PC or via the network with a laptop PC connected to another controller or via the network from the Operator Workstation.

#### 25 10 05 APPLICATION SPECIFIC CONTROLLERS

- A. Each Application Specific Controller (ASC) shall operate as a standalone controller capable of performing its control responsibilities independent of controllers in the network. Each unit shall be microprocessor based, digital control processor.
- B. Application Specific Controllers shall be applied to unitary equipment like Packaged Rooftop Air Handling Units (if controls not provided with RTU), Fan Coil Units, Unitary Ventilation Units, Variable Air Volume Terminal Units, etc.
- C. Application Specific Controllers shall be native Tier 3 communication devices.
- D. Each ASC shall either have a battery backed-up real time clock or shall receive a synchronized time and occupied/unoccupied status from a supervisory controller. Upon restoration after a loss of power, the ASC shall revert to its previous state prior to loss of power, or scheduled status based upon the value of the real time clock.
- E. All programs and user-defined configurations shall be stored in non-volatile EEPROM or have a minimum of 72-hour battery backup.
- F. Each terminal unit shall be individually controlled using an ASC controller. ASC controllers shall communicate with the Building Controller via Tier 3 communication to implement global control strategies including occupied/unoccupied, space setup/setback, warm-up/cooldown. Each ASC controller or the thermostat shall have access to allow local configuration at the terminal unit. ASC controller shall be mounted in the terminal unit control cabinet or as shown on the drawings.
  1. ASC for use with VAV or fan powered terminals (FTU) shall have a differential pressure transducer based flow sensor. Standard control routines shall include pressure independent VAV, constant volume, parallel FTU, series FTU, and dual duct as required by the sequences of operation. The control routines shall include: shutdown mode, power fail restart mode, occupied/unoccupied mode, temporary occupied mode, warm-up mode, setpoint calculation, temperature control loops, damper control, fan control, exhaust box control, baseboard heat, box heat, lighting control, and auto zero.
  2. ASC for use with fan coil units, heat pumps, unit ventilators, small packaged rooftop, or generic point multiplexer shall include the following control routines: shutdown mode, power fail restart mode, occupied/unoccupied mode, temporary occupied mode, warm-up mode plus those required by the sequence of operations for the type of equipment being controller.

3. Where ASC controllers are to be installed on terminal units, such as VAV boxes, reheat boxes, fan coil units, etc., the units may be field or factory installed or field installed. Regardless of whether the units are factory or field installed, all responsibilities and costs associated with coordinating this installation shall be carried by and under this section of the specification. This includes, but is not limited to, actuator coordination, velocity sensor coordination, relays, auxiliary contacts, enclosure requirements, power requirements, failure mode, normal position upon loss of power and signal, etc.

## 25 10 06 ENTERPRISE SERVER

### A. ENTERPRISE SERVER HARDWARE

1. Web server or workstation shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturers minimum requirements for their software. Provide sufficient internal memory for the specified sequences of operation and trend logging.

### B. ENTERPRISE SERVER SOFTWARE

1. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
  - a. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
  - b. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
  - c. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
  - d. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.
2. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
  - a. Automatic System Database Configuration: Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
  - b. Manual Controller Memory Download: Operators shall be able to download memory from the system database to each controller.
  - c. System Configuration: The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Operators shall be able to configure the system.



- d. On-Line Help: Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
  - e. Security: Each operator shall be required to log on to the system with user name and password in order to view, edit, add, or delete data.
    - 1. Operator Access: The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System Administrators shall also be able to vary and deny each operator's privileges based on the geographic location of the equipment, such as the ability to edit operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
    - 2. Automatic Log Out: Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
    - 3. Encrypted Security Data: Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
  - f. System Diagnostics: The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
- 3. The Enterprise Server shall contain licensing required for all system hardware and software needed to fulfill the requirements of the plans and specifications. This includes, but is not limited to: Point counts, connected controllers, RS-485 network drivers, TCIP/IP network drivers, third party integration protocols.
  - 4. Alarm Processing: System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
  - 5. Alarm Messages: Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
  - 6. Alarm Reactions: Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
  - 7. Alarm and Event log: Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
  - 8. Trend Logs: The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Trends shall be BACnet trend objects.
  - 9. Object and Property Status and Control: Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.

10. Clock Synchronization: Provide open-protocol time synchronization service for all controllers on the connected network. The system shall automatically synchronize system clocks daily via the distributed network. The system shall automatically adjust for daylight savings and standard time as applicable.
11. Reports and Logs: Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
12. Standard Reports: Furnish the following standard system reports:
  - a. Objects: System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
  - b. Alarm Summary: Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
  - c. Logs: System shall log the following to a database or text file and shall retain data for an adjustable period:
    1. Alarm History.
    2. Trend Data: Operator shall be able to select trends to be logged.
    3. Operator Activity: At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
- C. Workstation Application Editors: Each browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
  1. Controller: Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
  2. Scheduling: An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
  3. Custom Application Programming: Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
    - a. Language: Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
    - b. A full-screen character editor programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate features such as cut/ paste and find.
    - c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
    - d. The programming language shall support conditional statements (IF/THEN/ELSE/ ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

- e. The programming language shall support floating-point arithmetic using the following operators: +, -, ×, and square root. The following mathematical functions also shall be provided: absolute value and minimum/maximum value.
- f. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program.
- g. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.

## 25 10 07 USER INTERFACE AND SOFTWARE

### A. GRAPHICAL USER INTERFACE

1. The Graphical User Interface (GUI) computer shall be a network computer provided and maintained by the Owner on their Local Area Network. Interface to the BAS GUI shall be through a web browser installed on that computer (Safari, Microsoft Edge, or Chrome), native and compatible with the Operating System installed on that computer.
2. Basic Interface Description
  - a. GUI shall be English language prompting, English language point identification, on-line help, and industry standard PC application software. The software shall provide, as a minimum, the following functionality:
    1. Real-time graphical viewing and control of environment.
    2. Scheduling and override of building operations.
    3. Collection and analysis of historical data.
    4. Definition and construction of dynamic color graphic displays.
    5. Editing, programming, storage and downloading of controller databases.
    6. Alarm reporting, routing, messaging, and acknowledgment.
    7. Display of dynamic trend data plot.
  - b. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows:
    1. Dynamic color graphics and graphic control.
    2. Alarm management, routing to designated locations, and customized messages.
    3. Week at a Glance Time-of-day scheduling.
    4. Trend data definition and presentation.
    5. Graphic definition and construction.
    6. Program and point database editing on-line.
  - c. Operator specific password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation that they log onto.
  - d. Operator Activity Tracking - An audit trail report to track system changes, accounting for operator initiated actions, changes made by a particular person or changes made to a specific piece of equipment over a designated time frame shall be printable and

archived for future use. The operator activity tracking shall be in a tamperproof buffer file.

- e. Reports shall be generated on demand or via pre-defined schedule and directed to either displays, printers, email recipient, or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
    - 1. A general listing of all or selected points in the network.
    - 2. List of all points currently in alarm.
    - 3. List of all points currently in override status.
    - 4. List of all disabled points.
    - 5. List of user accounts and access levels.
    - 6. List all weekly schedules.
    - 7. List of holiday programming.
    - 8. System diagnostic reports including a list of DDC panels on line and communicating and status of all DDC terminal unit device points.
    - 9. List of programs.
  - f. Scheduling and override shall be accomplished via a graphical format for simplification of time-of-day scheduling and overrides of building operations.
  - g. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Archival trend data may be stored at the Enterprise Server for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
    - 1. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily exported in CSV format.
3. Dynamic Color Graphic Displays
- a. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
  - b. Dynamic values, with the specified units and precision, for temperature, humidity, flow, position, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without predefined screen refresh rates.
  - c. Provide the user the ability to display blocks of point data by defined point groups.
  - d. Alarm conditions shall be identified graphically unique from other monitor points, with the use of flashing, text color, text background color, or other indication native to the DDC software platform.
  - e. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or setpoint.
  - f. Colors shall be used to indicate status and change as the status of the equipment changes.
  - g. A dynamic display of the site specific control architecture showing the status of all controllers, operator workstations, and networks shall be provided.

#### 4. System Configuration & Definition

- a. Network wide control strategies shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
- b. Provide automatic backup and restore of all DDC controller databases on the Enterprise Server. In addition, all database changes shall be performed while the workstation is online without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
- c. System configuration, programming, editing, graphics generation shall be performed online.

#### 5. Alarm Management

- a. Alarm Routing shall allow the user to send alarm notification to network printers or email recipients based on time of day, alarm severity, or point type.
- b. Alarm Notification shall be provided priority levels, to distinguish between routine, maintenance type alarms and critical alarms.
- c. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message.
- d. Alarm messages shall be customizable for each point to display detailed instructions to the user regarding actions to take in the event of an alarm.

#### 6. Workstation Communications - Provide remote access for buildings as required by the contract documents. Automatic dial-out communications shall include the following features as a minimum:

- a. Critical alarms shall automatically dial out for email recipients to be defined in the software database.
- b. Alarms shall automatically display at the Graphical User Interface.

#### 7. Application Notes for Specific Graphic Displays

- a. System schematics for each piece of mechanical equipment, including air handling units, chilled water systems, hot water boiler systems, and zone controls shall be provided to optimize system performance analysis and speed alarm recognition. System arrangement on the graphical displays shall match the installed equipment configuration exactly, with respect to order and arrangement of components.
- b. Each graphic shall contain the date, time, outdoor air temperature and humidity.
- c. Floor plan graphics shall display zone temperatures. A graphic component indicating the actual location of the zone temperature sensor shall be included for each terminal unit or unitary equipment. Where a single VAV box is controlling multiple spaces, it should clearly identify all zones served by that VAV box.
- d. System summary screens in a tabular format shall be provided for each system for overall system operation evaluation by the operators. These screens do not have graphical representation of the equipment, but are dynamically populated spreadsheet-type presentations of operational data of the supplied systems.
  - 1. Each individual air handling unit shall have a summary of the terminal units it serves, with one terminal unit on each row of the table. The table columns shall be: the terminal unit tag, zone temperature setpoint, zone temperature, airflow

setpoint, airflow, damper command/position, heating command, discharge air temperature.

2. An air system summary shall be provided, with one air handling unit on each row of the table. The table columns shall be: equipment tag, discharge temperature setpoint, discharge temperature, fan status, fan speed command, cooling command, heating command.

#### B. IMPLEMENTATION/DEVELOPMENT OF SEQUENCES OF OPERATION

1. General: Software sequences shall be provided as described on the drawings and/or as specified herein and as required to initialize and load the field point data base.
2. Draft programs for all sequences and an example of a typical program listing with comment lines shall be submitted for review and approval as a part of the shop drawing review process.
3. Software testing requirements shall include testing in the field of all logic sequences including actual simulation of different processes and events and observing program response to the process or event. All deviations from the requirements of the sequence as specified shall be corrected immediately at no additional cost to the Owner.
4. Where several analog outputs are to be controlled in sequence by one control loop, software shall be arranged so that the sequence is guaranteed regardless of the spring range of the actuators and to prevent simultaneous heating and cooling.
5. Programs controlling several pieces of equipment as one system shall reside in one field panel. Where programs use data points that reside in other panels the programs shall employ logic (either in software, firmware, hardware, or a combination of all three) to detect loss of communications with the remote panels containing the required data. When such a failure is detected, the program logic shall revert to a safe operating mode that will allow the controlled systems to remain in operation until normal system communication resumes.
6. Data Base Generation: Provide all required standard data base development, input, and debugging as required by the project and point list including but not limited to point names, point groupings, point ranging, point alarm limits, backup file creation, message development, graphics development, etc.
  - a. Equipment controller naming, hardware naming, software naming, etc. shall all be named to match the unique equipment tag listed on the equipment schedules.
    1. For terminal devices and unitary equipment, the area of service description shall be the actual room number(s) on the building signage plus the space description agreed upon with the Owner.
7. Point Lists: The point lists indicated on the points list and sequences of operation are minimum requirements for the job. The contractor shall provide all input and output points required by his system to perform the indicated sequence of operation, regardless of whether or not they are specifically listed in the points list or sequence of operation.
  - a. All set points shall be developed as software points stored at memory locations so that set points can be changed by recommending the data stored at the memory location rather than by entering the program and changing parameters and lines in programs.

#### 25 10 08 LABELING AND IDENTIFICATION

- A. All devices relating to the work or systems included herein, including controllers, valves, motors, relays, auxiliary panels, etc., shall be identified with a unique identification number or name on the submitted engineering drawings. This identification number or name, along with the service of the device (discharge air controller, mixed air controller, etc.), shall be

permanently affixed adjacent to the respective device. Identification shall be vinyl labels printed with thermal transfer printers, 1/2" high labels minimum.

- B. Terminal strips shall be labeled using plastic labels designed to snap into the label mounting slots on the terminals. For input/output wiring, cabling, or tubing, the panel side of the terminals shall be labeled with the automation panel circuit board and terminal numbers associated with the point.
- C. All wiring, tubing, and cabling both inside and outside of control panels shall be labeled at both ends using Thomas and Betts EDP printable wire and cable markers using style WSL self-laminating vinyl. Input and output cables and wiring shall be labeled with the point number and the point description such as:

CPDPS005

Primary Heating Water

Pump #1 Proof of Operation

Cable and wiring not specifically associated with an input or output shall be labeled with a number and a function description such as:

+120 VAC power

Panel DP2 Ckt. 1

#### 25 10 09 CALIBRATION REQUIREMENTS

- A. Calibration shall be checked at a minimum of one point on the span of the device for temperature, pressure, and humidity sensors.
- B. For flow meters provide a factory calibration certificate where manufacturing tolerance are verified to prove geometric similarity to the original design standard upon which the product accuracy statements are based. NIST certificates are not required unless specifically noted in the flow meter specification.
- C. Specified accuracy shall be achieved at the field termination points of the device and shall include both sensor errors and transmitter errors.

#### 25 10 10 BAS PERFORMANCE

- A. Performance Standards: System shall conform to the following minimum standards over network connections:
  - 1. Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 s.
  - 2. Graphic Refresh: A graphic with 20 dynamic points shall update with current data within 8 s.
  - 3. Object Command: Devices shall react to command of a binary object within 2 s. Devices shall begin reacting to a command of an analog object within 2 s.
  - 4. Object Scan: Data used or displayed at a controller or workstation shall have been current within the previous 6 s.
  - 5. Alarm Response Time: An object that goes into alarm shall be annunciated at the workstation within 45 s. Note that this is not a statement of alarm state evaluation, only of announcement of the alarm condition.
  - 6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 s. Select execution times consistent with the mechanical process under control.
  - 7. Performance: Programmable controllers shall be able to completely execute BAS PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.

## 25 10 11 AUXILIARY PANELS INSTALLATION AND FABRICATION

- A. Auxiliary panels shall be fabricated to match the approved shop drawings submitted by the control contractor. Fabrication shall be in a neat and workmanlike manner and shall facilitate repair, maintenance, and adjustment of the equipment contained therein.
- B. All equipment that is not providing an input from a field sensed process (static pressure, temperature, proof of flow, etc.) shall be installed in an auxiliary panel located as indicated on the drawings or as directed by the engineer.
- C. Auxiliary panels shall be fabricated and laid out to incorporate the following features:
  - 1. Identification of all internally and cover mounted devices. Cover mounted labels shall be engraved labels or shall be vinyl labels printed with thermal transfer printers, 1" high labels minimum. Labels for internal devices may be shall be vinyl labels printed with thermal transfer printers, ½" high labels minimum. Labels shall be mounted adjacent to the device they are associated with so that replacement of the device does not eliminate the label.
  - 2. All input and output wiring entering the stand alone control units shall be terminated on terminal strips. If such terminal strips are not furnished as a standard part of the stand-alone control unit termination points, then they shall be installed in an auxiliary panel located immediately adjacent to the stand-alone unit.
  - 3. All internal wiring shall be run inside plastic wiring duct as manufactured by Tyton. Wire duct shall be sized to hold the required number of wires without crimping the wires and with sufficient space to allow wiring to be traced during troubleshooting operation.
  - 4. Wires that pass from the panel interior to cover mounted devices shall be provided with a flex loop that is anchored on both sides of the hinge.
  - 5. All control panels shall be provided with removable sub-panels to allow the panel enclosures to be installed at the job site during rough in while the panels are fabricated off-site for later installation.
  - 6. Provide strain relief type cord and cable connectors for all cables that leave the panel as individual cables not in conduit.
  - 7. Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic or electrical control components. This receptacle may be served from the control panel's 120 VAC power source.
  - 8. Each panel shall be provided with a control power disconnect switch located and wired so as to disconnect all control power in the panel. The leaving side of this switch shall be wired to the panel and field components through a fuse or fuses sized and applied to protect both the components of the system as well as the wire and as required for code compliance.
  - 9. Enclosures shall be NEMA 1 for indoor dry locations and NEMA 4/12 for indoor wet and outdoor locations. Enclosures shall be fabricated from a minimum of 16 gauge steel with continuously welded and ground smooth seems. Doors shall have hinges to open 180°, oil resistant gasket, a removable print pocket, quarter turn latch mechanism with key lock handle and lock cylinder. Grounding studs shall be welded to both the body and the door. Collar studs shall be provided to mount a subpanel. Finish shall be gray ANSI 61 polyester powder inside and out over phosphatized surfaces.
  - 10. All wiring leaving the panel shall be separated by classification; i.e., Class 1 circuits shall not be run with Class 2 circuits, etc. Segregation shall be maintained inside the panel to the fullest extent possible. Where low voltage wires carrying low level AC and DC signals cross wires containing power and high level ac signals, the wires shall cross at a 90° angle.



11. Panels shall be shop fabricated and tested prior to installation in the field. The Owner's representative shall be given the opportunity to witness the testing of the panels. The panels may be inspected and approved by the Owner's representative at the assembly location prior to installation in the field.
12. Panels with controls for equipment and systems that operate on generator power shall have a local UPS power supply integral to the primary power circuit of the panel to retain controller power throughout the Automatic Transfer Switch switching period, minimum of 10 s.

## **25 20 00 AIR SIDE CONTROL EQUIPMENT**

### **25 21 01 TEMPERATURE MEASUREMENT**

#### **A. Outdoor Air Temperature Sensor:**

1. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
  - a. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at  $25^{\circ}\text{C}$  or  $\pm 0.36^{\circ}\text{F}$  accuracy.
  - b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at  $25^{\circ}\text{C}$  or  $\pm 0.36^{\circ}\text{F}$  accuracy.
2. The housing shall be a NEMA 4 aluminum box with gasket cover or ABS enclosure that will accept water tight conduit connections. The sensor shall be integrally shielded from sunlight and weather with good ventilation for accurate readings, do not rely on building structure to provide shade. If sensor is not provided with integral sun shield, provide optional accessory to accommodate.
3. Acceptable sensors are Precon model ST-O, ACI model A/xx-O-BB(EH), BAPI model BA/10K(1K)-O-BB2, or approved equivalent.
4. Outdoor air sensor shall be located where shown on the drawings or in a place as directed by the Architect/Engineer. Location shall be accessible for annual routine maintenance of sensor for calibration or replacement.

#### **B. Duct Temperature Sensor – For Air Handling Unit Systems:**

1. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
  - a. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at  $25^{\circ}\text{C}$  or  $\pm 0.36^{\circ}\text{F}$  accuracy.
  - b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at  $25^{\circ}\text{C}$  or  $\pm 0.36^{\circ}\text{F}$  accuracy.
2. The housing shall be a 4" x 2" galvanized steel utility box with cover or ABS enclosure that will accept conduit connections. The bottom of the housing shall have a foam gasket to seal the housing to the duct to minimize air leakage.
3. Acceptable sensors are Minco model S451PFY, Precon model ST-Dx-XH(P), ACI model A/10K(1K)-D-8-GD(BB), BAPI model BA/10K(1K)-D-8"-JB, or approved equivalent.
4. Sensor length shall be coordinated with ductwork; length shall be at least 6" beyond insulation or inner wall of duct.

#### **C. Duct Temperature Sensor – For Terminal Unit Equipment:**

1. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
  - a. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at  $25^{\circ}\text{C}$  or  $\pm 0.36^{\circ}\text{F}$  accuracy.

- b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at  $25^{\circ}\text{C}$  or  $\pm 0.36^{\circ}\text{F}$  accuracy.
- 2. The sensor shall be provided without enclosure, but with mounting tabs, grommet seal, and integral plenum rated cable of sufficient length (5' minimum) that sensor terminations are made directly at the terminal unit controller without any splices between sensor and controller.
- 3. Acceptable sensors are Precon model KTVx-XCP5, Mamac model TE-701-BX-x-A, BAPI model BA/10K(1K)-D-4"-NB-5', or approved equivalent.
- 4. Sensor length shall be coordinated with ductwork; length shall be at least 4" beyond insulation or inner wall of duct.
- 5. Sensor shall be installed on a vertical duct face, at the midpoint of the duct to avoid stratification and mixing effects from the reheat coil. Sensors shall not be installed on the top or bottom of the duct without explicit direction or approval of the Engineer. Sensor shall be installed before the first air outlet tap from the distribution ductwork, but as far downstream as allowable by the integrated plenum cable.

**D. Duct Temperature Bendable Averaging Elements**

- 1. Sensor shall be bendable copper or aluminum sheath, continuous sensing 10,000 ohm Thermistor or 1,000 ohm RTD.
  - a. The element shall be 10,000 ohm thermistor, with a reference temperature coefficient of resistance (TCR R25/125) compatible with the system installed,  $\pm 0.36^{\circ}\text{F}$  accuracy.
  - b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at  $25^{\circ}\text{C}$  or  $\pm 0.36^{\circ}\text{F}$  accuracy.
- 2. The housing shall be 4" x 2" galvanized steel utility box with cover or ABS enclosure that will accept conduit connections. The bottom of the housing shall have a foam gasket to seal the housing to the duct to minimize air leakage.
- 3. Sensor length shall provide coverage of 20' element per 25 square feet of installed area.
- 4. Acceptable sensors are Precon model ST-FZ, ACI Model A/xx-A-24-GD, BAPI model BA/10K-x-A24-JB, or approved equivalent.
- 5. Temperature sensing elements shall be strung in free air and shall not be supported from the face of the coil to prevent the temperature of the coil media from affecting the element reading. Where element is bent to turn in air stream, provide a manufactured insulated capillary mounting clip at each turn point. Capillary mounting clip shall be Klipet CC-1G-K, M-648-K copper clad mounting clip (only if element insulated from metal-to-metal contact with polyethylene tubing around element within capillary clip), or approved equivalent.

**E. Low Limit Thermostat (Freezestat):**

- 1. All low limit thermostat circuits shall have a manual reset function to restore normal system operation following correction of freeze condition. The manual reset function may be achieved with manual reset low limit thermostats, or with automatic reset low limit thermostats and manual reset circuits as indicated below:
  - a. For installations where all low limit thermostats can be mounted on the exterior of the unit, or inside the unit on the same side as the access door, and within 8 feet of the finished floor, manual reset low limit thermostats may be used.
  - b. For installations where any low limit thermostat is mounted above 8 feet over the finished floor or on the interior of the unit on the opposite side of the access door, automatic reset low limit thermostats with manual reset circuits must be used.

- c. Low limit thermostat arrangements must meet the installation details indicated in the specifications that follow, and must meet the manufacturer's installation requirements.
- 2. Low limit thermostats shall be snap-acting contact thermostats with vapor-charged sensing element. Thermostat shall have normally closed SPST main contact and normally open SPST auxiliary contact. Main contact shall be rated 16 A inductive load at 120 VAC. Auxiliary contact shall be rated 16 A inductive load at 120 VAC.
  - a. Thermostat shall have setpoint range of 15°F – 55°F.
  - b. Thermostat shall have a 20-foot long remote bulb strung in free air downstream of the heating coil but upstream of the cooling coil. The control shall respond to the lowest temperature along any one foot section of sensing element.
  - c. The coil shall have the manufacturer's recommended coverage, with 20' element per 25 square feet of installed area minimum. Provide multiple thermostats wired in series where the coil area exceeds the maximum coverage.
  - d. Temperature sensing elements shall be strung in free air and shall not be supported from the face of the coil to prevent the temperature of the coil media from affecting the element reading. Where element is bent to turn in air stream, provide a manufactured insulated capillary mounting clip at each turn point. Capillary mounting clip shall be Klipet CC-1G-K, M-648-K copper clad mounting clip (only if element insulated from metal-to-metal contact with polyethylene tubing around element within capillary clip), or approved equivalent.
  - e. The thermostat shall only be installed in the vertical position, with the sensing bellows on the bottom of the thermostat. The thermostat shall be mounted above the capillary sensing tube and the sensing tube shall run horizontally, below the bellows.
- 3. Manual reset low limit thermostats shall be operate by manual reset (no fixed differential). Thermostat shall be Johnson Controls A70HA-1C, Robertshaw T322, or approved equivalent.
- 4. Automatic reset low limit thermostats shall operate on a fixed 5°F differential. Thermostat shall be Johnson Controls A70GA-1 or approved equivalent.
  - a. Application of automatic reset low limit thermostats requires the pairing of a manual reset circuit. That manual reset circuit may be achieved with a latching relay and pushbutton reset, or with a packaged fan safety relay board with manual reset switch, at contractor's option. The reset button may be located at the unit in a remote enclosure, or inside the unit control enclosure, at contractor's option.

**F. Room Temperature Sensor:**

- 1. Sensor/thermostat shall be 10,000-ohm thermistor with an accuracy of  $\pm 0.36^{\circ}\text{F}$ . Room temperature sensor covers shall all match on the project, with the exception of sensor type S2 listed below.
- 2. Type S1 shall be temperature sensors with plastic covers to match the thermostats.
- 3. Type S2 shall be temperature sensors box mounted with flush stainless steel wall plate.
- 4. Type T1 shall be temperature sensors with temperature adjustment only.
- 5. Type T2 shall be similar to Type T1, with addition of local override button.
- 6. All sensors shall have service jack for local configuration.
- 7. In general, the following shall apply unless noted differently elsewhere:
  - a. S2 shall be used in public spaces (i.e., corridors, restrooms, stairs, multipurpose rooms, etc.).
  - b. S2 shall be used in spaces where damage could occur (i.e., gymnasiums, storage rooms, loading docks).
  - c. S2 shall be provided for all cabinet unit heaters.

- d. T2 shall be used in Offices, classrooms and Conference Rooms.
  - e. T1 shall be used in all other spaces.
8. Unless noted differently elsewhere, S1 shall be used in public spaces (i.e., corridors, restrooms, lounges, etc.), T2 shall be used in Offices, TC2 for Conference Rooms, T1 shall be used in all other spaces.

G. Room Mounted Device Installation:

- 1. All devices shall be installed on boxes or mounting plates secured to the building structure, wall studs, etc., prior to the installation of the wall covering or finish.
- 2. Rough-ins for low voltage electric and/or electronic devices shall consist of a box or plate with the required number of conductors or cables securely fastened to it and extended to a location out of the wall in which the thermostat is mounted for connection to the control system. Conduit shall be provided at locations where the conductors will be embedded in plaster, concrete, or masonry to protect the conductors and allow easy replacement if necessary.
- 3. Rough-ins for line voltage devices shall be in conduit in all cases.
- 4. Mounting heights for temperature sensor/ thermostats located on walls in occupied spaces shall be adjacent to the light switch (for ADA accessibility) unless otherwise directed by the Architect/Engineer.
- 5. Mounting heights for CO2 and other gasses with a density similar to air, or other sensors not requiring user adjustment, located on walls in occupied spaces shall be at 60" AFF, unless otherwise directed by the Architect/Engineer.
- 6. Mounting heights of sensors for gasses lighter than air (methane, ammonia, etc.) shall be located near or on the ceiling, gasses heavier than air (refrigerants, propane, etc.) shall be located near the floor, review proposed locations with Engineer prior to installation.
- 7. Mounting heights for CO2 and other gasses with a density similar to air, or other sensors not requiring user adjustment, located on walls in occupied spaces shall be at 60" AFF, unless otherwise directed by the Architect/Engineer.
- 8. Mounting heights of sensors for gasses lighter than air (methane, ammonia, etc.) shall be located near or on the ceiling, gasses heavier than air (refrigerants, propane, etc.) shall be located near the floor, review proposed locations with Engineer prior to installation.
- 9. All room sensors installed on exterior walls shall include insulated backing, utilizing 0.25" closed cell foam pads as a minimum.

H. Room Mounted Device Installation:

- 1. All devices shall be installed on boxes or mounting plates secured to the building structure, wall studs, etc., prior to the installation of the wall covering or finish.
- 2. Rough-ins for low voltage electric and/or electronic devices shall consist of a box or plate with the required number of conductors or cables securely fastened to it and extended to a location out of the wall in which the thermostat is mounted for connection to the control system. Conduit shall be provided at locations where the conductors will be embedded in plaster, concrete, or masonry to protect the conductors and allow easy replacement if necessary.
- 3. Rough-ins for line voltage devices shall be in conduit in all cases.
- 4. Mounting heights for temperature sensor/ thermostats located on walls in occupied spaces shall be adjacent to the light switch (for ADA accessibility) unless otherwise directed by the Architect/Engineer.

5. Mounting heights for CO2 and other gasses with a density similar to air, or other sensors not requiring user adjustment, located on walls in occupied spaces shall be at 60" AFF, unless otherwise directed by the Architect/Engineer.
6. Mounting heights of sensors for gasses lighter than air (methane, ammonia, etc.) shall be located near or on the ceiling, gasses heavier than air (refrigerants, propane, etc.) shall be located near the floor, review proposed locations with Engineer prior to installation.
7. Mounting heights for CO2 and other gasses with a density similar to air, or other sensors not requiring user adjustment, located on walls in occupied spaces shall be at 60" AFF, unless otherwise directed by the Architect/Engineer.
8. Mounting heights of sensors for gasses lighter than air (methane, ammonia, etc.) shall be located near or on the ceiling, gasses heavier than air (refrigerants, propane, etc.) shall be located near the floor, review proposed locations with Engineer prior to installation.
9. All room sensors installed on exterior walls shall include insulated backing, utilizing 0.25" closed cell foam pads as a minimum.

#### 25 20 02 HUMIDITY SENSOR

- A. General: Due to the wide variation in Relative Humidity sensor performance and the importance of the information used based on their readings, the sensors listed herein as approved sensors have third party testing results verifying performance characteristics. A primary resource for this reference is the National Building Controls Information Program April 2004 Product Testing Report on Duct-Mounted Relative Humidity Transmitters. The intent of the listed products is not to limit manufacturers used, but to ensure similar demonstrated performance of allowed devices. Consideration for substitute sensors should include a similar published third party product report. Consideration for substitute sensors will be made based on Owner's current installed stock. Application consideration has been given to differentiate use of the sensors specified herein above and beyond the use of Room Smart Sensors specified elsewhere in this specification. Engineer has determined that the sensors indicated in this section are required for this specific application.
- B. General Purpose Duct Relative Humidity Sensor:
  1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC transmitter factory matched and calibrated and replaceable tip. Sensor may incorporate integral temperature sensor. Sensor shall be ACI A/RH3-D or approved equal.
- C. General Purpose Room Relative Humidity Sensor:
  1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC sensor transmitter factory matched and calibrated and replaceable tip.. Sensor may incorporate internal temperature sensor. Sensor shall be ACI A/RH3-R, JCI HT-6703-0N00W, Mamac HU-225-3 or approved equal.
- D. General Purpose Outside Relative Humidity Sensor:
  1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC transmitter factory matched and calibrated and replaceable tip. Sensor may incorporate integral temperature sensor. If not included in

#### 25 20 03 PRESSURE SENSOR

- A. General Purpose Air Differential Pressure Transmitter:
  1. Transmitter range shall be as indicated on the Points List. Transmitter shall be a fixed range device, multi-range devices are not acceptable.

2. Transmitters shall be a two-wire device producing a 4-20 mA output. Accuracy shall be 1% full scale or better, including non-linearity and hysteresis.
3. Transmitters that are panel mounted may be open frame design. Transmitters that are not installed in an auxiliary control panel shall be provided with an enclosure that accommodates a conduit connection.
4. Transmitter shall be Setra model 264, Ashcroft model CXLdp, or Modus model T30.
5. If not designated otherwise on the Points List, sensor ranges shall be as follows:
  - a. Fan discharge pressure transmitters shall be unidirectional with the smallest range, which is larger than 1.2 times greater than fan pressure.
  - b. AHU downstream (remote from unit) duct static pressure transmitters shall be unidirectional, 0-2.5"w.c. range.
  - c. AHU discharge (local to unit) duct static pressure transmitters shall be unidirectional, 0-5.0"w.c. range.
  - d. Mixed air and relief air box pressure transmitters shall be bidirectional,  $\pm 0.50$ "w.c. range for air handling units without heat wheels.
  - e. Mixed air and relief air box pressure transmitters shall be bidirectional,  $\pm 1.00$ "w.c. range for air handling units with heat wheels.
  - f. Building pressure transmitters shall be bidirectional,  $\pm 0.10$ "w.c. range.
  - g. Space pressure transmitters shall be bidirectional,  $\pm 0.10$ "w.c. range.

**B. Very Low Air Differential Pressure Transmitter:**

1. Transmitter range shall be as indicated on the Points List. Transmitter shall be a fixed range device, multi-range devices are not acceptable.
2. Transmitters shall be a two-wire device producing a 4-20 mA output. Accuracy shall be 0.5% full scale or better, including non-linearity and hysteresis.
3. Transmitters shall be panel mounted, with be open frame design.
4. Transmitter shall be Setra model 269, Ashcroft model CXLdp, or Ashcroft model XLdp.
5. If not designated otherwise on the Points List, sensor ranges shall be as follows:
  - a. Space pressure transmitters shall be bidirectional,  $\pm 0.1$ "w.c. range.
  - b. Airflow monitoring station transmitters shall be unidirectional, 0-0.25"w.c. range.

**C. Differential Pressure Transmitter Sensing Probe:** For all pressure sensing locations that are remote from the pressure transmitter, provide an appropriate static pressure sensing probe as described below. Connections between differential pressure transmitter and static pressure probes shall be made with 1/4" polyethylene tubing for all runs under 10 feet. For runs longer than 10 feet, run 1/4" OD, 0.020" wall hard copper tubing with solder fittings. Terminate ends of copper tubing with 1/4" ID to 1/4" barbed adapter or 1/4" compression to 1/4" compression coupling for polyethylene final connections (within 9") to device. Where compression fittings are used, use plastic tubing inserts for polyethylene tubing. Polyurethane tubing may not be used in any exposed applications, only within a control panel as it is not plenum rated.

1. For unit or duct mounted pressure sensing locations, provide static pressure probe with 1/4" brass barb or compression connection and gasketed mounting flange. Static pressure probe shall be Mamac model A-520, Dwyer model A-489/491/493, or approved equal.
2. For space mounted pressure sensing locations, provide flush mounted white ABS static pressure probe with 1/4" barb connection, for mounting on single gang electrical box or ceiling tiles. Static pressure probe shall be Mamac model A-523, Dwyer model A-465, or approved equal. Provide minimum of 25 feet of 1/4" polyethylene tubing between static

pressure probe and pressure transmitter, coiled and wrapped neatly, to provide surge dampening for opening and closing of doors.

3. For outside air reference pressure sensing locations, provide plastic pressure probe with internal reservoir, sensing head baffle to negate wind effects, mounting bracket, and 50 feet of vinyl tubing. Do not trim vinyl tubing to length, leave at full length to provide surge dampening of sensed pressure.
4. Outside air reference tubing exceeding 75 feet in length shall be increased in size from ¼" tubing to 3/8" OD, 0.020" wall hard copper tubing with solder fittings, and transitional fittings provided at each connected device.

#### 25 20 04 AUTOMATIC CONTROL DAMPERS

##### A. General:

1. Control dampers shall be provided where indicated on the drawings or as required for proper system operation.
2. Actuators shall be direct coupled.
3. Provide pin extensions.
4. Provide external bearing bracket assembly.

##### B. Airfoil Dampers: Dampers shall be constructed from minimum 12 gauge extruded aluminum blades and frames. Blades shall be locked to the blade shaft by a positive means other than setscrews. Such means include ribs extruded into the blade that fit slots in the damper shaft and hexagonal shafts that fit tightly in hexagonal holes extruded into the blades.

1. Shafts shall be provided with bearings at all support locations.
2. Dampers shall be equipped with blade and jamb seals and shall have a leakage rate less than 0.1% of maximum flow.
3. Linkage shall be concealed in the jamb out of the air stream where such an arrangement will be accessible for maintenance and lubrication without removal of the unit from the duct system or fan system that it is installed in. In all other cases the linkage shall not be concealed in the frame.
4. Dampers with vertically oriented blades shall be provided with thrust bearings to support the vertical blades.
5. Airfoil dampers shall be provided where fan discharge dampers are required and/or where minimum pressure drop at full flow is necessary.
6. Dampers shall be Ruskin Model CD-40, Greenheck Model VCD-43 or approved equal.

##### C. Non-Airfoil Blade Dampers shall be constructed from minimum 16-gauge steel or minimum 12 gauge extruded aluminum blades and frames. Blades shall be locked to the blade shaft by a positive means other than setscrews. Such means include ribs extruded into the blade that fit slots in the damper shaft and hexagonal shafts that fit tightly in hexagonal holes extruded into the blades.

1. Shafts shall be provided with bearings at all support locations.
2. Dampers shall be equipped with blade and jamb seals and shall meet the leakage specifications indicated on the damper schedule.
3. Linkage shall be concealed in the jamb out of the air stream where such an arrangement will be accessible for maintenance and lubrication without removal of the unit from the duct system or fan system that it is installed in. In all other cases the linkage shall not be concealed in the frame.

4. Dampers with vertically oriented blades shall be provided with thrust bearings to support the vertical blades.
  5. Non-Airfoil dampers shall be provided at locations where Airfoil dampers are not required. Dampers shall be sized to provide adequate pressure drop at full flow to insure adequate control without hunting.
  6. Dampers shall be Ruskin CD-36, Greenheck Model VCD-23 or approved equal.
- D. Modulating damper sizing shall be based on the following conditions:
1. Minimum velocity - 2000 fpm
  2. Maximum velocity - 3000 fpm
  3. Minimum pressure drop - 0.2"w.c.
  4. Maximum pressure drop - 0.3"w.c.
  5. Coordinate with the installing trade contractor any required blank-off plates for dampers that are smaller than duct size.
- E. Two position dampers shall be the full size of the duct they are associated with unless otherwise specified.
- F. Flow rates for damper sizing shall be based upon the flow rates indicated on the equipment schedules.

#### 25 20 05 DAMPER ACTUATORS

A. General:

1. Actuators shall be sized with enough torque to close damper against fan shut off pressure. Provide multiple dampers and actuators as required to obtain close off. In all cases torque shall be a minimum 7.5 in-lb/ft<sup>2</sup> for opposed blade dampers and 10.5 in-lb/ft<sup>2</sup> for parallel blade dampers.

B. Direct Coupled Electric Actuator:

1. Actuators shall have electronic overload or digital rotation sensing circuit to prevent damage to the actuator throughout the full range of movement. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.
2. For power-failure/safety applications, a mechanical spring return mechanism shall be used. Non-mechanical forms such as battery back-up and capacitor discharge are not acceptable. The normal position is the position that the actuator must fail to upon loss of control signal or power.
3. Proportional and triac actuators shall have an external gear release. Spring return proportional actuators shall have a manual crank to allow manual positioning when the actuator is not powered.
4. Proportional actuators shall accept a 2 to 10 VDC or 4-20 mA input signal. Actuators shall operate on less than 10 VA.
5. Actuators shall have a direction rotation switch to aid in installation and provide proper control response.
6. Actuators shall be listed under UL873.
7. Actuators shall have a 2-year warranty starting from the date of acceptance.
8. Actuators shall be Belimo, Siemens, or approved equal.

C. In general, unless noted elsewhere, the following shall apply:



1. Air handling unit control dampers shall be 2-10 VDC proportional, spring return actuators. Outdoor air and relief air shall be NC, return air shall be NO.
2. VAV box damper actuators shall be Triac (tri-state).

## **25 30 00 HYDRONIC CONTROL EQUIPMENT**

### **25 30 01 TEMPERATURE MEASUREMENT**

- A. The contractor shall provide for installation under other sections of the specification thermometer wells for all temperature transmitters, remote bulb sensors, etc., installed in piping systems and at other locations as indicated on the plans, flow diagrams, details and specifications. When two (2) wells are shown at the same location: One well will be installed for the sensing element. The second well will be installed to allow a separate calibration instrument to be used to calibrate the sensor without removing it from the line; it shall have a cap and chain for protection when not in use.
- B. Temperature sensor immersion well and calibration wells (see above) shall be brass or 316 SS  $\frac{3}{4}$ " NPT or  $\frac{1}{2}$ " NPT pipe connection size with  $\frac{1}{2}$ " NPT female threads. Thermometer wells shall have an overall length of 6". For larger pipe the fluid insertion length shall be 4-1/2". For smaller pipes the insertion length shall be 2-1/2" with a 2" lag length. For general use, a straight stepped shank may be used, provided it is less than 70% of the manufactures critical velocity rating, otherwise use a heavy duty tapered shank to meet the required stiffness. Sensor wells internal bore shall match sensor provided; calibration wells shall have 3/8" internal diameter.
- C. The contractor shall be responsible for coordination, with the installing trade contractor of the other sections of the specification, the location of all thermometer wells and insertion depths required by this section. The tip of the sensor shall be completely in the process fluid. Thread-o-lets and any required bushings shall be coordinated the installing trade contractor. Sensor shall be installed with thermally conductive paste equal to Omegatherm -201 manufactured by Omega Engineering.
- D. Insertion Element Fluid Temperature Sensor
  1. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD. Sensors shall be 6" long, with either 3/8" or 1/4" diameter screwed or smooth shanks.
    - a. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at 25°C or  $\pm 0.36^\circ\text{F}$  accuracy.
    - b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed,  $\pm 1\%$  at 25°C or  $\pm 0.36^\circ\text{F}$  accuracy.
  2. The housing shall be a weather tight cast aluminum utility box and stamped aluminum cover with a full gasket, or UV-resistant polycarbonate box with hinged cover and thumb latch.
  3. Acceptable sensors are Precon KTW Series, BAPI BA/10K(1K) or approved equivalent.

### **25 30 02 PRESSURE MEASUREMENT**

- A. The contractor shall provide for installation by others, isolation valves, snubbers, and access fittings to be used at all pressure transmitter and pressure sensor locations. The connections shall be configured by the installer so that the isolation valve isolates the sensor and calibration port (Pete's plug, Schraeder valve, or access fitting) from the process monitored.
- B. Provide an engraved 4" x 3" nameplate, white letters on a red background:  
WARNING: OPEN EQUALIZING VALVES PRIOR TO OPENING OR CLOSING THE SERVICE VALVES THAT CONNECT THIS TRANSMITTER TO THE PROCESS LINE.
- C. This section shall be responsible for coordination of the installation of all pressure sensor taps required under this section of the specification with other sections of the specification.

D. Hydronic Differential Pressure Transmitter

1. The transmitters shall be a high quality HVAC grade with an accuracy of +/- 0.25% of full scale or better (including linearity, hysteresis, and repeatability) with a drift of 0.5% of span per year or less. All wetted parts shall be 316 stainless steel for long life. Units shall be rated for an operating static pressure of 100 psig.
2. Enclosure shall be NEMA 4 weather tight construction with 1/2" conduit connection and 1/8" NPT process connections.
3. If not designated otherwise on the Points List, sensor ranges shall be as follows:
  - a. Pressure transmitters at pumps or in central plant mechanical rooms shall be 0-25 psid.
  - b. Pressure transmitters located at end-of run equipment for pump control shall be 0-10 psid.
4. Acceptable manufacturers are Setra model 230 with 3-valve manifold, Graystone model WP-D, or approved equivalent.
5. Transmitters that utilize independent pressure transducers on the high and low pressure lines are not allowed.

E. Hydronic Gauge Pressure Transmitter

1. The transmitters shall be a high quality HVAC grade with an accuracy of +/- 0.25% of full scale or better (including linearity, hysteresis, and repeatability) with thermal effects of zero shift of +/- 2.0%/100°F and +/- 1.5%/100°F. All wetted parts shall be 17-4 PH stainless steel for long life. Units shall be rated for shock of 200g operating, as tested per Mil-Std. 202, Method 213B, Cond. C.
2. Provide terminal block with conduit cover enclosure option and 1/8" MNPT process connection.
3. Sensor range shall be as indicated on Notes column of Points List.
4. Acceptable manufacturer is Setra model 209, or approved equivalent.

25 30 03 CONTROL VALVES

A. Valve actuator requirements shall be as follows.

1. Torque rating shall be based on the valve manufacturers operating torque requirements at the design flows and pressure drops or shall be based on the manufacturers required shut-off torque to achieve 100% flow shut off at pump shut off head on the system in which they are installed, whichever is greater.
  - a. For exterior located valves, torque ratings shall be based on 0°F outside ambient temperature.
2. For power-failure/safety applications, a mechanical, spring return mechanism shall be used. Non-mechanical forms such as battery back-up and capacitor discharge, are not acceptable. The normal position is the position that the actuator must fail to upon loss of control signal or power.
3. In general the following types of actuators shall be used unless otherwise indicated: Proportional spring return valves (4-20 mA, 0-10 VDC, 3-15 psi) will be used for heating coils on units with outdoor air connections and heat exchangers, refer to sequences or points list for fail-safe position. Proportional non-spring return valves (4-20 mA, 0-10 VDC, 3-15 psi) will be used for cooling coils and reheat coils. Triac or floating valves will only be allowed on VAV box reheat coils, fan coil units, terminal heating equipment, etc.

4. In general the following types of valves shall be used unless otherwise indicated: Cooling valves shall be ball valves for 3" and smaller, and butterfly valves for 4" and larger. Hydronic heating valves shall be ball valves for 3" and smaller, and butterfly valves for 4" and larger. Steam heating valves shall be globe valves for all applications. Heating and cooling valves on unitary terminal equipment shall be ball-type zone valves.
  5. Globe valves shall be Belimo, Schneider Electric, Johnson, Siemens or equivalent. Globe valves shall be threaded bronze body or flanged cast iron body, stainless steel stem, brass plug, composition disk, bronze seat, rated at 250 psi working pressure, and 35 psi differential pressure.
  6. Ball valves shall be Belimo, Siemens, or Bray. Ball valves shall be threaded bronze body, chrome plated ball, blowout proof stem, Teflon seat, rated at 600 psi W-O-G working pressure, and 35 psi differential pressure.
  7. Butterfly valves shall be Belimo or Bray. Butterfly valves shall be lug body style, cast iron body, aluminum bronze disk, EPDM seats, and stainless steel shaft. Valves to be selected for maximum open position of 60°.
  8. Electrical actuated valves shall be provided with Belimo, Bray or Siemens actuators. Actuators shall have current limiting circuitry incorporated in its design to prevent damage to the actuator. A gear release shall be provided on the motor to allow for manual override. Modulating actuators shall be rated for a 4-20 mA input signal. Actuators shall be rated for 24 VAC power. The units shall have visual mechanical position indication showing output shaft and valve position.
- B. Modulating valve sizing shall be based on the following conditions.
1. Water Valves:
    - a. Minimum pressure drop - 3 psi or equivalent to the waterside pressure drop of the coil it is associated with, whichever is greater.
    - b. Maximum pressure drop - 5 psi.
  - C. Two position valves shall be the full size of the pipe they are associated with unless otherwise specified.
  - D. Two-way valve actuators shall be sized to close off tight against the full pump shut off head on the system in which they are installed.
  - E. Flow rates for valve sizing shall be based upon the flow rates indicated on the equipment schedules on the drawings.
  - F. Valve sizing shall consider the valve cavitation coefficient. In no case shall a valve be sized so that the pressure drop through the valve causes cavitation with fluid temperatures and pressures encountered in the system during start up or normal operation. If cavitation is possible in a single valve, select two control valves to be piped in series to avoid cavitation.

## 25 30 04 FLOW MEASUREMENT

### A. General

1. Flow meters shall be as scheduled on the plans and specified here-in.
2. The controls contractor shall provide flow meters and associated installation kits to the mechanical contractor for installation under other sections of the specification.
3. All necessary power requirements for the transmitter shall be provided under this section of the specification.
4. Temperature control contractor shall review with the mechanical contractor the required upstream and downstream requirements for the meter technology. In general unless the

meter alters the flow profile as part of its technology then the following general rules shall be followed:

- a. Single elbow preceded by greater than 9 diameters – 10 diameters upstream, 5 diameters downstream
  - b. Single elbow preceded by less than 9 diameters – 15 diameters upstream, 5 diameters downstream
  - c. Out flowing tee, or pump discharge – 20 diameters upstream, 5 diameters downstream
  - d. In flowing tee – 30 diameters upstream, 5 diameters downstream
  - e. Multiple bends out of plane – 30 diameters upstream, 5 diameters downstream
  - f. Tee – 30 diameters upstream, 5 diameters downstream
  - g. Control valve – 30 diameters upstream, 5 diameters downstream
5. Include with the bid one each of any necessary configuration tools required to set up the meter if the setup cannot be accomplished from the meter electronics package itself to be turned over to the Owner upon project completion.

**B. Insertion Electromagnetic Fluid Flow Measurement**

1. Technology: Insertion electromagnetic
2. Range: 0.1 ft/sec to 20 ft/sec
3. Accuracy: +/-1% of reading between 2-20 ft/sec; +/-0.02 ft/sec below 2 ft/s
4. Pipe sizes: 4" and Larger
5. Output: 4-20 mA signal proportional to line velocity
6. Installation: 1-1/4" thread-o-let (1-1/2" for hot tap) installed by the Mechanical Contractor. Provide adequate room for removal/installation of meter
7. Flow meter shall be Onicon F-3500.

**25 40 00 AUXILIARY EQUIPMENT**

**25 40 01 CURRENT OPERATED SWITCHES**

**A. Adjustable Trip Current Switch**

1. General: Adjustable trip current switches shall be used on belt driven or coupled equipment. Switches shall be provided with mounting hardware, and securely mounted and located such that they are easily adjustable without the possibility of shock from the starter components.
2. Current operated switch shall be capable of changing the state of an isolated dry contact or switch when a flow of current is sensed in the wire they are monitoring. The isolated output must be rated at 1 A at 30 VAC or VDC, they shall incorporate a status LED, and shall be UL listed. Trip points shall be between 0.5 A to 135 A, depending on motor size and application. Acceptable manufacturers and models are Veris H308, Veris H908, Functional Devices RIBXGH Series.

**B. Fixed Trip Current Switch**

1. General: Fixed trip current switches shall be used on direct drive equipment. Switches shall be securely mounted and located such that they are easily adjustable without the possibility of shock from the starter components.
2. Current operated switch shall be capable of changing the state of an isolated dry contact or switch when a flow of current is sensed in the wire they are monitoring. The isolated

output must be rated at 1 A at 30 VAC or VDC, they shall incorporate a status LED, and shall be UL listed. Trip points shall be between 0.5 A to 135 A, depending on motor size and application. Acceptable manufacturers and models are Veris H300, Veris H900, Functional Devices RIBXGH Series.

- C. Current Switch Integral Command Relay: Current operated switches may be provided with integral command relays as required to perform the indicated functions in the sequences of operation at the contractor's option. In addition to the requirements set forth above for the current switch, relay contacts shall be SPST, rated for 5 A at 250 VAC minimum, sized for the application.
- D. Current Switch Installation and Configuration
  - 1. For variable speed applications, trip point shall be set with motor at full speed under normal loading conditions (connected to system of service).
  - 2. For variable speed applications, following trip point set at motor full speed, verify proof of operation at motor minimum speed. If current range between minimum and maximum speed prevents reliable proof indication in a single current switch, provide two switches (one for minimum speed and one for maximum speed) and program logic to accommodate proper status indication.
  - 3. Split core current switches are preferred due to their ability to be changed without removal of phase conductors when the equipment has been placed into service. Solid core current transformers will be considered if there are space constraint considerations.
  - 4. If motor current draw is less than listed minimum trip point for the current switch, wrap phase conductor around current switch the minimum number of passes to reach threshold trip current.

## 25 40 02 CONTROL POWER TRANSFORMERS

- A. 24 VAC Control Power Transformers
  - 1. Transformers shall be NEC Class 2 general purpose transformers with primary windings as required by the application and 24 VAC secondary windings rated for 40 VA at 100% power factor. Transformers shall be installed in a suitable enclosure to prevent contact with the primary and/or secondary terminals when the cover is on the enclosure. Where transformers are provided for installation by others, the transformers shall be provided mounted in the enclosure. The mounting arrangement shall be such that the terminals are accessible for connection without removing the transformer from the enclosure.
  - 2. Transformers with higher VA ratings may be supplied but must be designed and installed to meet all requirements of NEC article 725 when used to serve Class 1, Class 2, or Class 3 low voltage circuits.
  - 3. Where fuses are provided, a minimum of two (2) spare fuses of the same type and rating at each location.
- B. 24 VAC Control Power Load Centers
  - 1. Control Power Load Centers are used for distributed 24 VAC power supply of terminal control devices.
  - 2. Load Centers shall have NEC Class 2 rated secondary winding circuit distribution. General purpose transformers up to 500 VA shall have 480/277/240/120 VAC primary windings and 24 VAC secondary windings. Primary input terminals shall be finger-safe. Secondary winding distribution shall have circuit breakers to provide 4 Amp overcurrent protection on isolated circuits. Each secondary winding distribution circuit shall have an isolation switch, status indicator light, and screw terminals for termination. Load Center shall be provided with NEMA 1 metal enclosure.

3. Load Center shall be Function Devices model PSH500A or approved equivalent.
4. Load Centers are provided by the Division 25 Contractor, secondary wiring is provided and performed by the Division 25 Contractor, primary wiring and conduit is provided and performed by the Division 26 Contractor.

#### 25 40 03 PRESSURE SWITCHES

- A. Manual Reset Air Differential Pressure Switch: Switches shall be arranged to actuate a snap acting single pole single throw normally closed switch based on the difference between two pressures as sensed by a diaphragm with a manual reset button. The setpoint shall be adjustable between 0.40"w.c.  $\pm$ 0.06"w.c. and 12.0"w.c., with a progressive switching differential between 0.06"w.c.  $\pm$ 0.01"w.c. at minimum setpoint to 0.8"w.c. at maximum setpoint. Diaphragm shall be rated for a maximum pressure of 0.5 psig. Switches shall be rated for a minimum of 15A at 115 – 277 VAC. Switches shall be rated for 6,000 cycles at maximum operating pressure and maximum electrical load. Enclosures shall be rated NEMA 1 and shall be provided with conduit connection and ¼" compression piping connections. Switches shall be Cleveland Controls model AFS-460 or approved equal.

#### 25 40 04 TERMINAL BLOCKS

- A. Fuse Holder Terminal Blocks: Terminal block shall be arranged to allow a fuse to be installed in the terminal strip between the entering and leaving wires of the termination point. Terminals shall be provided with LED, Neon, or mechanical fuse status indicators. Terminals shall be rated for the voltage and current of the circuit they are contained in at a minimum. Terminals shall be suitable for and mounted on a standard DIN EN 50022 mounting rail. Acceptable models and manufacturers are as follows:

| MANUFACTURER | MODEL          | COMMENTS                                              |
|--------------|----------------|-------------------------------------------------------|
| Weidmuller   | SAKS Series    | With accessories as required for a complete assembly. |
| Entrelec     | MB10/12 Series | With accessories as required for a complete assembly. |
| Phoenix      | UK5 Series     | With accessories as required for a complete assembly. |

- B. Feed Through Terminal Blocks: Feed through terminal blocks shall be compatible with the special purpose terminals specified above and shall mount on the same DIN rail system. Terminals shall be clamp type terminals suitable for solid or stranded wire from #18 AWG to #12 AWG (minimum range). Terminals shall be rated for the voltage and current at which they are applied and shall be provided with all necessary end caps, separators, etc., required for a complete installation.

#### 25 40 05 RELAYS

- A. Plug-In General Purpose Relays
  1. Application: Plug-in general purpose relays shall be used in auxiliary panels and in controlled device power enclosures. Application may be for duplication of a signal for multiple devices, or for segregation of operating voltage of controlled devices.

2. Description: Blade style 3PDT relay with socket and LED or mechanical indicator. Coil nominal (rated) voltage shall be dictated by application requirements, shall withstand 110% rated voltage continuous, have pull-in voltage of 80% of rated voltage, drop-out voltage of 30% rated voltage, and resistance of 103 ohms at 24 VAC / 10,800 ohms at 120 VAC. Contacts shall be silver cadmium oxide, rated for 7.5A at 120 VAC resistive load. Relays shall be Idec RH series with SH series socket or approved equal.

B. Track Mounted Relays

1. Application: Track mounted relays are allowed for use in controlled device power enclosures whose space limitations prevent the use of plug-in relays, or for whose configuration prevent the use of enclosed relays.
2. Description: Track mounted relay with LED indicator, dual voltage coil for 24 VAC or 120 VAC, SPDT contact rated for 10A at 120 VAC resistive load. Relays shall be Air Products and Controls MR-800 series, Functional Devices RIMMNU1C, or approved equal.

C. Enclosed Relays

1. Application: Enclosed relays shall be used at controlled device power enclosures for remote operation of equipment.
2. Description: Enclosed relay with LED indicator, dual voltage coil for 24 VAC or 120 VAC, SPDT contact rated for 10A at 277 VAC resistive load. Relays shall be Functional Devices RIBU1C or approved equal.

D. Fan Safety Alarm Circuit Relays

1. Application: Fan safety alarm circuit relays are permitted for use of fan hardwired interlocks at the contractor's option. If used, they shall be mounted in the auxiliary panel in which the air handling unit's controller is mounted.
2. Description: Track mounted relay with LED indicators for power, master relay on, and status of input safeties, 24 VAC supply power (at 4A), SPST actuator control contact rated for 3A at 24 VAC, SPST fan safety control contact rated for 750 mA at 24 VAC, and one SPST dry contact for each monitored safety. Relays shall be Functional Devices RIBMNLB or approved equal.
  - a. For application with automatic reset low limit thermostats (see section 25 21 01), set board jumpers to enable latching circuit and manual reset button on low limit thermostat relay input.

E. Network Compatible Relays

1. Application: Network compatible relays are permitted for use only as specifically identified on the drawings, points list, or as expressly allowed by the engineer.

F. Time Delay Relays

1. Application: Time delay relays should normally be avoided, time delays shall be accommodated in programming where possible. In the event that time delay relays are required for a specific application, they shall be mounted in the auxiliary panel that has the controller for the controlled equipment, or in a specifically fabricated panel for the controlled equipment that is approved by the engineer.
2. Description: 11-blade style plug in relays requiring 24 VAC power supply, signal-triggered timing circuit, selectable timing functions (on-delay, off-delay, one-shot), adjustable time delay setting between 0.1 s – 600 hours, Form C output contacts, power and timer LED indicators, and UL listed. Relays shall be Idec RTE-B2 series or approved equal.

G. Latching Relays

1. Application: Latching relays are normally not used, except in applications where automatic reset low limit thermostats are allowed (see section 25 21 01) and the Fan Safety Alarm Circuit Relay is not used, where specifically required by the points list or sequence, or as specifically approved by the engineer.
2. Description: Blade style plug-in latching relay with permanent magnet self-holding function, with set and reset coils, check button, 3 A at 250 VAC. Relays shall be Idec RY2KS-UC or approved equal.

H. Relay & AC Current Switch Combo

1. Application: Enclosed relays & AC current switch combos shall be used at controlled device power enclosures for remote operation of equipment when status feedback is required.
2. Description: Enclosed relay/ac switch combination with adjustable threshold and override switch, solid state contact output, 24 VAC coil, SPDT contact rated for 20A at 277 VAC resistive load. Relays shall be Functional Devices RIBX24SBA or approved equal.

25 40 06 DAMPER END SWITCHES

A. Damper End Switches

1. End switches used for damper permissive fan safety circuits shall be safety limit switches, heavy-duty NEMA style, plug-in body. Enclosure shall be NEMA 4, 13 with ½" EMT conduit connection and ambient temperature rating 0°F to 230°F. Actuator head shall be rotary style, CW and CCW actuation, spring return, 4 in-lb operating torque, 13° max travel to operate contacts, 7° max travel to reset contacts, 90° max travel. Switch shall have two snap-acting contacts, 1 N.O. and 1 N.C., 30A make at 120 VAC, 3.0A break at 120 VAC, 5A at 120 VAC continuous operating current. Operating lever shall be adjustable lever, 1.19 in. to 3 in. radius, with 0.63" diameter by 0.25" thick nylon roller (min.). End switch shall be Allen-Bradley 802T-AP or Square D 9007C54B2.
2. End switch and operating lever shall be installed such that contacts prove when damper blade is at 95% open. Operating lever roller shall contact damper blade directly, no contact with damper seal is acceptable. Where end switch cannot be directly mounted to duct wall, provide 12 gauge galvanized steel mounting bracket. Operating lever shall be Allen-Bradley 802T-W2 or Square D 9007HA23.

25 40 07 OCCUPANCY SENSORS

- A. Ceiling mounted occupancy sensors shall be dual-technology and white in color unless otherwise noted: Watt Stopper #DT-300, Hubbell #OMNI-DT-1000, Leviton #OSC10-MOW, Sensorswitch #CM-PDT-9, Lutron LOS-LDT-1000-WH or approved equivalent.
  1. Sensors shall be programmed to 5 minutes time delay.
- B. Wall mounted occupancy sensors shall be dual-technology and white in color: Watt Stopper #DT-200, Hubbell #LODT, Leviton #OSW12-RMW, Sensorswitch #WV-PDT-16, Lutron LOS-WDT-WH or approved equivalent.
  1. Sensors shall be programmed to 5 minutes time delay.

25 40 08 MANUAL COUNTDOWN TIMERS

- C. The timer shall be of the appropriate dimensions and design to fit in a single gang 2 ½" deep junction box.
- D. The timer shall have a UL listed rating of 20 Amp, 120 VAC, 60 Hz.
- E. Spring wound manually set timer switches shall be single pole single throw, provided with a commercial brushed metal finished plate, have a 4 hour time cycle, and shall not include a hold function.



- F. Switches shall be Intermatic FF Series, Marktime 9300 Series, or Tork C Series.

## **25 50 00 WIRING MATERIALS AND METHODS**

### **25 50 01 POWER FOR CONTROL PANELS, EQUIPMENT AND SYSTEMS**

- A. Power for control panels shall be as shown by Division 26, where no power is shown or additional power is required for panels shown or additional panels required but not shown on the plans, then this section shall be responsible for bringing all power required by the control systems from the source (lighting panel, distribution panel, etc.) to the point of use.
- B. This section shall be responsible for bringing all power required by, but not limited to, actuators, transmitters, VAV boxes, etc. from the source (lighting panel, distribution panel, etc.) to the point of use. This includes furnishing and installing any branch circuit protection equipment and disconnecting equipment required to comply with code requirements.
- C. Power for control panels that serve equipment and systems that operate on generator power shall also be powered by the generator emergency power distribution system.
- D. The section shall be responsible for coordination of power requirements with the Electrical Contractor for the project and/or the Owner.
- E. The "power" distribution system includes 480/277 volt three phase four wire, and 208/120 volt three phase four wire systems.
- F. The Contractor shall extend existing equipment grounding system. The Contractor shall use only approved grounding clamps and connectors as manufactured by Penn-Union, Burndy, or O-Z Manufacturing Company.
  - 1. Install a green equipment grounding conductor inside all conduits. Bond all junction boxes, conduit, and equipment. Terminate equipment grounding conductor at electrical panel grounding bus.

### **25 50 02 WIRING**

- A. All wiring required for work under this section of the specification shall be provided under this section of the specification unless otherwise specified.
- B. Interlock wiring as shown on the electrical drawings is the responsibility of Division 26 utilizing equipment provided under this section of the specification. Generally this will mean that Division 26 wires the series safety circuit in the starter as shown on the drawings using switches and devices furnished by this section. Equipment not normally mounted by Division 26 shall be mounted as well as furnished by this section. Starter automation as required by the sequences of operation shall be provided and wired by this section with connections made to terminals on the automatic side of the selector switch and on starter coil auxiliary contacts. It is the intention that Division 26 provide all wiring necessary to make the starter run with the selector switch in the hand position and this section provide all additional automation required. Relays, electro-pneumatic switches, etc., required by this section to operate in parallel with the starter coil shall be piloted by auxiliary contacts on the starter furnished under Division 26 and shall not be directly paralleled with the starter coil.

### **25 50 03 CONDUIT AND WIRE**

- A. All wiring will comply with applicable codes and regulations and will be as specified in the applicable portions of this section of the specification, the electrical section of the specification, and as indicated on the drawings.
  - 1. Conduit shall be required for: all power wiring, all wiring exposed to view in finished spaces, all thermostat rough-ins, all exterior wiring, wiring below 8' AFF exposed to view in unfinished spaces.

2. Open wiring will be permitted: above lay-in ceilings, and unfinished spaces above 8' AFF. **Cables shall be supported with "J-Hooks" a minimum of every six feet. Bridal rings can be used when supporting a maximum of 6 wires. Support devices are to be attached to permanent structure.**
3. Cable tray may be substituted for conduit at the Contractor's option for input/output wiring in mechanical equipment rooms.

B. Conduit Material:

1. Electrometallic tubing shall be installed for all exposed work and for all concealed work in applications where conduit is required.
2. PVC conduit shall be used for all conduit installed below ground or under concrete. Where installed under concrete, provisions shall be made to assure a minimum cover of 2 inches of concrete during and after the pour. Where installed underground, a minimum of 18 inches of cover shall be provided. PVC conduit shall transition to heavy wall conduit or electrometallic tubing (as required by the application and defined in the specification) within 2 inches of the point where it emerges from the ground or concrete in which it is installed.
3. Jacketed flexible steel conduit (Sealtite) shall be used in wet areas where flexible conduit connections are required and at connections to all motorized equipment and motors. For work under this specification, all equipment rooms are considered to be wet areas. Heavy wall conduit shall be used for exterior locations unless specified otherwise. Aluminum conduit shall be used at the following locations: at cooling towers
4. Conduit shall be by Allied, Triangle, Republic, Youngstown, Carlon, Rob Roy, or approved equal.

C. Conduit Installation:

1. Conduit bends shall be made with standard hickies of proper size; radius of bends to be at least 6 times the diameter of the conduit. Runs between outlets shall not contain more than the equivalent of three-quarter bends. Conduit runs shall be continuous from outlet to outlet, outlet to cabinet, etc.
2. Conduits shall be installed with pitch toward outlet box wherever possible. All heavy wall conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub. Fittings on electrometallic tubing shall be compression type.
3. A bushing shall be used where conduit enters a panel box. Bushing for No. 4 AWG or larger shall be insulated type with provisions for grounding as type "BL" made by O-Z Electric Company, or approved equal.
4. All exposed conduits shall be installed parallel or at right angles to the building walls or floors
5. Expansion fittings shall be provided at all conduits across the building expansion joints. Fittings shall be Type "AX" or "TX" as made by O-Z Electric Company, or approved equal. Provide copper bonding jumper at each expansion fitting.
6. Exposed conduit shall be securely fastened in place on maximum 5 ft. intervals for ¾" through 2-1/2" nominal sizes. Supports may be one hole malleable straps or other approved devices. No perforated metal straps will be permitted.
7. Pull boxes and junction boxes shall be installed where indicated on the drawings or where required to facilitate wire installation. Locate in conjunction with other trades so as to install without conflict with other materials or equipment.
8. Care shall be used to avoid proximity to heat ducts and/or steam lines. Where crossings are unavoidable, conduit shall clear covering of line by at least six inches.

9. All conduit for automation wiring shall be identified by painting junction box covers as follows: Voltages above 24 shall be blue and red, voltages at 24 or below shall be blue.
- D. Provisions for Wiring: Wire and cable of the sizes and types shown on the plans and/or hereinafter specified shall be furnished and installed by the Contractor. All wire and cable shall be new soft drawn copper and shall conform to all the latest requirements of the National Electrical Code, IPCEA, and shall meet the specifications of the ASTM.
- E. Power Conductors: All feeder and branch circuit wire shall be 600 V insulated of THHN type unless shown or specified to be otherwise. No wires less than No. 12 gauge shall be used except for control circuits or low voltage wiring. Wire sizes No. 14 to No. 10 shall be solid except where otherwise indicated. Wire sizes No. 8 and larger shall be stranded. All wire sizes shown are American Wire Gauge sizes. Where power conductors are run in cable tray, furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 318 and/or 725.
1. Acceptable Manufacturers: Cable and wire shall be a standard type as manufactured by General Electric Company, National Electric Company, U. S. Rubber Company, Simplex, General Cable Company, Carol, Anaconda, Rome, Southwire, Belden, Alpha, Houston Wire and Cable, or ITT Royal.
- F. Motor Interlock Wiring: Interlock circuit wiring shall be No. 14 solid or stranded wire. Stranded wire only shall be used where wiring is used for flexible wiring harnesses. Stranded control wire shall be provided with crimp type spade terminators. Interlock circuit wiring shall be color-coded or numbered using an identical number on both ends of the conductor. Wire numbers shall be installed before conductors are pulled. Where motor interlock conductors are run in cable tray, furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 318 and/or 725.
- G. Automation Input/Output Wiring: Wiring serving inputs and outputs from the automation system shall be cables consisting of single or multiple twisted pairs, an overall aluminum foil type shield with a 22 AWG stranded drain wire. Cables installed without conduit shall be plenum rated and comply with NEC article 725. Multi-conductor cable shall only be used where all the points are at a single location and for the same device (i.e., variable frequency drives, each individual motor starter). Single conductor cables shall be used for all temperature transmitters, pressure transmitters, flow meters, differential pressure switches, control valves and any other locations where the points are not grouped together at the same device. Where automation input/output wiring is run in cable tray furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 318 and/or 725. Conductors shall be minimum #18 wire gauge, stranded copper. All wires shall be continuous from outlet to outlet and there shall be no unnecessary slack in the conductors.
- H. Floor level network (FLN): Wiring serving communication trunks from the automation system shall be as required by the network protocol. Cables installed without conduit shall be plenum rated and comply with NEC article 725. Where wiring is run in cable tray furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 318 and/or 725.
- I. Splices: All splices, taps, and terminations shall be made at outlet, junction, or pull boxes. Wire to No. 6 gauge shall be spliced using Scotchlok wire nuts. No Bakelite wirenuts shall be used. Wire No. 6 and larger shall be spliced using solderless connectors as manufactured by Penn Union Company. Splices No. 6 and larger shall be insulated by taping with plastic vinyl tape as manufactured by (3M) Minnesota Mining and Manufacturing Company. Splices shall not be permitted in automation input and output wiring without specific written authorization from the Engineer. If such a splice is approved, the location of the splice shall be clearly documented on the "As Built" drawings. Splices in automation wiring, if necessary, shall be made using Thomas & Betts STA-KON connectors installed per the manufacturer's directions to maintain NEMA specified voltage drops and wire retention forces.

#### 25 50 04 JUNCTION BOXES, FITTINGS AND WIREWAYS

- A. Quality: All switch, pull, junction boxes, etc., shall be hot dipped galvanized or sherardized, concrete tight, with interlocking ring or multiple point locking devices. Connectors shall be three piece. Indentation fittings are not acceptable.
- B. Attaching: Boxes shall be attached by fasteners designed for the purpose and shall provide adequate mechanical strength for future maintenance.
- C. Size: Junction and pull boxes not dimensioned shall be minimum 4 inch square.
- D. Furnish and install at all control panel locations a NEMA 1 lay in wire way system to bring cable into and out of the panel as detailed on the drawings and specified here-in. Furnish 3 wire-ways at each panel location; one for tubing, one for Class 1 wiring, and 1 for Class 2 and Class 3 wiring.
- E. Wireway systems at locations where cables are to be run without conduit or in a cable tray shall consist of a connection to the control panel with a vertical extension to 8'-0" or the pipe rack or cable tray level, whichever is higher. The vertical section shall terminate in a 90° fitting with a closure plate. The closure plate shall be provided with a conduit nipple with locknuts and bushings as a wire entry point into the square duct. The conduit nipple shall be 1 size smaller than the wireway it is associated with.
- F. Wireway systems at locations where cables are to be run in conduit shall consist of a horizontal section of wire way with a length equal to the control panel width and located above the control panel and connected to the control panel with 3 conduit nipples, locknuts, and bushings; one for tubing, one for Class 1 wiring and one for Class 2 and 3 wiring. Conduits for cable runs shall terminate on the wireway.
- G. The intent of the wireway configurations outlined above is to provide a method for adding input and output wiring to the control panel without having to drill directly into the electronics enclosure after the system is on line and running. The installation of the wireway shall be made with this consideration in mind.

#### 25 50 05 CONTACT LOCATIONS IN STARTER CONTROL CIRCUITS

- A. Three Phase Starters
  - 1. All contacts controlling motor starters, including overload contacts, shall be located on the hot side of the coil (ungrounded control power leg). Coordination of this requirement with the electrical contractor and compliance with this requirement shall be the responsibility of this section of the specification.
- B. Single Phase Motor Control
  - 1. The wiring of single phase motors and all devices and equipment where the circuit that is interrupted by control devices is also the circuit carrying power to the equipment shall be coordinated with the Division 26.
  - 2. Division 26 shall be responsible for bringing power to the motor and providing a disconnecting means and overload protection as specified in his contract. This section shall furnish a horsepower rated control device or devices as required by the plans and specifications to Division 26 for installation at the disconnecting means location. Division 26 shall mount this device(s) and wire the power circuit through the device(s). This section shall extend the pilot signal for the device from the signal source to the device and terminate the signal at the device.
  - 3. All contacts interrupting single-phase motor circuits shall be horsepower rated and match the voltage, amperage, and horsepower characteristics of the motor they serve.

#### 25 50 06 SAFETY CIRCUITS

- A. All safety circuits shall be hard-wired circuits using standard snap acting electric or pneumatic switches as required by the function, and shall be totally independent of the DDC system controllers. Operation of safeties shall be independent of the position of any Hand-Off-Auto selector switches. This includes interlocks that return dampers and valves to some normal, fail-safe position when the system they are associated with shuts down. It is the intent of this paragraph that the systems have the capability to be operated manually complete with safeties and fail safe interlocks even if the DDC system is off line. Software safeties will not be accepted.

#### 25 50 07 HANGERS AND ANCHORS

- A. Where control system tubing is run on trapezes and/or hangers used by and or installed by other trades, supports for the trapezes shall be coordinated by all trades using the trapeze to assure that the anchor system is not overloaded and is sufficient for the load imposed including a margin of safety and seismic considerations. Under no circumstances shall a trapeze or hanger system installed by the electrical trades be used to support work by any other trade, nor shall the electrical trades use the trapezes installed by any of the other trades for the support of electrical equipment, all as required by the National Electric Code. Similarly, under no circumstances shall a trapeze or hanger system installed by the sprinkler trades be used to support work by any other trade, nor shall the sprinkler trades use the trapezes installed by any of the other trades for the support of sprinkler systems or equipment, all as required by NFPA 13, Standard For The Installation Of Sprinkler Systems.
- B. Anchors to be loaded in tension for use in existing concrete structure and anchors loaded in tension and not cast in place shall be epoxy resin set anchors installed per the manufacturers recommendations for technique, size, loading, embedment, etc. Where anchors are loaded in shear at these locations, suitably sized and installed wedge type anchors may be used.
- C. In all cases, anchor loading shall be based on hanger spacing, weight of the pipe to be supported when full and insulated, weight of any additional loads imposed upon the anchor, wind loading, seismic loading, quality of the material that the anchor is being installed in, etc. The contractor shall verify in the field that the anchors used and the materials that they are being installed in are suitable for the load imposed and shall bring any problems to the attention of the Owner's Representative in writing immediately and not proceed without direction from the Owner's representative.
- D. Wedge type anchors shall be Hilti Kwik Bolt II. Adhesive anchors shall be Hilti HVA.

END OF SECTION

104313.000

# INTEGRATED AUTOMATION CONTROL SEQUENCES FOR HVAC OFSD NEW ES

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## 25 95 01 MISCELLANEOUS AIR SYSTEM CONTROL REQUIREMENTS

- A. Graphics: All graphics shall display time of day, date, outdoor air temperature and outdoor air relative humidity.
1. Cooling Plant Graphics: Graphics showing cooling towers shall include outdoor air wet-bulb temperature. Cooling plant graphics shall show number of pressure reset requests.
  2. Air Handling System Graphics: when applicable, system graphics shall show number of incoming heating and cooling requests, pressure reset requests, total VAV flow, total VAV flow setpoint, Max VAV damper position, and Min VAV damper position.
  3. VAV Graphics: All VAV graphics shall include room name and number, and a link to the RTU which serves the VAV.
  4. Air Handling unit Summary Table: A summary table shall include a list of all rooftops and/or air handling equipment. Columns shall include fan status, fan speed, static pressures, discharge temperature, valve, and damper positions.
  5. VAV Summary Table: A summary table for each air handling system shall include a list of all VAVs served by the system. Columns shall include air flow, air flow setpoint, damper position, supply temperature, valve position, zone temperature, and zone temperature setpoint.
- B. Safety Devices: All safety devices described herein shall be hard wired to the fan controllers to disable the respective fan and actuate dampers and valves to their normal (spring return) positions. Relays shall be provided to provide both the hard wired interlock to the unit and DDC system.
1. Smoke Detectors: Smoke duct detectors shall be furnished and installed by Division 26 in the return and supply air ductwork on each air handling system 2000 CFM or greater in compliance with Division 26 and as indicated on the Air Flow Diagrams. Smoke detectors or supervised relays shall shut down and lock out the corresponding system fans regardless of the position of the selector switch. Manual reset within the Fire Alarm System will be required to resume normal operation. The function shall be provided by external starter wiring and equipment all provided under Division 26. Any wiring not shown on the electrical drawings that is required to implement these functions shall also be provided under this section of the specification. Items not normally installed by Division 26 shall also be installed under Section 25 95 00 of the specification.
    - a. A fire alarm contact will be hard wired to the fire alarm control panel. This will indicate through the DDC system that the fire alarm system is in alarm
  2. Low Limit Thermostat (Freezestat): Freezestats shall be furnished with manual reset capability. When a single switch is required, the contractor has the option to install a manual reset switch located next to the access door or install an automatic reset switch with a latching circuit mounted in the control panel. Manual reset switches shall not be installed on the opposite side to the access door. When multiple switches are required, the contractor shall install automatic reset switches with a latching circuit in the control panel. Manual reset of the latching circuit shall be required to resume operation.
- C. Input Value Filtering: Every sensor input data point shall incorporate input value filtering, a time averaged value is preferable to change of value (COV) techniques. Due to the great variety in filtering requirements based on sensed value stability and process variable use, a prescriptive specification will not be provided in this guideline requirement. Rather, this requirement is to ensure that filtering is present in some form so that it may be adjusted during system tuning and acceptance, if so required, at no additional programming or cost.
- D. Network Dependent Processes: Generally speaking, network dependent processes should be avoided. For control processes, particularly PID loops, all input sensor readings, output device operations, and logic control algorithms shall reside in a single field controller. For particularly difficult applications, or for less critical applications, network dependent processes should be

presented specifically to the Engineer during the Shop Drawing submittal for review and acceptance.

- E. System Motor Starters: Each fan starter is equipped with a control power transformer, control fuse, overload protection, auxiliary contacts, and Hand-Off-Auto switch under Division 26. An overload trip shall shutdown and lockout the fan regardless of the selector switch position. Manual reset shall be required to resume normal operation for all safeties. This function shall be provided by internal starter wiring under Division 26 as shown on the electrical drawings.
- F. The status of each motor shall be monitored by the DDC system via a current sensing relay to be provided for each motor listed in this sequence.
- G. Additional Wiring: Any wiring not shown on the electrical drawings that is required to implement the functions in these sequences shall be provided under section 25 95 00 of the specification. In addition, items not normally supplied under Division 26 shall be included under this section.
- H. Definitions:
  - 1. Adjustable (Adj.): Acknowledging that all values within a DDC system are adjustable using appropriate configuration software, the use of the term adjustable or adj. in the following statements has the specific meaning that the term described will be adjustable at the GUI without the need for any software. This adjustment may be password protected to limit access to an appropriate user level and may use an adjustment mechanism similar to point overrides.
  - 2. Archive: The repository of trend data on the enterprise level server for the automation engine that houses extended data for historical reference. Data stored in archive shall be accessible through trend reporting engines at the GUI.
  - 3. BAS: Building Automation System, computer-based control system which controls and monitors the building's mechanical and electrical equipment.
  - 4. Deadband: The difference between two setpoint or configuration values during which no output function is performed.
  - 5. Dewpoint Temperature: Dewpoint temperature (or also referred to simply as Dewpoint) is the saturation temperature of water in moist air, as evidenced by the temperature at which water will condense out of air. Dewpoint temperature is an evaluation of the absolute water content of moist air, so for control applications, it is used where moisture content of air needs to be maintained, such as humidification or dehumidification processes.
  - 6. Differential: The range or units of measure that separate the enable point from the disable point.
  - 7. Direct Acting: When an output signal varies equal in action to its corresponding input related signal, i.e., an increase in input corresponds to an increase in output.
  - 8. Discharge Temperature: The temperature discharged from a piece of equipment, but not necessarily to an end use consumer.
  - 9. eNC Actuator: A normally closed actuator that does not achieve closure with a mechanical spring, but rather, with an electronic means (capacitor, battery, etc.) when supply power is disconnected.
  - 10. eNO Actuator: A normally closed actuator that does not achieve opening with a mechanical spring, but rather, with an electronic means (capacitor, battery, etc.) when supply power is disconnected.
  - 11. Enthalpy: Thermodynamic quantity equivalent to the total heat content of air. It is usually used to evaluate if the outside air contains less heat than the return air and determine whether to enable economizer.
  - 12. Floating Actuator: An actuator that requires separate excitation power to drive open and to drive closed. This actuator has no normal position, it is fail-in-place.
  - 13. GUI: Graphic User Interface, the operational interface for an end user to the DDC system.
  - 14. Hard Wired Control: Control method using relays to enable and interrupt signals without the use of a controller.



15. Modulating Actuator: An actuator that utilizes a proportional input signal to drive the actuator to a correspondingly scaled output position.
16. Occupied Mode: When a unit is in occupied mode, ventilation air must be present because people are present. Zone setpoints are also adjusted to meet the requirements of the people present.
17. Proportional: A set of signals that vary in a continuously linear relationship with each other. They may be direct or reverse acting.
18. NC Actuator: A normally closed actuator that achieves closure with a mechanical spring or device when supply power is disconnected.
19. NC Contact: An electrical contact that is closed when its controlling signal is deenergized. The contact opens when the controlling signal is energized.
20. NO Actuator: A normally open actuator that achieves opening with a mechanical spring or device when supply power is disconnected.
21. NO Contact: An electrical contact that is open when its controlling signal is deenergized. The contact closes when the controlling signal is energized.
22. NSR Actuator: A non-spring actuator has no mechanical or electrical device to return it to a fixed position on power loss, a fail-in-place actuator.
23. Relative Humidity: Relative humidity is an evaluation of how much water vapor is present in air relative to the capacity of air at the current temperature and pressure to hold water. While it is a good measure of comfort levels, the temperature dependence of this value can make it an unstable control variable.
24. Reverse Acting: When an output signal varies opposite in action to its corresponding input related signal, i.e., an increase in input corresponds to a decrease in output.
25. Supply Temperature: The temperature supplied to an occupied zone or terminal equipment point of use.
26. Temperature: The use of the common term temperature refers specifically to the psychrometric value dry bulb temperature.
27. Wet Bulb Temperature: The psychrometric property wet bulb temperature is the equilibrium temperature at which liquid water evaporates into the air at saturation. It can be measured with a thermometer that has a wick saturated in water. For control processes, it is typically used for the control of cooling towers since it is related to the evaporation of water in air. This is a different value from dewpoint temperature.

## 25 95 02 GLOBAL STATUS POINTS

- A. Common DDC signals for outdoor air temperature and outdoor air relative humidity provide an input the DDC system. These sensors shall be wired to the main control panel and be permitted to be utilized across the network as a common point to be used by any control loop. This point shall be configured as a virtual point and upon sensor failure or loss of communication the virtual point shall remain at the last value. Where this cannot be achieved, a hardwired point shall be created as inputs into all standalone controllers which require outdoor air temperature.

## 25 95 03 SCHEDULES

- A. Overview: Different schedules shall be programmed for different areas of the building. Each rooftop unit operates on two different schedules, one for normal operation where ventilation is introduced, and a custodial schedule where occupied temperature setpoints are maintained without introducing ventilation. Additionally, a summer schedule will be used to enable the administration area and any other area at the owner's request, while leaving the rest of the building unoccupied. The schedules shown here are for startup and reference only, final schedule hours and assignments shall be coordinated with the owner.
- B. Classroom Schedule: shall be occupied from 7:00 AM to 4:00 PM (adjustable). Space nominal setpoint shall be 72°F, with a +/- 2°F user adjustment at the zone sensor. Heating setpoint

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Orchard Farm New Elementary School

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shall be nominal setpoint - 2°F (68-72) and cooling setpoint shall be nominal setpoint + 2°F (72-76). Ventilation shall be for normal occupancy.

- C. Summer Schedule: shall be occupied from 7:00 AM to 4:00 PM (adjustable). Space nominal setpoint shall be 72°F, with a +/- 2°F user adjustment at the zone sensor. Heating setpoint shall be nominal setpoint - 2°F (68-72) and cooling setpoint shall be nominal setpoint + 2°F (72-76). Ventilation shall be 50% of normal occupancy.
- D. Gym Schedule: shall be occupied from 7:00 AM to 9:00 PM (adjustable). Space nominal setpoint shall be 72°F, with a +/- 2°F user adjustment at the zone sensor. Heating setpoint shall be nominal setpoint - 2°F (68-72) and cooling setpoint shall be nominal setpoint + 2°F (72-76). Ventilation shall be for normal occupancy.
- E. Administration Schedule: shall be occupied from 7:00 AM to 6:00 PM (adjustable). Space nominal setpoint shall be 72°F, with a +/- 2°F user adjustment at the zone sensor. Heating setpoint shall be nominal setpoint - 2°F (68-72) and cooling setpoint shall be nominal setpoint + 2°F (72-76). Ventilation shall be for normal occupancy.
- F. Kitchen Schedule: shall be occupied from 7:00 AM to 3:00PM (adjustable) during weekdays, and unoccupied during weekends and holidays.
- G. Custodial Schedule: shall be occupied from the time the respective unit schedule ends to 11:00 PM (adjustable). Space nominal setpoint shall be 72°F, with no user adjustment at the zone sensor. Heating setpoint shall be nominal setpoint - 4°F (68) and cooling setpoint shall be nominal setpoint + 4°F (76). Ventilation shall zero.
- H. Unoccupied Schedule: the building shall be unoccupied from 11:00 PM to 7:00 AM. Space setpoints shall be 65°F for heating, and 79°F for cooling. Rooftop equipment shall cycle on/off to maintain unoccupied setpoints.

## 25 95 04 COOLING PLANT SYSTEM

### A. Overview:

1. The cooling plant consists of three centrifugal chillers piped in a variable-prime configuration, three loop pumps, a two-cell cooling tower, and three condenser pumps serving a header.
2. The chillers are staged based on available capacity; the loop pumps are staged based on pump speed; the cooling towers and condenser pumps are staged based on the number of online chillers.
3. A remote bypass valve maintains minimum chilled water flow. The valve is located such that it creates the largest possible water volume to reduce chiller cycling under low load.
4. Chilled water loop pressure and temperature are reset based on cooling demand; once pressure reaches a maximum value, then temperature is reduced.
5. Chillers are fitted with modulating isolation valves controlled by the BAS for slow actuation.

### B. Safeties:

1. A refrigerant monitor is hardwired to disable the chillers and boilers. An alarm is wired to the BAS to alert the operator upon a leak detection.
2. Flow switches are provided with the chillers to prevent operation under no flow condition.

### C. Chiller Operation Parameters (per unit):

1. Design Capacity: 200 Tons
2. Design Leaving Water: 45°F
3. Design Entering Condenser: 85°F
4. Design Evaporator Flow: 400 gpm
5. Minimum Evaporator Flow: 166 gpm
6. Design Condenser Flow: 500gpm

### D. Startup/Shutdown:

1. The plant shall be enabled if all the following conditions are satisfied:
  - a. The Outside Air Temperature is above 55°F
  - b. There are more than 3 Calls for Cooling from the air handlers
  - c. The plant has been disabled for more than 60 minutes
2. The plant shall be disabled if either one of the following conditions is met:
  - a. There are 0 Calls for Cooling and the plant has been enabled for more than 60 minutes
  - b. The Outside Air Temperature is below 54°F and the plant has been enabled for more than 60 minutes
  - c. There are no chillers available to run
  - d. There are no loop pumps available to run
  - e. There are no condenser pumps available to run
  - f. There are no cooling towers available to run
  - g. The refrigerant alarm is active

### E. Chiller Staging Control:

1. Overview: Three chillers are staged based on available capacity. When the online chillers are running out of capacity, the next chiller will be enabled. When the available capacity is sufficiently greater than the load, a chiller will be disabled. A variable in the graphics allows the operator to place a chiller in service mode to be excluded from the rotation.
2. Lead/Lag Operation: Runtime hours for each chiller shall be totaled and shall never reset. The chillers will not rotate, when a chiller needs to be disabled, the chiller with the most runtime hours will be disabled. When a chiller needs to be enabled, the chiller with the least runtime hours will be enabled.

3. Available Capacity:
    - a. Available capacity (in tons) is calculated by subtracting the instantaneous chiller load from the maximum potential plant capacity given the loop temperature differential. If the leftover capacity is below the acceptable threshold (35T adjustable), a chiller will be started. The potential capacity of the chillers is adjusted based on the potential peak plant temperature differential to start a chiller before the online chiller runs out of capacity.
    - b. AvailCap = Maximum (0, (MaxPotCap – ChillersLoad))
    - c. MaxPotCap = CHPotCap \* Number of Online Chillers
    - d. CHPotCap = Minimum (DesCap, (DesFlow \* PkChwDt / 24))
    - e. DesCap = Chiller scheduled design capacity in tons
    - f. DesFlow = Chiller scheduled evaporator flow in gpm
    - g. PkChwDt = Peak potential plant chilled water temperature differential = (CWR-T – Minimum (CWT-SP, CWS-T))
    - h. ChillersLoad = Instantaneous system load in tons = Maximum (0, CHW-Flow \* (CWR-T – CWS-T) / 24)
  4. Staging Up:
    - a. If AVAILCAP is less than 10 tons (adj.) or the chilled water temperature rises 2°F above setpoint for 15 minutes, and it has been more than 30 minutes since the last stage down, and there is a chiller available, then the chiller with the least number of runtime hours must be started.
  5. Staging Down:
    - a. If AVAILCAP is greater than 220 tons (adj) for 15 minutes and chilled water is within 1°F of setpoint, and it has been more than 30 minutes since then last stage up, then stop the chiller with the most amount of runtime hours.
  6. Starting a Chiller:
    - a. Command operating chillers to reduce demand to 75% of their current load. Wait until actual demand <80% of current load up to a maximum of 5 minutes before proceeding.
    - b. Start the next condenser water pump and tower cell.
    - c. Open the condenser water valve for the chiller being enabled
    - d. Slowly open the chilled water isolation valve of the chiller being enabled. Determine valve timing in the field as that required to prevent nuisance trips. Start at 120seconds.
    - e. As the valve opens, slowly increase the minimum flow setpoint to that appropriate for the stage transition.
    - f. Command the next stage chiller on.
  7. Stopping a Chiller:
    - a. Command the chiller with the most runtime hours off.
    - b. When the chiller controller indicates no request for chilled water flow or 3 minutes have elapsed, slowly close the chilled water isolation valve.
    - c. As the valve closes, slowly decrease the minimum flow setpoint to the appropriate value.
    - d. Shut off the condenser pump with the most runtime hours and close the condenser isolation valve.
  8. Chiller Failure:
    - a. If an online chiller fails, the next chiller must be started after a 30 second delay.
  9. Chiller Service Mode:
    - a. The operator shall have the ability to place a chiller in service mode, this will exclude the chiller from the sequence.
- F. Chiller Isolation Valve Control:
1. Each chiller is provided with modulating isolation valves at the evaporator and condenser bundles. The BAS monitors the chiller pump run request contact via hardwire connection and opens the valves slowly as described in the Chiller Staging Control sequence above.

2. When the plant is off, all evaporator valves are commanded open to allow for chilled water flow in case of a freeze stat trip, all condenser valves are commanded closed to allow for tower basin heater operation.

G. Chiller Minimum Flow Control:

1. Overview:
  - a. Minimum flow through the chillers is maintained by modulating a fast-acting valve located in Game Storage 226 using a flow meter located in the mechanical plant.
2. Chilled Water Flow Set Point:
  - a. The flow setpoint shall be calculated based on the number of online chillers and their individual minimum flow. The flow setpoint shall be slowly reset up and down when the chiller isolation valves are stroked open or closed as described in the Chiller Staging Control sequence.
3. Chilled Water Flow PID:
 

|            |                                 |
|------------|---------------------------------|
| Action:    | Reverse                         |
| Input:     | Chilled Water Flow              |
| Output:    | CHW Bypass Valve Command        |
| Set Point: | CHW Flow SP                     |
| Max:       | 100                             |
| Min:       | 0                               |
| Enable:    | At least one chiller is running |

H. Chilled Water Plant Reset

1. Chilled water supply temperature setpoint and loop differential pressure setpoint are reset based on system demand.
2. The plant sums of all chilled water pressure requests from the associated air handlers and uses the sum as an input to a PID loop. The loop setpoint is 1, and the loop output is used to reset the plant pressure and temperature setpoint.
3. Plant Reset PID:
 

|               |                          |
|---------------|--------------------------|
| Action:       | Direct                   |
| Input:        | Sum of Pressure Requests |
| Output:       | CHW Plant Reset          |
| Subdivision1: | CWDP-SP                  |
| Subdivision2: | CWT-SP                   |
| Set Point:    | 1                        |
| Max:          | 100                      |
| Min:          | 0                        |
| Enable:       | Plant is enabled         |
4. As the CHW Plant Reset goes from 0 to 50, CWDP-SP resets from CW-DPmin to CW-DPmax.
  - a. CW-DPmin shall be set to 5psi (adj.)
  - b. CW-DPmax shall be determined by the balancer such that all coils can achieve design flow.
5. As the CHW Plant Reset goes from 55 to 100, CWT-SP resets from CWSTmax (50°F) to CWSTmin (45°F).
6. The Plant Reset loop shall be enabled when the plant is enabled and disabled when the plant is disabled.
7. When a plant stage change is initiated, CHW Plant Reset logic shall be disabled and value fixed at its last value for the longer of 15 minutes and the time it takes for the plant to successfully stage.

I. Chilled Water Temperature Control:

1. The Chilled Water Temperature Set Point shall be set to the value calculated by the Chilled Water Plant Reset sequence based on system demand and passed to the chillers via network connection.

J. Chilled Water Pressure Control:

1. Overview:

- a. Pressure is maintained using a control loop, the pressure sensor is used as an input to a PID loop, the loop setpoint is reset based on system demand and the loop output is used to reset the local pressure setpoint at the cooling plant.

2. LocalDPmin shall be set such that the plant achieves chiller minimum flow with the bypass 100% open.

3. LocalDPmax shall be determined by the balancer such that all devices can achieve design flow.

4. Local Pressure Control PID:

|            |                  |
|------------|------------------|
| Action:    | Reverse          |
| Input:     | Local-DP         |
| Output:    | CHW Pump Speed   |
| Set Point: | LocalDP-SP       |
| Max:       | 100              |
| Min:       | 20               |
| Enable:    | Plant is enabled |

K. Chilled Water Pump Control:

1. The plant is equipped with three equally sized secondary pumps in a header system. Pumps are enabled and disabled based on the speed command.

2. Lead/Lag Operation:

- a. Total runtime hours for each pump shall be tallied and never zeroed.
- b. Pumps shall not rotate, when a pump needs to be enabled, the pump with the least number of hours will be enabled. When a pump needs to be disabled, the pump with the most hours will be disabled.

3. Pump Enable:

- a. When the plant is first enabled, the pump with the least number of hours will be enabled.
- b. If pump speed is over 90% for 5 minutes, then the next pump will be enabled.

4. Pump Disable:

- a. If pump speed times the number of pumps divided by the number of pumps minus one is less than 65 for 15 minutes, then disable a pump.
  - 1) Example, 3 pumps running at 40%:  $40 * 3 / (3-1) = 60$ , one pump should be disabled.

5. Pump Speed Control:

- a. Once enabled, the pumps shall control to the same speed to maintain differential pressure as commanded by the CHW Pump Speed command output of the Local Pressure Control PID.
- b. Pumps' acceleration VFD settings shall be set to 90 seconds.

6. Pump Service Mode:

- a. The operator shall have the ability to place a pump in service mode. This will exclude the pump from the rotation.

7. Pump Failure:

- a. A pump shall be considered to have failed if the command is on and no status is received for 30 seconds. If an online pump fails, the next pump must be immediately enabled.

L. Condenser Water Pump Control:

1. The plant is equipped with three equally sized condenser pumps in a header system. The pumps are enabled and disabled together with the chillers. The number of pumps enabled must match the number of chillers enabled.

2. Lead/Lag Operation:

- a. Total runtime hours for each pump shall be tallied and never zeroed.
- b. Pumps shall not rotate, when a pump needs to be enabled, the pump with the least number of hours will be enabled. When a pump needs to be disabled, the pump with the most hours will be disabled.

3. Pump Enable:
    - a. When a chiller is enabled, the pump with the least number of hours will be enabled.
  4. Pump Disable:
    - a. When a chiller is disabled, the pump with the most hours is disabled.
    - b. If all the chiller isolation valves are closed, all the pumps are commanded off.
  5. Pump Speed Control:
    - a. Pump speeds shall be determined by the balancer for 1, 2, and 3, chillers in operation. All pumps are commanded to the same constant speed, the speed is adjusted based on the number of chillers in operation.
  6. Pump Service Mode:
    - a. The operator shall have the ability to place a pump in service mode. This will exclude the pump from the rotation.
  7. Pump Failure:
    - a. A pump shall be considered to have failed if the command is on and no status is received for 30 seconds. If an online pump fails, the next pump must be immediately enabled.
- M. Condenser Water Temperature Control:
1. Condenser water temperature is controlled by modulating the bypass valve and the speed of the cooling tower fans, and by cycling the fans on and off.
  2. Condenser Water Temperature Setpoint:
    - a. The setpoint shall be linearly reset based on outside air wet bulb temperature. When the outside air wet bulb is below 50°F the condenser water temperature will be 65°F, when the outside air wet bulb is above 81°F the condenser water temperature set point will be 85°F.
  3. Condenser Water Temperature PID:
 

|            |                             |
|------------|-----------------------------|
| Action:    | Direct                      |
| Input:     | Condenser Water Temperature |
| Output:    | CTPIDOUT                    |
| Set Point: | Condenser Water Temp SP     |
| Max:       | 100%                        |
| Min:       | 0%                          |
| Enable:    | Any chiller is ON           |

The output of the PID is used to control the bypass valve and the fans as described below.
- N. Cooling Tower Valve Control:
1. Condenser Water Bypass Valve:
    - a. The condenser water loop is fitted with a modulating indoor bypass which is used upon startup of the plant to prevent the cold tower water from being fed into the chillers.
    - b. When the plant is started the condenser water bypass is in recirculation (closed to the towers), as the chiller warms up the valve starts opening and mixing the cold tower water. Once the tower water is warm the bypass valve will close.
    - c. When the plant is enabled the bypass valve shall be controlled by the Condenser Water Temperature PID as follows:
      - 1) CNDVLCMD = SPAN (CTPIDOUT, 0, 100, 5, 0)
    - d. When the plant is off the valve shall be commanded closed to allow for freeze protection operation.
  2. Cooling Tower Isolation Valve:
    - a. Each cooling tower is fitted with a control valve which allows water to flow over the top. If one chiller is enabled, then only one valve is open, if two or more chillers are enabled, then both valves are open.
    - b. Tower Duty Cycle: When a valve needs to open, the tower whose fan has the least number of hours will open its valve. When a valve needs to close, the tower with the greatest number of hours will close its valve.

3. Cooling Tower Bypass Valve:
    - a. The cooling tower is fitted with a control valve that allows water to flow directly into the basin, bypassing the fill.
    - b. When the plant is disabled, the tower bypass valve is kept open to allow for freeze protection.
    - c. When the plant is enabled, the valve is commanded closed.
- O. Cooling Tower Fan Control:
1. Fan Duty Cycle:
    - a. A total of runtime hours (RTH) for each of the two cooling tower fans will be maintained on record.
    - b. When a fan needs to be enabled, the fan with the least number of hours will be enabled. When a fan needs to be disabled, the fan with the greatest number of hours will be disabled.
  2. Fan Start/Stop:
    - a. The number of fans in operation will depend on the output of the Condenser Water Temperature PID and the number of cells enabled.
      - 1)  $FANCMD = SPAN(CTPIDOUT, 5, 0, 100, 100)$
      - 2)  $ONCELLS = \text{Number of isolation valves open}$
      - 3)  $FANDB = 15 / ONCELLS$
      - 4)  $FAN1SP = 5 + FANDB$
      - 5)  $FAN2SP = 5 + 2 * FANDB$
      - 6)  $FAN1SS = \text{On if } FANCMD > FAN1SP \text{ and } CT1ISOVLV = \text{Open}$
      - 7)  $FAN1SS = \text{Off if } FANCMD < (FAN1SP - FANDB) \text{ or } CT1ISOVLV = \text{Closed}$
      - 8)  $FAN2SS = \text{On if } FANCMD > FAN2SP \text{ and } CT2ISOVLV = \text{Open}$
      - 9)  $FAN2SS = \text{Off if } FANCMD < (FAN2SP - FANDB) \text{ or } CT2ISOVLV = \text{Closed}$
  3. Fan Speed Control:
    - a. Fan speed will modulate to maintain Condenser Water Temperature Set-Point.
    - b. When a fan is enabled, it will be commanded to its minimum speed of 15Hz. As the cooling demand increases and the Condenser Water Temperature PID output rises the fan speed will increase from 25% to 100% (15Hz to 60Hz).
    - c. All enabled fans shall be controlled to the same speed. If a fan is disabled, it shall be commanded to 0% speed.
    - d.  $FANVFD = MAX(25, FANCMD)$
- P. Cooling Tower Basin Water Level Control:
1. The water level sensor provides an input to a PID, the loop setpoint is constant, and the output is used to modulate the makeup water valve.
  2. Tower Level Set Point: The tower level shall be initially set to 8" and field calibrated such that the level is maintained at the manufacturer's recommended level as indicated by markings inside the towers' basin.



3. Tower Level PID:

|            |                      |
|------------|----------------------|
| Action:    | Reverse              |
| Input:     | Tower Water Level    |
| Output:    | Makeup Valve_Lvl Cmd |
| Set Point: | Tower Level SP (8")  |
| Max:       | 100                  |
| Min:       | 0                    |
| Enable:    | Plant is enabled     |

Q. Cooling Tower Basin Freeze Protection Control:

1. The cooling towers are fitted with a freeze protection system consisting of a circulator pump and a hot water heat exchanger. When the outdoor air temperature drops below 40°F the freeze protection pump is enabled and the heat exchanger's valve modulates to maintain tower leaving water temperature.
2. During freeze protection, the towers' isolation and basin valves remain open and the plant bypass valve remains closed.
3. Tower Freeze Protection PID:

|            |                             |
|------------|-----------------------------|
| Action:    | Reverse                     |
| Input:     | Condenser Water Temperature |
| Output:    | HX Valve_Temp Cmd           |
| Set Point: | 40°F                        |
| Max:       | 100                         |
| Min:       | 0                           |
| Enable:    | OAT < 40°F                  |

R. Alarms:

1. Chiller Fault: all alarms shall be pulled from the chiller controller via network connection.
2. Chiller Failure: an alarm is generated if a chiller is commanded on by the BAS, no status is received and chilled water temperature is 5°F above setpoint for 5 minutes.
3. Pump Failure: a pump is commanded on and no status is received for 15 seconds.
4. Fan Failure: a fan is commanded on and no status is received for 15 seconds.
5. High Chilled Water Temp: the plant is enabled, and chilled water temperature is 5°F above setpoint for 30 minutes.
6. High Condenser Water Temp: tower temperature is above 100°F for 5 minutes.
7. Low Condenser Water Temp: tower temperature drops below 35°F for 5 minutes.
8. Tower High Water Level: tower water level is 2" above setpoint for 5 minutes.
9. Tower Low Water Level: tower water is 2" below setpoint for 5 minutes.

## 29 95 05 HEATING PLANT SYSTEM

### A. Overview:

1. The heating plant consists of three boilers piped in a variable-primary configuration and three variable speed loop pumps which modulate to maintain pressure.
2. Loop pressure is reset based on load demand.
3. The plant is enabled all the time when ambient conditions are low, during occupied hours regardless of ambient temperature, or when needed during unoccupied hours.
4. The BAS sends an enable and a setpoint signal to the lead boiler, the boiler controller stages and modulates all boilers as needed.

### B. Safeties:

1. A carbon monoxide sensor serves the Fire Alarm System.
2. An emergency push button is hardwired to the boilers' power circuit. When the button is pushed, the boilers and pumps will lose power and their gas valves will close.
3. The refrigerant alarm panel shall be hardwired to disable the boiler system if a refrigerant leak is detected

### C. Boiler Operating Parameters (per unit):

1. Nominal Capacity: 3,000 MBH
2. Absolute Min Flow: 25 gpm
3. Design Flow: 300gpm
4. Leaving Water Temp: 140°F
5. Entering Water Temp: 120°F

### D. Startup/Shutdown:

1. The plant shall be enabled if any of the following conditions are met:
  - a. Outside air temperature is below 60°F, and there are at least 10 Calls for Heating (adj.)
  - b. The outside air temperature drops below 40°F
  - c. The building is occupied
2. The plant shall be disabled if any of the following conditions are met:
  - a. Schedule is unoccupied and outside air temperature is above 62°F
  - b. There are 0 Calls for Heating and outside air temperature is above 42°F
  - c. The hot water supply temperature drops below 45°F
  - d. The refrigerant alarm is active
3. Minimum Runtime: Once enabled, the plant shall remain enabled for a minimum of 60 minutes. Once disabled, the plant shall not start for a minimum of 60 minutes.
4. Latch enable command: Once the plant is enabled, it shall remain enabled until the disable conditions are met and clear the latch.
5. Call for Heating: Each hot water valve that is open more than 10% for 15 minutes sends a call for heating to the plant, once the valve closes the call stops. Each zone that has gone into unoccupied setback sends a call for heating to the plant, once zone temperature is satisfied the call stops.

### E. Boiler Duty Cycle:

1. The boiler controller shall be programmed to cycle the boilers to obtain equal runtime.

### F. Boiler Isolation Valves:

1. The boilers shall be programmed to open their isolation valves when the plant is disabled.
2. The BAS monitors valve positions for each boiler.

- G. Boiler Minimum Flow Control:
1. Overview:
    - a. Minimum flow through the boilers is maintained by modulating a fast-acting valve located in Game Storage 226 using a flow meter.
  2. Heating Water Flow Set Point:
    - a. The flow setpoint shall be calculated based on the number of online boilers by monitoring the status of their isolation valves. The plant shall maintain a minimum of 30gpm per online boiler.
  3. Heating Water Flow PID:
 

|            |                         |
|------------|-------------------------|
| Action:    | Reverse                 |
| Input:     | Heating Water Flow      |
| Output:    | HW Bypass Valve Command |
| Set Point: | HW Flow SP              |
| Max:       | 100                     |
| Min:       | 0                       |
| Enable:    | Plant is enabled        |
- H. Heating Water Temperature Set Point:
1. The temperature setpoint shall be linearly reset from 110°F when the Outside Air Temperature is above 70°F, to 140°F when the Outside air temperature drops below 50°F.
  2. Setpoint limits shall be made adjustable by the operator.
- I. Heating Water Pressure Control:
1. Overview:
    - a. Pressure is maintained using a control loop, the pressure sensor is used as an input to a PID loop, the loop setpoint is reset based on system demand and the loop output is used to reset the local pressure setpoint at the cooling plant.
  2. The plant sums of all pressure requests and uses the sum as an input to a PID loop. The loop setpoint is 1, and the loop output is used to reset the remote pressure setpoint.
  3. Setpoint Reset PID:
 

|            |                          |
|------------|--------------------------|
| Action:    | Direct                   |
| Input:     | Sum of Pressure Requests |
| Output:    | HWDP-SP                  |
| Set Point: | 1                        |
| Max:       | HW-DPmax                 |
| Min:       | HW-DPmin                 |
| Enable:    | Plant is enabled         |

    - a. HW-DPmin shall be set to 5psi (adj.)
    - b. HW-DPmax shall be determined by the balancer such that all coils can achieve design flow.
    - c. LocalDPmin shall be set such that the plant achieves minimum flow with the bypass 100% open.
    - d. LocalDPmax shall be determined by the balancer such that all devices can achieve design flow.
  4. Local Pressure Control PID:
 

|            |                  |
|------------|------------------|
| Action:    | Reverse          |
| Input:     | Local-DP         |
| Output:    | HW Pump Speed    |
| Set Point: | LocalDP-SP       |
| Max:       | 100              |
| Min:       | 20               |
| Enable:    | Plant is enabled |
- J. Heating Water Pump Control:
1. Lead/Lag Operation:

- a. Total runtime hours for each pump shall be tallied and never zeroed.
    - b. Pumps shall not rotate, when a pump needs to be enabled, the pump with the least number of hours will be enabled. When a pump needs to be disabled, the pump with the most hours will be disabled.
  - 2. Pump Enable:
    - a. When the plant is first enabled, the pump with the least number of hours will be enabled.
    - b. If pump speed is over 90% for 5 minutes, then the next pump will be enabled.
  - 3. Pump Disable:
    - a. If pump speed times the number of pumps divided by the number of pumps minus one is less than 65 for 15 minutes, then disable a pump.
      - 1) Example, 3 pumps running at 40%:  $40 * 3 / (3-1) = 60$ , one pump should be disabled.
  - 4. Pump Speed Control:
    - a. Once enabled, the pumps shall control to the same speed to maintain differential pressure as commanded by the HW Pump Speed command output of the Local Pressure Control PID.
    - b. Pumps' acceleration VFD settings shall be set to 90 seconds.
  - 5. Pump Service Mode:
    - a. The operator shall have the ability to place a pump in service mode. This will exclude the pump from the rotation.
  - 6. Pump Failure:
    - a. If an online pump fails, the next pump must be immediately enabled.
- K. Alarms:
- 1. Boiler Failure: All boiler fault signals are received by the BAS from the boiler control panel.
  - 2. Pump Failure: A pump is commanded on, but no status is received for 15 seconds.
  - 3. Low Heating Water Temp: the plant is enabled and heating water temperature is 15°F below setpoint for 30 minutes
  - 4. Emergency Stop: An alarm is generated when the button is pressed. The boilers stop and the pumps continue to run to distribute heat through the building until the water temperature drops below 45°F.

## 25 95 06 MULTIPLE-ZONE VAV ROOFTOP UNIT (RTU-6)

- A. Overview:
1. This variable flow rooftop unit provides conditioned air to reheat terminal boxes.
  2. Constant ventilation is maintained through the minimum outside air damper by modulating the return damper to maintain constant pressure.
  3. The economizer damper modulates to maintain mixed air temperature.
  4. General relief fan RLF-3 relieves excess building pressure from economizer mode.
  5. Discharge air temperature and discharge static pressure are reset based on zone demand as energy conservation measures.
  6. The unit is setup as a rooftop unit with separate relief fan and is provided with ECM supply fans, pumped hot water preheat coil, chilled water coil, minimum outside air, economizer, and return dampers, and filters.
- B. Safeties:
1. The unit is provided with smoke detectors, low limit thermostat, low pressure and high-pressure switches.
  2. All safety devices are hardwired such that a trip of any device disables all fans.
  3. The low limit thermostat is also hardwired to all the damper and valve actuators, such that a Freezestat trip would interrupt power to the actuators returning them to their normal position.
  4. Manual reset shall be required to resume normal operation for all safeties.
- C. Schedule:
1. Each unit runs in the schedule corresponding to its area of service. See Schedules section above.
  2. Optimum Start: the unit shall start and run continuously with the ventilation damper closed prior to the schedule going occupied. The controller shall calculate the required number of minutes the unit needs to be started ahead of schedule such that the space reaches the occupied setpoint by the time the schedule goes occupied.
- D. Zone Temperature Control:
1. Occupied Operation: the unit runs continuously during occupied hours. Temperature and pressure are both reset based on zone demand.
  2. Unoccupied Operation: the unit cycles the fans on/off to maintain all zones within the unoccupied setpoints. Temperature is reset to maximum or minimum depending on whether the space needs heating or cooling. When a space drift past its setpoint, a Night Setback or Night Setup variable will be enabled, and a call for cooling or heating will be sent to the respective plant. The plant will wait until there are several calls before starting, the rooftop will remain off until the plant has started.
- E. Discharge Air Temperature Control:
1. Occupied Operation: discharge temperature is reset from 55°F to 65°F based on zone deviation from setpoint when the outside air dew point temperature is below 55°F. If the outside air dew point is above 55°F, then the discharge temperature setpoint shall be set to 55°F. A single PID is used to control the heating and cooling valves to maintain discharge temperature setpoint.
    - a. Discharge Air Temperature Setpoint Reset: Each zone sends up to three cooling or heating requests, the unit subtracts the sum of heating requests from the sum of cooling requests and inputs the remainder to a PID-type control loop with a setpoint of zero. The PID output resets the supply air temperature setpoint.
    - b. Discharge Air Temperature Setpoint PID:

|         |                                  |
|---------|----------------------------------|
| Action: | Reverse                          |
| Input:  | Sum of Temp Requests (Clg – Htg) |
| Output: | DAT-SP                           |

Set Point: 0  
 Bias: 60  
 Max: 65  
 Min: 55  
 Enable: Unit Enabled & OA-DewPt < 55

c. Discharge Air Temperature PID:

Action: Direct  
 Input: DA-T  
 Output: DAT Command Output  
 Subdivision 1: Cooling Valve\_DAT Cmd  
 Subdivision 2: Heating Valve\_DAT Cmd  
 Set Point: DAT-SP  
 Bias: 50  
 Max: 100  
 Min: 0  
 Enable: Unit Enabled

d. DAT Command Output Table:

| DAT<br>Cmd<br>Output | Clg<br>Cmd | Htg Cmd |
|----------------------|------------|---------|
| 0                    | 0          | 100     |
| 50                   | 0          | 0       |
| 100                  | 100        | 0       |

- Unoccupied Operation: during unoccupied hours the unit shall cycle on/off as required whenever a space drift past the unoccupied setpoints. The discharge temperature shall be set to 70°F if the space drifts below 65°F, or to 55°F if the space drifts above 79°F.

F. Cabinet Temperature Control (freeze protection):

- Overview: cooling coil leaving air temperature is maintained by the preheat valve when the rooftop unit is not in operation and ambient temperatures are cold.
- When outside air temperature is below 40°F and the supply fan status is off, the preheat valve shall modulate to maintain 50°F (adj.) inside the unit as measured by the averaging sensor located downstream of the cooling coil.

3. RTU Cabinet Temperature PID:

Action: Reverse  
 Input: Cooling Valve LAT  
 Output: Heating Valve\_Freeze Cmd  
 Set Point: 50  
 Bias: 100  
 Max: 100  
 Min: 0  
 Enable: Unit Disabled & OA-T < 40°F

G. Mixed Air Temperature Control (Economizer):

- Overview: mixed air temperature is maintained when economizer is enabled by modulating the economizer damper to meet the Mixed Air Temperature setpoint.
- Economizer enable: economizer shall be enabled if all three conditions are met,
  - outside air temperature must be below 65°F
  - outside air dew point must be below 55°F
  - heating valve command must be 0%
- If any of the three conditions becomes false, economizer must be disabled. Use +/-1°F and 3% deadbands to prevent cycling.

4. Mixed Air Temperature SP: the setpoint shall be calculated by subtracting fan heat from the discharge air setpoint. Fan heat shall be calculated using the two temperature sensors on each side of the supply fan.

- a.  $\text{Fan Heat} = \text{SA-T} - \text{CCLA-T}$

- b.  $\text{MAT-SP} = \text{Clg SAT-SP} - \text{Fan Heat}$

5. Mixed Air Temperature PID:

|            |                          |
|------------|--------------------------|
| Action:    | Direct                   |
| Input:     | MA-T                     |
| Output:    | Economizer_MAT Cmd       |
| Set Point: | MAT-SP                   |
| Bias:      | 0                        |
| Max:       | 100                      |
| Min:       | 0                        |
| Enable:    | Unit Enabled & ECON = ON |

#### H. Building Static Pressure Control:

1. Building static pressure is maintained by RLF-2. See Transfer and Exhaust Fans for control strategy.

#### I. Discharge Air Static Pressure Control:

1. Overview: discharge air pressure is maintained by modulating the supply fan speed. The pressure setpoint is reset to maintain one VAV damper over 85% open as described in the VAV control sequence.

2. Discharge Air Static Pressure Setpoint: each VAV sends up to two pressure increase requests to the rooftop unit when the damper is above 85% open and flow has not reached setpoint. The rooftop unit adds all the requests and uses the sum as an input to a PID.

3. Discharge Air Static Pressure Setpoint Reset PID:

|            |                                |
|------------|--------------------------------|
| Action:    | Direct                         |
| Input:     | Sum of Pressure Reset Requests |
| Output:    | DASP-SP                        |
| Set Point: | 1                              |
| Bias:      | 0                              |
| Max:       | 2.0" (adj.)                    |
| Min:       | 0.5" (adj.)                    |
| Enable:    | Unit Enabled                   |

4. Discharge Air Static Pressure PID:

|            |                    |
|------------|--------------------|
| Action:    | Reverse            |
| Input:     | DA-SP              |
| Output:    | Fan Speed_DADP Cmd |
| Set Point: | DASP-SP            |
| Bias:      | 20                 |
| Max:       | 100                |
| Min:       | 20                 |
| Enable:    | Unit Enabled       |

5. Maximum static pressure and maximum fan speed shall be determined by the balancer such that the fan supplies design flow with at least one VAV damper fully open and maintaining design VAV flow.

#### J. Outside Air Differential Pressure Control (ventilation):

1. Overview: ventilation is achieved by modulating the return damper to maintain constant outside air pressure when the unit is operating in occupied mode.

2. Outside Air Differential Pressure Setpoint: the pressure setpoint shall be determined by the balancer such that minimum outside air flow is introduced through the minimum outside air damper when the unit is operating at maximum airflow.

- a. Open the minimum outside air damper and the return damper

- b. Set all VAVs to max flow and allow the supply fan to stabilize, then override supply fan speed.
  - c. Modulate the return damper until the desired amount of ventilation is introduced. If outside airflow is above design minimum, leave return damper open and adjust the min outside air damper linkage
  - d. Record the outside air pressure at this point, this will be used as the outside air pressure setpoint.
- 3. Outside Air Differential Pressure PID:
 

|            |                                 |
|------------|---------------------------------|
| Action:    | Reverse                         |
| Input:     | OA-DP                           |
| Output:    | RA Damper_OADP Cmd              |
| Set Point: | OADP-SP                         |
| Bias:      | 100                             |
| Max:       | 100                             |
| Min:       | 0                               |
| Enable:    | Unit Enabled and Schedule = OCC |
- K. Supply Fan Control:
  - 1. Fan Enable:
    - a. The fan is enabled by the Occupied, Optimum Start, Night Setup, or Night Setback commands
  - 2. Fan Speed Control:
    - a. The fan array controls to maintain duct static pressure as commanded by the Discharge Air Static Pressure Control sequence.
    - b. When enabled outside of occupied hours, the fan shall remain at minimum speed until confirmation of the heating or cooling plant status is received.
  - 3. Fan Failure:
    - a. When a fan in the array fails, an alarm is generated and the remainder fans continue to run.
- L. Chilled Water Valve Control:
  - 1. The chilled water valve modulates to maintain discharge air temperature as commanded by the Cooling Valve\_DAT Cmd described above.
  - 2. The valve shall be locked out (commanded to 0%) if the rooftop unit is off, or if the outside air temperature is below 55°F.
- M. Preheat Water Valve Control:
  - 1. The preheat valve modulates to maintain discharge air temperature when the unit is enabled, and it also modulates to maintain cooling coil leaving air temperature when the unit is disabled during low ambient temperature conditions.
  - 2. The valve shall take the maximum between the Heating Valve\_DAT Cmd and the Heating Valve\_Freeze Cmd.
  - 3. The valve shall be locked out (commanded to 0%) if the outside air temperature is greater than 55°F, or if the output of the Mixed Air Temperature PID is greater than zero.
- N. Minimum Outside Air Damper Control:
  - 1. The 2-position damper shall be commanded open when the schedule is occupied.
  - 2. When the unit is disabled, or when the unit is operating in Optimum Start, Custodial, Night Setup, or Night Setback modes, then the damper shall be closed.
- O. Economizer Damper Control:
  - 1. The economizer damper modulates to maintain mixed air temperature as commanded by the Mixed Air Temperature PID.



2. The damper shall only be allowed to modulate if the outside air temperature is below 65°F, the outside air dew point is below 55°F, and the heating valve is closed. If these three conditions are not met, then the damper shall remain closed.
- P. Return Air Damper Control:
1. The damper shall control to maintain Outside Air Differential Pressure as commanded by the Outside Air Differential Pressure PID when the Minimum Outside Air damper is open.
  2. The damper shall only be allowed to modulate if the unit is operating in Occupied mode. When the unit is disabled, or when the unit is operating in Optimum Start, Custodial, Night Setup, or Night Setback, the damper shall be commanded fully open.
  3. The return air damper maximum position shall be limited to 100% minus Economizer damper position.
- Q. Freeze Protection Pump Control:
1. The pump shall be enabled when the preheat valve is open more than 5% or outside air temperature is below 40°F and remain running until the valve is fully closed and outside air temperature is above 42°F.
- R. Chilled Water Pressure Request:
1. A pressure increase request shall be sent to the cooling plant when the chilled water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- S. Hot Water Pressure Request:
1. A pressure increase request shall be sent to the heating plant when the hot water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- T. Call for Cooling:
1. The unit shall send a call for cooling to the plant if the chilled water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setup is enabled because a space drifted above the unoccupied or custodial setpoint.
- U. Call for Heating:
1. The unit shall send a call for heating to the plant if the hot water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setback is enabled because a space drifted above the unoccupied or custodial setpoint.
- V. Alarms:
1. Supply Fan Failure: ECM controller alarm contact
  2. Freeze Pump Failure: alarm if the pump is commanded on and no status is received from the CT.
  3. High and Low Discharge Temperature: alarm if the discharge temperature is 5°F above or below setpoint for more than 30 minutes.
  4. Discharge High and Low Static: alarm if the discharge static is 0.5" above or below setpoint for more than 30 minutes.
  5. Safety Alarms: an alarm shall be generated for each safety independently
    - a. Mixed Air Low Pressure
    - b. Discharge Air High Pressure
    - c. Freezestat
    - d. Smoke
- W. Graphics:
1. All graphics shall include time of day, outside air temperature, outside air humidity, outside air dewpoint, the sum of all corresponding VAV Flow Setpoints, the sum of all VAV Flows, the Max VAV damper position, the Min VAV damper position, incoming heating requests, incoming cooling requests, and incoming pressure requests.



25 95 07 MULTIPLE-ZONE VAV ROOFTOP UNIT WITH ENERGY RECOVERY (RTU-5, RTU-7, RTU-8)

A. Overview:

1. This variable flow rooftop unit provides conditioned air to reheat terminal boxes.
2. Constant ventilation is maintained through the minimum outside air damper by modulating the return damper to maintain constant pressure.
3. The economizer damper modulates to maintain mixed air temperature.
4. Economizer relief is controlled with RLF-2. See Exhaust and Transfer Fans for control.
5. The exhaust fan is enabled during occupied hours and commanded to its balanced constant speed.
6. The supply fan maintains supply duct static pressure setpoint.
7. Discharge air temperature and discharge static pressure are reset based on zone demand as energy conservation measures.
8. The custom unit is set up with an energy recovery ventilation section which provides constant, fixed quantities of outside air and exhaust air. The exhaust and return air paths do not mix.
9. The unit is provided with ECM supply and exhaust fans, pumped hot water preheat coil, chilled water coil, energy recovery wheel, minimum outside air, economizer and exhaust dampers, and filters.

B. Safeties:

1. The unit is provided with smoke detectors, low limit thermostat, low pressure and high-pressure switches.
2. All safety devices are hardwired such that a trip of any device disables all fans.
3. The low limit thermostat is also hardwired to all the damper and valve actuators, such that a Freezestat trip would interrupt power to the actuators returning them to their normal position.
4. Manual reset shall be required to resume normal operation for all safeties.

C. Schedule:

1. Each unit runs in the schedule corresponding to its area of service. See Schedules section above.
2. Optimum Start: the unit shall start and run continuously with the ventilation damper closed prior to the schedule going occupied. The controller shall calculate the required number of minutes the unit needs to be started ahead of schedule such that the space reaches the occupied setpoint by the time the schedule goes occupied.

D. Zone Temperature Control:

1. Occupied Operation: the unit runs continuously during occupied hours. Temperature and pressure are both reset based on zone demand.
2. Unoccupied Operation: the unit cycles the fans on/off to maintain all zones within the unoccupied setpoints. Temperature is reset to maximum or minimum depending on whether the space needs heating or cooling. When a space drifts past its setpoint, a Night Setback or Night Setup variable will be enabled, and a call for cooling or heating will be sent to the respective plant. The plant will wait until there are several calls before starting, the rooftop will remain off until the plant has started.

E. Discharge Air Temperature Control:

1. Occupied Operation: discharge temperature is reset from 55°F to 65°F based on zone deviation from setpoint when the outside air dew point temperature is below 55°F. If the outside air dew point is above 55°F, then the discharge temperature setpoint shall be set to 55°F. A single PID is used to control the heating and cooling valves to maintain discharge temperature setpoint.

- a. Discharge Air Temperature Setpoint Reset: Each zone sends up to three cooling or heating requests, the unit subtracts the sum of heating requests from the sum of cooling requests and inputs the remainder to a PID-type control loop with a setpoint of zero. The PID output resets the supply air temperature setpoint.

- b. Discharge Air Temperature Setpoint PID:

Action: Reverse  
 Input: Sum of Temp Requests (Clg – Htg)  
 Output: DAT-SP  
 Set Point: 0  
 Bias: 60  
 Max: 65  
 Min: 55  
 Enable: Unit Enabled & OA-DewPt < 55

- c. Discharge Air Temperature PID:

Action: Direct  
 Input: DA-T  
 Output: DAT Command Output  
 Subdivision 1: Cooling Valve\_DAT Cmd  
 Subdivision 2: Heating Valve\_DAT Cmd  
 Set Point: DAT-SP  
 Bias: 50  
 Max: 100  
 Min: 0  
 Enable: Unit Enabled

- d. DAT Command Output Table:

| DAT<br>Cmd<br>Output | Clg<br>Cmd | Htg Cmd |
|----------------------|------------|---------|
| 0                    | 0          | 100     |
| 50                   | 0          | 0       |
| 100                  | 100        | 0       |

2. Unoccupied Operation: during unoccupied hours the unit shall cycle on/off as required whenever a space drift past the unoccupied setpoints. The discharge temperature shall be set to 70°F if the space drifts below 65°F, or to 55°F if the space drifts above 79°F.

F. Cabinet Temperature Control (freeze protection):

1. Overview: cooling coil leaving air temperature is maintained by the preheat valve when the rooftop unit is not in operation and ambient temperatures are cold.
2. When outside air temperature is below 40°F and the supply fan status is off, the preheat valve shall modulate to maintain 50°F (adj.) inside the unit as measured by the averaging sensor located downstream of the cooling coil.
3. RTU Cabinet Temperature PID:

Action: Reverse  
 Input: Cooling Valve LAT  
 Output: Heating Valve\_Freeze Cmd  
 Set Point: 50  
 Bias: 100  
 Max: 100  
 Min: 0  
 Enable: Unit Disabled & OA-T < 40°F

G. Mixed Air Temperature Control (Economizer):

Orchard Farm School District  
 Orchard Farm New Elementary School

AUTOMATION CONTROL SEQUENCES  
 McClure Project #104313.000  
 100% CD Issue

1. Overview: mixed air temperature is maintained when economizer is enabled by modulating the wheel bypass damper and the economizer damper.
2. Economizer enable: economizer shall be enabled if all three conditions are met,
  - a. outside air temperature must be below 65°F
  - b. outside air dew point must be below 55°F
  - c. heating valve command must be 0%
3. If any of the three conditions becomes false, economizer must be disabled. Use +/-1°F and 3% deadbands to prevent cycling.
4. Mixed Air Temperature SP: the setpoint shall be calculated by subtracting fan heat from the discharge air setpoint. Fan heat shall be calculated using the two temperature sensors on each side of the supply fan.
  - a. Fan Heat = SA-T – CCLA-T
  - b. MAT-SP = Clg SAT-SP – Fan Heat
5. Mixed Air Temperature PID:
 

|            |                          |
|------------|--------------------------|
| Action:    | Direct                   |
| Input:     | MA-T                     |
| Output:    | Economizer_MAT Cmd       |
| Set Point: | MAT-SP                   |
| Bias:      | 0                        |
| Max:       | 100                      |
| Min:       | 0                        |
| Enable:    | Unit Enabled & ECON = ON |

H. Building Static Pressure Control:

1. Overview: General Zone Pressure is maintained by RLF-2. See Exhaust and Transfer Fans for control intent.

I. Discharge Air Static Pressure Control:

1. Overview: discharge air pressure is maintained by modulating the supply fan speed. The pressure setpoint is reset to maintain one VAV damper over 85% open as described in the VAV control sequence.
2. Discharge Air Static Pressure Setpoint: each VAV sends up to two pressure increase requests to the rooftop unit when the damper is above 85% open and flow has not reached setpoint. The rooftop unit adds all the requests and uses the sum as an input to a PID.
3. Discharge Air Static Pressure Setpoint Reset PID:
 

|            |                                |
|------------|--------------------------------|
| Action:    | Direct                         |
| Input:     | Sum of Pressure Reset Requests |
| Output:    | DASP-SP                        |
| Set Point: | 1                              |
| Bias:      | 0                              |
| Max:       | 2.0" (adj.)                    |
| Min:       | 0.5" (adj.)                    |
| Enable:    | Unit Enabled                   |
4. Discharge Air Static Pressure PID:
 

|            |                    |
|------------|--------------------|
| Action:    | Reverse            |
| Input:     | DA-SP              |
| Output:    | Fan Speed_DADP Cmd |
| Set Point: | DASP-SP            |
| Bias:      | 20                 |
| Max:       | 100                |
| Min:       | 20                 |
| Enable:    | Unit Enabled       |
5. Maximum static pressure and maximum fan speed shall be determined by the balancer such that the fan supplies design flow with at least one VAV damper fully open and maintaining design VAV flow.

- J. Outside Air Differential Pressure Control (ventilation):
1. Overview: ventilation is achieved by modulating the return damper to maintain constant outside air pressure when the unit is operating in occupied mode.
  2. Outside Air Differential Pressure Setpoint: the pressure setpoint shall be determined by the balancer such that minimum outside air flow is introduced through the minimum outside air damper when the unit is operating at maximum airflow.
    - a. Open the minimum outside air damper and the return damper
    - b. Set all VAVs to max flow and allow the supply fan to stabilize, then override supply fan speed.
    - c. Modulate the return damper until the desired amount of ventilation is introduced. If outside airflow is above design minimum, leave return damper open and adjust the min outside air damper linkage
    - d. Record the outside air pressure at this point, this will be used as the outside air pressure setpoint.
  3. Outside Air Differential Pressure PID:
 

|            |                                 |
|------------|---------------------------------|
| Action:    | Reverse                         |
| Input:     | OA-DP                           |
| Output:    | RA Damper_OADP Cmd              |
| Set Point: | OADP-SP                         |
| Bias:      | 100                             |
| Max:       | 100                             |
| Min:       | 0                               |
| Enable:    | Unit Enabled and Schedule = OCC |
- K. Supply Fan Control:
1. Fan Enable:
    - a. The fan is enabled by the Occupied, Optimum Start, Night Setup, or Night Setback commands
  2. Fan Speed Control:
    - a. The fan array controls to maintain duct static pressure as commanded by the Discharge Air Static Pressure Control sequence.
    - b. When enabled outside of occupied hours, the fan shall remain at minimum speed until confirmation of the heating or cooling plant status is received.
  3. Fan Failure:
    - a. When a fan in the array fails, an alarm is generated and the remainder fans continue to run.
- L. Exhaust Fan Control:
1. The fan runs continuously at a constant speed when the schedule is occupied, when the unit is enabled for custodial or unoccupied operation the fan shall remain off.
  2. Fan Enable:
    - a. The fan shall be enabled by sending it the balanced speed command when the schedule goes occupied. For initial programming set the command to 100% and adjust while balancing.
  3. Fan Speed Control:
    - a. The fan is capable of variable speed; however, it shall be operated at constant speed.
  4. Fan Failure:
    - a. When a fan in the array fails, an alarm is generated and the remainder fans continue to run.
- M. Chilled Water Valve Control:
1. The chilled water valve modulates to maintain discharge air temperature as commanded by the Cooling Valve\_DAT Cmd described above.
  2. The valve shall be locked out (commanded to 0%) if the rooftop unit is off, or if the outside air temperature is below 55°F.

- N. Preheat Water Valve Control:
1. The preheat valve modulates to maintain discharge air temperature when the unit is enabled, and it also modulates to maintain cooling coil leaving air temperature when the unit is disabled during low ambient temperature conditions.
  2. The valve shall take the maximum between the Heating Valve\_DAT Cmd and the Heating Valve\_Freeze Cmd.
  3. The valve shall be locked out (commanded to 0%) if the outside air temperature is greater than 55°F, or if the output of the Mixed Air Temperature PID is greater than zero.
- O. Minimum Outside Air Damper Control:
1. The 2-position damper shall be commanded open when the schedule is occupied.
  2. When the unit is disabled, or when the unit is operating in Optimum Start, Custodial, Night Setup, or Night Setback modes, then the damper shall be closed.
- P. Economizer Damper Control:
1. The economizer damper modulates to maintain mixed air temperature as commanded by the Mixed Air Temperature PID.
  2. The damper shall only be allowed to modulate if the outside air temperature is below 65°F, the outside air dew point is below 55°F, and the heating valve is closed. If these three conditions are not met, then the damper shall remain closed.
- Q. Return Air Damper Control:
1. The damper shall control to maintain Outside Air Differential Pressure as commanded by the Outside Air Differential Pressure PID when the Minimum Outside Air damper is open.
  2. The damper shall only be allowed to modulate if the unit is operating in Occupied mode. When the unit is disabled, or when the unit is operating in Optimum Start, Custodial, Night Setup, or Night Setback, the damper shall be commanded fully open.
  3. The return air damper maximum position shall be limited to 100% minus Economizer damper position.
- R. Exhaust Air Damper Control:
1. The 2-position damper is commanded open 30 seconds before enabling the exhaust fan, and it is commanded closed 30 seconds after disabling the exhaust fan.
- S. Energy Recovery Wheel Bypass Damper Control:
1. The wheel bypass damper is opened and closed based on outside air temperature, and it also modulates to the same signal as the economizer damper when allowed.
  2. The damper shall be closed if the outside air temperature is greater than the return air temperature (use +/-1°F differential).
  3. The damper shall be open if the outside air temperature is lower than the return air temperature and higher than the discharge air temperature setpoint (use +/-1°F differential).
  4. The damper shall modulate together with the economizer signal if the outside air temperature is lower than the discharge air temperature setpoint (use +/-1°F differential).
- T. Energy Recovery Wheel Control:
1. The wheel shall be enabled if the wheel bypass damper is less than 90% open and continue to run until the damper is 100% open.
  2. While the bypass damper is 100% open, the wheel shall be jogged for rotation for 30 seconds every half an hour. The wheel shall be off for 29.5 minutes, and on for 0.5 minutes.
- U. Freeze Protection Pump Control:
1. The pump shall be enabled when the preheat valve is open more than 5% or outside air temperature is below 40°F and remain running until the valve is fully closed and outside air temperature is above 42°F.

- V. Chilled Water Pressure Request:
  - 1. A pressure increase request shall be sent to the cooling plant when the chilled water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- W. Hot Water Pressure Request:
  - 1. A pressure increase request shall be sent to the heating plant when the hot water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- X. Call for Cooling:
  - 1. The unit shall send a call for cooling to the plant if the chilled water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setup is enabled because a space drifted above the unoccupied or custodial setpoint.
- Y. Call for Heating:
  - 1. The unit shall send a call for heating to the plant if the hot water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setback is enabled because a space drifted above the unoccupied or custodial setpoint.
- Z. Alarms:
  - 1. Supply Fan Failure: ECM controller alarm contact
  - 2. Exhaust Fan Failure: ECM controller alarm contact
  - 3. Freeze Pump Failure: alarm if the pump is commanded on and no status is received from the CT.
  - 4. High and Low Discharge Temperature: alarm if the discharge temperature is 5°F above or below setpoint for more than 30 minutes.
  - 5. Discharge High and Low Static: alarm if the discharge static is 0.5" above or below setpoint for more than 30 minutes.
  - 6. Safety Alarms: an alarm shall be generated for each safety independently
    - a. Mixed Air Low Pressure
    - b. Exhaust Air High Pressure
    - c. Discharge Air High Pressure
    - d. Freezestat
    - e. Smoke
- AA. Graphics:
  - 1. All graphics shall include time of day, outside air temperature, outside air humidity, outside air dewpoint, the sum of all corresponding VAV Flow Setpoints, the sum of all VAV Flows, the Max VAV damper position, the Min VAV damper position, incoming heating requests, incoming cooling requests, and incoming pressure requests.



## 25 95 08 SINGLE-ZONE VAV ROOFTOP UNIT WITH ENERGY RECOVERY WHEEL (RTU-1)

### A. Overview:

1. This variable-volume air handling unit operates as a single zone running continuously during occupied hours and cycling at night.
2. The custom unit is setup as a rooftop unit with a built-in outside air conditioning section.
3. The unit is provided with ECM supply fans, pumped hot water preheat, chilled water cooling and hot water reheat coils, minimum outside air, economizer, return, and relief dampers, and filters.
4. The supply fan modulates together with the cooling and reheat coils to maintain zone temperature.
5. The relief damper and fan RLF-1 modulate in sequence to maintain space pressure.
6. Ventilation is maintained through the minimum outside air damper by modulating the return damper to maintain constant pressure.
7. The dedicated economizer damper modulates to maintain mixed air temperature.
8. The cafeteria is provided with occupancy sensors which override the schedule and set the unit to high ventilation.

### B. Safeties:

1. The unit is provided with smoke detectors, low limit thermostat, low and high pressure switches.
2. All safety devices are hardwired such that a trip of any device disables all the fans.
3. The low limit thermostat is also hardwired to all the damper and valve actuators, such that a Freezestat trip would interrupt power to the actuators returning them to their normal position.
4. Manual reset shall be required to resume normal operation for all safeties.

### C. Schedule:

1. Each unit runs in the schedule corresponding to its area of service. See Schedules section above.
2. Optimum Start: the unit shall start and run continuously with the ventilation damper closed prior to the schedule going occupied. The controller shall calculate the required number of minutes the unit needs to be started ahead of schedule such that the space reaches the occupied setpoint by the time the schedule goes occupied.

### D. Zone Temperature Control:

1. Nominal Occupied Setpoint: 72°F
  - a. Occupied Cooling Setpoint: Nominal + 2°F = 74°F
  - b. Occupied Heating Setpoint: Nominal - 2°F = 70°F
  - c. Custodial Cooling Setpoint: Nominal + 4°F = 76°F
  - d. Custodial Heating Setpoint: Nominal - 4°F = 68°F
  - e. Unoccupied Cooling Setpoint: 79°F
  - f. Unoccupied Heating Setpoint: 65°F
2. Occupied Operation:
  - a. During occupied hours the fan is enabled at minimum speed and the supply temperature is reset from minimum to maximum to maintain space setpoint. Once the supply temperature has reached its maximum or minimum value, the fan speed is increased to provide more cooling or heating as needed.
  - b. Heating and cooling modes are enabled using thermostatic functions with 4-degree dead-bands, enable heating when space drops 2°F below the heating setpoint and disable 2°F above setpoint. Similar for cooling, enable when space rises 2°F above the cooling setpoint and disable 2°F below setpoint.

#### c. Zone Heating PID:

|         |         |
|---------|---------|
| Action: | Reverse |
| Input:  | ZN-T    |

Output: ZN Htg Cmd  
Subdivision1: Htg SAT-SP  
Subdivision2: SF Speed\_Htg Cmd  
Set Point: ZN Htg SP  
Max: 100  
Min: 0  
Enable: Heating is enabled

- 1) As the ZN Htg Cmd goes from 0 to 50, Htg SAT-SP resets from 90°F to 65°F
- 2) As the ZN Htg Cmd goes from 50 to 100, SF Speed\_Htg Cmd goes from 40% to 100%

d. Zone Cooling PID:

Action: Direct  
Input: ZN-T  
Output: ZN Clg Cmd  
Subdivision1: Clg SAT-SP  
Subdivision2: SF Speed\_Clg Cmd  
Set Point: ZN Clg SP  
Max: 100  
Min: 0  
Enable: Cooling is enabled

- 1) As the ZN Clg Cmd goes from 0 to 50, Clg SAT-SP resets from 75°F to 55°F
- 2) As the ZN Clg Cmd goes from 50 to 100, SF Speed\_Clg Cmd goes from 40% to 100%

3. Unoccupied and Custodial Operation:

- a. During unoccupied and custodial operation, the supply temperature setpoint is set to a maximum or minimum and the supply fan cycles at 80% speed.
- b. Heating and cooling modes are enabled using thermostatic functions with 4-degree dead-bands, as described under the occupied operation.
- c. Supply temperature setpoint shall set to 55°F for cooling and 90°F for heating.

E. Supply Air Temperature Control:

1. Overview: supply air temperature is maintained using separate cooling and heating PIDs, only one PID can be enabled at a time. The setpoint is reset to maintain zone temperature as described in the Zone Temperature Control sequence above.

2. Supply Air Heating PID:

Action: Reverse  
Input: SA-T  
Output: Heating Valve\_SAT Cmd  
Set Point: Htg SAT-SP  
Max: 100  
Min: 0  
Enable: Heating is ON and Cooling is OFF

3. Supply Air Cooling PID:

Action: Direct  
Input: SA-T  
Output: Cooling Valve\_SAT Cmd  
Set Point: Clg SAT-SP  
Max: 100  
Min: 0  
Enable: Cooling is ON and Heating is OFF

F. Preheat Air Temperature Control:

1. Overview: the preheat coil maintains 50°F leaving air when ambient conditions are below 50°F and the economizer damper is closed.

2. Preheat Air Temperature PID:

Action: Reverse  
Input: PH-T  
Output: Preheat Valve\_PHT Cmd  
Setpoint: 50  
Bias: 0  
Max: 100  
Min: 0  
Enable: OAT < 50°F & Econ Dpr = 0

G. Cabinet Temperature Control (Freeze protection):

1. Overview: mixed air temperature is maintained by the preheat and reheat valves when the rooftop unit is not in operation and ambient temperatures are cold.
2. When outside air temperature is below 40°F and the supply fan status is off, the preheat and reheat valves shall modulate together to maintain 50°F (adj.) inside the unit as measured by the averaging sensor located between the cooling coils.

3. RTU Cabinet Temperature PID:

Action: Reverse  
Input: MA-T  
Output: Heating Valve\_Freeze Cmd  
Set Point: 50  
Bias: 50  
Max: 100  
Min: 0  
Enable: Unit Disabled & OA-T < 40°F

H. Mixed Air Temperature Control (Economizer):

1. Overview: mixed air temperature is maintained when economizer is enabled by modulating the economizer damper.
2. Economizer enable: economizer shall be enabled if the three conditions below are met,
  - a. outside air temperature must be below 65°F
  - b. outside air dew point must be below 55°F
  - c. heating valve command must be 0%
  - d. If any of the three conditions becomes false, economizer must be disabled. Use +/-1°F and 3% deadbands to prevent cycling.
3. Mixed Air Temperature SP: the setpoint shall be calculated by subtracting fan heat from the discharge air setpoint. Fan heat shall be calculated using the two temperature sensors on each side of the supply fan.
  - a. Fan Heat = SA-T – CC-T
  - b. MAT-SP = Clg SAT-SP – Fan Heat

4. Mixed Air Temperature PID:

Action: Direct  
Input: MA-T

|            |                          |
|------------|--------------------------|
| Output:    | Economizer_MAT Cmd       |
| Set Point: | MAT-SP                   |
| Bias:      | 0                        |
| Max:       | 100                      |
| Min:       | 0                        |
| Enable:    | Unit Enabled & ECON = ON |

I. Zone Static Pressure Control:

1. Overview: zone pressure is measured by a sensor with a reference to outside, as zone pressure increases the relief damper opens and the relief fan is enabled at minimum speed. Once the damper is fully open then fan speed increases. The control is enabled when zone pressure rises above 0.05 in.wc. and disabled when zone pressure drops below 0.01 in.wc.

2. Zone Static Pressure PID:

|               |                                      |
|---------------|--------------------------------------|
| Action:       | Direct                               |
| Input:        | ZN-P                                 |
| Output:       | Zone Pressure Cmd                    |
| Subdivision1: | Relief Damper_ZNP Cmd                |
| Subdivision2: | Relief Fan Spd_ZNP Cmd               |
| Setpoint:     | 0.03 in.wc.                          |
| Bias:         | 0                                    |
| Max:          | 100                                  |
| Min:          | 0                                    |
| Enable:       | Schedule = OCC, and ZN-P > 0.05" wc. |

J. Outside Air Differential Pressure Control (Ventilation):

1. Overview: ventilation volume is controlled by modulating the return air damper to maintain constant outside air pressure when the unit is operating in occupied mode.
2. Cafeteria Ventilation Pressure Setpoint: Two pressure setpoints shall be determined, one for low ventilation and one for high ventilation.
  - a. Open the minimum outside air damper and the return damper
  - b. Set the supply fan to maximum speed.
  - c. Modulate the return damper until maximum ventilation is introduced
    - 1) See flow diagrams for design ventilation value.
  - d. Record the outside air pressure at this point, this will be used as the high ventilation pressure setpoint.
  - e. Modulate the return damper until minimum ventilation is introduced
    - 1) See flow diagrams for minimum ventilation, if not shown use 60% of design value.
  - f. Record the outside air pressure at this point, this will be used as the low ventilation pressure setpoint.
3. Cafeteria Ventilation Reset (RTU-1): The Cafeteria is provided with occupancy sensors, when the 80% sensors record activity for more than 10 minutes, the outside air pressure will be set to maintain high ventilation. After 15 minutes of inactivity, the outside air pressure will be set to maintain low ventilation.
4. Outside Air Differential Pressure PID:

|            |                             |
|------------|-----------------------------|
| Action:    | Reverse                     |
| Input:     | OA-DP                       |
| Output:    | RA Damper_OADP Cmd          |
| Set Point: | OADP-SP                     |
| Bias:      | 100                         |
| Max:       | 100                         |
| Min:       | 0                           |
| Enable:    | Unit Enabled and Zone = OCC |

K. Supply Fan Control:

Orchard Farm School District  
Orchard Farm New Elementary School

AUTOMATION CONTROL SEQUENCES  
McClure Project #104313.000  
100% CD Issue

1. Fan Enable:
  - a. The fan is enabled by the Occupied, Optimum Start, Night Setup, or Night Setback commands.
2. Fan Speed Control:
  - a. During occupied hours the fan is enabled at 40% speed and modulates up to 100% as commanded by the Zone Heating PID and the Zone Cooling PID.
  - b. During unoccupied hours the fan is commanded to 40% speed until confirmation of plant operation is received. Once the corresponding heating or cooling plant is running the fan is commanded to 80% speed until the space is satisfied.
- L. Minimum Outside Air Damper Control:
  1. The 2-position damper shall be commanded open when the schedule is occupied.
  2. When the unit is disabled, or when the unit is operating in Optimum Start, Custodial, Night Setup, or Night Setback modes, then the damper shall be closed.
- M. Economizer Damper Control:
  1. The economizer damper modulates to maintain mixed air temperature as commanded by the Mixed Air Temperature PID.
  2. The damper shall only be allowed to modulate if the outside air temperature is below 65°F, the outside air dew point is below 55°F, and the heating valve is closed. If these conditions are not met, then the damper shall remain closed.
- N. Return Air Damper Control:
  1. The damper shall control to maintain Outside Air Differential Pressure as commanded by the Outside Air Differential Pressure PID when the Minimum Outside Air damper is open.
  2. The damper shall only be allowed to modulate if the unit is operating in Occupied mode. When the unit is disabled, or when the unit is operating in Optimum Start, Custodial, Night Setup, or Night Setback, the damper shall be commanded fully open.
  3. The return air damper maximum position shall be limited to 100% minus Economizer damper position.
- O. Chilled Water Valve Control:
  1. The valve modulates to maintain discharge air temperature for zone temperature control.
  2. The valve shall be locked out (commanded to 0%) if the rooftop unit is off, or if the outside air temperature is below 55°F.
- P. Preheat Valve Control:
  1. The valve modulates to maintain preheat temperature when the unit is on and ambient temperature is below 50°F.
  2. When the unit is off and outside air temperature is below 40°F the valve modulates to maintain cabinet temperature as measured by the cooling coil discharge temperature sensor.
  3. When the unit is off or outside air temperature is above 55°F the valve shall be commanded closed.
- Q. Reheat Valve Control:
  1. The valve modulates to maintain discharge air temperature for zone temperature control when heating is enabled.
  2. When the unit is disabled and outside air temperature is below 40°F, the valve is commanded together with the preheat valve to maintain cabinet temperature.
- R. Freeze Protection Pump Control:
  1. Pump Enable: The pump shall be enabled when the preheat valve is open more than 5% or outside air temperature is below 40°F and remain running until the valve is fully closed and outside air temperature is above 42°F.

- S. Chilled Water Pressure Request:
  - 1. A pressure increase request shall be sent to the cooling plant when the chilled water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- T. Hot Water Pressure Request:
  - 1. A pressure increase request shall be sent to the heating plant when the hot water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- U. Call for Cooling:
  - 1. The unit shall send a call for cooling to the plant if the chilled water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setup is enabled because the space drifted above the unoccupied or custodial setpoint.
- V. Call for Heating:
  - 1. The unit shall send a call for heating to the plant if the hot water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setback is enabled because the space drifted above the unoccupied or custodial setpoint.
- W. Alarms:
  - 1. Supply Fan Failure: ECM controller alarm contact.
  - 2. Freeze Pump Failure: alarm if the pump is commanded on and no status is received from the CT.
  - 3. High and Low Zone Temperature: alarm if the zone temperature is 5°F above or below setpoint for more than 30 minutes.
  - 4. High Zone Humidity: alarm if zone humidity is above 65%RH during occupied hours
  - 5. Negative Building Pressure: Alarm if building pressure is negative for more than 60 minutes.
  - 6. Safety Alarms: an alarm shall be generated for each safety independently
    - a. Mixed Air Low Pressure
    - b. Relief High Pressure
    - c. Freezestat
    - d. Smoke
- X. Graphics:
  - 1. Graphics shall include time of day, outside air temperature, outside air humidity, outside air dewpoint, and room name and number

## 25 95 09 GYM / STORM SHELTER (RTU-4)

### A. Overview:

1. The single-zone variable air volume air handling unit provides conditioned air to the Gymnasium.
2. The custom unit is setup in a relief fan configuration (separate RLF Fan), with an energy recovery ventilation section. There is a return path into the return plenum for recirculation, and a separate path for exhaust.
3. The unit is provided with ECM supply and exhaust fans, pumped hot water preheat coil, chilled water coil, reheat coil, energy recovery wheel, minimum outside air, economizer, return, and exhaust dampers, and filters. Relief fan and relief damper are provided separately and located in the shelter mezzanine.
4. Minimum ventilation is maintained during occupied hours. During custodial and unoccupied hours, the unit operates in full recirculation. Ventilation volume is maintained constant by opening the minimum outside air damper and modulating the return damper to maintain constant pressure.
5. Zone temperature is maintained by resetting the discharge air temperature setpoint and modulating supply fan speed.
6. When enabled, the economizer damper modulates to maintain mixed air temperature.
7. Zone pressure is maintained by modulating the relief damper CD-X.X and relief fan RLF-3 speed.
8. Supply fan SF-1 and Relief fan RLF-3 serve the ventilation needs of the storm shelter during a storm event. These units and their respective control components (controllers, isolation dampers, control dampers, etc) will be on emergency power.
9. During a storm event, the operator places the system in Storm Shelter Mode using a digital timer switch. RTU-4 will be disabled and the storm system (SF-1, RLF-3, and associated components) will be enabled.

### B. Safeties:

1. The unit is provided with smoke detectors, low limit thermostat, and a low pressure switch.
2. The fans are provided with high and low duct pressure switches.
3. All safety devices are hardwired such that a trip of any device would interrupt the power to the respective system fans.
4. The low limit thermostat is also hardwired to all the damper and valve actuators, such that a Freezestat trip would interrupt power to the actuators returning them to their normal position.
5. Manual reset shall be required to resume normal operation for all safeties.

### B. Schedule:

1. The unit runs in the Gym Schedule
2. A local occupancy sensor is used to override the schedule and set the unit to occupied when the schedule is unoccupied. After 15 minutes of inactivity, if the schedule is unoccupied, the unit is allowed to go into unoccupied mode.
3. Optimum Start: the unit shall start and run continuously with the ventilation damper closed prior to the schedule going occupied. The controller shall calculate the required number of minutes the unit needs to be started ahead of schedule such that the space reaches the occupied setpoint by the time the schedule goes occupied.

### C. Zone Temperature Control:

1. Nominal Occupied Setpoint: 72°F
  - a. Occupied Cooling Setpoint: Nominal + 2°F = 74°F
  - b. Occupied Heating Setpoint: Nominal - 2°F = 70°F
  - c. Custodial Cooling Setpoint: Nominal + 4°F = 76°F
  - d. Custodial Heating Setpoint: Nominal - 4°F = 68°F

- e. Unoccupied Cooling Setpoint: 79°F
  - f. Unoccupied Heating Setpoint: 65°F
  - 2. Occupied Operation:
    - a. During occupied the fan is enabled at minimum speed and the supply temperature is reset from minimum to maximum to maintain space setpoint. Once the supply temperature has reached its maximum or minimum value, the fan speed is increased to provide more cooling or heating as needed.
    - b. Heating and cooling modes are enabled using thermostatic functions with 4-degree dead-bands, enable heating when space drops 2°F below the heating setpoint and disable 2°F above setpoint. Similar for cooling, enable when space rises 2°F above the cooling setpoint and disable 2°F below setpoint.
    - c. Zone Heating PID:
 

|               |                    |
|---------------|--------------------|
| Action:       | Reverse            |
| Input:        | ZN-T               |
| Output:       | ZN Htg Cmd         |
| Subdivision1: | Htg SAT-SP         |
| Subdivision2: | SF Speed_Htg Cmd   |
| Set Point:    | ZN Htg SP          |
| Max:          | 100                |
| Min:          | 0                  |
| Enable:       | Heating is enabled |

      - 1) As the ZN Htg Cmd goes from 0 to 50, Htg SAT-SP resets from 90°F to 65°F
      - 2) As the ZN Htg Cmd goes from 50 to 100, SF Speed\_Htg Cmd goes from 40% to 100%
    - d. Zone Cooling PID:
 

|               |                    |
|---------------|--------------------|
| Action:       | Direct             |
| Input:        | ZN-T               |
| Output:       | ZN Clg Cmd         |
| Subdivision1: | Clg SAT-SP         |
| Subdivision2: | SF Speed_Clg Cmd   |
| Set Point:    | ZN Clg SP          |
| Max:          | 100                |
| Min:          | 0                  |
| Enable:       | Cooling is enabled |

      - 1) As the ZN Clg Cmd goes from 0 to 50, Clg SAT-SP resets from 75°F to 55°F
      - 2) As the ZN Clg Cmd goes from 50 to 100, SF Speed\_Clg Cmd goes from 40% to 100%
  - 3. Unoccupied and Custodial Operation:
    - a. During unoccupied and custodial operation, the supply temperature setpoint is set to a maximum or minimum and the supply fan cycles at 80% speed.
    - b. Heating and cooling modes are enabled using thermostatic functions with 4-degree dead-bands, as described under the occupied operation.
    - c. Supply temperature setpoint shall set to 55°F for cooling and 90°F for heating.
- D. Zone Humidity Control:
- 1. Overview: zone humidity is controlled by setting the cooling coil discharge temperature to 55°F when outside air humidity is high. The humidity sensor in the space is used to generate an alarm.
  - 2. When outside air dewpoint is above 55°F and the unit is running occupied, the cooling coil discharges 55°F to prevent high humidity in the space.



3. Zone Humidity PID:

Action: Direct  
Input: CC-T  
Output: Cooling Valve\_Hum Cmd  
Setpoint: 55  
Bias: 0  
Max: 100  
Min: 0  
Enable: OADwPt > 55°F & OCC

E. Supply Air Temperature Control:

1. Overview: supply air temperature is maintained using two separate PIDs for cooling and heating, only one PID can be enabled at a time. The setpoint is reset to maintain zone temperature as described in the Zone Temperature Control sequence above.

2. Supply Air Heating PID:

Action: Reverse  
Input: SA-T  
Output: Heating Valve\_SAT Cmd  
Set Point: Htg SAT-SP  
Max: 100  
Min: 0  
Enable: Heating is ON and Cooling is OFF

3. Supply Air Cooling PID:

Action: Direct  
Input: SA-T  
Output: Cooling Valve\_SAT Cmd  
Set Point: Clg SAT-SP  
Max: 100  
Min: 0  
Enable: Cooling is ON and Heating is OFF

F. Preheat Air Temperature Control:

1. Overview: the preheat coil maintains 55°F leaving air when ambient conditions are below 50°F and the economizer damper is closed.

2. Preheat Air Temperature PID:

Action: Reverse  
Input: PH-T  
Output: Preheat Valve\_PHT Cmd  
Setpoint: 55  
Bias: 0  
Max: 100  
Min: 0  
Enable: OAT < 50°F & Econ Dpr = 0

G. Mixed Air Temperature Control (Economizer):

1. Overview: mixed air temperature is maintained when economizer is enabled by modulating the economizer damper.
2. Economizer enable: economizer shall be enabled if the three conditions below are met,
  - a. outside air temperature must be below 65°F
  - b. outside air dew point must be below 55°F
  - c. heating valve command must be 0%
- d. If any of the three conditions becomes false, economizer must be disabled. Use deadbands to prevent cycling.

3. Mixed Air Temperature SP: the setpoint shall be calculated by subtracting fan heat from the discharge air setpoint. Fan heat shall be calculated using the two temperature sensors on each side of the supply fan.

- a. Fan Heat = SA-T – CCLA-T
- b. MAT-SP = Clg SAT-SP – Fan Heat

4. Mixed Air Temperature PID:

|            |                          |
|------------|--------------------------|
| Action:    | Direct                   |
| Input:     | MA-T                     |
| Output:    | Economizer_MAT Cmd       |
| Set Point: | MAT-SP                   |
| Bias:      | 0                        |
| Max:       | 100                      |
| Min:       | 0                        |
| Enable:    | Unit Enabled & ECON = ON |

#### H. Outside Air Differential Pressure Control (Ventilation):

1. Overview: outside air pressure is maintained at either the event ventilation airflow or the standard ventilation airflow by modulating the outside air damper and return air damper when the unit is operating in occupied mode.
2. Outside Air Differential Pressure Setpoint: Two differential pressure setpoints shall be determined by the balancer. The pressure setpoint shall be determined by the balancer such that minimum outside air flow is introduced through the minimum outside air damper when the unit is operating at maximum airflow for both normal mode and event mode.
  - a. Open the minimum outside air damper and the return damper
  - b. Set the supply fan to max flow.
  - c. Modulate the return damper until the desired amount of ventilation is introduced. If outside airflow is above design minimum, leave return damper open and adjust the min outside air damper linkage
  - d. Record the outside air pressure at this point, this will be used as the outside air pressure setpoint.

3. Outside Air Differential Pressure PID:

|            |                             |
|------------|-----------------------------|
| Action:    | Reverse                     |
| Input:     | OA-DP                       |
| Output:    | RA Damper_OADP Cmd          |
| Set Point: | OADP-SP                     |
| Bias:      | 100                         |
| Max:       | 100                         |
| Min:       | 0                           |
| Enable:    | Unit Enabled and Zone = OCC |

#### I. Zone Static Pressure Control:

1. Overview: zone pressure is measured by a sensor with a reference to outside, as zone pressure increases the relief damper modulates open and fan speed increases. The control is enabled when zone pressure rises above 0.05 in.wc. and disabled when zone pressure drops below 0.01 in.wc.

2. Zone Static Pressure PID:

|               |                   |
|---------------|-------------------|
| Action:       | Direct            |
| Input:        | ZN-P              |
| Output:       | ZN Pressure Cmd   |
| Subdivision1: | RLA Dpr_ZNP Cmd   |
| Subdivision2: | RLF Speed_ZNP Cmd |
| Setpoint:     | 0.03 in.wc.       |
| Bias:         | 0                 |
| Max:          | 100               |
| Min:          | 0                 |

Enable: Schedule = OCC and ZN-P > 0.05" wc.

3. As ZN Pressure Cmd goes from 0 to 30, RLA Dpr\_ZNP Cmd goes from 10% to 100%.
4. As ZN Pressure Cmd goes from 30 to 100, RFL Speed\_ZNP Cmd goes from 30% to 100%.

J. Supply Fan Control:

1. Fan Enable:
  - a. The fan is enabled by the Occupied, Optimum Start, Night Setup, or Night Setback commands; or if Storm Shelter Mode is active.
2. Fan Speed Control:
  - a. During occupied hours the fan is enabled at 40% speed and modulates up to 100% as commanded by the Zone Heating PID and the Zone Cooling PID.
  - b. During unoccupied hours the fan is commanded to 40% speed until confirmation of plant operation is received. Once the corresponding heating or cooling plant is running the fan is commanded to 80% speed until the space is satisfied.
  - c. If Storm Event Mode is active, the unit is disabled.

K. Relief Fan RLF-3 Control:

1. Fan Enable:
  - a. The fan shall be enabled when the Zone Static Pressure PID output rises above 5. When the PID is 0, the fan is disabled.
  - b. The fan shall only be enabled during Occupied or Storm mode. If the schedule is unoccupied and storm mode is off, the fan is off.
  - c. If Storm Shelter Mode is active, the fan is enabled regardless of building pressure.
2. Fan Speed Control:
  - a. As the Zone Static Pressure PID goes from 30 to 100, the fan speed goes from 30 to 100.
  - b. If Storm mode is on, fan speed is 100.
  - c. Fan speed must be rate limited to allow for the relief damper to fully open before the fan reaches 100% speed.

L. Relief Air Damper Control:

1. The relief air damper modulates to maintain zone pressure. When the Zone Static Pressure PID output rises over 5, damper control is enabled. As the output goes from 0 to 30, the damper modulates from 10 to 100. When the loop output reaches 0, the damper is closed.
2. If storm mode is enabled, the damper opens to 100%

M. Exhaust Fan Control:

1. Fan Enable:
  - a. The fan runs continuously at a constant speed when the schedule is occupied. When the unit is enabled for custodial or unoccupied operation the fan shall remain off.
  - b. The fan shall be enabled by sending it the balanced speed command when the schedule goes occupied. For initial programming set the command to 100% and adjust while balancing.
2. Fan Speed Control:
  - a. The fan is capable of variable speed; however, it shall be operated at constant speed.

N. Minimum Outside Air Damper Control:

1. The 2-position damper shall be commanded open when the schedule is occupied.
2. When the unit is disabled, or when the unit is operating in Optimum Start, Custodial, Night Setup, or Night Setback modes, then the damper shall be closed.

- O. Economizer Damper Control:
1. The economizer damper modulates to maintain mixed air temperature as commanded by the Mixed Air Temperature PID.
  2. The damper shall only be allowed to modulate if the outside air temperature is below 65°F, the outside air dew point is below 55°F, and the heating valve is closed. If these conditions are not met, then the damper shall remain closed.
- P. Return Air Damper Control:
1. The damper shall control to maintain Outside Air Differential Pressure as commanded by the Outside Air Differential Pressure PID when the Minimum Outside Air damper is open.
  2. The damper shall only be allowed to modulate if the unit is operating in Occupied mode. When the unit is disabled, or when the unit is operating in Optimum Start, Custodial, Night Setup, or Night Setback, the damper shall be commanded fully open.
- Q. Exhaust Air Damper Control:
1. The 2-position damper is commanded open 30 seconds before enabling the exhaust fan, and it is commanded closed 30 seconds after disabling the exhaust fan.
- R. Energy Recovery Wheel Bypass Damper Control:
1. The wheel bypass damper is opened and closed based on outside air temperature, and it also modulates to the same signal as the economizer damper when allowed.
  2. The damper shall be closed if the outside air temperature is greater than the return air temperature (use +/-1°F differential).
  3. The damper shall be open if the outside air temperature is lower than the return air temperature and higher than the discharge air temperature setpoint (use +/-1°F differential).
  4. The damper shall modulate together with the economizer signal if the outside air temperature is lower than the discharge air temperature setpoint (use +/-1°F differential).
- S. Energy Recovery Wheel Control:
1. The wheel shall be enabled if the wheel bypass damper is less than 90% open and continue to run until the damper is 100% open.
  2. While the bypass damper is 100% open, the wheel shall be jogged for rotation for 30 seconds every half an hour. The wheel shall be off for 29.5 minutes, and on for 0.5 minutes.
- T. Chilled Water Valve Control:
1. The valve modulates to maintain discharge air temperature for zone temperature control, or cooling coil leaving air temperature for zone humidity control, whichever sequence requires the valve further open.
  2. The valve shall be locked out (commanded to 0%) if the rooftop unit is off, or if the outside air temperature is below 55°F.
- U. Preheat Valve Control:
1. The valve modulates to maintain preheat temperature when the unit is on and ambient temperature is below 50°F.
  2. When the unit is off or outside air temperature is above 55°F the valve shall be commanded closed.
- V. Reheat Valve Control:
1. The valve modulates to maintain discharge air temperature for zone temperature control when heating is enabled.
  2. When the unit is disabled and outside air temperature is below 40°F, the valve is commanded together with the preheat valve to maintain cabinet temperature.
- W. Freeze Protection Pump Control:

1. Pump Enable: The pump shall be enabled when the preheat valve is open more than 5% or outside air temperature is below 40°F and remain running until the valve is fully closed and outside air temperature is above 42°F.
- X. Chilled Water Pressure Request:
1. A pressure increase request shall be sent to the cooling plant when the chilled water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- Y. Hot Water Pressure Request:
1. A pressure increase request shall be sent to the heating plant when the hot water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- Z. Call for Cooling:
1. The unit shall send a call for cooling to the plant if the chilled water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setup is enabled because the space drifted above the unoccupied or custodial setpoint.
- AA. Call for Heating:
1. The unit shall send a call for heating to the plant if the hot water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setback is enabled because the space drifted above the unoccupied or custodial setpoint.
- BB. Alarms:
1. Supply Fan Failure: ECM controller alarm contact.
  2. Relief Fan Failure: ECM controller alarm contact.
  3. Exhaust Fan Failure: alarm if the fan is commanded on and no status is received from the CT.
  4. Freeze Pump Failure: alarm if the pump is commanded on and no status is received from the CT.
  5. High and Low Zone Temperature: alarm if the zone temperature is 5°F above or below setpoint for more than 30 minutes.
  6. High Zone Humidity: alarm if zone humidity is above 65%RH during occupied hours
  7. Negative Building Pressure: Alarm if building pressure is negative for more than 60 minutes.
  8. Safety Alarms: an alarm shall be generated for each safety independently
    - a. Mixed Air Low Pressure
    - b. Freezestat
    - c. Smoke
- CC. Graphics:
1. Graphics shall include time of day, outside air temperature, outside air humidity, outside air dewpoint, and room name and number

## 25 95 10 MECHANICAL ROOM (RTU-3)

- A. Overview:
1. This single-zone variable air volume rooftop unit supplies conditioned air to the utility plant mechanical room.
  2. The air handling unit is equipped with a variable speed supply fan, a pre-heat coil, a cooling coil, and filters.
  3. When the mechanical room lights are on, the unit runs continuously and modulates to maintain occupied setpoints. When the lights are off the unit cycles to maintain unoccupied setpoints.
  4. If the refrigerant alarm is active, the unit provides 100% outside air.
- B. Safeties: Duct mounted smoke detectors and unit mounted low limit thermostats will be furnished and installed as described in the Miscellaneous System Control Requirements of this specification. Manual reset shall be required to resume normal operation for all safeties.
- C. Schedule: There is no schedule for this unit, light status is monitored using a current transducer, when the lights are on the unit maintains occupied setpoints. When the lights are off the unit cycles to maintain unoccupied setpoints.
- D. Zone Temperature Control:
1. Nominal Occupied Setpoint: 72°F
    - a. Occupied Cooling Setpoint: Nominal + 4°F = 76°F
    - b. Occupied Heating Setpoint: Nominal - 4°F = 68°F
    - c. Unoccupied Cooling Setpoint: 79°F
    - d. Unoccupied Heating Setpoint: 65°F
  2. Occupied Operation:
    - a. During occupied the fan is enabled at minimum speed and the supply temperature is reset from minimum to maximum to maintain space setpoint. Once the supply temperature has reached its maximum or minimum value, the fan speed is increased to provide more cooling or heating as needed.
    - b. Heating and cooling modes are enabled using thermostatic functions with 4-degree dead-bands, enable heating when space drops 2°F below the heating setpoint and disable 2°F above setpoint. Similar for cooling, enable when space rises 2°F above the cooling setpoint and disable 2°F below setpoint.
    - c. Zone Heating PID:

|               |                    |
|---------------|--------------------|
| Action:       | Reverse            |
| Input:        | ZN-T               |
| Output:       | ZN Htg Cmd         |
| Subdivision1: | Htg SAT-SP         |
| Subdivision2: | SF Speed_Htg Cmd   |
| Set Point:    | ZN Htg SP          |
| Max:          | 100                |
| Min:          | 0                  |
| Enable:       | Heating is enabled |

      - 1) As the ZN Htg Cmd goes from 0 to 50, Htg SAT-SP resets from 90°F to 65°F
      - 2) As the ZN Htg Cmd goes from 50 to 100, SF Speed\_Htg Cmd goes from 40% to 100%

d. Zone Cooling PID:

Action: Direct  
Input: ZN-T  
Output: ZN Clg Cmd  
Subdivision1: SAT-SP  
Subdivision2: SF Speed\_Clg Cmd  
Set Point: ZN Clg SP  
Max: 100  
Min: 0  
Enable: Cooling is enabled

- 1) As the ZN Clg Cmd goes from 0 to 50, Clg SAT-SP resets from 75°F to 55°F
- 2) As the ZN Clg Cmd goes from 50 to 100, SF Speed\_Clg Cmd goes from 40% to 100%

3. Unoccupied Operation:

- a. During unoccupied and custodial operation, the supply temperature setpoint is set to a maximum or minimum and the supply fan cycles at 80% speed.
- b. Heating and cooling modes are enabled using thermostatic functions with 4-degree dead-bands, as described under the occupied operation.
- c. Supply temperature setpoint shall set to 55°F for cooling and 90°F for heating.

E. Supply Air Temperature Control:

1. Overview: supply air temperature is maintained using two separate PIDs for cooling and heating, only one PID can be enabled at a time. The setpoint is reset to maintain zone temperature as described in the Zone Temperature Control sequence above.

2. Supply Air Heating PID:

Action: Reverse  
Input: SA-T  
Output: Heating Valve\_SAT Cmd  
Set Point: Htg SAT-SP  
Max: 100  
Min: 0  
Enable: Heating is ON and Cooling is OFF

3. Supply Air Cooling PID:

Action: Direct  
Input: SA-T  
Output: Cooling Valve\_SAT Cmd  
Set Point: Clg SAT-SP  
Max: 100  
Min: 0  
Enable: Cooling is ON and Heating is OFF

F. Mixed Air Temperature Control (Economizer):

1. Overview: mixed air temperature is maintained when economizer is enabled by modulating the economizer damper.
2. Economizer enable: economizer shall be enabled if the three conditions below are met,
  - a. outside air temperature must be below 65°F
  - b. outside air dew point must be below 55°F
  - c. heating valve command must be 0%
  - d. If any of the three conditions becomes false, economizer must be disabled. Use deadbands to prevent cycling.
3. Mixed Air Temperature SP: the setpoint shall be calculated by subtracting fan heat from the discharge air setpoint. Fan heat shall be calculated using the two temperature sensors on each side of the supply fan.
  - a. Fan Heat = SA-T – CCLA-T

- b.  $\text{MAT-SP} = \text{Clg SAT-SP} - \text{Fan Heat}$
4. Mixed Air Temperature PID:
- |            |                          |
|------------|--------------------------|
| Action:    | Direct                   |
| Input:     | MA-T                     |
| Output:    | Economizer_MAT Cmd       |
| Set Point: | MAT-SP                   |
| Bias:      | 0                        |
| Max:       | 100                      |
| Min:       | 0                        |
| Enable:    | Unit Enabled & ECON = ON |
- G. RTU Cabinet Temperature Control (freeze protection):
- Overview: cooling coil leaving air temperature is maintained by the preheat valve when the rooftop unit is not in operation and ambient temperatures are cold.
  - When outdoor air temperature is below 40°F and the supply fan status is off, the preheat valve shall modulate to maintain 50°F inside the unit as measured by the averaging sensor located downstream of the cooling coil.
3. RTU Cabinet Temperature PID:
- |            |                             |
|------------|-----------------------------|
| Action:    | Reverse                     |
| Input:     | Cooling Coil LAT            |
| Output:    | Heating Coil_Freeze Cmd     |
| Set Point: | 50                          |
| Bias:      | 100                         |
| Max:       | 100                         |
| Min:       | 0                           |
| Enable:    | Unit Disabled & OA-T < 40°F |
- H. Outside Air Ventilation Control:
- Overview: Under normal operation, this unit is recirculation only. In the event of refrigerant detection, the outside air damper shall open to a fixed position to achieve the ventilation air as required on the flow diagram and the supply fan shall be commanded to its maximum speed.
- I. Supply Fan Control:
- The fan is fitted with an ECM motorized impeller. The fan is enabled when a speed voltage signal is sent to the fan. A 0V signal must be sent to disable the fan.
  - Fan Enable: The fan shall be enabled when occupancy is enabled or when heating or cooling modes are enabled during unoccupied hours, or when the refrigerant alarm is triggered.
  - Fan Speed Control: when occupancy is enabled, fan speed modulates to maintain zone temperature by taking the maximum between the SF Speed\_Htg Cmd and SF Speed\_Clg Cmd. When occupancy is disabled, the fan is commanded to 80% speed if heating or cooling modes are enabled. If both modes are disabled and occupancy is off, the fan shall be disabled (0% command). If the refrigerant alarm is triggered the fan is commanded to its maximum speed
- J. Chilled Water Valve Control:
- The cooling valve operates to maintain discharge air temperature as commanded by the Discharge Air Temperature PID when the cooling plant is enabled, and the rooftop unit is on. If the cooling plant is disabled or if the rooftop unit is off, then the valve shall be closed.
- K. Preheat Water Valve Control:
- The preheat valve modulates to maintain discharge air temperature when the unit is enabled, and it also modulates to maintain cooling coil leaving air temperature when the unit is disabled during low ambient temperature conditions.



2. The valve shall take the maximum between the Heating Coil\_DAT Cmd and the Heating Coil\_Freeze Cmd.
  3. The valve shall be locked out (commanded to 0%) if the outdoor air temperature is greater than 55°F, or if the output of the Mixed Air Temperature PID is greater than zero.
  4. If there is a refrigerant alarm and the outdoor air temperature is below 40°F, then the valve shall be commanded to 100% open.
- L. Minimum Outside Air Damper Control:
1. The 2-position damper shall be commanded open when the space is occupied.
  2. When the unit is disabled, or when the space is unoccupied the damper shall be closed.
- M. Economizer Damper Control:
1. The economizer damper modulates to maintain mixed air temperature as commanded by the Mixed Air Temperature PID.
  2. The damper shall only be allowed to modulate if the outside air temperature is below 65°F, the outside air dew point is below 55°F, and the heating valve is closed. If these conditions are not met, then the damper shall remain closed.
- N. Return Air Damper Control:
1. The damper shall be equal and opposite to the economizer damper.
- O. Freeze Protection Pump Control:
1. Pump Enable: The pump shall be enabled when the preheat valve is open more than 5% or the outside air temperature is lower than 40°F and remain running until the valve is fully closed and the outside air temperature is above 45°F.
- P. Chilled Water Pressure Request:
1. A pressure increase request shall be sent to the cooling plant when the chilled water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- Q. Hot Water Pressure Request:
1. A pressure increase request shall be sent to the heating plant when the hot water valve is open more than 95%. When the valve closes below 85% the request shall be disabled.
- R. Call for Cooling:
1. The unit shall send a call for cooling to the plant if the chilled water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setup is enabled because the space drifted above the unoccupied or custodial setpoint.
- S. Call for Heating:
1. The unit shall send a call for heating to the plant if the hot water valve is open more than 10% for 15 minutes, or if the schedule is unoccupied and Night Setback is enabled because the space drifted above the unoccupied or custodial setpoint.
- T. Alarms:
1. Supply Fan Failure: ECM controller alarm contact.
  2. Freeze Pump Failure: alarm if the pump is commanded on and no status is received from the CT.
  3. High and Low Discharge Temperature: alarm if the discharge temperature is 5°F above or below setpoint for more than 30 minutes.
  4. Safety Alarms: an alarm shall be generated for each safety independently
    - a. Freezestat alarm
    - b. Smoke alarm
- U. Graphics:

1. Graphics shall include time of day, outside air temperature, outside air humidity, outside air dewpoint, and room name and number

## 25 95 11 KITCHEN (RTU-2)

### A. Overview:

1. The multiple-zone packaged variable air volume unit provides conditioned air to hot water terminal reheat boxes.
2. The unit is provided with packaged controls, dx cooling, hot water heating coil with freeze protection pump, modulating supply fan, economizer and barometric relief damper.
3. Discharge pressure is reset based on zone demand.
4. The packaged controller receives enable, temperature setpoint, and pressure setpoint signals from the BAS.
5. The BAS monitors unit status and alarms via network connection.

### B. Safeties:

1. The unit is provided with factory safeties for its dx cooling system.
2. Smoke detectors are field installed and hardwired to disable the unit upon a trip.
3. A field provided and installed bendable element supply air duct temperature sensor shall be configured as a remotely resettable Freezestat that shuts down the unit upon a measured air temperature below 40F.
4. Manual reset shall be required to resume normal operation for all safeties.

### C. Schedules:

1. The unit operates on the Kitchen schedule.

### D. Discharge Temperature:

1. The BAS sends a constant setpoint of 55°F to the rooftop. The setpoint is adjustable by the operator.

### E. Discharge Pressure:

1. The BAS calculates a pressure setpoint based on VAV damper position. Each VAV sends up to two pressure increase requests to the BAS when the damper is above 85% open and flow has not reached setpoint. The BAS unit sums all the requests and uses the sum as an input to a PID.

#### 2. Discharge Air Static Pressure Setpoint Reset PID:

|            |                         |
|------------|-------------------------|
| Action:    | Direct                  |
| Input:     | Pressure Reset Requests |
| Output:    | DASP-SP                 |
| Set Point: | 1                       |
| Bias:      | 0.5" (adj.)             |
| Max:       | 2.0" (adj.)             |
| Min:       | 0.5"                    |
| Enable:    | Unit Enabled            |

- F. Economizer shall be enabled when Outside Air Temperature is below 65°F and dewpoint is below 55F.

### G. Alarms:

1. All alarms from the packaged controllers shall be mapped to the BAS.

## 25 95 12 VARIABLE AIR VOLUME TERMINAL UNIT WITH HW REHEAT (TYPICAL)

### A. Overview:

1. This sequence is typical for all units unless specified elsewhere herein.
2. The terminal unit is provided with a damper, flow measuring station, modulating heating coil, a discharge temperature sensor, and a room temperature sensor.
3. The unit has separate cooling and heating setpoints. When the zone temperature rises above the cooling setpoint the flow will go from minimum to maximum cooling flow. Once the zone temperature drops below the cooling setpoint the flow will remain at minimum until the zone drops below the heating setpoint. Once the zone drops below the heating setpoint the supply temperature will reset from 55°F to 90°F, and upon a further need for heating the flow will rise to maximum heating flow.

### B. Zone Occupancy:

1. Occupancy is determined based on the schedule and the zone occupancy sensors (Auxiliary connections on lighting occupancy sensors) when sensors are present. See lighting plans for locations. If the schedule is occupied and the sensors do not detect motion for 15 minutes, the zone maintains standby temperature and airflow setpoints until motion is detected or the schedule changes. If the custodial schedule is enabled, the unit maintains custodial setpoints. If all schedules are unoccupied, the unit maintains unoccupied setpoints.
2. Verify occupied and custodial schedule hours with the owner.

### C. Zone Temperature Setpoint:

1. Pressure independent VAV boxes shall maintain the following space air temperature setpoints:
  - a. Nominal Occupied Setpoint: 72°F
  - b. Occupied Cooling Setpoint: Nominal + 2°F = 74°F
  - c. Occupied Heating Setpoint: Nominal – 2°F = 70°F
  - d. Standby Cooling Setpoint: Nominal + 3°F = 75°F
  - e. Standby Heating Setpoint: Nominal – 3°F = 69°F
  - f. Custodial Cooling Setpoint: Nominal + 4°F = 76°F
  - g. Custodial Heating Setpoint: Nominal – 4°F = 68°F
  - h. Unoccupied Cooling Setpoint: 79°F
  - i. Unoccupied Heating Setpoint: 65°F
2. Setpoints shall be made globally adjustable at the graphics user interface.

### D. Zone Flow Setpoint Reset (Demand Control Ventilation)

1. When the schedule is unoccupied or the schedule is occupied but the occupancy sensors have not detected motion for 15 minutes, the minimum VAV flow setpoint shall be allowed to be reset to 20% of its maximum scheduled value. Upon detection of motion, the minimum flow setpoint shall return to its scheduled value.

### E. Zone Setpoint Adjustment:

1. Adjustments made at the space sensor shall modify the Nominal Occupied Setpoint, while the Cooling and Heating setpoints shall remain a fixed 4°F range from the Nominal Setpoint. The setpoint adjustment shall be limited to 2°F above and 2°F below Nominal Setpoint. If the Nominal Setpoint is considered at 72°F, the occupant can adjust the Nominal Setpoint from 70°F to 74°F.
2. Example: If the occupant adjusts the thermostat to 74°F, the heating and cooling setpoints are now 72°F and 76°F. If the occupant adjusts the thermostats to 70°F, the heating and cooling setpoints are now 68°F and 72°F.

### F. Zone Temperature Control:

1. Zone Temperature is controlled by modulating airflow through the box and resetting the supply temperature setpoint. Minimum Flow will be reset based on occupancy status

2. Zone Cooling PID:

Action: Direct  
Input: Zone Temperature  
Output: VAV Flow SP\_Clg Command  
Set Point: Zone Cooling Setpoint (74)  
Max: Max Cooling Flow  
Min: Min Flow  
Enable: AHU is Enabled

3. Zone Heating PID:

Action: Reverse  
Input: Zone Temperature  
Output: Zone Heating Command  
Subdivision1: Supply Temperature SP\_Htg Command  
Subdivision2: VAV Flow SP\_Htg Command  
Set Point: Zone Heating Setpoint (70)  
Max: 100  
Min: 0  
Enable: AHU is Enabled

4. Zone Heating Command Output Table:

| Zone Heating Command | Supply Temp SP | Heating Flow SP |
|----------------------|----------------|-----------------|
| 0                    | 55             | Min Flow        |
| 50                   | 90             | Min Flow        |
| 100                  | 90             | Max HTG         |

G. VAV Supply Temperature Control:

1. The heating valve modulates to maintain supply temperature as determined by the Zone Heating PID. As the PID goes from 0 to 50, the Supply Temperature Setpoint goes from 55°F to 90°F.

2. Supply Temperature PID:

Action: Reverse  
Input: Supply Temperature  
Output: Heating Valve Command  
Set Point: Supply Temperature SP\_Htg Cmd  
Max: 100  
Min: 0  
Enable: Heating is ON

H. Temperature Reset Request:

1. Discharge air temperature from the air handler is reset based on zone deviation from setpoint. Each VAV sends cooling and heating requests, the rooftop unit gathers all the requests and adjusts the discharge temperature.
2. Each VAV outputs up to (3) cooling or heating requests depending on the zone temperature deviation from setpoint.
  - a. One degree below setpoint represents one heating request; one degree above setpoint represents one cooling request.
  - b. Two degrees below setpoint represents two heating requests; two degrees above setpoint represents two cooling requests.
  - c. If the zone is more than three degrees above or below setpoint, it will only issue three heating or cooling requests.
  - d. The heating or cooling requests will not exceed a maximum of three (3).

I. Pressure Reset Request:

Orchard Farm School District  
Orchard Farm New Elementary School

AUTOMATION CONTROL SEQUENCES  
McClure Project #104313.000  
100% CD Issue

1. Duct pressure is modulated to maintain at least one terminal unit damper above 85% open and within 10% of flow setpoint.
    - a. The terminal unit shall monitor damper position, when the damper is over 85% open the terminal unit shall send one pressure request.
    - b. If the flow is 20% below setpoint for a period longer than 15 minutes the unit shall output a second pressure request.
    - c. Once the flow is within 10% of setpoint the second request will be disabled.
    - d. Once the damper closes below 80% there should be no pressure requests.
  2. The air handler will add all the VAV pressure requests and adjust the pressure setpoint as necessary to maintain one VAV with the damper above 85% open and within 10% of flow setpoint.
- J. Multiple Units Serving One Room:
1. When more than one terminal unit serve a single room, the lead unit performs the zone temperature control calculations and passes the airflow and discharge temperature setpoints to the follower unit. The temperature sensors are averaged for control.
- K. Alarms:
1. Zone Hi and Lo Temperature Alarms shall be generated if the zone temperature rises 2°F above or if it drops 2°F below setpoint for a period longer than 60 minutes.
  2. Discharge Hi and Lo Temperature Alarms shall be generated if the discharge temperature rises above 100°F or drops below 50°F.
  3. Insufficient Air Flow Alarm shall be generated if the damper is 100% open and the Flow is below 15% of Flow SP for a period longer than 60 minutes.
  4. Insufficient Water Flow Alarm shall be generated if the valve is fully open and the discharge temperature is below 80°F
  5. Flow Out of Calibration Alarm shall be generated if the damper is fully closed and the Flow is greater than 100cfm or lower than 0cfm.
- L. Graphics:
1. All VAV graphics shall include time of day, outside air temperature, outside air humidity, room name and number, and a link to the RTU which serves the VAV.
  2. A VAV summary page for each RTU shall list the following information in a table form:
    - a. VAV Box Number
    - b. Flow
    - c. Flow Setpoint
    - d. Discharge Temperature
    - e. Discharge Temperature Setpoint
    - f. Zone Temperature
    - g. Zone Temperature Setpoint
    - h. Minimum Flow
    - i. Max Heating Flow
    - j. Max Cooling Flow

## 25 95 13 FAN COIL UNIT (TYPICAL)

- A. Overview:
  - 1. This sequence is typical for all fan coil units.
  - 2. The Fan Coil unit is provided with a filter, a constant speed ECM fan with balance dial, modulating heating and cooling coils, a discharge temperature sensor, and a room temperature sensor.
  - 3. Fan speed shall be selected to match scheduled airflow.
  - 4. Room temperature sensors in corridors, stairs, lockers, and other common areas shall be box mounted with flush stainless steel wall plate.
- B. Safeties:
  - 1. Overload relay trip on the supply fan shall shutdown and lock out the fan. Manual reset will be required to resume normal operation. The status of the spaces served shall be monitored by the DDC system via a space temperature sensor.
- C. Zone Temperature Setpoint:
  - 1. Fan Coil units serving lockers, corridors, and offices shall maintain the following space air temperature setpoints:
  - 2. Nominal Occupied Setpoint: 72°F
    - a. Occupied Cooling Setpoint: Nominal + 2°F = 74°F
    - b. Occupied Heating Setpoint: Nominal - 2°F = 70°F
    - c. Custodial Cooling Setpoint: Nominal + 4°F = 76°F
    - d. Custodial Heating Setpoint: Nominal - 4°F = 68°F
    - e. Unoccupied Cooling Setpoint: 79°F
    - f. Unoccupied Heating Setpoint: 65°F
  - 3. Fan Coil units serving stairs and vestibules shall maintain unoccupied setpoints 24/7.
  - 4. Nominal Occupied Setpoint shall be made globally adjustable at the graphics user interface.
- D. Zone Setpoint Adjustment:
  - 1. Offices are provided with adjustable controls. Adjustments made at the space sensor shall modify the Nominal Occupied Setpoint, while the Cooling and Heating setpoints shall remain a fixed 4°F range from the Nominal Setpoint. The setpoint adjustment shall be limited to 2°F above and 2°F below Nominal Setpoint. If the Nominal Setpoint is considered at 72°F, the occupant can adjust the Nominal Setpoint from 70°F to 74°F.
  - 2. Example: If the occupant adjusts the thermostat to 74°F, the heating and cooling setpoints are now 72°F and 76°F. If the occupant adjusts the thermostats to 70°F, the heating and cooling setpoints are now 68°F and 72°F.
- E. Zone Temperature Control:
  - 1. Occupied Operation:
    - a. Fans serving offices run continuously during occupied hours.
    - b. Fans serving vestibules and corridors are only enabled when cooling or heating is required.
    - c. Zone temperature setpoints shall as described above. Heating and cooling modes are enabled using thermostatic functions with 4-degree dead-bands, enable heating when space drops 2°F below setpoint and disable 2°F above setpoint. Similar for cooling, enable when space rises 2°F above setpoint and disable 2°F below setpoint.



- d. Zone Heating PID:
  - Action: Reverse
  - Input: ZN-T
  - Output: Heating Valve\_SAT Cmd
  - Set Point: ZN Htg SP
  - Max: 100
  - Min: 0
  - Enable: Heating is ON and Cooling is OFF
- e. Zone Cooling PID:
  - Action: Direct
  - Input: ZN-T
  - Output: Cooling Valve\_SAT Cmd
  - Set Point: ZN Clg SP
  - Max: 100
  - Min: 0
  - Enable: Cooling is ON and Heating is OFF
- 2. Unoccupied and Custodial Operation:
  - a. During unoccupied and custodial operation, the fan is enabled and the heating or cooling valve is commanded 100% open as needed for heating or cooling.
  - b. Zone temperature setpoints shall be reset to 65°F for heating, and 79°F for cooling when the schedule is unoccupied, and 68°F for heating and 76°F for cooling when in custodial operation.
  - c. Heating and cooling modes are enabled using thermostatic functions with 4-degree dead-bands, as described under the occupied operation.
- F. Alarms:
  - 1. Zone Hi and Lo Temperature Alarms shall be generated if the zone temperature rises 4°F above or if it drops 4°F below setpoint for a period longer than 60 minutes.

## 25 95 14 CABINET UNIT HEATERS

- A. Overview:
  - 1. Cabinet unit heaters are provided with vandal resistant box mounted zone temperature sensors with flush stainless steel wall plate.
  - 2. The unit controller operates the constant volume fan and two-position heating valve to maintain a constant heating setpoint.
- B. Zone Temperature Control:
  - 1. The zone temperature setpoint shall be constant 65°F, adjustable by the operator.
  - 2. When the zone temperature drops 1°F below setpoint, the valve will open and the fan will start.
  - 3. Once the zone temperature rises 1°F above setpoint, the valve closes and the fan stops.
- C. Alarms:
  - 1. Zone Low Temperature: Alarm if zone temperature drops below 55°F

## 25 95 15 DUCTLESS SPLIT SYSTEMS

- A. Overview:
  - 1. Data closets and electrical rooms are provided with cooling only high efficiency split systems. These systems are integrated the BAS system via BACnet.
- B. Alarm:
  - 1. Wire all split system alarms back to the BAS via BACnet connection. Provide temperature alarm if the space temperature increased above 80°F (adjustable).

## 25 95 16 EXHAUST AND TRANSFER FANS

- A. KITCHEN HOOD FANS
  - 1. These variable-volume fans are controlled by the exhaust hood controllers. The controller enables one transfer fan per each exhaust fan to provide makeup for exhaust.
  - 2. The hood fan command and the fan status are monitored by the BAS.
  - 3. An alarm is generated if the hood is commanding a fan on and no status is received.
  - 4. Exhaust and transfer fans are to operate in pairs, an alarm shall be generated if only one of the two fans is running by itself for more than 10 minutes.
  - 5. EF fan and TF fan pairs increase speed up as temperature increases in the exhaust airstream to maintain a hood temperature setpoint as determined by the hood manufacturer.
  - 6. Fans included in this group:
    - a. EF-1
    - b. EF-2
    - c. TF-1
    - d. TF-2
- B. DISHWASHER EXHAUST
  - 1. The dishwasher exhaust fan is a constant speed exhaust fan controlled by the dishwasher controller, control wiring is provided by the TC contractor.
  - 2. Fan status is monitored by the BAS; an alarm is generated is the status is on for more than 24 hours.
  - 3. Fans included in this group:
    - a. EF-3
- C. TEACHER'S LUNCH ROOM HOOD EXHAUST

1. The constant speed exhaust fan is controlled by the hood and monitored by the BAS; the makeup air is provided by VAV 6-01. When the kitchen hood fan is enabled, VAV 6-01 airflow setpoint shall be set to minimum 600 cfm.
2. Hood may be shipped with a loose manual switch which will require installation by TC contractor, refer to food serving drawings for details.
3. Fans included in this group:
  - a. EF-7

#### D. MECHANICAL ROOM EXHAUST

1. Overview:
  - a. The fan provides refrigerant and economizer exhaust for the mechanical room.
2. Fan Enable:
  - a. The mechanical room exhaust fan is enabled when the economizer damper is greater than 30% open or if there is an active refrigerant alarm.
3. Fan speed control:
  - a. The mechanical room fan speed shall be tied to the economizer damper signal. As the damper position increases from 30% to 100%, fan speed shall be commanded from 30% to 100%.
  - b. If the refrigerant monitor is tripped, the fan shall be commanded to its maximum speed.
4. Fan status is monitored by the BAS.
5. Isolation damper is commanded open on fan enable.
6. Fans included in this group:
  - a. EF-4.

#### E. GENERAL RESTROOM/SHOWER/NURSE EXHAUST

1. This fan provides toilet and general exhaust for the nurse station and is controlled by the BAS. The fan is enabled when the corresponding schedule is occupied.
2. An alarm is generated if status doesn't match the command.
3. Fans included in this group:
  - a. EF-6
  - b. EF-8
  - c. EF-9

#### F. KILN EXHAUST SYSTEM

1. Overview:
  - a. A kiln room transfer and exhaust system maintains a temperate environment room during kiln operation. The kiln exhaust fan increases speed as zone temperature increases to maintain an 80F setpoint. The kiln transfer fan speed command shall match that of the kiln exhaust fan.
2. An alarm shall be generated if:
  - a. The kiln room temperature exceeds 90F.
  - b. The status of the kiln fan and transfer fan do not match.
3. Fans in this group
  - a. TF-3
  - b. EF-5

#### G. BUILDING PRESSURE RELIEF

1. OVERVIEW: RTU-5, RTU-6, RTU-7, RTU-8 economizer systems are served by a common economizer relief fan, RLF-2, and RTU-1 is served by a separate economizer relief fan, RLF-1.
2. Zone pressure is measured by a sensor with reference to outside, as zone pressure increases the relief damper modulates open and fan speed increases. The control is enabled when zone pressure rises above 0.05 in.wc. and disabled when zone pressure drops below 0.01 in.wc.
3. Zone Static Pressure PID:

Action: Direct  
Input: ZN-P  
Output: ZN Pressure Cmd  
Subdivision1: RLA Dpr\_ZNP Cmd  
Subdivision2: RLF Speed\_ZNP Cmd  
Setpoint: 0.03 in.wc.  
Bias: 0  
Max: 100  
Min: 0  
Enable: Schedule = OCC and ZN-P > 0.05" wc.

- a. As ZN Pressure Cmd goes from 0 to 30, RLA Dpr\_ZNP Cmd goes from 10% to 100%.
  - b. As ZN Pressure Cmd goes from 30 to 100, RFL Speed\_ZNP Cmd goes from 30% to 100%.
4. Fan status is monitored by the BAS.
  5. Fans included in this group:
    - a. RLF-1.
    - b. RLF-2.

#### 25 95 17 DOMESTIC HOT WATER SYSTEMS

- A. Systems are configured with an independently controlled water heater, hot water circulating pump, and a mixing valve.
- B. Water heater and mixing valve controllers are networked to the BAS for monitoring.
- C. Start/stop command and status monitoring of each pump shall be included with this scope of work. The temperature maintenance building pumps shall be enabled 30 minutes before the building occupied period and shall be disabled at the end of the building occupied period.
- D. Start and stop scheduling of domestic water pumps shall be adjustable.
- E. Each of the domestic hot systems has sensors for monitoring of the tempered hot water temperatures by the DDC system. Refer to points list and flow diagrams for sensor locations.

## 25 95 18 SERVICE REMINDER ALARMS

- A. Virtual points and service reminders shall be created and displayed on the graphics showing the alarm status and the next time that the alarm is scheduled to go off.
- B. The alarms must remain active until cleared by the operator.
- C. Service Reminder Alarms shall include the following at a minimum:
  - 1. Grease Interceptor Service Alarm
    - a. Alarm every 6 months
    - b. Alarm frequency is user-adjustable
  - 2. Water Softener Service Alarm
    - a. Alarm every 6 months
    - b. Alarm frequency is user-adjustable
  - 3. Dirty Filter Alarm
    - a. Replace filters every 6 months
    - b. Alarm frequency is user-adjustable

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## **28 00 00 ELECTRONIC SAFETY AND SECURITY**

### **28 00 01 GENERAL**

- A. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Division 28 of the Specifications.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Division 28 of these Specifications.

### **28 00 02 REFERENCES, REGULATORY REQUIREMENTS**

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc., as identified in Division 28.

### **28 00 03 REFERENCES, RELATED SECTIONS of the SPECIFICATIONS**

- A. Requirements of the following Sections of the Specifications apply to Work for this Section:

Division 26 – Electrical  
Division 27 – Communications

### **28 00 04 DEFINITIONS**

- A. Refer to Section 26 00 05 – Definitions.

### **28 00 05 WORK INCLUDED**

- A. Furnish material, labor and services necessary for, and incidental to, installing the following systems where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications to provide for complete systems.

### **28 00 06 SUBMITTALS:**

- A. The Contractor shall submit the following for approval in accordance with Subsection 20 00 43, Duties of the Contractor - Submittals.
- B. Provide manufacturer's technical product data of each material and accessory item with engineering support information, installation manual, operation and maintenance manual. Data shall be specific to product specified and clearly identified on all data sheets, which contains multiple models or sizes.

## **28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY**

### **28 05 28 PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS**

- A. All requirements listed in 27 05 28 shall apply for Electronic Safety and Security low voltage cabling unless noted below.

- B. Cabling may be run as open-type plenum rated cable concealed above lay-in ceiling space and exposed open to structure above or cloud type ceilings unless noted below. Cabling shall be installed above bar joist flanges to conceal cabling from view when routed through exposed ceiling. Non plenum rated cabling shall be installed in conduit. Cabling shall be installed in conduit in all exterior locations, all areas exposed below 8' A.F.F., and all inaccessible locations including inside wall partitions or above drywall, wood, and other inaccessible ceilings. Cabling shall be installed in conduit in the following spaces:
  - 1. Electrical, Mechanical Equipment Rooms
  - 2. Storage and Janitor Closets
  - 3. Gymnasium
  - 4. Locker Rooms
- C. Cables shall be continuous from outlet to termination equipment.
- D. Cables shall be terminated using tools recommended by the termination manufacturer.
- E. Provide 2" minimum sleeves in all walls which cable runs pass through.
- F. Furnish and install a minimum of (1) one cable pathway device through fire rated partitions and floors, and where indicated on the drawings. Device shall be Specified Technologies, Inc. EZDP33FWS, 3M QuickPass, or equivalent.
- G. Refer to 26 05 29 for fire sealing of penetrations through fire rated walls.
- H. Provide access panels as necessary for cable routing.

#### 28 05 28.29 HANGERS AND SUPPORTS FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS

- A. Cables shall be supported by Cable Tray (Reference Specification 26 05 36 for requirements) or J-Hooks at the Contractor's option. Cables shall be supported with "J-Hooks" a minimum of every six feet. A minimum size of 4" J-Hooks must be used for the pathway through the corridors. In the instances where wire basket is used, it is the responsibility of the Electrical Contractor to hold coordination meetings with all other trades in order to establish a route to install wire basket and supports. Wire basket fill shall not exceed the manufacturer's recommendations. Support devices of wire basket and J-Hooks are to be attached to existing permanent structure.
- B. Cable supports (cable tray and j-hooks) should be mounted below duct work to allow for access in future cable installs. Provide a minimum of 25% spare capacity in the cable supports installed.
- C. Cables shall be installed in cable pathways where available.
- D. Cables shall be continuous from outlet to termination equipment.
- E. Cables shall be terminated using tools recommended by the termination manufacturer.
- F. Cables and supports shall be installed at a readily accessible location above ceilings.

#### 28 05 28.33 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

- A. Furnish and install conduit rough-ins at all outlets locations where shown on drawings. Rough-in shall consist of a two-gang outlet box, single gang trim ring, and a minimum



1" conduit stubbed above an accessible ceiling. Plastic bushings shall be installed on both ends of conduit. Install blank covers on all unused rough-ins.

- C. All conduits serving telephone/data communication outlets shall be 1" minimum. Conduits for all other system cable runs shall be sized for 40% maximum fill, or as shown on the drawings. Redundant paths shall be installed where fill exceeds 40%.
- D. Provide pull strings in all conduits.
- E. Conduit bends shall accommodate radius requirements of fiber cable as necessary.

## **28 13 00 ACCESS CONTROL**

### **PART 1 – GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1 Adding access control including access control door hardware, card readers, duress (panic) buttons and associated electronic equipment.
  - 2. Install RS485 loop serving reader interface panels and wire into new Intelligent System Controller ('ISC').
  - 3. Access control hardware for swinging doors.
  - 4. Access control hardware for other doors to the extent indicated.
- B. Section includes, but is not necessarily limited to, the following for the integrated access control security and site management system:
  - 1. Integrated Wiegand access control door hardware.
  - 2. Monitoring and signaling equipment.
  - 3. System network control processors.
  - 4. Reader controller interfaces and modules.
  - 5. Input monitor and output control interfaces and modules.
  - 6. Remote card readers and display terminals.
  - 7. Power sourcing equipment, network switches and wireless access points.
  - 8. Access control cards and credentials.
  - 9. Access control system application software.
  - 10. Access control system power supplies, back-ups and surge protection.
- C. Related Sections:
  - 1. Section 06 10 00 - Rough Carpentry.
  - 2. Section 06 20 00 - Finish Carpentry.
  - 3. Section 08 01 00 - Operations and Maintenance.
  - 4. Section 08 11 13 - Hollow Metal Doors and Frames.
  - 5. Section 08 14 16 - Flush Wood Doors.
  - 6. Section 08 14 23 - Clad Wood Doors.

7. Section 08 41 13 - Aluminum-Framed Entrances and Storefronts.
  8. Section 08 70 00 - Door Hardware.
  9. Division 14 Section "Elevators" for security access to elevator floor selection controls.
  10. Division 26 Sections for connections to electrical power system and for low-voltage wiring work.
  11. Division 28 Section "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion detection system.
  12. Division 28 Section "Video Surveillance" for motion detection and video camera devices and equipment installed at door openings and provided as part of a security and site management system.
  13. Division 28 Section "Fire Detection and Alarm" for connections to building fire alarm system.
- D. Codes and References: Comply with the current version year adopted by the Authority Having Jurisdiction.
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  2. ICC/IBC - International Building Code.
  3. NFPA 70 - National Electrical Code.
  4. NFPA 80 - Fire Doors and Windows.
  5. NFPA 101 - Life Safety Code.
  6. NFPA 105 - Installation of Smoke Door Assemblies.
- E. Products installed, but not provided under this Section include the following. Coordination to remain a requirement of this Section.
1. Security or High Security keyed cylinders, including provisions for temporary construction keying, provided for mechanical override at access control locking hardware to be furnished under Division 08 Section "Door Hardware". Permanent cores and keys to be installed by Owner, Contractor, or Supplier as directed.

### 1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. System Operational Descriptions: Complete system operational narratives for the integrated access controlled openings defining the owner's prescribed requirements for the opening functionality. Narratives include, but are not limited to, the following situations: normal secured/unsecured state of door; authorized access; authorized egress; unauthorized access; unauthorized egress; fire alarm and loss of power conditions, and interfaces with other building control systems.
- C. Shop Drawings: Details of electrified integrated locking hardware and access control firmware, indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication and control of the access control system electrified hardware and firmware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
  - b. Complete (risers, point-to-point) access control system block wiring diagrams.
- 2. Electrical Coordination: Coordinate with related Division 26 Electrical Sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified and authorized provider of the primary access control components.
- E. Keying Schedule: Reference Division 08 Section "Door Hardware".
- F. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- G. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete access control and site management installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and telephone number of the supplier/integrator providing the installation and the nearest service representatives for each item of equipment included in the system. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- 1. As-Built Drawings: During system installation, the Contractor to maintain a separate hard copy set of drawings, elevation diagrams, and wiring diagrams of the access control system to be used for record drawings. This set to be kept up to date by the Contractor with all changes and additions to the access control system accurately recorded.
- H. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum **[5]** years of documented experience in providing access control and security systems equipment and software similar to that indicated for this Project and that have a proven record of successful in-service performance.
  - 1. Software and access control systems components to have been previously and thoroughly tested together with proven installations similar in size and functionality to the design requirements indicated for this Project.
- B. Integrator Qualifications: Systems Integrators, verifiably factory trained and certified by the primary product manufacturers, with a minimum 3 years documented experience installing complete integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance. Qualifications include, but are not

necessarily limited, to the following:

1. References: Provide a list of references for similar projects including contact name, phone number, name and type of project.
  2. Professional Staffing: Firms to have a dedicated access control systems integration department with full time, experienced professionals on staff experienced in providing on site consulting services for both electrified door hardware and integrated access control systems installations.
  3. Factory Training: Installation and service technicians are to be competent factory trained and certified personnel capable of maintaining the system.
  4. Service Center: Firms to have a service center capable of providing training, in-stock parts, and emergency maintenance and repairs at the Project site with 24-hour/7-days a week maximum response time.
- C. Supplier/Dealer Qualifications: Supplier/Dealers, verifiably authorized and in good standing with the primary product manufacturers, with a minimum **3** years experience supplying integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance.
- D. Integrated Wiegand Output, Wireless, and IP-Enabled access control products are required to be supplied and installed only through designated ASSA ABLOY "Authorized Channel Partner" (ACP) and "Certified Integrator" (CI) accounts.
- E. Source Limitations: Obtain the access control door hardware, system firmware and application software specified in this Section from a single source, qualified supplier/integrator unless otherwise indicated.
1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
  2. Provide integrated access control door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:
1. Comply with NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  2. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:
    - a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
    - b. Door Closers: Comply with the following maximum opening-force requirements indicated:
      - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
      - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Comply with NFPA 101 "Life Safety Code" for doors in a means of egress.
    - a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
  4. Comply with NFPA 80 "Fire Doors and Windows" for fire labeled opening assemblies.
  5. The installed access control system shall conform to all local jurisdiction requirements.
- G. Keying Conference: Reference Division 08 Section "Door Hardware".
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), Systems Integrator(s), and Contractor(s) to review proper methods and procedures for receiving, handling, and installing door and access control hardware to manufacturer's recommendations and according to specifications.
1. Prior to installation of door hardware, arrange for manufacturers' representatives to hold a project specific training meeting on the proper installation and adjustment of their respective products. Product training to be attended by the installers of access control hardware for the aluminum, hollow metal and wood door sections. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
  2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
  3. Review sequence of operation narratives for each unique access controlled opening.
  4. Review and finalize construction schedule and verify availability of materials.
  5. Review the required inspecting, testing, commissioning, and demonstration procedures.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
1. Access control firmware and software: Where approved and directed, inventory upon receipt and store electronic access control equipment in a secure, temperature and humidity controlled environment in original manufacturer's sealed containers.
- B. Tag each item or package separately with identification related to the final Access Control Door Schedule, and include basic installation instructions with each item or package.
- C. Deliver permanent keys, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner established at the "Pre-Submittal Conference".

## 1.6 COORDINATION

- A. Coordinate quantity and arrangement of assemblies with ceiling space configuration and with components occupying ceiling space, including structural members, pipes, air-distribution components, raceways, cable trays, recessed lighting fixtures, and other items.
- B. Integrated Access Control Door Hardware and Electrical Coordination: Coordinate the layout and installation of scheduled integrated access control door hardware, and related access control equipment, with required connections to source power junction boxes, power supplies, detection and monitoring hardware and fire alarm system.
  - 1. Door Hardware Interface: The access control system to interface and be connected to electrified and integrated access control door hardware as described under Division 08 Sections "Door Hardware" or "Access Control Door Hardware". Coordinate the installation and configuration of electrified door hardware being monitored or controlled with the controls, software and access control hardware specified in this Section.
- C. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing electrified door hardware and access control system components. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing access control system hardware to comply with indicated requirements.
- D. Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

## 1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article will not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and are in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of the installed access control system hardware and software that fails in materials or workmanship, including all related parts and labor, within specified warranty period after final testing and acceptance by the Owner. Failures include, but are not limited to, the following:
  - 1. Structural failures including excessive deflection, cracking, or breakage.
  - 2. Faulty operation of the hardware.
  - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:

1. Two years for Integrated Access Control Door Hardware.

#### 1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of standard and access control door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.
- C. Maintenance Support and Extended Service Agreement: Submit for Owner's consideration an optional extended Service Agreement for the installed access control system, including support for software related issues. The extended Service Agreement is considered elective and is without manufacturer's requirement stipulating mandatory coverage for owner and/or vendor system support.
  1. A published copy of this agreement to be included with the submittal package
  2. Support for the installed access control system components is provided through the vendor under a 24 hour technical assistance program.
  3. Access control and management system components are to be available on a one-day turn-around time frame from the manufacturer.
  4. Primary systems manufacturer to offer and provide remote modem or internet access for direct factory support to the vendor. The factory level support to include diagnostics and troubleshooting support on systems related issues at no additional cost to the owner.
- D. Access Control Software Upgrades: Version upgrades and "fix" releases to the access control system software are available at no extra charge as long as the version of software provided in this specification remains the current manufacturer's version or for up to (2) years after a new version release.
  1. Major access control software revisions that provide new functionality to the product provided free of charge for up to one (1) year from the date of substantial completion.
  2. Access control system software is to be upgradeable as may be required or as necessary, to expand and manage the owner's site or sites. Upgrades are to be offered at a published flat fee for the primary system software, with single license modules included in the primary fee structure. System upgrades offered at a costing structure based upon the original number of licensed modules issued, or on those to be purchased at a future date, are not allowed.
  3. As part of the submittal package, provide a list of available software upgrades and/or expansions modules. List to identify related costs for upgrades, or expansions to the original system, up to the next qualifying operational level.

#### 1.9 SCOPE OF WORK

- A. Access Control Site Management System: Furnish and install at the indicated locations the specified integrated access control door hardware and access control system

firmware and software for a completely operational access control and security site management system. System includes, but is not necessarily limited, to the following:

1. Electrified integrated access control locks and exit hardware, network control processors, reader controller panels, I/O monitor/control interfaces, door position switches, remote card readers, keypads, and display terminals, access cards and credentials, system application software, special tools, operating manuals, and required cabling and accessories as detailed below and listed in the Access Control Hardware Sets at the end of Part 3.
  - a. Provide the appropriate number of reader controller panels and I/O monitoring/control expansion interfaces as needed to handle the number of card readers, locking devices, door status devices, and identified alarm inputs specified in this section, and as shown on the security drawings.
  - b. Provide manufacturer approved integrated access control locks, exit hardware, and remote mounted card readers, keypads, and display terminals that are functionally compatible with the specified access control equipment interfaces.
2. Access control system equipment to be installed in an enclosure box compatible with the specified components. This enclosure to include, but is not necessarily limited to, the network control processor, I/O monitor/control interface panels, power supplies, terminal strips, wire ducts, keyed lock cylinder, integrated outlet for A/C power, and standoffs.
  - a. Enclosure box to be located in the designated rooms per floor plan drawings with connection to the owner designated local area network for communication back to the central server host.
3. Owner to provide the following:
  - a. Computer hardware and peripherals to be from an approved, major line computer manufacturer. The following manufacturers will be considered "pre-approved", however, specific information detailing compliance with the manufacturer's requirements must be included within the project submittal package as specified.
    - 1) Compaq
    - 2) Dell
    - 3) Hewlett-Packard
    - 4) IBM
  - b. Owner will be responsible for ensuring that each computer hardware component includes the required interfaces, expansion boards, and peripherals that will be necessary to allow the system to operate as described within this specification and as indicated on the drawings.
  - c. Power Sourcing, Network Switches and Wireless Access Points: Quantity as required to accommodate installed access control (and video surveillance) devices.
  - d. Network Control Processor Connections:
    - 1) LAN/Ethernet communication ports (jacks) and network interface



cards as needed, CAT6 cabling from network router/switch to network control processor, outlet and cover plates and/or patch cables required for network connection within each designated IT/Telecom room.

- 2) Required static IP addresses.
4. Power Supplies, including battery or uninterrupted backup powers supply (UPS) and separately fused surge protection, required for the electrified door hardware, access control equipment, and PoE switches or wireless routers driving the integrated card reader locking devices.
5. Installation, final configuration and commissioning of electrified door and access control system hardware, communication firmware, power supplies and related accessories.
6. System application software including installation, programming, and end user training of the access control system demonstrating operating, repair, and maintenance procedures. Include on-site central server training for designated personnel (facilities maintenance, security, IT, administration) by a factory certified representative.
  - a. Include Client Software Application (client workstation) training at each of the remote installed facilities for local administrative staff.
7. Provide manufacturer required power controllers, interface boards, and programming that may be required for approved electric latch retraction exit devices supplied under Division 08 Section "Door Hardware."
8. Electrical contractor, Division 26, to provide the following:
  - a. Source power wiring (120VAC) as required for the integrated locking and access control hardware, equipment, accessories and power supplies. This includes quad outlets as required on a dedicated circuit in the designated IT/Telecom room(s) and the related conduit, stub-in, junction boxes and connectors required for the source power delivery and connections.
  - b. Provide required conduit, stub-in, junction and back boxes for both the electrified locking hardware and access control equipment at each of the access controlled or monitored openings per plan drawings and specs. Supply and install conduit between each of the aforementioned devices and between the electrical junction boxes, power supplies and access control equipment located on or above the door opening.
    - 1) At wall mounted remote readers, provide conduit on the secured side of the door, 36" from the finish floor and 6" from the edge of the frame, to the related power supplies and access control equipment.
    - 2) At electrical hardware power transfers provide conduit on the secured side of the opening from the power transfer, thru-wire hinge, or serviceable panel location on the frame jamb to the related power supplies and access control equipment.
  - c. Electrical Contractor to provide all 120VAC cabling connections and terminations from the electrical junction boxes to these electrical devices.
9. Access Control System Integrator to provide the following:

- a. Low voltage wiring (12/24VDC) and communication cabling (RS-232/RS-485) from network control processors to reader controllers, I/O monitor/control interface panels, electrified and integrated locking hardware, remote card readers, keypads, or display terminals, monitoring and signaling switches, and power supplies. Work includes related connectors, final terminations, and hook-ups required for a complete and functional access controlled opening in accordance with applicable codes and specified system operational narratives.
- 10. Elevator Contractor to provide the following:
  - a. Interface or landing of interface cable onto the elevator call button will be performed by a certified elevator contractor.
  - b. Coordinate with access control systems integrator provisions for a card reader with output allowing the elevator call button to be activated. A validated card read will be required for activation.
- 11. Full and seamless integration of the analog, digital or IP-enabled CCTV video surveillance system (Division 28) if applicable, with the installed site access control system software.
- 12. Full and seamless integration of the site intrusion alarm service and motion detector systems, (Division 28) if applicable, with the installed site access control system software.
- 13. Final connections to fire alarm system, if required, by electrical and fire alarm system contractors.
- 14. Provide permits, submittals and approvals required by the authority having jurisdiction, prior to commencing with work.

## PART 2 - PRODUCTS

### 2.1 SYSTEM ARCHITECTURE - ACCESS CONTROL SITE MANAGEMENT SYSTEM (ACSMS)

- A. General: The ACSMS is a modular and networked based system providing physical access control security to a high school campus with the ability to be expanded for a future elementary school on the same site. The system to be capable of controlling and integrating multiple security functions including the configuration, management and monitoring of cardholder access, locking hardware units, events, alarms, visitors, and real-time tracking and reporting. The ACSMS is to be alterable at any time depending on the facility requirements and will allow for easy upgradeability or modification of network processors, controller, interface modules, card data, inputs, outputs, and remote work stations. The ACSMS to include, but is not be limited to, the following features and functions:

An "Enterprise" class access control software application.

- 2. Client/Server model operating central server host software modules and client workstation software applications in a multi-user and a multi-tasking environment.
  - a. The ACSMS to permit multiple instances of client software applications to

run simultaneously on the network. The base system to include [ ] software application licenses with an unlimited number of licenses available subject to connection fees.

3. Partitioning: The system to support security partitioning enabling system administrator to segment the configuration database and group multiple entities within the security partition.
  - a. Security partitions limit what users can view in the configuration database. Administrators, who have all rights and privileges, can segment a database into multiple security partitions. A user who is given access to a specific partition will only be able to view entities (components) within the partition they have been assigned.
4. Encryption: The system to support encrypted communication between the central server software and client software applications (server-to-server and client-to-server) using a 128-bit AES encryption algorithm (at a minimum).
  - a. Communication between the central server host software module and system controllers to be encrypted if supported by the controllers.
  - b. The ACSMS client software applications to be password protected with passwords stored in the central server database in an encrypted manner.
5. Distributed Processing: The system is a fully distributed processing application allowing information, including time, date, zones, valid codes, tasks, access levels, and similar data, to be downloaded from the central host station to controller interface devices allowing access-control decisions with or without central host station communication. If communications to a central host station are lost, the controllers will automatically buffer event transactions until communications are restored and events are automatically uploaded to the central host station.
  - a. Provide for a higher level of distributed database management at defined perimeter access points such that no single point of failure will allow more than two access points to fail, or affect more than two access points at perimeter points system wide.
6. Single Data Base: The system to support a single database for access control site setup, credential and identity file creation, alarm and control setup, and system user operation and command functions.
7. System Access Management: The system to allow operators through password authentication the ability to make access granted or denied decisions, define access levels, time zones, holidays, assign cardholders, access groups, develop tasks, and generally manage access control, alarm monitoring and response activities system wide from a single login. Operator and user privileges are managed by a system administrator allowing for different levels of system access and system control. Authorization management is fully Owner definable.
8. Cardholder Management: The system to include a cardholder management system integrated within the access control system. This cardholder management functionality allows the enrollment of cardholders into the database, and import/export of employee data.
9. Access Groups and Access Levels: The system to provide adequate access groups and access level assignment capability to meet Owner requirements for the specified project. If required, software application can be expandable to support unlimited access groups and access levels.
10. Alarm Monitoring: The system is able to monitor, report, and provide information

about the time and location of alarms, along with their priority.

11. Event Monitoring: The system is able to monitor, report, and archive network access control activity.
  12. Transaction Logs: The system to support an unlimited number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.
  13. System Monitoring: The system to have ability to report on the integrity of all network assigned devices, circuits and communications and provide a diagnostics screen showing field level communications system wide
  14. Lock/Unlock Commands: The system to allow an operator to manually lock and unlock doors overriding scheduled access control restrictions and configurations if necessary.
  15. Hardware Interface: The system to integrate with and control specified electrified hardware, signaling and monitoring devices.
  16. Report Generator: The system to have the ability to generate and output reports with any and all combinations of system fields and data including, but not limited to: by cardholder, by door, by site, by time, by groups of doors and by cardholder field. Any and all combinations of fields must be available for reporting. The report feature to allow exporting of generated reports over a network connection or by remote printing.
  17. Multi-User/Web Based Network Capabilities: The system to support multiple operator workstations via local area network/wide area network (LAN/WAN), the Internet, or VPN. The system to be capable of supporting minimum of [ ] concurrent users/clients with software expansions to an unlimited number of workstations based on the Owners network requirements.
  18. Systems Integration: The system to have the ability to be fully and seamlessly integrated with existing or specified intrusion detection alarm and video surveillance (CCTV) systems.
- B. Open Architecture: The access control system infrastructure will be based on an open architecture design capable of supporting multiple access control hardware manufacturers and integrate with multiple non-proprietary network processors, controllers, interface modules, integrated locking hardware, remote card readers, keypads and display terminals, and other third party applications.
- C. Network Support: Communication network connecting the central server host software modules, client workstation software applications, and hardware controllers to be designed to support all of the following:
1. LAN/Ethernet enterprise ring topology and localized star topology based on TCP/IP.
  2. Direct-connected RS-232 and RS-485 communication cabling.
  3. Dial-up modem connection using a standard dial-up telephone line.

## 2.2 MANUFACTURERS

- A. General: Provide integrated access control door hardware and access control system equipment and accessories for each designated opening to comply with requirements in this Section and with the Access Control Hardware Sets listed at the end of Part 3.
1. Access Control Hardware Sets: Requirements for quantity, item, model, design, grade, finish, size, and other distinctive qualities of each type of integrated door and access control hardware are indicated in the Access Control Hardware Sets at the end of Part 3.

2. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- B. System Design: The equipment and materials supplied are to be standardized components regularly manufactured and utilized within the source manufacturer's access control systems.
1. System components to be non-proprietary in design and implementations, providing for an open protocol platform with multiple manufacturers having functional software capable of integrating with the hardware specified. The installed integrated product is to be part of a single, cohesive management and access control system.
- C. Substitutions: Requests for substitution and product approval for inclusive integrated access control door and access control systems hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.
1. The access control system described in this specification represents a complete engineered system. If alternate products are submitted, it is the responsibility of the Supplier/Dealer/Integrator to provide an acceptable complete and working system layout, including re-engineering of elevation and wiring diagrams, as applicable. Complete systems to include at a minimum required power supplies, power transfers, and integrated access control locking hardware and accessories.
- D. Approved Access Control and Site Management System Manufacturers:
1. HID Global (Access Cards and Credentials, Remote Readers).
  2. Sargent Manufacturing (Integrated Access Control Locking Devices and Accessories).
  3. Securitron Corporation (Power Supplies).
  4. S2 Security to match High School, no exceptions (Access Control System); provide all necessary licensing upgrades for elementary school system to be integrated into District S2 Security system at new High School and Early Learning Center.
- Addendum #2**

## 2.3 ACCESS CONTROL AND SITE MANAGEMENT SYSTEM HARDWARE

- A. General: Provide all necessary access control field hardware devices required to receive alarms and administer all access granted/denied decisions. Field hardware devices must be designed and installed in accordance with applicable electrical codes.
- B. Central Computer Host Server (Owner Provided): The central host server is interconnected to all system components, including client workstations and field installed controllers, providing operator interface, interaction, display, control, and real-time monitoring.

## **2.4 ACCESS CONTROL DOOR HARDWARE**

- A. All door hardware, including but not limited to butts, panic devices, actuators, power transfers, latch retraction and power supplies to be provided and installed by Division 8 Door Hardware contractor. Electrical contractor to install necessary rough-ins, wiring and final terminations.**
- B. All combination keypad/card readers to be Schlage MTMSK15 as specified in the Division 8 Door Hardware specifications. The combination keypad/card readers are to be provided by Division 8 Door Hardware contractor. Electrical contractor to install necessary rough-ins, wiring, final terminations and mounting of keypad card reader.**
- C. Electrical contractor to provide access control system that integrates with the Schlage MTMSK15 combination keypad/card reader.**
- D. Electrical contractor to provide and program a quantity of 250 fobs for use by the District.**
- E. Coordinate with Division 8 Door Hardware specifications for sequence of operations for the controlled doors. Sequence of operations to be integrated into access control system programming.**
- F. Electrical contractor and their access control system integrator to attend a meeting with the Division 8 Door Hardware contractor, Architect and Engineer to review door hardware submittals and coordinate work.**

## **2.5 ELECTRONIC ACCESSORIES**

- A. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.**
  - 1. Acceptable Manufacturers:**
    - a. Securitron (SU)**

## **2.6 CABLES AND WIRING**

- A. Comply with Division 27 Section "Conductors and Cables for Electronic Safety and Security."**
- B. Data Line Supervision: System to include alarm initiation capability in response to opening, closing, shorting, or grounding of data transmission lines.**
- C. Install appropriate number of conductor pairs, in the wire gage (AWG) recommended by manufacturer, corresponding to the electronic locking functions specified, amperage drawn and distances covered between the power supplies, power transfer devices, electrified hardware and access control equipment.**

## 2.7 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

## 2.8 ACCESS CONTROL HARDWARE FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Protect mechanical finishes on exposed surfaces from damage by applying temporary protective coverings before shipping.
- C. Where specified, finishes on integrated card key locksets or exit hardware to incorporate an FDA recognized antimicrobial coating (i.e., MicroShield™) listed for use on equipment as a suppressant to the growth and spread of a broad range of bacteria, algae, fungus, mold and mildew.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance of the installed access control system.
- B. Examine roughing-in for electrical source power to verify actual locations of wiring connections before electrified and integrated access control door hardware installation.
- C. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- D. Notify architect of any discrepancies or conflicts between the specifications, drawings and scheduled access controlled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

## 3.2 PREPARATION

- A. Doors and frames at scheduled access controlled openings to be properly prepared to receive specified electrified and access control hardware and connections without additional in-field modifications.

## 3.3 INSTALLATION

- A. Install each item of integrated access control door hardware and access control equipment to comply with manufacturer's written instructions and according to

specifications.

- B. Mounting Heights: Mount integrated access control door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
  - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
  - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
  - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
- C. Boxed Power Supplies: Verify locations.
  - 1. Configuration: Provide the least number of power supplies required to adequately serve doors with access control hardware and equipment.
- D. Final connect the system control switches (integrated access control door hardware, remote readers, keypads, display terminals, biometrics), and monitoring, and signaling equipment to the related Controller devices at each opening to properly operate the electrified door and access control hardware according to system operational narratives.
- E. Retrofitting: Install each door hardware and access control item to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- F. Networked System Application Software: Install, and test application(s) software and databases for the complete and proper operation of systems involved. Assign software license(s) to Owner.

#### 3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Perform a final inspection of the installed integrated access control door hardware and access control system and state in report whether installed work complies with or deviates from requirements, including whether each component representing the opening assembly is properly installed, adjusted, operating and performing to system operational narratives.
- B. Commissioning and Testing Schedule: Prior to final acceptance of the access control system installation, the following testing and documentation to be performed and provided to the Owner.
  - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
  - 2. Pre-testing: Program and adjust the system and pretest all components, wiring, and functions to verify they conform to specified requirements. Provide testing reports indicating devices tested, pass/fail status, and actions taken to resolve problem(s) on failed tests.
  - 3. Acceptance Test Schedule: Correct deficiencies identified by tests and



- observations and retest until specified requirements are met.
4. Provide "as designed" drawings showing each device and wiring connection and electronic enclosure legends indicating cabling in and out.
  5. Provide a complete set of operating instructions for access control hardware devices and a complete software user manual. The documentation includes module reference guides for each electronic enclosure.

### 3.5 ADJUSTING

- A. Adjust and check each operating item of integrated access control door hardware, and each door opening to ensure proper secured operation and function of every unit. Replace units that cannot be adjusted to operate as intended.

### 3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all integrated access control door hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by access control system installation.
- C. Clean operating items as necessary to restore proper finish and provide final protection and maintain conditions that ensure access control door hardware is without damage or deterioration at time of owner occupancy.

### 3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain electronic integrated door hardware and the access control system.

## 28 23 00 VIDEO SURVEILLANCE

1. Cameras are furnished by owner and installed by owner. Contractor to provide data outlet only as detailed in Division 27 specifications and locations per drawings.

## 28 30 00 ELECTRONIC DETECTION AND ALARM

### 28 31 00 FIRE DETECTION AND ALARM

#### A. Description of Work

1. Install a complete and operational addressable fire alarm system with live and recorded emergency voice communications as indicated by drawings, schedules, and riser diagrams. The system shall be connected to a UL Listed monitoring station which will notify the fire department and owners designated representative upon system activation. In jurisdictions required by ordinance to be UL Certificated per UL Category UUFX the documentation and UL Certificate shall be provided and posted at the job site.

2. The equipment supplier must be the local factory authorized representative and must also be factory authorized, trained and certified to perform warranty service for the equipment being supplied providing local factory authorized service and spare parts inventory. The supplier or installer must be NICET Certified level IV and NICET certificate must be submitted with shop drawings.
3. Equipment manufacturer shall be regularly engaged in manufacturer of fire alarm systems of types, sizes, and electrical characteristics required, and whose products have been in satisfactory use in similar service for not less than 5 years.
4. Installer shall have at least 5 years of successful experience on projects with fire alarm systems work similar to that required for this project and be a licensed contractor.
5. For a period of one year from date of Owner's first beneficial use, the system shall be under a no charge warranty/service contract, as authorized by the manufacturer. During that period, replacement components and labor shall be readily available during standard business hours. After the one-year guarantee period, the supplier warrants that he is capable of providing service on a 24 hour, 7-day a week basis for at least five (5) additional years.
6. Provide shop drawings in accordance with the appropriate paragraphs the applicable version of NFPA 72 for the following items:
  - 1 - Written narrative providing intent and system description.
  - 2 - Floorplan layout showing location of all devices, including isolation components to comply with the applicable NFPA 72 chapter on the Performance of Signaling Line Circuits (SLCs) referencing fault tolerances and manufacturer's specific product requirements, strobe candela ratings, speaker taps, control equipment, supervising station equipment. Include point of compass (north arrow), scale used, room use identification and building features that will affect installed devices such as shelving or floor mounted equipment such as kitchen equipment.
  - 3 – Sequence of operation in a matrix form.
  - 4 – Equipment data sheets.
  - 5– Battery and voltage drop calculations.
  - 6– Mounting elevations of wall mounted equipment.
  - 7– Wiring pathway diagrams.
  - 8– Manufacturers published instructions including operation and maintenance manuals. (Hard copy of information shall be left with owner)
  - 9 – Record of Completion, per applicable NFPA 72. (Hard copy of information shall be left with owner)
  - 10 – Site specific software in the form of a thumb drive.
  - 11 – Record (as built) drawings. (Hard copy of information shall be left with owner)
  - 12 – Completed record of inspection and testing per NFPA 72 (Hard copy of information shall be left with owner)
  - 13 – Provide NICET level IV (minimum) certificate of individual responsible for the design and calculations of the fire alarm system.

Submittals shall be submitted in two packages; the first package shall include items 1-7 and 13. Package two shall include items 8-12 submitted after project is completed. Refer to specification section 26 00 38 for other as-built requirements. Partial submittal packages may be returned as rejected without being reviewed.

7. Engineered sealed fire alarm drawings prepared by fire alarm supplier required for permit application are the responsibility of the Contractor and fire alarm system

supplier. Coordinate any system design drawing submission requirements with the Engineer.

B. Acceptable Manufacturers

1. Subject to compliance with requirements, provide fire alarm components from one of the following system:

Notifier NFS Series, no exceptions

C. Fire Alarm Control Panel

1. The Fire Alarm System will be microprocessor based, non-coded, and utilize addressable devices with integrated or adjacently mounted voice controls. It will be electronically supervised, common signaling, individual device indicating, with remote central station monitoring. The system shall operate from manual fire alarm stations, smoke detectors, thermal detectors, duct smoke detectors, water flow, and tamper switches.
2. The panel shall include an integral 80 character LCD display that can be viewed without opening the front cover of the control panel. Located within the panel or adjacently mounted to the panel there shall be a microphone, speaker selection switches and voice control equipment including amplifiers and audio message generators. Systems specified without selectable speaker zones (general alarm) shall not require speaker selection switches. See paragraph I Sequence of Operations for requirements.
3. The panel shall include SLC loop modules for a minimum of 198 addressable points. Addressable points shall include at a minimum 99 modules such as relays, monitor points and manual stations and 99 addressable detectors such as smoke, heat or CO. Additional loop modules or loop capacity must be provided to assure 40% spare addresses for any type of device added to the system.
4. The system shall transmit alarm signals to a remote central station in full compliance with NFPA 72. The batteries will be able to operate the system under maximum normal load condition for not less than 24 consecutive hours followed by fifteen (15) minutes of alarm.
5. Provide a low voltage, 24 volt DC fire alarm control panel including all circuitry, amplifiers, power supplies, batteries, programming and cabinet space necessary to perform required functions, and to service as test and trouble signal points.
6. All input/output cards shall be modular, plug-in type devices.
7. Equip control panel for number of initiating addresses as required plus 40% spare capacity. Provide 25% spare amplifier capacity.
8. The control panel shall include the following additional features:

Walk test feature for single person testing of the system. This feature includes special audible indication and zone trouble indication.

Alarm verification, programmable per device.

Totally field programmable with multiple password protection.

All initiation and indication circuits shall be power limited for use with limited energy cables.

Addressable monitor modules may be field programmed for normal water flow or supervisory operation.

Any output control/relay module circuit may be mapped to any input device in non-volatile program memory.

Display program function allows system field program information to be easily displayed using front panel controls.

Disable capability for each device shall be provided from the control panel.

A 1000 event history log stored in non-volatile memory with storage of alarm verification activities.

Serial annunciator port shall be provided for high-speed 4-wire annunciation of the system.

9. Contractor to provide dedicated 20A, 120VAC power connections to fire alarm control panel, amplifier cabinets and fire alarm strobe extender power panels.
10. Provide and install clamp-on breaker locking cleats manufactured by Brady, Space Age Electronics, or equivalent for all breakers serving the fire alarm system components. Each breaker shall be labeled with a red identifier noting "fire alarm". Coordinate with Division 26 contractor.

D. Integrated Fire Alarm Communicator:

1. The FACP shall include a UL Listed integrated commercial fire digital communicator complete with the following features:

Meet NFPA 72 requirements for Digital Alarm Communicator Transmitter.

Capable of seizing the telephone line at the protected premises, disconnecting an outgoing or incoming call, and preventing its use until signal transmission has been completed.

Connections for two separate telephone lines at protected premises.

Capable of selecting the operable line in the event of a failure on either line.

Programmed to call a second number should the signal transmission be unsuccessful.

The digital communicator shall be connected to the fire alarm system to receive and transmit alarm signals, trouble conditions and supervisory conditions using Contact ID transmission protocol.

2. The system shall include a dual path commercial fire alarm communicator with cellular and IP communication capabilities (Honeywell #IPGSM-4G or equal). The Contractor shall provide cable, connectors and installation of IP data cables from the data rack. The communicator will transmit each event as digital information over the IP and cellular network. The contractor shall test the signal of the cellular antenna and provide additional antennae as required to produce a reliable cellular signal.

E. Remote Annunciator/Remote Microphone

1. Remote annunciator panel shall include an 80-character backlit LCD display to mirror the fire alarm control panel display and piezo sounder to notify of system trouble. Provide a microphone with speaker selector switches in the same enclosure with the remote annunciator or a general remote paging microphone as specified in section I Sequence of Operations.
2. Remote annunciator/microphone to be provided with key lock switch and control keypad for system acknowledge, audible signal silence, system reset functions and speaker zone selection if specified in paragraph I Sequence of Operations.
3. Flush or surface mounting of remote annunciator panel to be coordinated prior to installation.

F. Field Devices

1. Manual Fire Alarm Stations: Addressable non-coded, red semi-flush, dual action manual station manufactured of Lexan with clearly visible operating instructions on the cover. Where noted on drawings, provide a Safety Technology International Stopper II cover without horn.
2. Photoelectric Detectors Addressable photoelectric smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density. Provide detectors as shown on plans and as a minimum provide a smoke detector at control panel and each remote power supply location.
3. Duct Detector: Addressable photoelectric duct mounted smoke detector with sampling tube and protective housing. Provide remote test switches or remote LED's where noted on plans. Contractor to provide all load relays necessary for fan shut-down.
- 4.
5. Thermal Detector: Addressable fixed temperature low profile device with twist lock base. Temperature rating to be 135 degrees or 190 degrees (High temp version). In elevator equipment rooms and shafts, heat detectors shall be located within two feet of each sprinkler head.
6. Relay Modules: Addressable relay modules with LED indicator light.
7. Control Modules: Addressable control modules with LED indicator light.
8. Monitor Modules: Addressable monitor modules with LED indicator light.

9. Door Holders: Flush wall mount electromagnetic door holder controlled by fire alarm system. Provide extension rods or box extensions as necessary. Door Holders shall be 24V or 120V powered. Provide power supplies as necessary. Label power supplies "Door Holder Power Supply". Door Holders provided by fire alarm supplier. At the contractors option provide either 24 volt or 120 volt door holders for this project.
10. Carbon Monoxide Detector: Provide an addressable CO detector that looks similar to an addressable smoke detector. The detector shall be connected to the SLC circuit and include an audible base providing a code 4 temporal pattern. If addressable CO detectors are unavailable by the specific system supplier a 4-wire carbon monoxide detector monitored by a fire alarm system monitor module with local alarm sounder and trouble relay will be considered equal. Mount per manufacturer's instructions.
11. All initiating devices shall be identified with a black-on-clear (1/4" text minimum) printed adhesive label affixed to the device. This label shall include the device address.

G. Signaling Appliances

1. Speakers. Speakers shall be combined with strobes or stand alone as indicated on plans. Speakers shall be wall or ceiling mounted and white in color.
  - a. All speakers shall operate on 25 VRMS or with field selectable output taps from 0.25 to 2.0 Watts.
  - b. Speakers in corridors and public spaces shall produce a minimum nominal sound output of 83 dBA at 10 feet (3m).
  - c. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
  - d. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.
2. Strobes. Strobes shall be wall or ceiling mounted and white in color. Strobes shall be combined with speakers or stand alone as indicated on plans. Strobe lights shall be multi-candela units and meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
  - a. The maximum pulse duration shall be 2/10 of one second.
  - b. Strobe intensity and flash rate shall meet the requirements of UL 1971.
  - c. Strobes shall be synchronized.
  - d. The signals shall operate on 24 VDC polarized and the device shall be able to test circuit supervision without disconnecting wires.
  - e. There shall be FIRE lettering clearly visible from both sides. Red or white device color to be coordinated with Architect.
  - f. Visual and audible devices shall be synchronized within the project area and synchronized with all adjacent areas. This Contractor and equipment supplier shall provide cabling and equipment to achieve synchronization between the project area and adjacent spaces- including but not limited the installation of synchronization modules, Sync Protocols, replacement of power supplies, replacing strobes without synchronization capability, and associated cabling. Locating existing power supplies outside the

project area shall be the responsibility of the Contractor/equipment suppliers.

3. Provide remote strobe signal expander power supplies as necessary. Provide dedicated 20A, 120V circuit to each remote power supply or group of power supplies not exceeding 80% of AC circuit capacity.

#### H. Waterflow Exterior Signaling Appliances

1. Potter SASH -120 volt exterior audible/visual alarm signal representing sprinkler system activation.
  - a. Device shall operate on 120 volt and connected to a set of contacts from the main waterflow switch.
  - b. Device shall be outdoor rated and include verbiage identifying a "sprinkler alarm" and call 911.

#### I. System Wiring

1. All wiring will be as required by the Equipment Supplier. Wire color-coding and the color shall remain the same throughout the system. In general, all initiating devices such as manual stations, smoke detectors and all modules will be installed across a common #18AWG twisted unshielded pair or as required by system supplier. The strobe circuits shall require #14AWG unshielded or as required by system supplier. The speaker circuits shall require #16AWG shielded cable or as required by system supplier.
2. No conduit or raceway system will include Class I or non-power limited fire protection signaling circuits with Class II or power limited fire protection signaling circuits in accordance with N.E.C. Article 725 or 760.
3. All conduit and wiring to flow switches, tamper switches, etc., shall be furnished and installed as part of this work.
4. Test results shall be submitted to Engineer per this specification section paragraph A 6.
5. Wiring may be run as concealed open-type plenum rated cable. Exposed or inaccessible wiring shall be installed in conduit. Where possible wiring/conduit shall be concealed. Provide sleeves in all walls which cable runs pass through. Refer to 26 05 29 for fire sealing of penetrations through fire rated walls. Provide access panels as necessary for cable routing. Support devices are to be attached to existing permanent structure.

#### J. Sequence of Operations

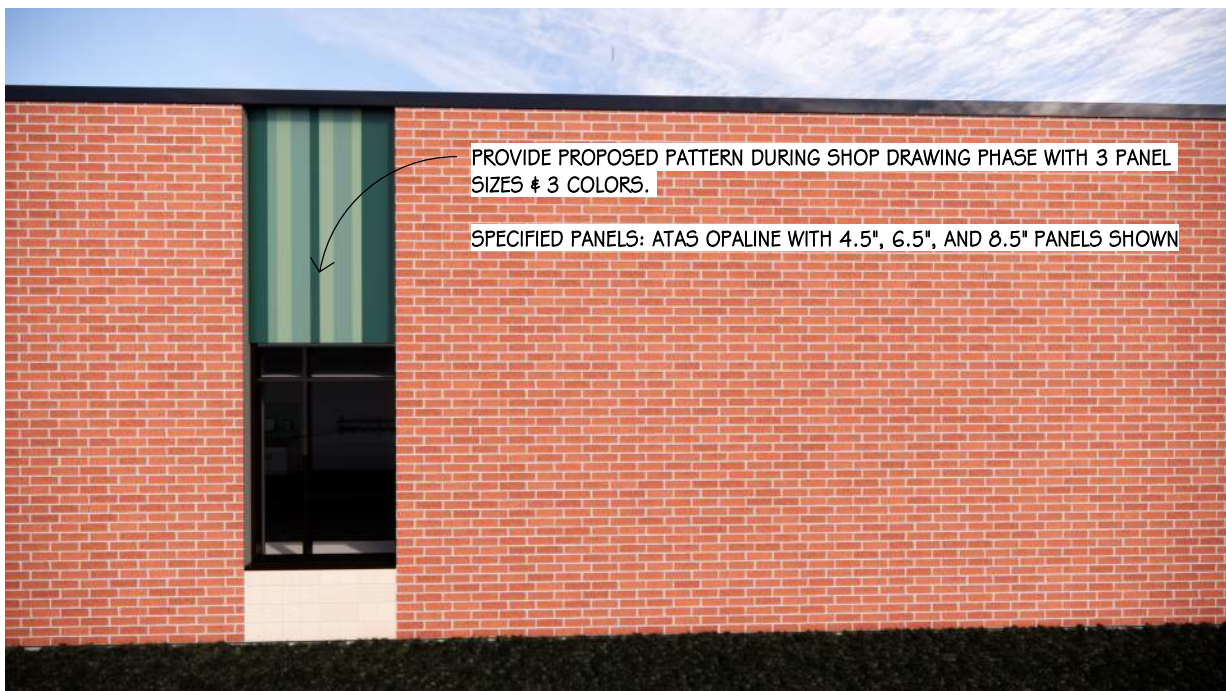
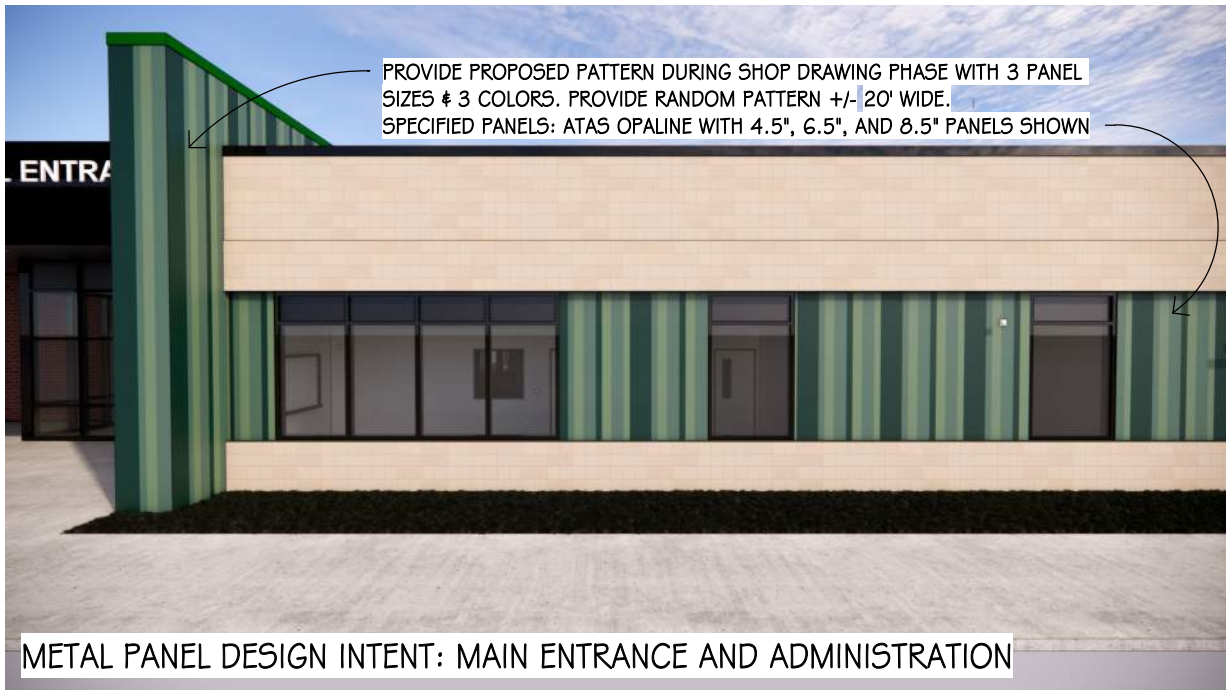
1. Fire alarm system shall evacuate entire building in the event of an alarm. The evacuation signal shall begin with a pre-announce tone in a code 3 temporal pattern repeated 3 times followed by the evacuation message. The message shall repeat until silenced or overridden by operators at the FACP or remote annunciator/microphone station with live voice instructions. Evacuation message shall be approved by the AHJ.

2. The following will occur upon activation of any alarm initiating device (smoke detector, heat detector, manual pull station and water flow monitor module):
  - a. Sound audible signals and flash visual signals.
  - b. Display alarm status information on the fire alarm control panel, each remote annunciator and send an alarm signal to the remote supervising station.
  - c. Activate addressable control modules to shut down air handling units, close fire/smoke dampers and release all smoke doors.
3. The following to occur upon activation of a trouble signal (open circuit, ground fault, low battery, loss of AC power, etc.):
  - a. Display trouble status at the fire alarm control panel, each remote annunciator and send a trouble signal to the remote supervising station.
4. A system duct detector activation shall shut-down all air handling units, display supervisory status at the fire alarm control panel, each remote annunciator and send a supervisory signal to the remote supervising station.
5. Tamper switch state change shall display supervisory status at the fire alarm control panel, each remote annunciator and send a supervisory signal to the remote supervising station
6. Exterior horn/strobe at fire department connection to only activate on water flow.
7. Kitchen hood fire detection to initiate full building alarm equal to the activation of a manual station or smoke detector.
8. Carbon monoxide detector activation shall display supervisory status at the fire alarm control panel, each remote annunciator and send a supervisory signal to the remote supervising station
9. The generator to be monitored by the fire alarm system to send supervisory signals to the fire alarm control panel for 'Generator Trouble', 'Generator Running', 'Battery Charger Trouble' and 'Generator Ground Fault'.

END OF SECTION  
104313.000



**\*\*PRINT IN COLOR\*\***



THIS SD IS PROVIDED TO DEMONSTRATE THE DESIGN INTENT FOR THE VERTICAL METAL PANELS. SEE A2.1 AND A2.2, KEYED NOTE #7.  
FINAL COLORS TO BE DETERMINED

**HOENER ASSOCIATES, INC.**  
ARCHITECTS  
ST. LOUIS, MISSOURI

MARK A. REUTHER  
LICENSE #006452

ARCHITECTURAL CORP.  
NO. 000193

PROJECT NO. 23-09B

BY: AC

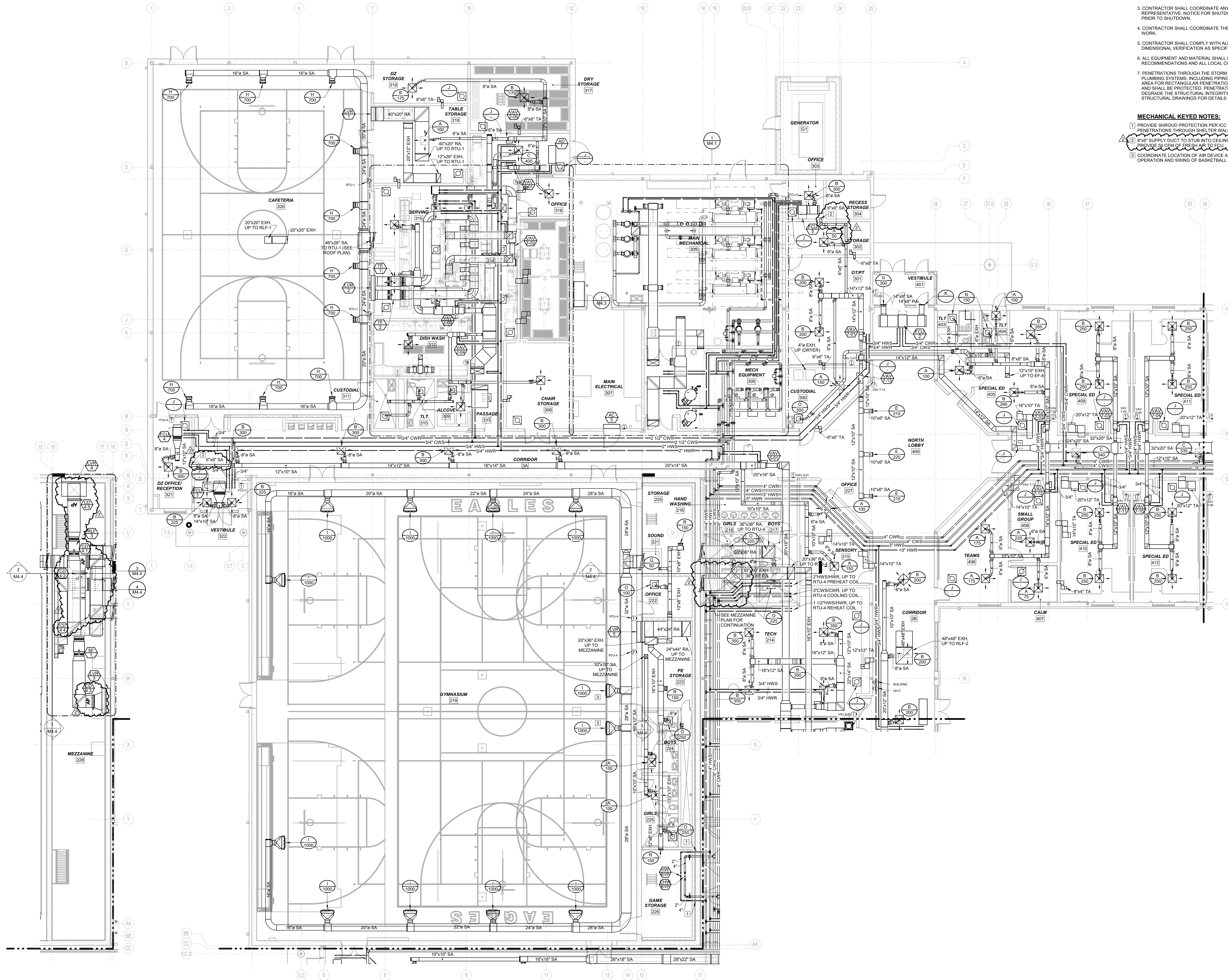
DATE: 07-02-2024

REV.: **ADDENDUM 2**  
08-01-2024

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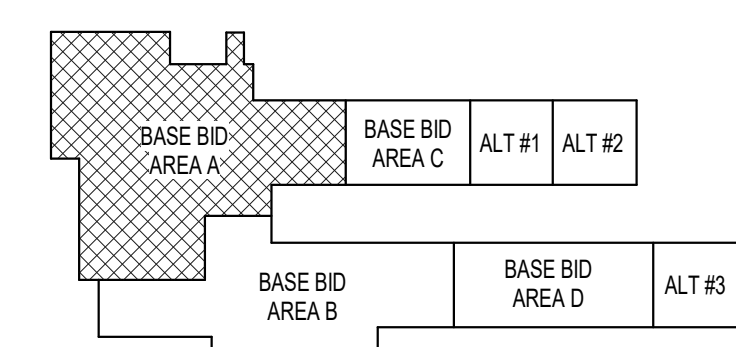
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MEZZANINE PLAN - MECHANICAL  
SCALE: 1/8" = 1'-0"

FLOOR PLAN - AREA A - MECHANICAL  
SCALE: 1/8" = 1'-0"



KEY PLAN

MECHANICAL GENERAL NOTES:

1. THESE DRAWINGS WERE PREPARED UTILIZING EXISTING DRAWINGS AND FIELD OBSERVATIONS. CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO STARTING WORK. NOTIFY CONSTRUCTION MANAGER IMMEDIATELY OF ANY DISCREPANCIES.
2. CONTRACTOR SHALL TAKE EXTREME CARE HANDLING MATERIAL DERRIS IN AN EFFORT TO AVOID ANY DISRUPTIONS OF ONGOING BUILDING OPERATIONS. PROJECT SHALL BE CLEANED FREE OF DUST AND DERRIS AT THE END OF THE WORK DAY.
3. CONTRACTOR SHALL COORDINATE ANY SHUTDOWN OF UTILITIES WITH THE OWNER'S REPRESENTATIVE. NOTICE FOR SHUTDOWN SHALL BE GIVEN TO THE OWNER AT LEAST THREE DAYS PRIOR TO SHUTDOWN.
4. CONTRACTOR SHALL COORDINATE THEIR WORK WITH ALL OTHER TRADES PRIOR TO BEGINNING WORK.
5. CONTRACTOR SHALL COMPLY WITH ALL REQUIREMENTS FOR FIELD COORDINATION AND DIMENSIONAL VERIFICATION AS SPECIFIED IN THE PROJECT MANUAL.
6. ALL EQUIPMENT AND MATERIAL SHALL BE INSTALLED ACCORDING TO THE MANUFACTURERS RECOMMENDATIONS AND ALL LOCAL CODES.
7. PENETRATIONS THROUGH THE STORM SHELTER ENVELOPE OF MECHANICAL, ELECTRICAL, AND PLUMBING SYSTEMS, INCLUDING PIPING AND UTILITY LINES, LARGER THAN 3-1/2 SQUARE INCHES IN AREA FOR RECTANGULAR PENETRATIONS OR 2-1/16" IN DIAMETER SHALL BE CONSIDERED OPENINGS AND SHALL BE PROTECTED. PENETRATIONS OF THE STORM SHELTER ENVELOPE SHALL NOT DEGRADE THE STRUCTURAL INTEGRITY OF THE STORM SHELTER ENVELOPE. REFER TO THE STRUCTURAL DRAWINGS FOR DETAILS OF A PROTECTIVE SHROUD.

MECHANICAL KEYED NOTES:

1. PROVIDE SHROUD PROTECTION PER ICC 500 FOR PIPE PENETRATIONS THROUGH SHELTER WALL.
2. PROVIDE SUPPLY DUCT TO SUB INTO CEILING SPACE TO PROVIDE 6" CMV OF FREE AIR TO FLOOR.
3. COORDINATE LOCATION OF AIR DEVICE AND DUCT WITH OPERATION AND SWING OF BASKETBALL GOAL.



ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000097

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

CONSULTING ENGINEERS:  
HOENER ASSOCIATES, INC. - ARCHITECTS  
1507 PULASKI AVE.  
ST. LOUIS, MISSOURI 63103  
OFFICE: 314. 781.9855  
HoenerArchitects.com

ORCHARD FARM SCHOOL DISTRICT  
ALL DIMENSIONS MUST BE  
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PROJ. NO. 23-09B

DATE ISSUED

07-02-2024

DATE REVISION

1 07/23/24 ADDENDUM #1

2 08/01/24 ADDENDUM #2

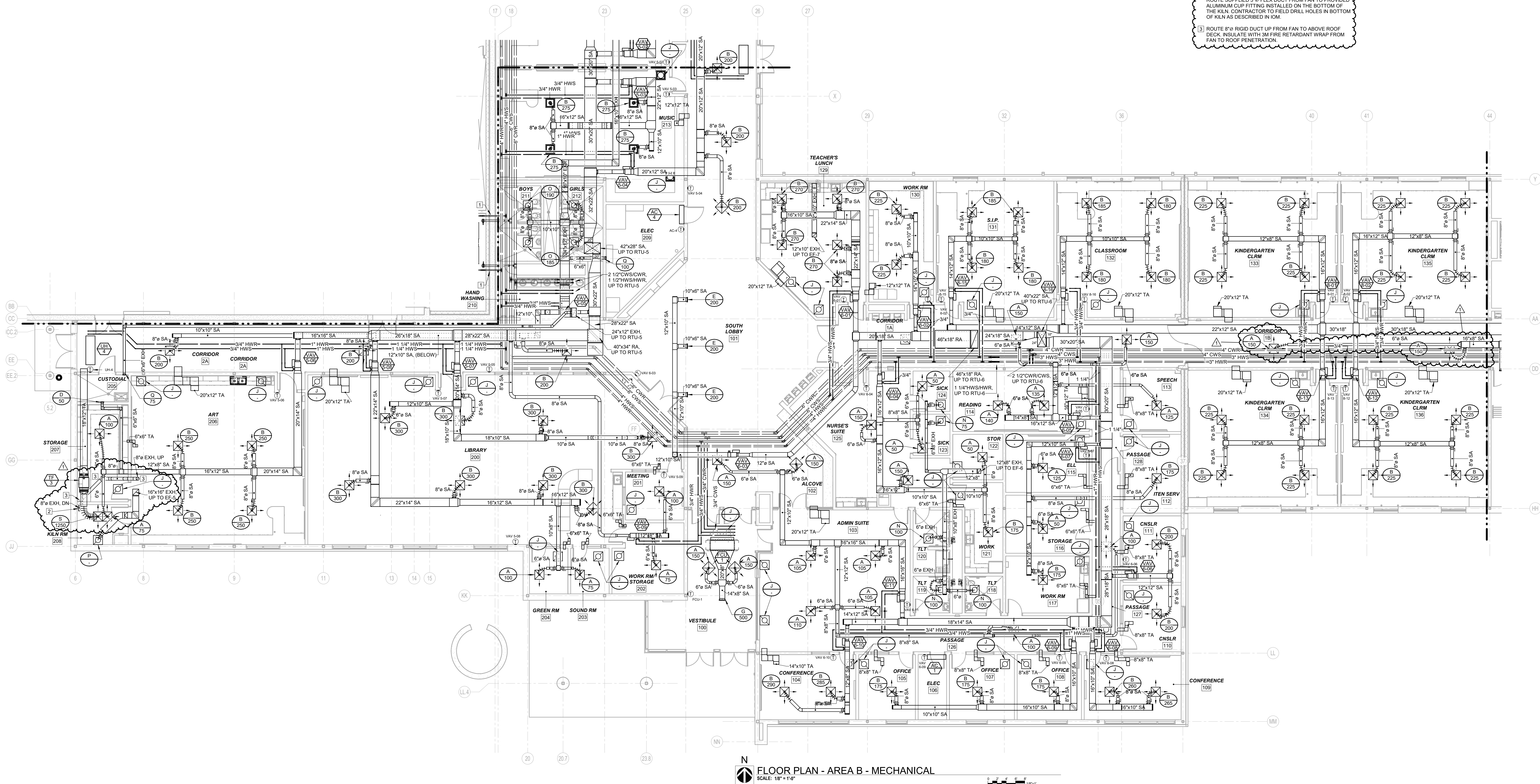
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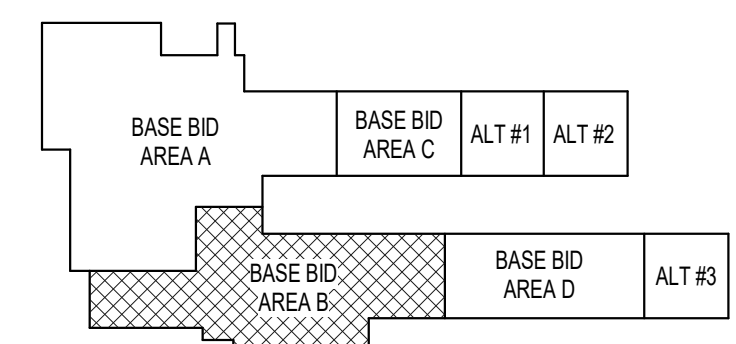


MECHANICAL GENERAL NOTES:

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4. CONTRACTOR SHALL COORDINATE THEIR WORK WITH ALL OTHER TRADES PRIOR TO BEGINNING WORK.
5. CONTRACTOR SHALL COMPLY WITH ALL REQUIREMENTS FOR FIELD COORDINATION AND DIMENSIONAL VERIFICATION AS SPECIFIED IN THE PROJECT MANUAL.
6. ALL EQUIPMENT AND MATERIAL SHALL BE INSTALLED ACCORDING TO THE MANUFACTURERS RECOMMENDATIONS AND ALL LOCAL CODES.
7. PENETRATIONS THROUGH THE STORM SHELTER ENVELOPE OF MECHANICAL, ELECTRICAL, AND PLUMBING SYSTEMS, INCLUDING PIPING AND UTILITY LINES, LARGER THAN 3/12 SQUARE INCHES IN AREA FOR RECTANGULAR PENETRATIONS OR 2-1/8" IN DIAMETER SHALL BE CONSIDERED OPENINGS AND SHALL BE PROTECTED. PENETRATIONS OF THE STORM SHELTER ENVELOPE SHALL NOT DEGRADE THE STRUCTURAL INTEGRITY OF THE STORM SHELTER ENVELOPE. REFER TO THE STRUCTURAL DRAWINGS FOR DETAILS OF A PROTECTIVE SHROUD.

MECHANICAL KEYED NOTES:

1. PROVIDE SHROUD PROTECTION PER ICC 500 FOR PIPE PENETRATIONS THROUGH SHELTER WALL.
2. INSTALL KILN FUME EXHAUST FAN IN AN ACCESSIBLE LOCATION. SUPPORT FAN AS REQUIRED WITH UNISTRUT. ROUTE SUPPLIED 3/4" FLEX DUCT FROM FAN TO PROVIDED ALUMINUM CUP FITTING INSTALLED ON THE BOTTOM OF THE KILN. CONTRACTOR TO FIELD DRILL HOLES IN BOTTOM OF KILN AS DESCRIBED IN IOM.
3. ROUTE 8" RIGID DUCT UP FROM FAN TO ABOVE ROOF DECK. INSULATE WITH 3M FIRE RETARDANT WRAP FROM FAN TO ROOF PENETRATION.



KEY PLAN

N  
FLOOR PLAN - AREA B - MECHANICAL  
SCALE: 1/8" = 1'-0"



ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000957

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

ORCHARD FARM SCHOOL DISTRICT  
HOENER ASSOCIATES, INC. - ARCHITECTS  
10701 PLUMMER AVE  
ST. LOUIS, MISSOURI 63141  
OFFICE: 314.781.9855  
HoenerArchitects.com

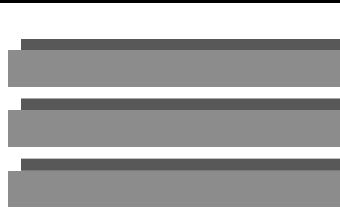
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SD: 40





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| 03/09/04 | APPENDIX III |

2 08/01/24 ADDENDUM #2

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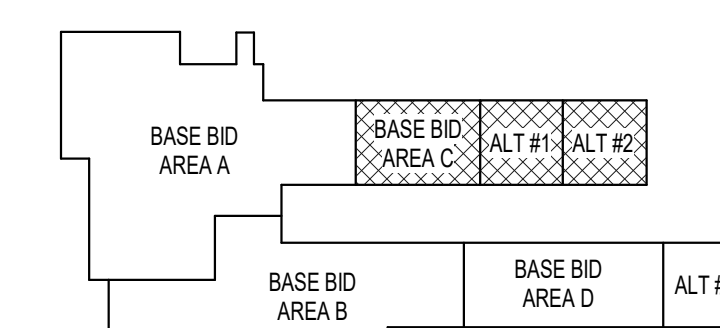
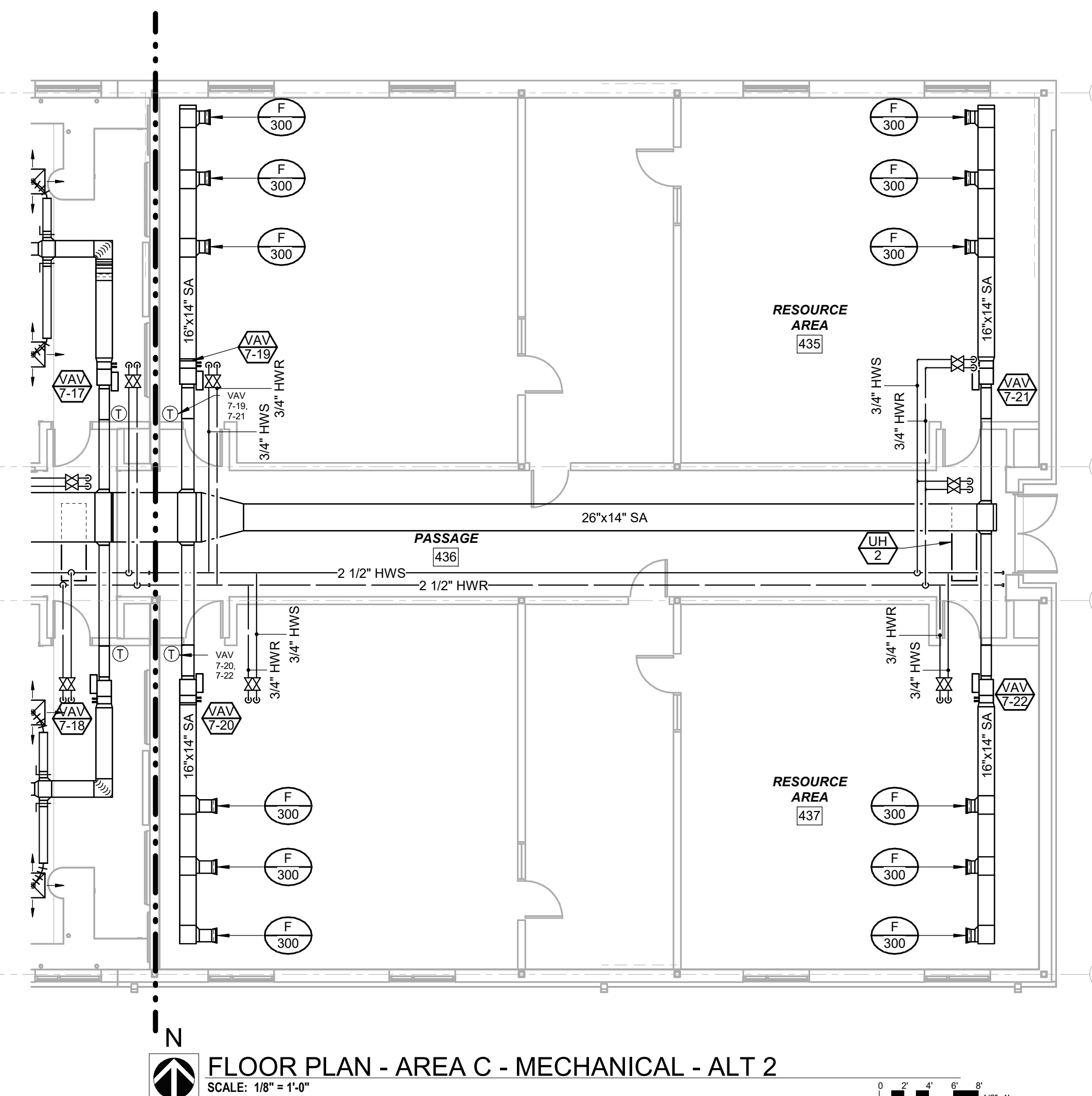
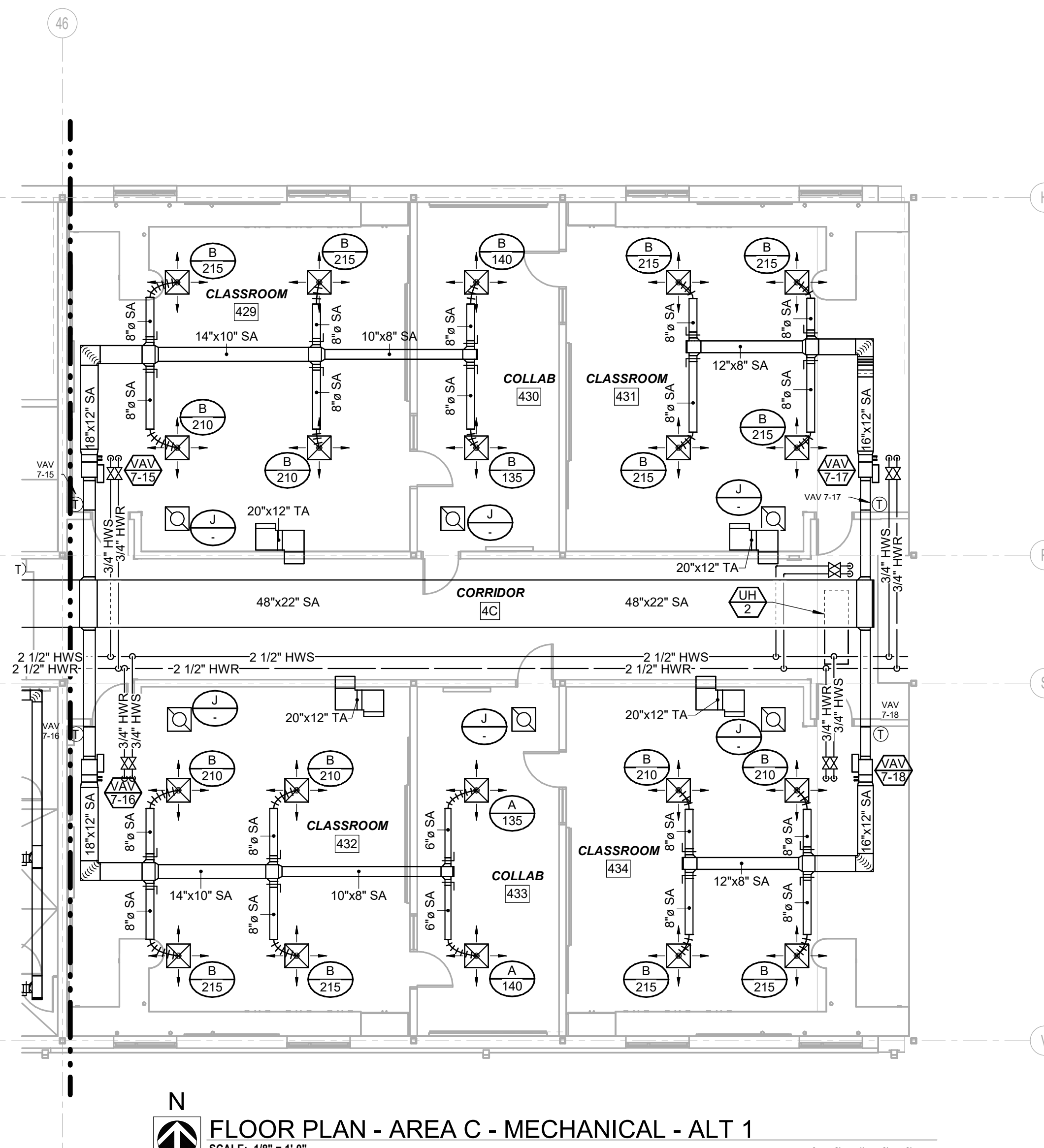
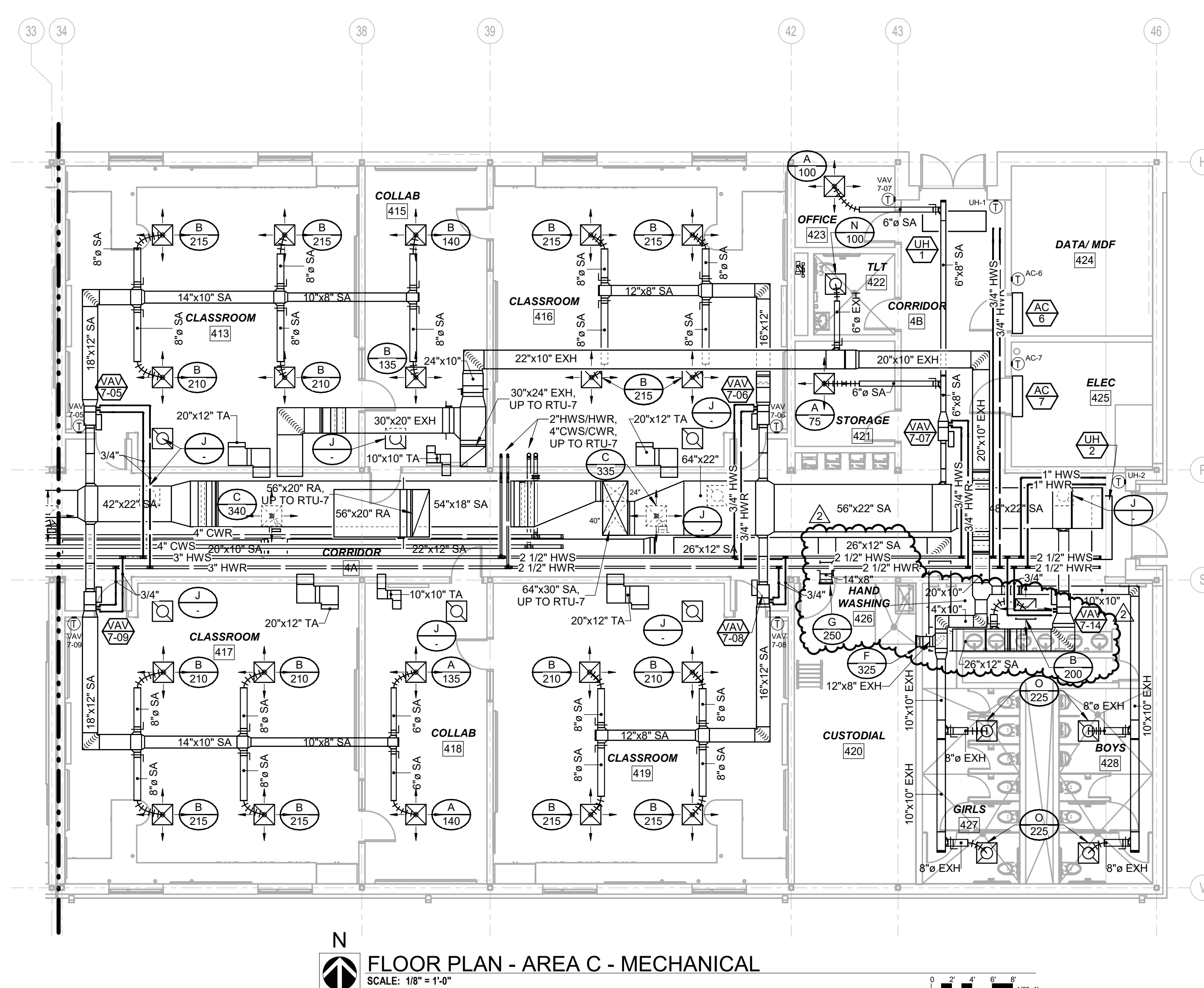
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M3 4

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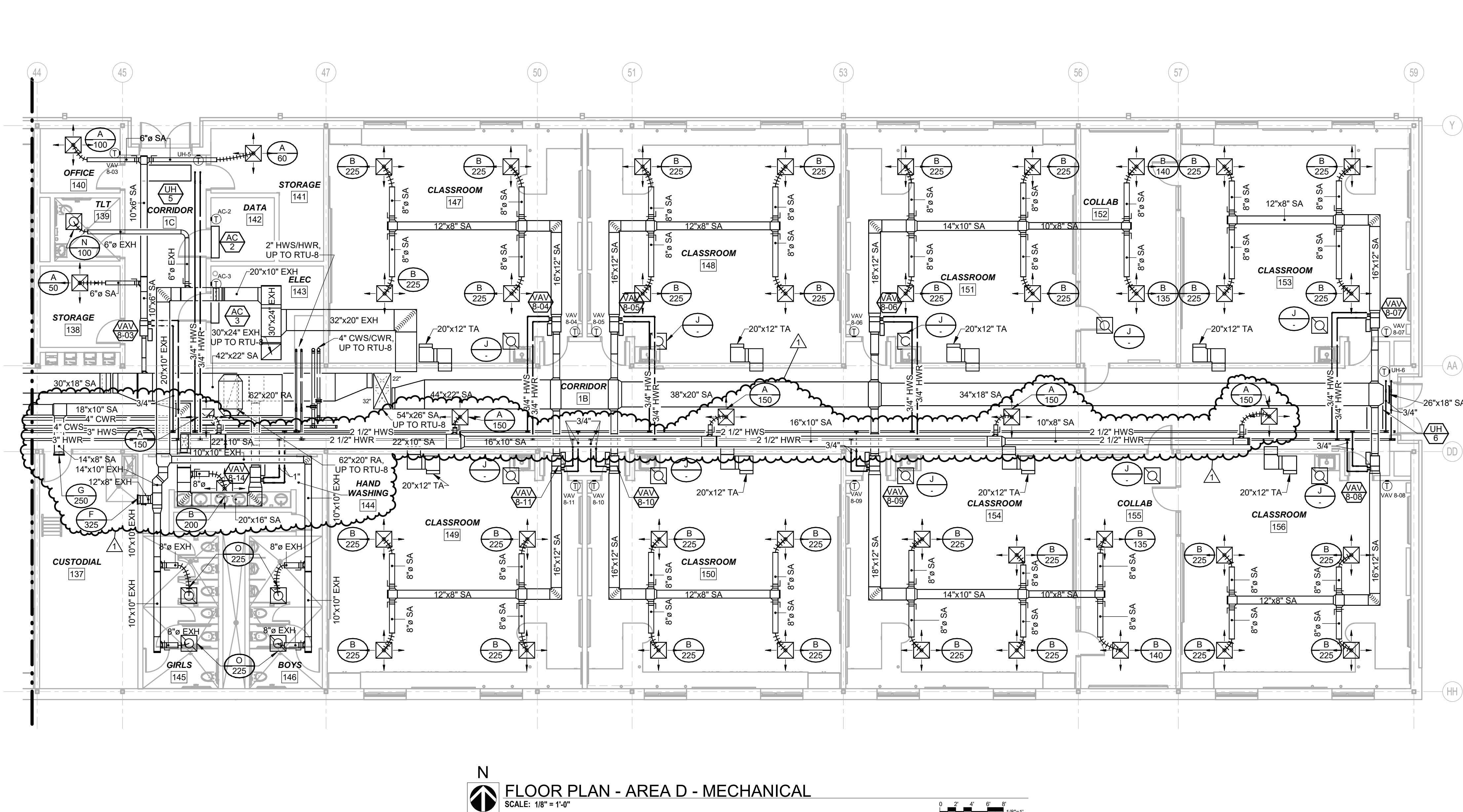
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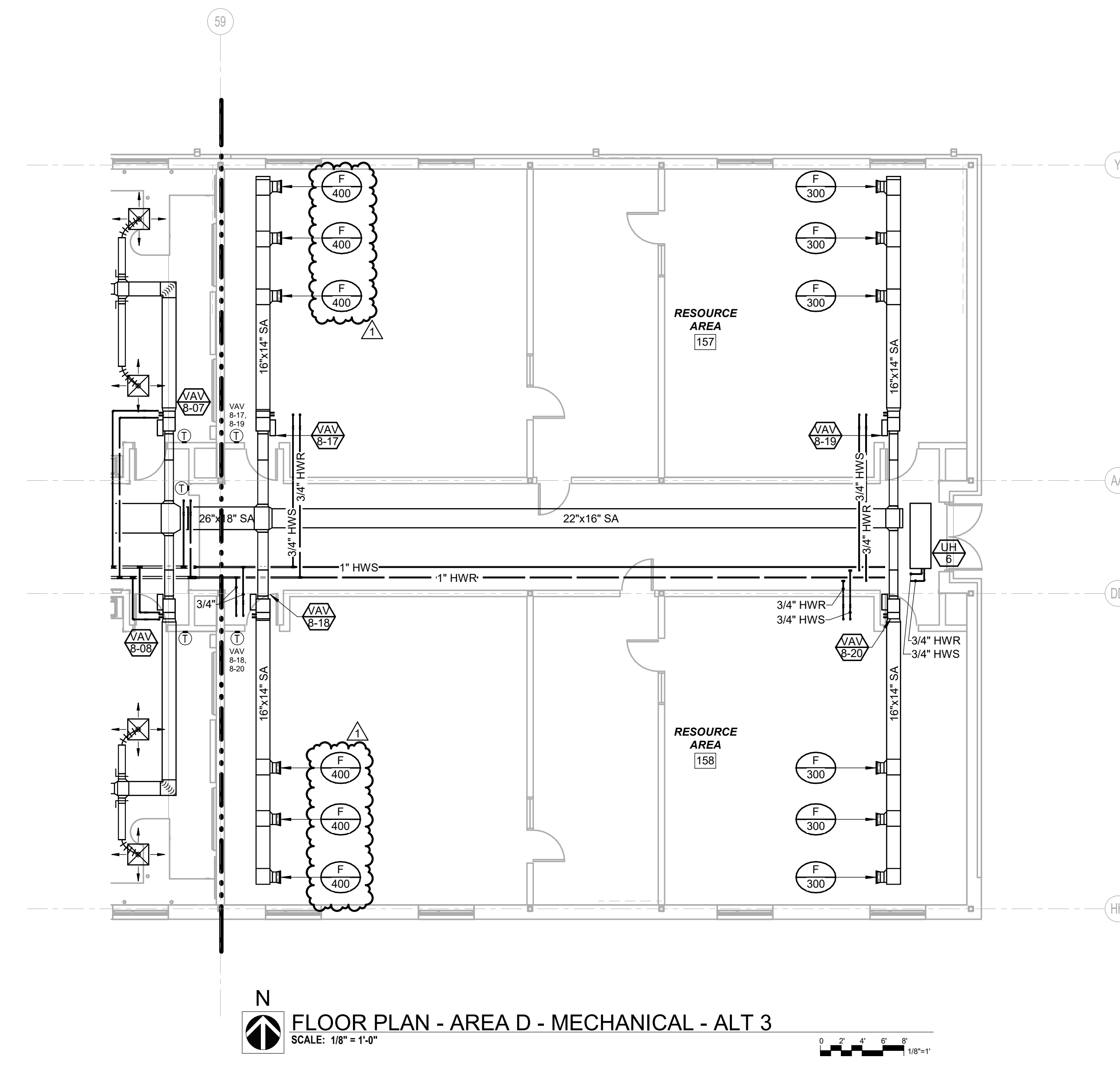
## KEY PLAN

FIRST FLOOR PLAN - AREA C - MECHANICAL

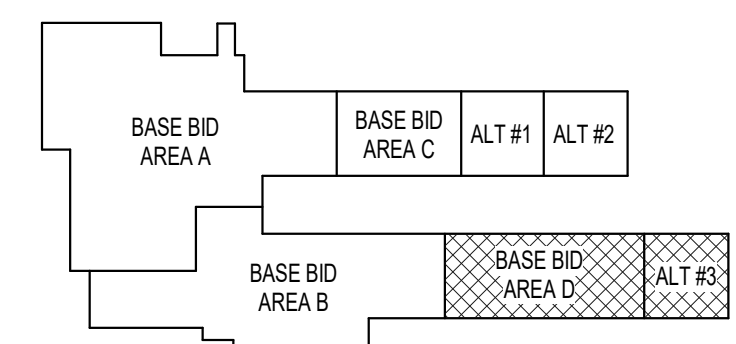




N  
FLOOR PLAN - AREA D - MECHANICAL  
SCALE: 1/8" = 1'-0"



N  
FLOOR PLAN - AREA D - MECHANICAL - ALT 3  
SCALE: 1/8" = 1'-0"



KEY PLAN

- MECHANICAL GENERAL NOTES:**
1. THESE DRAWINGS WERE PREPARED UTILIZING EXISTING DRAWINGS AND FIELD OBSERVATIONS. CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO STARTING WORK. NOTIFY CONSTRUCTION MANAGER IMMEDIATELY OF ANY DISCREPANCIES.
  2. CONTRACTOR SHALL TAKE EXTREME CARE HANDLING MATERIAL DEBRIS IN AN EFFORT TO AVOID ANY DISRUPTIONS OF ONGOING BUILDING OPERATIONS. PROJECT SHALL BE CLEANED FREE OF DUST AND DEBRIS AT THE END OF THE WORK DAY.
  3. CONTRACTOR SHALL COORDINATE ANY SHUTDOWN OF UTILITIES WITH THE OWNER'S REPRESENTATIVE. NOTICE FOR SHUTDOWN SHALL BE GIVEN TO THE OWNER AT LEAST THREE DAYS PRIOR TO SHUTDOWN.
  4. CONTRACTOR SHALL COORDINATE THEIR WORK WITH ALL OTHER TRADES PRIOR TO BEGINNING WORK.
  5. CONTRACTOR SHALL COMPLY WITH ALL REQUIREMENTS FOR FIELD COORDINATION AND DIMENSIONAL VERIFICATION AS SPECIFIED IN THE PROJECT MANUAL.
  6. ALL EQUIPMENT AND MATERIAL SHALL BE INSTALLED ACCORDING TO THE MANUFACTURERS RECOMMENDATIONS AND ALL LOCAL CODES.
  7. PENETRATIONS THROUGH THE STORM SHELTER ENVELOPE OF MECHANICAL, ELECTRICAL, AND PLUMBING SYSTEMS, INCLUDING PIPING AND UTILITY LINES, LARGER THAN 3-1/2 SQUARE INCHES IN AREA FOR RECTANGULAR PENETRATIONS OR 2-1/8" IN DIAMETER SHALL BE CONSIDERED OPENINGS AND SHALL BE PROTECTED. PENETRATIONS OF THE STORM SHELTER ENVELOPE SHALL NOT DEGRADE THE STRUCTURAL INTEGRITY OF THE STORM SHELTER ENVELOPE. REFER TO THE STRUCTURAL DRAWINGS FOR DETAILS OF A PROTECTIVE SHROUD.

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CIVIL / SURVEY  
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PLUMBING  
FOUNDATION

NEW ELEMENTARY SCHOOL - 2525 HWY B

CONSULTING ENGINEERS:

HOENER ASSOCIATES, INC. - ARCHITECTS  
ORCHARD FARM SCHOOL DISTRICT  
8707 PLUMS WISSAUBURNE  
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SD: 42





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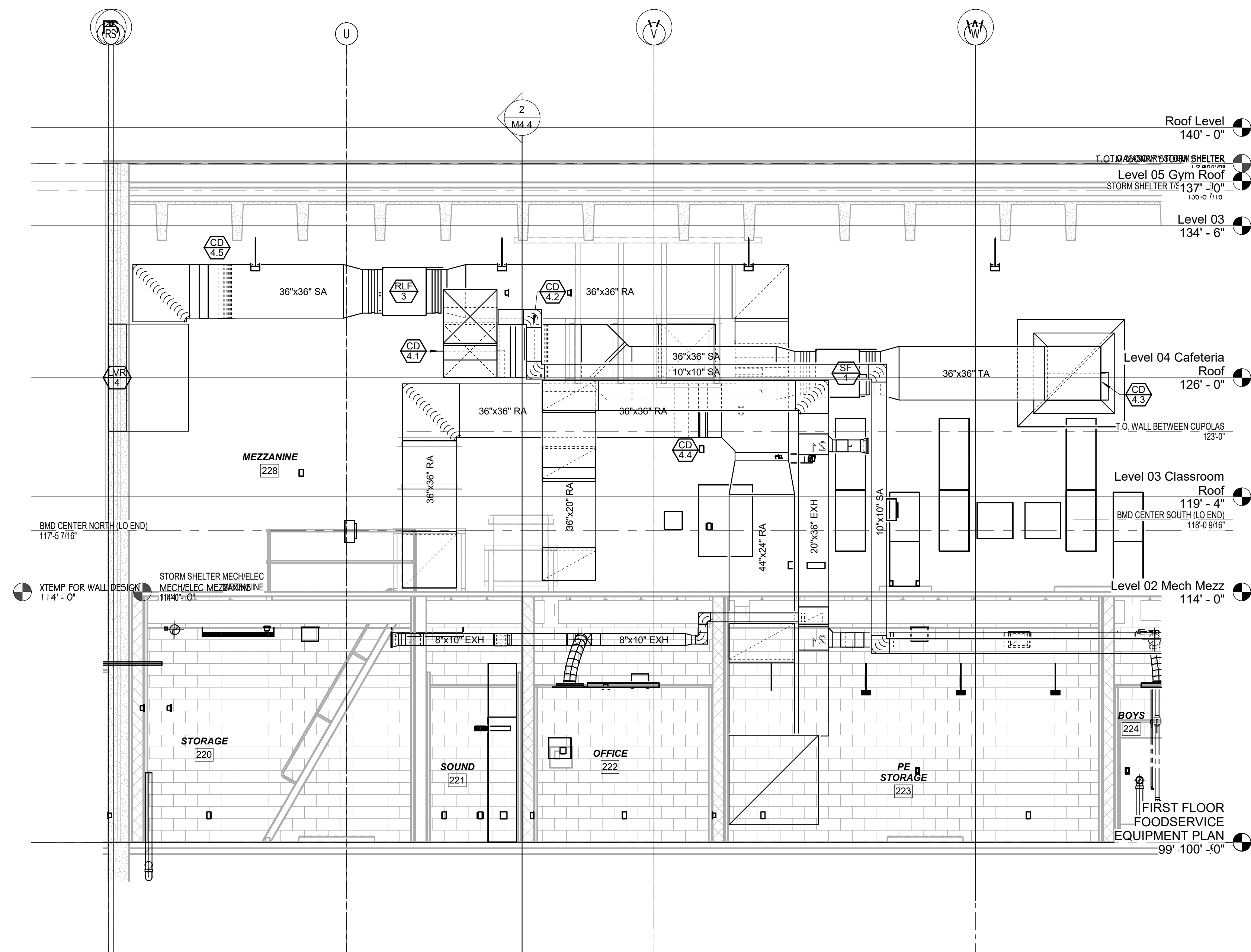
**M3.13**  
SD: 43

ROOF PLAN - AREA B - MECHANICAL

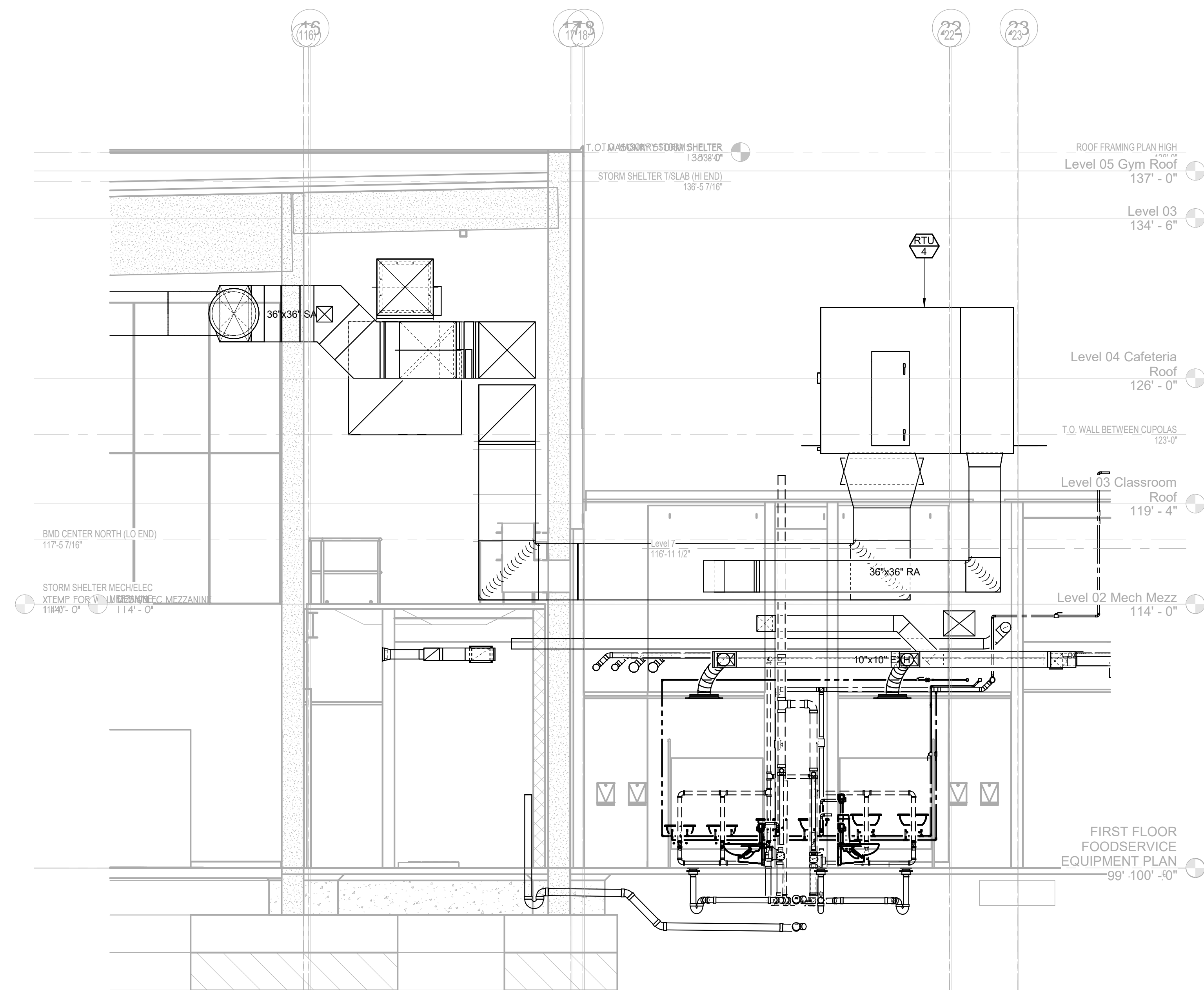


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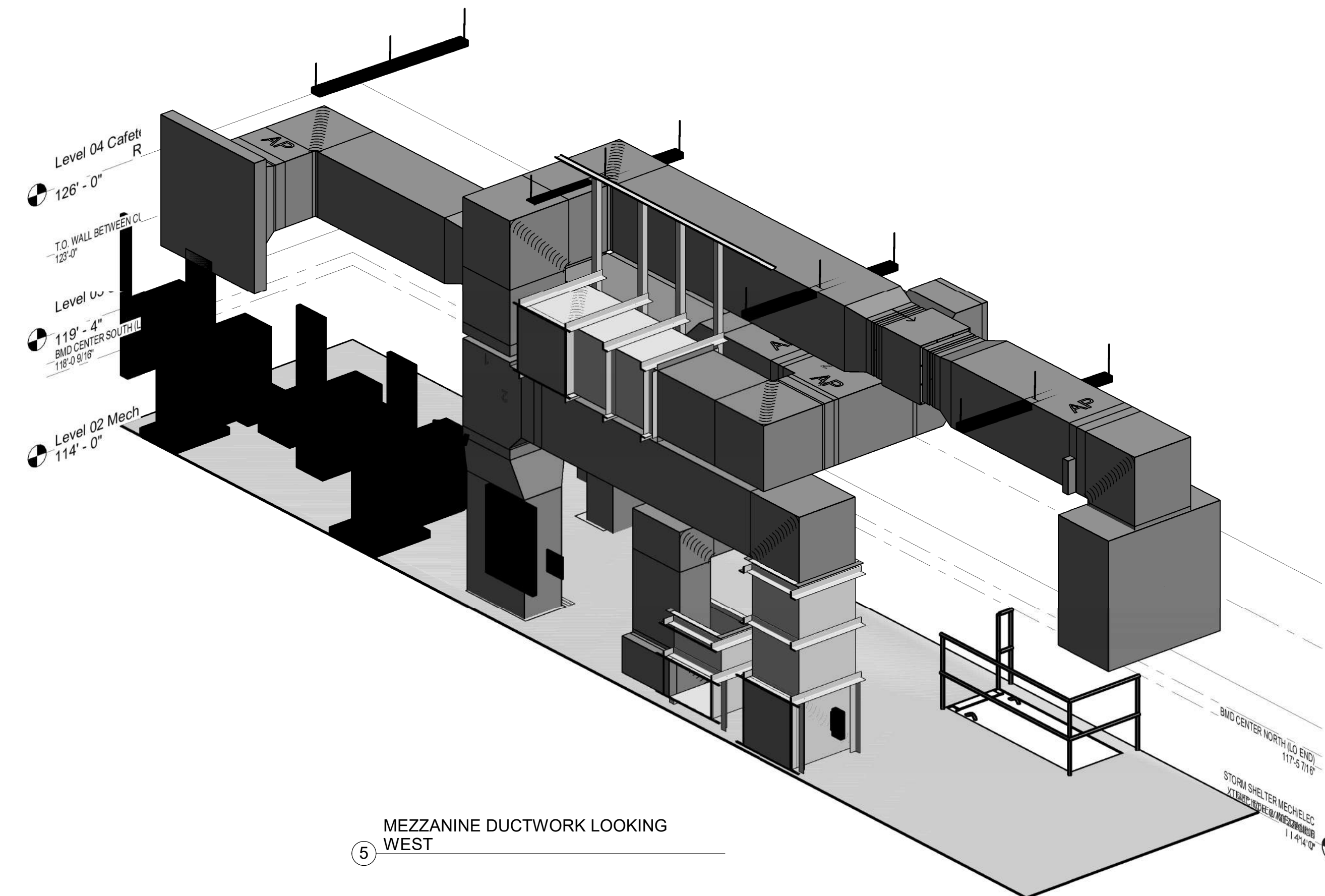
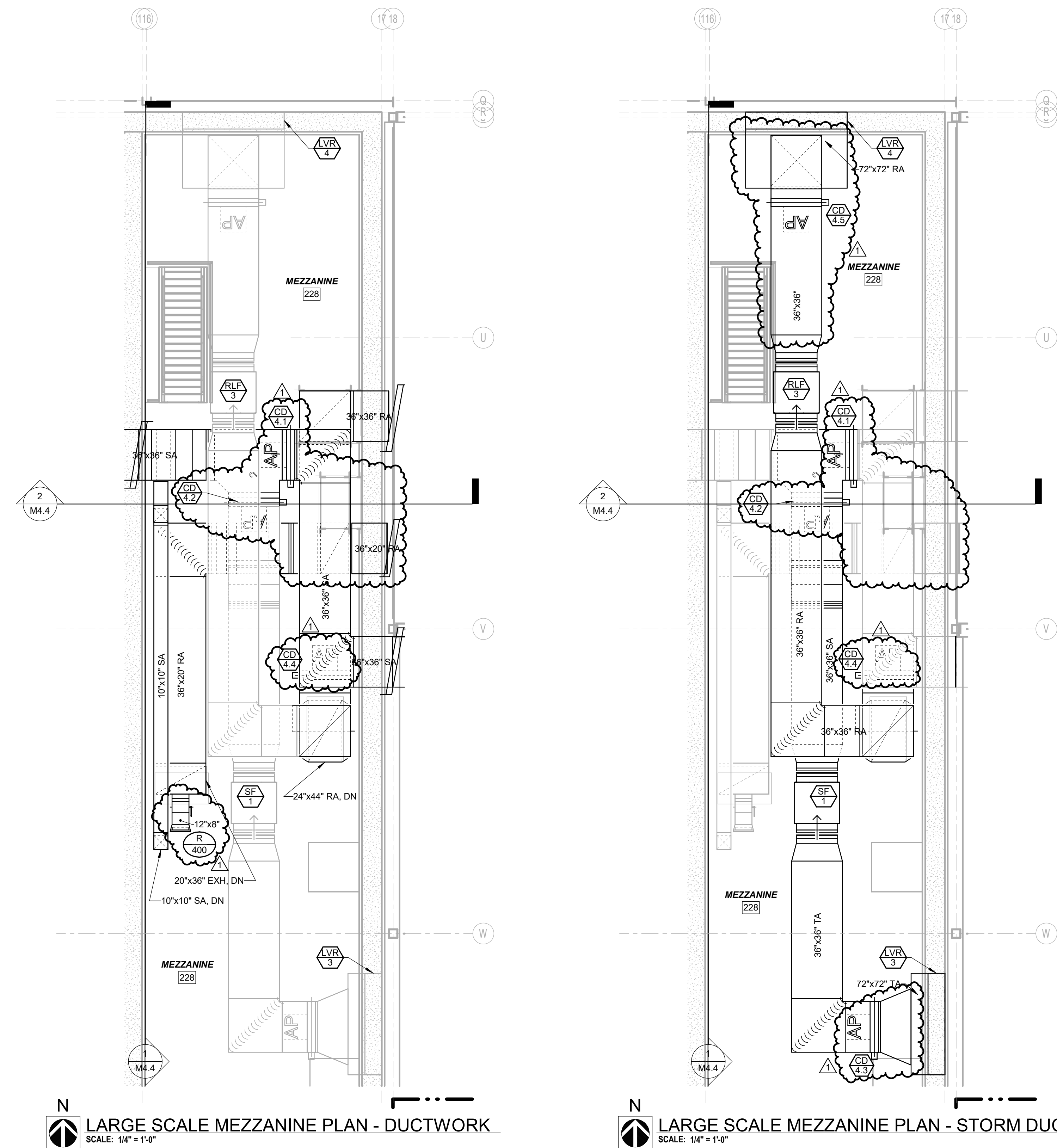




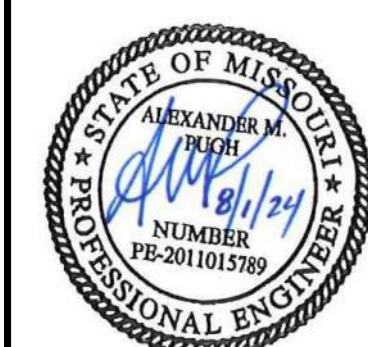
1  
M3.2  
**MEZZANINE DUCT ROUTING ELEVATION**  
SCALE: 1/4" = 1'-0"



2  
M3.2  
**RTU-4 AND STORM SHELTER PENETRATIONS**  
SCALE: 1/4" = 1'-0"



5  
**MEZZANINE DUCTWORK LOOKING WEST**



ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000087

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

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FOUNDATION ENGINEERS  
ENVIRONMENTAL ENGINEERS  
GENERAL ENGINEERS

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GENERAL ENGINEERS

ORCHARD FARM SCHOOL DISTRICT  
1807 PULASKI AVE  
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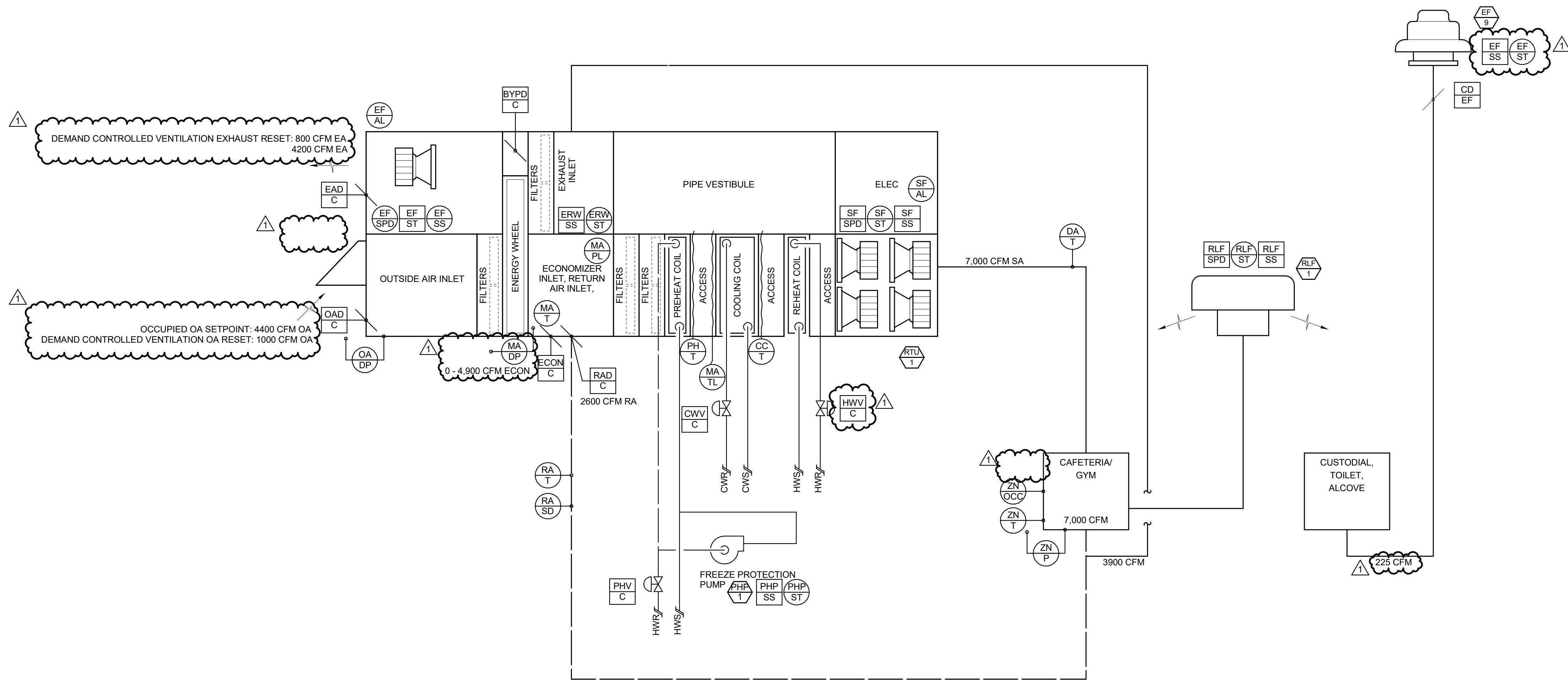
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**M4.4**  
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RTU-1 AIR FLOW DIAGRAM  
NO SCALE

RLF-1 POINTS LIST

| TYPE                                                                                                                                                                                                                                                               | NAME                        | POINT DESCRIPTION     |           | UNITS | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                       |  | NOTES                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------|-----------|-------|---------------|---------|---------------|---------|------------------------------------------------|--|-----------------------------------|
|                                                                                                                                                                                                                                                                    |                             | DESCRIPTION           |           |       | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                |  |                                   |
| BI                                                                                                                                                                                                                                                                 | RLF-ST                      | RELIEF FAN STATUS     | OFF / ON  |       | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                      |  |                                   |
| BO                                                                                                                                                                                                                                                                 | RLF-SS                      | RELIEF FAN START/STOP | OFF / ON  |       | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                            |  |                                   |
| AI                                                                                                                                                                                                                                                                 | ZONE-P                      | ZONE PRESSURE         | IN W.C. 1 |       | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | VERY LOW AIR DIFFERENTIAL PRESSURE TRANSMITTER |  | REFERENCE OUTSIDE AIR PRESSURE    |
| AO                                                                                                                                                                                                                                                                 | RLF-SPD                     | RELIEF FAN SPEED      | % 0       |       | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE           |  | 4-10 mA/2-10 VDC, COORD. WITH VFD |
| GENERAL NOTES<br>1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.<br>2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT. |                             |                       |           |       |               |         |               |         |                                                |  |                                   |
| BI                                                                                                                                                                                                                                                                 | BINARY INPUT                |                       |           |       |               |         |               |         |                                                |  |                                   |
| BO                                                                                                                                                                                                                                                                 | BINARY OUTPUT               |                       |           |       |               |         |               |         |                                                |  |                                   |
| BV                                                                                                                                                                                                                                                                 | BINARY VIRTUAL POINT        |                       |           |       |               |         |               |         |                                                |  |                                   |
| AI                                                                                                                                                                                                                                                                 | ANALOG INPUT                |                       |           |       |               |         |               |         |                                                |  |                                   |
| AO                                                                                                                                                                                                                                                                 | ANALOG OUTPUT               |                       |           |       |               |         |               |         |                                                |  |                                   |
| AV                                                                                                                                                                                                                                                                 | ANALOG VIRTUAL POINT        |                       |           |       |               |         |               |         |                                                |  |                                   |
| HW                                                                                                                                                                                                                                                                 | HARD WIRED INTERLOCK/SAFETY |                       |           |       |               |         |               |         |                                                |  |                                   |
| COS                                                                                                                                                                                                                                                                | CHANGE OF STATE             |                       |           |       |               |         |               |         |                                                |  |                                   |

TYPICAL EXHAUST FAN POINTS LIST

| TYPE                                                                                                                                                                                                                                                               | NAME                        | POINT DESCRIPTION      |               | UNITS | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION             |  | NOTES    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------|---------------|-------|---------------|---------|---------------|---------|--------------------------------------|--|----------|
|                                                                                                                                                                                                                                                                    |                             | DESCRIPTION            |               |       | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                      |  |          |
| BI                                                                                                                                                                                                                                                                 | EF-ST                       | EXHAUST FAN STATUS     | OFF / ON      |       | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH            |  |          |
| BO                                                                                                                                                                                                                                                                 | EF-SS                       | EXHAUST FAN START/STOP | OFF / ON      |       | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                  |  |          |
| EF-SPD                                                                                                                                                                                                                                                             |                             | EXHAUST FAN SPEED      | % 0           |       | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE |  | 2-10 VDC |
| BO                                                                                                                                                                                                                                                                 | EAD-C                       | EXHAUST AIR DAMPER     | OPEN / CLOSED |       | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR     |  |          |
| GENERAL NOTES<br>1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.<br>2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT. |                             |                        |               |       |               |         |               |         |                                      |  |          |
| BI                                                                                                                                                                                                                                                                 | BINARY INPUT                |                        |               |       |               |         |               |         |                                      |  |          |
| BO                                                                                                                                                                                                                                                                 | BINARY OUTPUT               |                        |               |       |               |         |               |         |                                      |  |          |
| BV                                                                                                                                                                                                                                                                 | BINARY VIRTUAL POINT        |                        |               |       |               |         |               |         |                                      |  |          |
| AI                                                                                                                                                                                                                                                                 | ANALOG INPUT                |                        |               |       |               |         |               |         |                                      |  |          |
| AO                                                                                                                                                                                                                                                                 | ANALOG OUTPUT               |                        |               |       |               |         |               |         |                                      |  |          |
| AV                                                                                                                                                                                                                                                                 | ANALOG VIRTUAL POINT        |                        |               |       |               |         |               |         |                                      |  |          |
| HW                                                                                                                                                                                                                                                                 | HARD WIRED INTERLOCK/SAFETY |                        |               |       |               |         |               |         |                                      |  |          |
| COS                                                                                                                                                                                                                                                                | CHANGE OF STATE             |                        |               |       |               |         |               |         |                                      |  |          |

RTU-1 POINTS LIST

| RTU-1 POINTS LIST                                                                                                                                              |                             |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------------------|--------------|---------------|---------|---------------|---------|--------------------------|---------------------------------------------------------|-------|-----------------------------------|
| POINT DESCRIPTION                                                                                                                                              |                             |                                         |              | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION |                                                         | NOTES |                                   |
| TYPE                                                                                                                                                           | NAME                        | DESCRIPTION                             | UNITS        | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE          |                                                         |       |                                   |
| GLOBAL POINTS (TO BE MAPPED...)                                                                                                                                |                             |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| AV                                                                                                                                                             | OA-T                        | OUTSIDE AIR TEMPERATURE REFERENCE       | °F, 1        | -             | -       | -             | -       |                          | BAS POINT MAPPED TO CONTROLLER                          |       |                                   |
| AV                                                                                                                                                             | OA-H                        | OUTSIDE AIR RELATIVE HUMIDITY REFERENCE | % RH, 1      | -             | -       | -             | -       |                          | BAS POINT MAPPED TO CONTROLLER                          |       |                                   |
| AV                                                                                                                                                             | OA-DWP                      | OUTSIDE AIR DEW POINT REFERENCE         | °F, 1        | -             | -       | -             | -       |                          | BAS POINT MAPPED TO CONTROLLER                          |       |                                   |
| AHU-UNIT LEVEL CONTROL...                                                                                                                                      |                             |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| AI                                                                                                                                                             | CC-T                        | COOLING COIL AIR TEMPERATURE            | °F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |       |                                   |
| AI                                                                                                                                                             | DA-T                        | DISCHARGE AIR TEMPERATURE               | °F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |       |                                   |
| AI                                                                                                                                                             | MA-T                        | MIXED AIR TEMPERATURE                   | °F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |       |                                   |
| AI                                                                                                                                                             | PH-T                        | PREHEAT AIR TEMPERATURE                 | °F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |       |                                   |
| AI                                                                                                                                                             | RA-T                        | RETURN AIR TEMPERATURE                  | °F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |       |                                   |
| AI                                                                                                                                                             | ZN-T                        | ZONE TEMPERATURE                        | °F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | ROOM SMART SENSOR                                       |       |                                   |
| AI                                                                                                                                                             | MA-DP                       | MIXED AIR DIFFERENTIAL PRESSURE         | IN W.C. 1    | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   |       | REFERENCE OUTSIDE AIR PRESSURE    |
| AO                                                                                                                                                             | EAD-C                       | EXHAUST AIR DAMPER                      | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DIRECT COUPLED ELECTRIC ACTUATOR                        |       |                                   |
| AO                                                                                                                                                             | OAD-C                       | MINIMUM OUTSIDE AIR DAMPER              | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DIRECT COUPLED ELECTRIC ACTUATOR                        |       |                                   |
| AO                                                                                                                                                             | BYPD-C                      | WHEEL BYPASS AIR DAMPER                 | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DIRECT COUPLED ELECTRIC ACTUATOR                        |       |                                   |
| AO                                                                                                                                                             | CWV-C                       | COOLING CONTROL VALVE                   | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | CONTROL VALVES                                          |       |                                   |
| AO                                                                                                                                                             | HWV-C                       | REHEAT CONTROL VALVE                    | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | CONTROL VALVES                                          |       |                                   |
| AO                                                                                                                                                             | ECON-C                      | ECONOMIZER DAMPER                       | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DIRECT COUPLED ELECTRIC ACTUATOR                        |       |                                   |
| AO                                                                                                                                                             | EF-SPD                      | EXHAUST FAN SPEED                       | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | HARDWIRED POINT TO CONTROLLED DEVICE                    |       | 4-10 mA/2-10 VDC, COORD. WITH VFD |
| AO                                                                                                                                                             | PHV-C                       | HEATING CONTROL VALVE                   | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | SEE CONTROL VALVE SCHEDULE                              |       |                                   |
| AO                                                                                                                                                             | RAD-C                       | RETURN AIR DAMPER                       | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DIRECT COUPLED ELECTRIC ACTUATOR                        |       |                                   |
| AO                                                                                                                                                             | SF-SPD                      | SUPPLY FAN SPEED                        | % 0          | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | HARDWIRED POINT TO CONTROLLED DEVICE                    |       | 4-10 mA/2-10 VDC, COORD. WITH VFD |
| BO                                                                                                                                                             | ERW-SS                      | ENERGY RECOVERY WHEEL START/STOP        | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | HARDWIRED POINT TO CONTROLLED DEVICE                    |       |                                   |
| AO                                                                                                                                                             | ERW-ST                      | ENERGY RECOVERY WHEEL STATUS            | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | FIXED TRIP CURRENT SWITCH                               |       |                                   |
| BI                                                                                                                                                             | EF-ST                       | EXHAUST FAN STATUS                      | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | FIXED TRIP CURRENT SWITCH                               |       |                                   |
| BI                                                                                                                                                             | PHP-ST                      | PREHEAT COIL PUMP STATUS                | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | RELAY & AC CURRENT SWITCH COMBO                         |       |                                   |
| BI                                                                                                                                                             | SF-ST                       | SUPPLY FAN STATUS                       | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | FIXED TRIP CURRENT SWITCH                               |       |                                   |
| BI                                                                                                                                                             | ZN-OCC                      | ZONE OCCUPANCY STATUS                   | UNOCC / OCC  | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | OCCUPANCY SENSOR RELAY (BY DIV 28)                      |       |                                   |
| BO                                                                                                                                                             | EF-SS                       | EXHAUST FAN START/STOP                  | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DRY CONTACT / RELAY                                     |       |                                   |
| BO                                                                                                                                                             | PHP-SS                      | PREHEAT COIL PUMP START/STOP            | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | RELAY & AC CURRENT SWITCH COMBO                         |       |                                   |
| BO                                                                                                                                                             | SF-SS                       | SUPPLY FAN START/STOP                   | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | DRY CONTACT / RELAY                                     |       | PROVIDE ONE SENSOR PER FAN        |
| BV                                                                                                                                                             | EF-AL                       | EXHAUST FAN EC CONTROLLER ALARM         | NORM / ALARM | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | NETWORK INTERFACE TO CONTROLLED DEVICE                  |       | PROVIDE ONE CONNECTION PER FAN    |
| BV                                                                                                                                                             | SF-AL                       | SUPPLY FAN EC CONTROLLER ALARM          | NORM / ALARM | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | NETWORK INTERFACE TO CONTROLLED DEVICE                  |       | PROVIDE ONE CONNECTION PER FAN    |
| HW                                                                                                                                                             | MA-TL                       | MIXED AIR LOW LIMIT THERMOSTAT          | NORM / ALARM | -             | -       | -             | -       |                          | LOW LIMIT THERMOSTAT                                    |       |                                   |
| HW                                                                                                                                                             | MA-PL                       | MIXED AIR LOW PRESSURE LIMIT SWITCH     | NORM / ALARM | -             | -       | -             | -       |                          | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |       |                                   |
| HW                                                                                                                                                             | RA-SD                       | RETURN AIR SMOKE DETECTOR               | NORM / ALARM | -             | -       | -             | -       |                          | FIRE ALARM RELAY (BY DIV 28)                            |       |                                   |
| MONITORED EQUIPMENT POINTS                                                                                                                                     |                             |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| BO                                                                                                                                                             | EF-SS                       | EF-FAN START/STOP                       | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | HARDWIRED POINT TO CONTROLLED DEVICE                    |       |                                   |
| BI                                                                                                                                                             | EF-ST                       | EF-FAN STATUS                           | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  |                          | FIXED TRIP CURRENT SWITCH                               |       |                                   |
| GENERAL NOTES                                                                                                                                                  |                             |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |                             |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |                             |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| BI                                                                                                                                                             | BINARY INPUT                |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| BO                                                                                                                                                             | BINARY OUTPUT               |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| BV                                                                                                                                                             | BINARY VIRTUAL POINT        |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| AI                                                                                                                                                             | ANALOG INPUT                |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| AO                                                                                                                                                             | ANALOG OUTPUT               |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| AV                                                                                                                                                             | ANALOG VIRTUAL POINT        |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| HW                                                                                                                                                             | HARD WIRED INTERLOCK/SAFETY |                                         |              |               |         |               |         |                          |                                                         |       |                                   |
| COS                                                                                                                                                            | CHANGE OF STATE             |                                         |              |               |         |               |         |                          |                                                         |       |                                   |



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ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

CONSULTING ENGINEERS:

HOENER ASSOCIATES, INC. - ARCHITECTS  
307 PULASKI AVENUE  
ST. LOUIS, MISSOURI 63103  
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ORCHARD FARM SCHOOL DISTRICT

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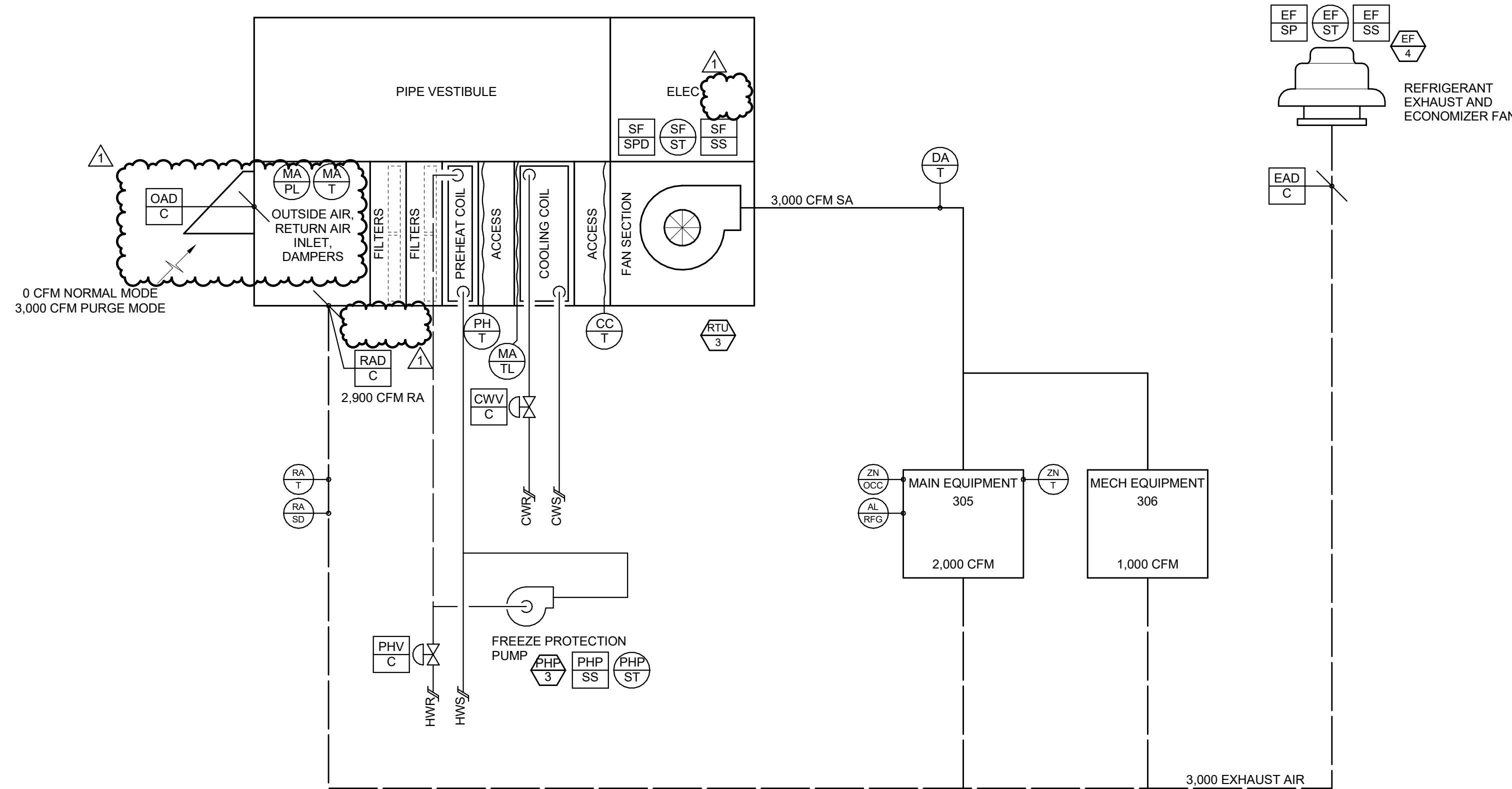
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| FAN COIL UNIT POINTS LIST                                                                                                                                                                                         |        |                          |          |                                                                                                                                                                                                                                                                    |               |         |                          |                                                       |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------|--------------------------|-------------------------------------------------------|-------|
| POINT DESCRIPTION                                                                                                                                                                                                 |        |                          |          | STARTUP TREND                                                                                                                                                                                                                                                      | SERVICE TREND |         | FIELD DEVICE DESCRIPTION |                                                       | NOTES |
| TYPE                                                                                                                                                                                                              | NAME   | DESCRIPTION              | UNITS    | FREQ                                                                                                                                                                                                                                                               | ARCHIVE       | FREQ    | ARCHIVE                  | INSTRUMENT TYPE                                       |       |
| AI                                                                                                                                                                                                                | SA-T   | SUPPLY AIR TEMPERATURE   | °F,1     | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   | DUCT TEMPERATURE SENSOR - FOR TERMINAL UNIT EQUIPMENT |       |
| AI                                                                                                                                                                                                                | ZN-T   | ZONE TEMPERATURE         | °F,1     | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   |                                                       |       |
| AO                                                                                                                                                                                                                | CWV-C  | COOLING CONTROL VALVE    | %,0      | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN.       | 15 MIN. | 1 WEEK                   | ROOM TEMPERATURE SENSOR                               |       |
| AO                                                                                                                                                                                                                | HWV-C  | HEATING CONTROL VALVE    | %,0      | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   | CONTROL VALVES                                        |       |
| BO                                                                                                                                                                                                                | FCU-SS | FAN COIL UNIT START/STOP | OFF / ON | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   | RELAY & AC CURRENT SWITCH COMBO                       |       |
| BI                                                                                                                                                                                                                | FCU-ST | FAN COIL UNIT FAN STATUS | OFF / ON | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   | RELAY & AC CURRENT SWITCH COMBO                       |       |
| BI<br>BINARY INPUT<br>BO<br>BINARY OUTPUT<br>BV<br>BINARY VIRTUAL POINT<br>AI<br>ANALOG INPUT<br>AO<br>ANALOG OUTPUT<br>AV<br>ANALOG VIRTUAL POINT<br>HW<br>HARD WIRED INTERLOCK/SAFETY<br>COS<br>CHANGE OF STATE |        |                          |          | GENERAL NOTES<br>1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.<br>2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT. |               |         |                          |                                                       |       |

| CABINET UNIT HEATER POINTS LIST                                                                                                                                                                                   |       |                       |          |                                                                                                                                                                                                                                                                    |               |         |                          |                                 |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------|--------------------------|---------------------------------|-------|
| POINT DESCRIPTION                                                                                                                                                                                                 |       |                       |          | STARTUP TREND                                                                                                                                                                                                                                                      | SERVICE TREND |         | FIELD DEVICE DESCRIPTION |                                 | NOTES |
| TYPE                                                                                                                                                                                                              | NAME  | DESCRIPTION           | UNITS    | FREQ                                                                                                                                                                                                                                                               | ARCHIVE       | FREQ    | ARCHIVE                  | INSTRUMENT TYPE                 |       |
| AI                                                                                                                                                                                                                | ZN-T  | ZONE TEMPERATURE      | °F,1     | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   | ROOM TEMPERATURE SENSOR         |       |
| BI                                                                                                                                                                                                                | F-ST  | FAN STATUS            | OFF / ON | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   | RELAY & AC CURRENT SWITCH COMBO |       |
| BO                                                                                                                                                                                                                | HWV-C | HEATING CONTROL VALVE | %,0      | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   | CONTROL VALVES                  |       |
| BO                                                                                                                                                                                                                | F-C   | FAN COMMAND           | OFF / ON | 1 MIN.                                                                                                                                                                                                                                                             | 30 MIN        | 15 MIN. | 1 WEEK                   | RELAY & AC CURRENT SWITCH COMBO |       |
| BI<br>BINARY INPUT<br>BO<br>BINARY OUTPUT<br>BV<br>BINARY VIRTUAL POINT<br>AI<br>ANALOG INPUT<br>AO<br>ANALOG OUTPUT<br>AV<br>ANALOG VIRTUAL POINT<br>HW<br>HARD WIRED INTERLOCK/SAFETY<br>COS<br>CHANGE OF STATE |       |                       |          | GENERAL NOTES<br>1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.<br>2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT. |               |         |                          |                                 |       |

| KITCHEN FAN SYSTEM POINTS LIST                                                                                                                                                                                                                                                           |                             |                               |               |               |         |                          |         |                                       |                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------------------------|---------------|---------------|---------|--------------------------|---------|---------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                                                                                                                          |                             | POINT DESCRIPTION             | STARTUP TREND | SERVICE TREND |         | FIELD DEVICE DESCRIPTION |         |                                       |                                                  |
| TYPE                                                                                                                                                                                                                                                                                     | NAME                        | DESCRIPTION                   | UNITS         | FREQ          | ARCHIVE | FREQ                     | ARCHIVE | INSTRUMENT TYPE                       | NOTES                                            |
| AO                                                                                                                                                                                                                                                                                       | EF1-SPD                     | EXHAUST FAN 1 SPEED COMMAND   | % 0           | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| AO                                                                                                                                                                                                                                                                                       | EF2-SPD                     | EXHAUST FAN 2 SPEED COMMAND   | % 0           | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| AO                                                                                                                                                                                                                                                                                       | EF7-SPD                     | EXHAUST FAN 7 SPEED COMMAND   | % 0           | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| AO                                                                                                                                                                                                                                                                                       | TF1-SPD                     | TRANSFER FAN 1 SPEED COMMAND  | % 0           | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| AO                                                                                                                                                                                                                                                                                       | TF2-SPD                     | TRANSFER FAN 2 SPEED COMMAND  | % 0           | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| AV                                                                                                                                                                                                                                                                                       | HD1-F                       | HOOD 1 AIRFLOW                | CFM 0         | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | BACNET INTERFACE TO CONTROLLED DEVICE |                                                  |
| HD2-F                                                                                                                                                                                                                                                                                    |                             | HOOD 2 AIRFLOW                | CFM 0         | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | BACNET INTERFACE TO CONTROLLED DEVICE |                                                  |
| BI                                                                                                                                                                                                                                                                                       | EF1-ST                      | EXHAUST FAN 1 STATUS          | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | FIXED TRIP CURRENT SWITCH             |                                                  |
| BI                                                                                                                                                                                                                                                                                       | EF2-ST                      | EXHAUST FAN 2 STATUS          | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | FIXED TRIP CURRENT SWITCH             |                                                  |
| BI                                                                                                                                                                                                                                                                                       | EF7-ST                      | EXHAUST FAN 7 STATUS          | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | FIXED TRIP CURRENT SWITCH             |                                                  |
| BI                                                                                                                                                                                                                                                                                       | EF5-ST                      | DISHWASHER EXHAUST FAN STATUS | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | FIXED TRIP CURRENT SWITCH             |                                                  |
| BI                                                                                                                                                                                                                                                                                       | TF1-ST                      | TRANSFER FAN 1 STATUS         | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | FIXED TRIP CURRENT SWITCH             |                                                  |
| BI                                                                                                                                                                                                                                                                                       | TF2-ST                      | TRANSFER FAN 2 STATUS         | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | FIXED TRIP CURRENT SWITCH             |                                                  |
| BO                                                                                                                                                                                                                                                                                       | EF1-SS                      | EXHAUST FAN 1 START STOP      | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| BO                                                                                                                                                                                                                                                                                       | EF2-SS                      | EXHAUST FAN 2 START STOP      | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| BO                                                                                                                                                                                                                                                                                       | EF7-SS                      | EXHAUST FAN 7 START STOP      | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| BO                                                                                                                                                                                                                                                                                       | EF5-SS                      | DISHWASHER FAN START STOP     | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | FAN START STOP BY DISHWASHER CONTROLLER          |
| BO                                                                                                                                                                                                                                                                                       | TF1-SS                      | TRANSFER FAN 1 START STOP     | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| BO                                                                                                                                                                                                                                                                                       | TF2-SS                      | TRANSFER FAN 2 START STOP     | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.                  | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE  | KITCHEN CONTROLS CONTRACTOR TO FIELD WIRE FAN... |
| <p><b>GENERAL NOTES</b></p> <p>1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.</p> <p>2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.</p> |                             |                               |               |               |         |                          |         |                                       |                                                  |
| BI                                                                                                                                                                                                                                                                                       | BINARY INPUT                |                               |               |               |         |                          |         |                                       |                                                  |
| BO                                                                                                                                                                                                                                                                                       | BINARY OUTPUT               |                               |               |               |         |                          |         |                                       |                                                  |
| BI                                                                                                                                                                                                                                                                                       | BINARY VIRTUAL POINT        |                               |               |               |         |                          |         |                                       |                                                  |
| AI                                                                                                                                                                                                                                                                                       | ANALOG INPUT                |                               |               |               |         |                          |         |                                       |                                                  |
| AO                                                                                                                                                                                                                                                                                       | ANALOG OUTPUT               |                               |               |               |         |                          |         |                                       |                                                  |
| AV                                                                                                                                                                                                                                                                                       | ANALOG VIRTUAL POINT        |                               |               |               |         |                          |         |                                       |                                                  |
| HW                                                                                                                                                                                                                                                                                       | HARD WIRED INTERLOCK/SAFETY |                               |               |               |         |                          |         |                                       |                                                  |
| CH                                                                                                                                                                                                                                                                                       | CHANGE OF STATE             |                               |               |               |         |                          |         |                                       |                                                  |





RTU-3 AIR FLOW DIAGRAM  
NO SCALE

| EF-4 POINTS LIST           |        |                             |              |                                                                                                    |         |               |         |                                      |          |
|----------------------------|--------|-----------------------------|--------------|----------------------------------------------------------------------------------------------------|---------|---------------|---------|--------------------------------------|----------|
| POINT DESCRIPTION          |        |                             |              | STARTUP TREND                                                                                      |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION             | NOTES    |
| TYPE                       | NAME   | DESCRIPTION                 | UNITS        | FREQ                                                                                               | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                      |          |
| BI                         | EF-ST  | RELIEF FAN STATUS           | OFF / ON     | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH            |          |
| BO                         | EF-SS  | RELIEF FAN START/STOP       | OFF / ON     | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                  |          |
| AO                         | EF-SPD | RELIEF FAN SPEED            | % 0          | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE | 2-10 VDC |
| AO                         | EAD-C  | EXHAUST AIR DAMPER          | % 0          | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR     |          |
| MONITORED EQUIPMENT POINTS |        |                             |              |                                                                                                    |         |               |         |                                      |          |
| BI                         | AL-RFG | REFRIGERANT DETECTION ALARM | NORM / ALARM | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                  |          |
| BI                         | BI     | BINARY INPUT                |              | GENERAL NOTES:                                                                                     |         |               |         |                                      |          |
| BO                         | BO     | BINARY OUTPUT               |              | 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR |         |               |         |                                      |          |
| BV                         | BV     | BINARY VIRTUAL POINT        |              | POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.                                        |         |               |         |                                      |          |
| AI                         | AI     | ANALOG INPUT                |              | 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                    |         |               |         |                                      |          |
| AO                         | AO     | ANALOG OUTPUT               |              |                                                                                                    |         |               |         |                                      |          |
| AV                         | AV     | ANALOG VIRTUAL POINT        |              |                                                                                                    |         |               |         |                                      |          |
| HW                         | HW     | HARD WIRED INTERLOCK/SAFETY |              |                                                                                                    |         |               |         |                                      |          |
| COS                        | COS    | CHANGE OF STATE             |              |                                                                                                    |         |               |         |                                      |          |

| RTU-3 POINTS LIST                               |        |                                         |              |                                                                                                    |         |               |         |                                                         |                                   |
|-------------------------------------------------|--------|-----------------------------------------|--------------|----------------------------------------------------------------------------------------------------|---------|---------------|---------|---------------------------------------------------------|-----------------------------------|
| POINT DESCRIPTION                               |        |                                         |              | STARTUP TREND                                                                                      |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                                | NOTES                             |
| TYPE                                            | NAME   | DESCRIPTION                             | UNITS        | FREQ                                                                                               | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                         |                                   |
| GLOBAL POINTS (TO BE MAPPED TO UNIT CONTROLLER) |        |                                         |              |                                                                                                    |         |               |         |                                                         |                                   |
| AV                                              | QA-T   | OUTSIDE AIR TEMPERATURE REFERENCE       | "F.1         | -                                                                                                  | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AV                                              | QA-H   | OUTSIDE AIR RELATIVE HUMIDITY REFERENCE | % RH.1       | -                                                                                                  | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AV                                              | QA-DWP | OUTSIDE AIR DEW POINT REFERENCE         | "F.1         | -                                                                                                  | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AHU UNIT-LEVEL CONTROL POINTS                   |        |                                         |              |                                                                                                    |         |               |         |                                                         |                                   |
| AI                                              | CC-T   | COOLING COIL AIR TEMPERATURE            | "F.1         | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                              | MA-T   | MIXED AIR TEMPERATURE                   | "F.1         | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                              | PH-T   | PREHEAT AIR TEMPERATURE                 | "F.1         | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                              | DA-T   | DISCHARGE AIR TEMPERATURE               | "F.1         | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |
| AI                                              | RA-T   | RETURN AIR TEMPERATURE                  | "F.1         | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |
| AO                                              | OAD-C  | OUTSIDE AIR DAMPER                      | % 0          | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                              | RAD-C  | RETURN AIR DAMPER                       | % 0          | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                              | OWV-C  | COOLING CONTROL VALVE                   | % 0          | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                              |                                   |
| AO                                              | PHV-C  | HEATING CONTROL VALVE                   | % 0          | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                              |                                   |
| AO                                              | SF-SPD | SUPPLY FAN SPEED                        | % 0          | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    | 4-10 mA/2-10 VDC, COORD. WITH VFD |
| BI                                              | SF-ST  | SUPPLY FAN STATUS                       | OFF / ON     | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |
| BO                                              | SF-SS  | SUPPLY FAN START/STOP                   | OFF / ON     | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                                     |                                   |
| BI                                              | PHP-ST | HOT WATER CIRCULATING PUMP STATUS       | OFF / ON     | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |
| BO                                              | PHP-SS | PREHEAT COIL PUMP START/STOP            | OFF / ON     | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |
| HW                                              | RA-SD  | RETURN AIR SMOKE DETECTOR               | NORM / ALARM | -                                                                                                  | -       | -             | -       | FIRE ALARM RELAY (BY DIV 28)                            |                                   |
| HW                                              | MA-TL  | MIXED AIR LOW LIMIT THERMOSTAT          | NORM / ALARM | -                                                                                                  | -       | -             | -       | LOW LIMIT THERMOSTAT                                    |                                   |
| AI                                              | ZN-T   | ZONE TEMPERATURE                        | "F.1         | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | ROOM SMART SENSOR                                       |                                   |
| BI                                              | AL-RFG | REFRIGERATION LEAK ALARM                | NORM / ALARM | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                                     |                                   |
| BI                                              | ZN-OCC | ZONE OCCUPANCY STATUS                   | UNOCC / OCC  | 1 MIN.                                                                                             | 30 MIN  | 15 MIN.       | 1 WEEK  | OCCUPANCY SENSOR RELAY (BY DIV 28)                      |                                   |
| GENERAL NOTES                                   |        |                                         |              |                                                                                                    |         |               |         |                                                         |                                   |
| BI                                              | BI     | BINARY INPUT                            |              | 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR |         |               |         |                                                         |                                   |
| BO                                              | BO     | BINARY OUTPUT                           |              | POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.                                        |         |               |         |                                                         |                                   |
| BV                                              | BV     | BINARY VIRTUAL POINT                    |              | 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                    |         |               |         |                                                         |                                   |
| AI                                              | AI     | ANALOG INPUT                            |              |                                                                                                    |         |               |         |                                                         |                                   |
| AO                                              | AO     | ANALOG OUTPUT                           |              |                                                                                                    |         |               |         |                                                         |                                   |
| AV                                              | AV     | ANALOG VIRTUAL POINT                    |              |                                                                                                    |         |               |         |                                                         |                                   |
| HW                                              | HW     | HARD WIRED INTERLOCK/SAFETY             |              |                                                                                                    |         |               |         |                                                         |                                   |
| COS                                             | COS    | CHANGE OF STATE                         |              |                                                                                                    |         |               |         |                                                         |                                   |



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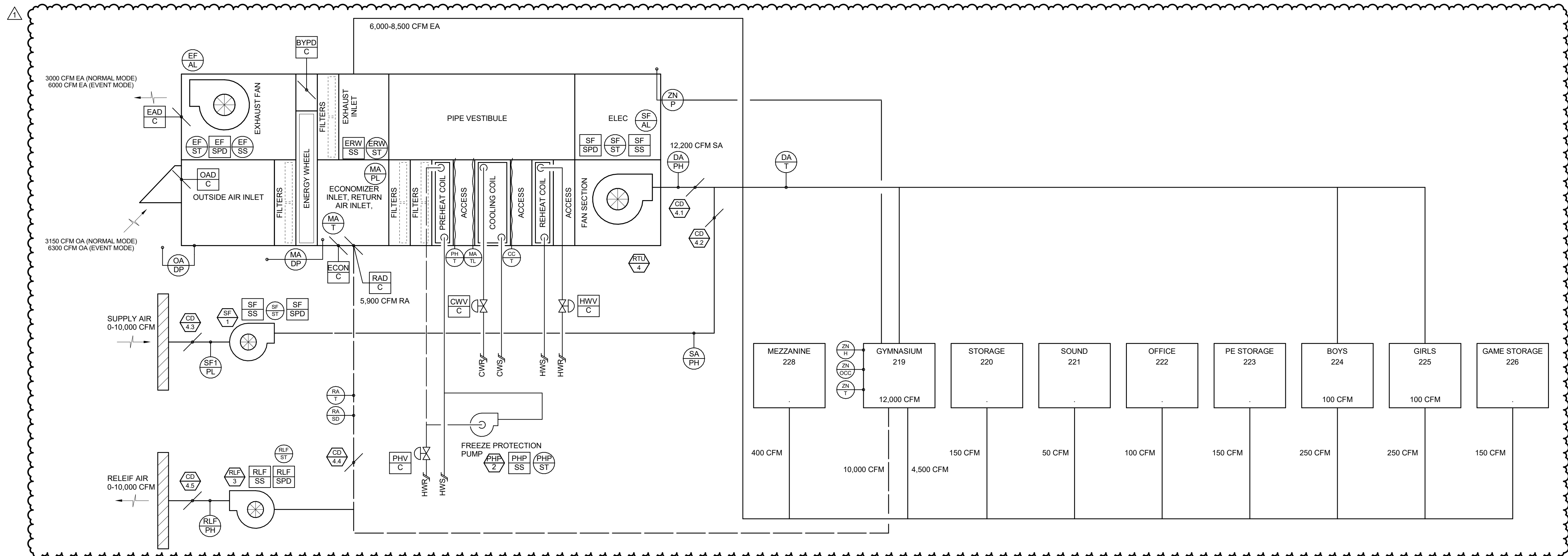
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M5.2  
SD: 47





RTU-4 AIR FLOW DIAGRAM  
NO SCALE

### STORM SHELTER POINTS LIST

| POINT DESCRIPTION |                             |                                                                                                                                                |               | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                      |       | NOTES |
|-------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------|---------|---------------|---------|-----------------------------------------------|-------|-------|
| TYPE              | NAME                        | DESCRIPTION                                                                                                                                    | UNITS         | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                               |       |       |
| BO                | SF-SS                       | SUPPLY FAN 1 START STOP                                                                                                                        | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE          | 0-10V |       |
| BI                | SF-ST                       | SUPPLY FAN 1 STATUS                                                                                                                            | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                     |       |       |
| HW                | SF-PH                       | SUPPLY FAN 1 HIGH PRESSURE LIMIT SWITCH                                                                                                        | NORM / ALARM  | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH |       |       |
| AO                | SF-SPD                      | SUPPLY FAN 1 SPEED COMMAND                                                                                                                     | % 0           | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE          |       |       |
| HW                | SF1-PL                      | SUPPLY FAN 1 LOW PRESSURE LIMIT SWITCH                                                                                                         | NORM / ALARM  | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH |       |       |
| BO                | CD-4.1                      | STORM SHELTER SUPPLY ISOLATION DAMPER                                                                                                          | OPEN / CLOSED | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR              |       |       |
| BO                | CD-4.2                      | NORMAL OPERATION ISOLATION DAMPER                                                                                                              | OPEN / CLOSED | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR              |       |       |
| BO                | CD-4.3                      | SUPPLY FAN 1 OA INTAKE DAMPER                                                                                                                  | OPEN / CLOSED | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR              |       |       |
| BO                | CD-4.4                      | RTU-4 RETURN AIR ISOLATION DAMPER                                                                                                              | OPEN / CLOSED | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR              |       |       |
| AO                | CD-4.5                      | RLF-5 ECONOMIZER RELIEF DAMPER                                                                                                                 | % 0           | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR              |       |       |
| BO                | RLF-SS                      | RELIEF FAN 3 START STOP                                                                                                                        | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE          | 0-10V |       |
| BI                | RLF-ST                      | RELIEF FAN 3 STATUS                                                                                                                            | ON / OFF      | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                     |       |       |
| HW                | RLF-PH                      | RELIEF FAN 3 HIGH PRESSURE LIMIT SWITCH                                                                                                        | NORM / ALARM  | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH |       |       |
| AO                | RLF-SPD                     | RELIEF FAN 3 SPEED COMMAND                                                                                                                     | % 0           | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE          |       |       |
| BI                | BINARY INPUT                | GENERAL NOTES                                                                                                                                  |               |               |         |               |         |                                               |       |       |
| BO                | BINARY OUTPUT               | 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL... |               |               |         |               |         |                                               |       |       |
| BI                | BINARY VIRTUAL POINT        | 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                |               |               |         |               |         |                                               |       |       |
| AI                | ANALOG INPUT                | 3. ALL POINTS ON THIS SCHEDULE TO BE ON EMERGENCY POWER                                                                                        |               |               |         |               |         |                                               |       |       |
| AO                | ANALOG OUTPUT               |                                                                                                                                                |               |               |         |               |         |                                               |       |       |
| AV                | ANALOG VIRTUAL POINT        |                                                                                                                                                |               |               |         |               |         |                                               |       |       |
| HW                | HARD WIRED INTERLOCK/SAFETY |                                                                                                                                                |               |               |         |               |         |                                               |       |       |
| COS               | CHANGE OF STATE             |                                                                                                                                                |               |               |         |               |         |                                               |       |       |

GENERAL NOTES  
1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL...  
2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.  
3. ALL POINTS ON THIS SCHEDULE TO BE ON EMERGENCY POWER

### RTU-4 POINTS LIST

| POINT DESCRIPTION                                                                                                                                              |        |                                          |              | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                                |  | NOTES                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------------|--------------|---------------|---------|---------------|---------|---------------------------------------------------------|--|-----------------------------------|
| TYPE                                                                                                                                                           | NAME   | DESCRIPTION                              | UNITS        | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                         |  |                                   |
| GLOBAL POINTS (TO BE MAPPED...)                                                                                                                                |        |                                          |              |               |         |               |         |                                                         |  |                                   |
| AV                                                                                                                                                             | OA-T   | OUTSIDE AIR TEMPERATURE REFERENCE        | % F.1        | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |  |                                   |
| AV                                                                                                                                                             | OA-H   | OUTSIDE AIR RELATIVE HUMIDITY REFERENCE  | % RH.1       | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |  |                                   |
| AV                                                                                                                                                             | OA-DWP | OUTSIDE AIR DEW POINT REFERENCE          | % F.1        | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |  |                                   |
| ADD UNIT LEVEL CONTROL...                                                                                                                                      |        |                                          |              |               |         |               |         |                                                         |  |                                   |
| AI                                                                                                                                                             | CC-T   | COOLING COIL AIR TEMPERATURE             | % F.1        | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |  |                                   |
| AI                                                                                                                                                             | MA-T   | MIXED AIR TEMPERATURE                    | % F.1        | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |  |                                   |
| AI                                                                                                                                                             | PH-T   | PREHEAT AIR TEMPERATURE                  | % F.1        | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |  |                                   |
| AI                                                                                                                                                             | DA-T   | DISCHARGE AIR TEMPERATURE                | % F.1        | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |  |                                   |
| AI                                                                                                                                                             | RA-T   | RETURN AIR TEMPERATURE                   | % F.1        | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |  |                                   |
| AI                                                                                                                                                             | MA-OP  | MIXED AIR DIFFERENTIAL PRESSURE          | IN W.C.1     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   |  | REFERENCE OUTSIDE AIR PRESSURE    |
| AI                                                                                                                                                             | ZN-T   | ZONE TEMPERATURE                         | % F.1        | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | ROOM SMART SENSOR                                       |  |                                   |
| AI                                                                                                                                                             | ZN-P   | ZONE PRESSURE                            | IN W.C.1     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | VERY LOW AIR DIFFERENTIAL PRESSURE TRANSMITTER          |  | REFERENCE OUTSIDE AIR PRESSURE    |
| AO                                                                                                                                                             | OAD-C  | MINIMUM OUTSIDE AIR DAMPER               | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |  |                                   |
| AO                                                                                                                                                             | ECON-C | ECONOMIZER DAMPER                        | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |  |                                   |
| AO                                                                                                                                                             | RAD-C  | RETURN AIR DAMPER                        | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |  |                                   |
| AO                                                                                                                                                             | EAD-C  | EXHAUST AIR DAMPER                       | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |  |                                   |
| AO                                                                                                                                                             | BYPD-C | WHEEL BYPASS AIR DAMPER                  | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |  |                                   |
| AO                                                                                                                                                             | CWV-C  | COOLING CONTROL VALVE                    | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                          |  |                                   |
| AO                                                                                                                                                             | PHV-C  | HEATING CONTROL VALVE                    | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                          |  |                                   |
| AO                                                                                                                                                             | RHV-C  | REHEATING CONTROL VALVE                  | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                          |  |                                   |
| AO                                                                                                                                                             | SF-SPD | SUPPLY FAN SPEED                         | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    |  | 4-10 mA/2-10 VDC. COORD. WITH VFD |
| AO                                                                                                                                                             | ERW-ST | ENERGY RECOVERY WHEEL STATUS             | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |  |                                   |
| EF-SPD                                                                                                                                                         |        | EXHAUST FAN SPEED                        | % 0          | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    |  | 4-10 mA/2-10 VDC. COORD. WITH VFD |
| AV                                                                                                                                                             | ZN-H   | ZONE HUMIDITY                            | % RH.1       | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | GENERAL PURPOSE ROOM RELATIVE HUMIDITY SENSOR           |  |                                   |
| BI                                                                                                                                                             | SF-ST  | SUPPLY FAN STATUS                        | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |  |                                   |
| BI                                                                                                                                                             | PHP-ST | HOT WATER CIRCULATING PUMP STATUS        | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | RELAY & A/C CURRENT SWITCH COMBO                        |  |                                   |
| BI                                                                                                                                                             | EF-ST  | EXHAUST FAN STATUS                       | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |  |                                   |
| BI                                                                                                                                                             | ZN-OC  | ZONE OCCUPANCY MODE                      | NORM / EVENT | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | MANUAL TIMER SWITCH                                     |  |                                   |
| BO                                                                                                                                                             | SF-SS  | SUPPLY FAN START/STOP                    | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                                     |  |                                   |
| BO                                                                                                                                                             | PHP-SS | PREHEAT COIL PUMP START/STOP             | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | RELAY & A/C CURRENT SWITCH COMBO                        |  |                                   |
| BO                                                                                                                                                             | ERW-SS | ENERGY RECOVERY WHEEL START/STOP         | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    |  |                                   |
| BO                                                                                                                                                             | EF-SS  | EXHAUST FAN START/STOP                   | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                                     |  |                                   |
| BV                                                                                                                                                             | SF-AL  | SUPPLY FAN EC ALARM                      | NORM / ALARM | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE                  |  |                                   |
| BV                                                                                                                                                             | EF-AL  | EXHAUST FAN EC ALARM                     | NORM / ALARM | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE                  |  |                                   |
| HW                                                                                                                                                             | RA-SD  | RETURN AIR SMOKE DETECTOR                | NORM / ALARM | -             | -       | -             | -       | FIRE ALARM RELAY (BY DIV 28)                            |  |                                   |
| HW                                                                                                                                                             | MA-TL  | MIXED AIR LOW LIMIT THERMOSTAT           | NORM / ALARM | -             | -       | -             | -       | LOW LIMIT THERMOSTAT                                    |  |                                   |
| HW                                                                                                                                                             | DA-PH  | DISCHARGE AIR HIGH PRESSURE LIMIT SWITCH | NORM / ALARM | -             | -       | -             | -       | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |  |                                   |
| HW                                                                                                                                                             | MA-PL  | MIXED AIR LOW PRESSURE LIMIT SWITCH      | NORM / ALARM | -             | -       | -             | -       | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |  |                                   |
| GENERAL NOTES                                                                                                                                                  |        |                                          |              |               |         |               |         |                                                         |  |                                   |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |        |                                          |              |               |         |               |         |                                                         |  |                                   |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |        |                                          |              |               |         |               |         |                                                         |  |                                   |

GENERAL NOTES  
1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.  
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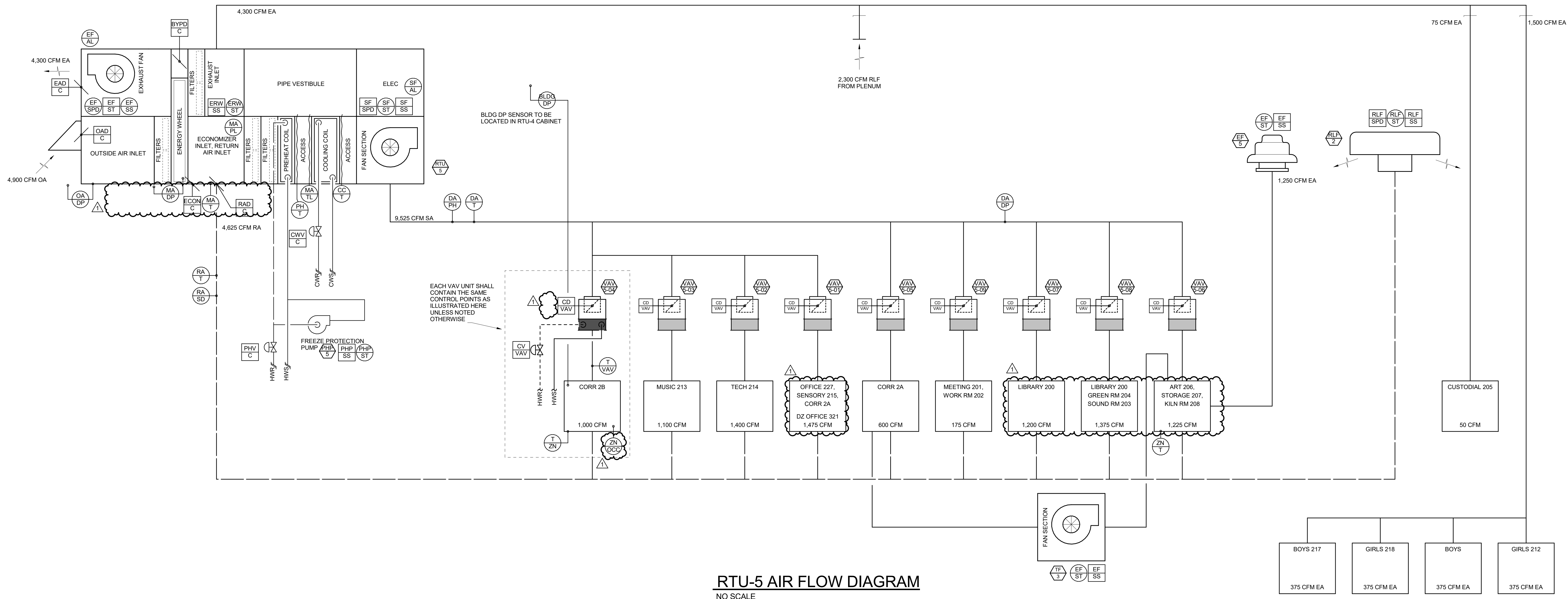
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SHEET NO.

M5.3  
SD: 48





### FAN COIL UNIT POINTS LIST

| POINT DESCRIPTION              |        |                          |          | STARTUP TREND                                                                                                                                                  |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                              |  | NOTES |
|--------------------------------|--------|--------------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------|---------|-------------------------------------------------------|--|-------|
| TYPE                           | NAME   | DESCRIPTION              | UNITS    | FREQ                                                                                                                                                           | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                       |  |       |
| AI                             | SA-T   | SUPPLY AIR TEMPERATURE   | "F, 1    | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR TERMINAL UNIT EQUIPMENT |  |       |
| AI                             | ZN-T   | ZONE TEMPERATURE         | "F, 1    | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | ROOM TEMPERATURE SENSOR                               |  |       |
| AO                             | CVW-C  | COOLING CONTROL VALVE    | % 0      | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                        |  |       |
| AO                             | HWV-C  | HEATING CONTROL VALVE    | % 0      | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                        |  |       |
| BO                             | FCU-SS | FAN COIL UNIT START/STOP | OFF / ON | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                       |  |       |
| BI                             | FCU-ST | FAN COIL UNIT FAN STATUS | OFF / ON | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                       |  |       |
| BI BINARY INPUT                |        |                          |          | GENERAL NOTES                                                                                                                                                  |         |               |         |                                                       |  |       |
| BO BINARY OUTPUT               |        |                          |          | 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |         |               |         |                                                       |  |       |
| BV BINARY VIRTUAL POINT        |        |                          |          | 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |         |               |         |                                                       |  |       |
| AI ANALOG INPUT                |        |                          |          |                                                                                                                                                                |         |               |         |                                                       |  |       |
| AO ANALOG OUTPUT               |        |                          |          |                                                                                                                                                                |         |               |         |                                                       |  |       |
| AV ANALOG VIRTUAL POINT        |        |                          |          |                                                                                                                                                                |         |               |         |                                                       |  |       |
| HW HARD WIRED INTERLOCK/SAFETY |        |                          |          |                                                                                                                                                                |         |               |         |                                                       |  |       |
| COS CHANGE OF STATE            |        |                          |          |                                                                                                                                                                |         |               |         |                                                       |  |       |

### VAV POINTS LIST

| POINT DESCRIPTION |                             |                                    |             | STARTUP TREND                                                                                                                                                  |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                              |  | NOTES |
|-------------------|-----------------------------|------------------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------|---------|-------------------------------------------------------|--|-------|
| TYPE              | NAME                        | DESCRIPTION                        | UNITS       | FREQ                                                                                                                                                           | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                       |  |       |
| AI                | T-VAV                       | SUPPLY AIR TEMPERATURE             | "F,1        | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR TERMINAL UNIT EQUIPMENT |  |       |
| BI                | ZN-OCC                      | ZONE OCCUPANCY STATUS              | UNOCC / OCC | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | OCCUPANCY SENSOR RELAY (BY DIV 28)                    |  |       |
| AI                | ZN-T                        | ZONE TEMPERATURE                   | "F,1        | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | ROOM SMART SENSOR                                     |  |       |
| AO                | CV-VAV                      | REHEAT CONTROL VALVE               | %,0         | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                            |  |       |
| AV                | DDR-C                       | ZONE DAMPER COMMAND                | %,0         | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | SOFTWARE (VIRTUAL) POINT                              |  |       |
| AV                | ZN-F                        | TERMINAL UNIT VOLUMETRIC FLOW RATE | CFM,0       | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | SOFTWARE (VIRTUAL) POINT                              |  |       |
| BI                | BINARY INPUT                |                                    |             | GENERAL NOTES                                                                                                                                                  |         |               |         |                                                       |  |       |
| BO                | BINARY OUTPUT               |                                    |             | 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |         |               |         |                                                       |  |       |
| BV                | BINARY VIRTUAL POINT        |                                    |             | 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |         |               |         |                                                       |  |       |
| AI                | ANALOG INPUT                |                                    |             |                                                                                                                                                                |         |               |         |                                                       |  |       |
| AO                | ANALOG OUTPUT               |                                    |             |                                                                                                                                                                |         |               |         |                                                       |  |       |
| AV                | ANALOG VIRTUAL POINT        |                                    |             |                                                                                                                                                                |         |               |         |                                                       |  |       |
| HW                | HARD WIRED INTERLOCK/SAFETY |                                    |             |                                                                                                                                                                |         |               |         |                                                       |  |       |
| COS               | CHANGE OF STATE             |                                    |             |                                                                                                                                                                |         |               |         |                                                       |  |       |

### KILN FAN SYSTEM POINTS LIST

| POINT DESCRIPTION |                             |                              |                                                                                                                                                                | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION             |  | NOTES |
|-------------------|-----------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------|---------------|---------|--------------------------------------|--|-------|
| TYPE              | NAME                        | DESCRIPTION                  | UNITS                                                                                                                                                          | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                      |  |       |
| AI                | ZN-T                        | ZONE TEMPERATURE             | "F,1                                                                                                                                                           | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | ROOM SMART SENSOR                    |  |       |
| BO                | EF-SS                       | EXHAUST FAN 5 START STOP     | ON / OFF                                                                                                                                                       | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE |  |       |
| AO                | EF-SPD                      | EXHAUST FAN 5 SPEED COMMAND  | %                                                                                                                                                              | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE |  |       |
| BI                | EF-ST                       | EXHAUST FAN 5 STATUS         | ON / OFF                                                                                                                                                       | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH            |  |       |
| BO                | TF3-SS                      | TRANSFER FAN 3 START STOP    | ON / OFF                                                                                                                                                       | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE |  |       |
| AO                | TF3-SPD                     | TRANSFER FAN 3 SPEED COMMAND | %                                                                                                                                                              | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE |  |       |
| BI                | TF3-ST                      | TRANSFER FAN 3 STATUS        | ON / OFF                                                                                                                                                       | 1 MIN.        | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH            |  |       |
| GENERAL NOTES     |                             |                              |                                                                                                                                                                |               |         |               |         |                                      |  |       |
| BI                | BINARY INPUT                |                              |                                                                                                                                                                |               |         |               |         |                                      |  |       |
| BO                | BINARY OUTPUT               |                              |                                                                                                                                                                |               |         |               |         |                                      |  |       |
| BV                | BINARY VIRTUAL POINT        |                              |                                                                                                                                                                |               |         |               |         |                                      |  |       |
| AI                | ANALOG INPUT                |                              | 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |               |         |               |         |                                      |  |       |
| AO                | ANALOG OUTPUT               |                              | 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |               |         |               |         |                                      |  |       |
| AV                | ANALOG VIRTUAL POINT        |                              |                                                                                                                                                                |               |         |               |         |                                      |  |       |
| HW                | HARD WIRED INTERLOCK/SAFETY |                              |                                                                                                                                                                |               |         |               |         |                                      |  |       |
| COS               | CHANGE OF STATE             |                              |                                                                                                                                                                |               |         |               |         |                                      |  |       |

### RTU-5 POINTS LIST

| POINT DESCRIPTION                                                                                                                                              |                             |                                          | STARTUP TREND |        | SERVICE TREND |         | FIELD DEVICE DESCRIPTION |                                                         | NOTES                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------------------|---------------|--------|---------------|---------|--------------------------|---------------------------------------------------------|-----------------------------------|
| TYPE                                                                                                                                                           | NAME                        | DESCRIPTION                              | UNITS         | FREQ   | ARCHIVE       | FREQ    | ARCHIVE                  | INSTRUMENT TYPE                                         |                                   |
| GLOBAL POINTS (TO BE MAPPED...                                                                                                                                 |                             |                                          |               |        |               |         |                          |                                                         |                                   |
| AV                                                                                                                                                             | OA-T                        | OUTSIDE AIR TEMPERATURE REFERENCE        | "F,1          | -      | -             | -       | -                        | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AV                                                                                                                                                             | OA-H                        | OUTSIDE AIR RELATIVE HUMIDITY REFERENCE  | % RH,1        | -      | -             | -       | -                        | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AV                                                                                                                                                             | OA-DWP                      | OUTSIDE AIR DEW POINT REFERENCE          | "F,1          | -      | -             | -       | -                        | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AHU UNIT LEVEL CONTROL...                                                                                                                                      |                             |                                          |               |        |               |         |                          |                                                         |                                   |
| AI                                                                                                                                                             | CC-T                        | COOLING COIL AIR TEMPERATURE             | "F,1          | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                                                                                                                                             | MA-T                        | MIXED AIR TEMPERATURE                    | "F,1          | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                                                                                                                                             | PH-T                        | PREHEAT AIR TEMPERATURE                  | "F,1          | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                                                                                                                                             | DA-T                        | DISCHARGE AIR TEMPERATURE                | "F,1          | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |
| AI                                                                                                                                                             | RA-T                        | RETURN AIR TEMPERATURE                   | "F,1          | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |
| AI                                                                                                                                                             | DA-DP                       | DISCHARGE AIR DIFFERENTIAL PRESSURE      | IN. W.C.,1    | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   | REFERENCE ZONE PRESSURE           |
| AI                                                                                                                                                             | MA-DP                       | MIXED AIR DIFFERENTIAL PRESSURE          | IN. W.C.,1    | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   | REFERENCE OUTSIDE AIR PRESSURE    |
| AO                                                                                                                                                             | OAD-C                       | MINIMUM OUTSIDE AIR DAMPER               | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                                                                                                                                             | ECON-C                      | ECONOMIZER DAMPER                        | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                                                                                                                                             | RAD-C                       | RETURN AIR DAMPER                        | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                                                                                                                                             | EAD-C                       | EXHAUST AIR DAMPER                       | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                                                                                                                                             | BYPD-C                      | WHEEL BYPASS AIR DAMPER                  | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                                                                                                                                             | CVW-C                       | COOLING CONTROL VALVE                    | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | SEE CONTROL VALVE SCHEDULE                              |                                   |
| AO                                                                                                                                                             | PHW-C                       | HEATING CONTROL VALVE                    | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | SEE CONTROL VALVE SCHEDULE                              |                                   |
| AO                                                                                                                                                             | SF-SPD                      | SUPPLY FAN SPEED                         | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | HARDWIRED POINT TO CONTROLLED DEVICE                    | 4-10 mA/2-10 VDC, COORD. WITH VFD |
| AO                                                                                                                                                             | EF-SPD                      | EXHAUST FAN SPEED                        | %             | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | HARDWIRED POINT TO CONTROLLED DEVICE                    | 4-10 mA/2-10 VDC, COORD. WITH VFD |
| BI                                                                                                                                                             | ERW-ST                      | ENERGY RECOVERY WHEEL STATUS             | OFF / ON      | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | FIXED TRIP CURRENT SWITCH                               |                                   |
| BI                                                                                                                                                             | SF-ST                       | SUPPLY FAN STATUS                        | OFF / ON      | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | FIXED TRIP CURRENT SWITCH                               |                                   |
| BI                                                                                                                                                             | PHW-ST                      | PREHEAT COIL PUMP STATUS                 | OFF / ON      | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | RELAY & AC CURRENT SWITCH COMBO                         |                                   |
| BI                                                                                                                                                             | EF-ST                       | EXHAUST FAN STATUS                       | OFF / ON      | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | FIXED TRIP CURRENT SWITCH                               |                                   |
| BO                                                                                                                                                             | SF-SS                       | SUPPLY FAN START/STOP                    | OFF / ON      | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | RELAY & AC CURRENT SWITCH COMBO                         |                                   |
| BO                                                                                                                                                             | PHW-SS                      | PREHEAT COIL PUMP START/STOP             | OFF / ON      | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | RELAY & AC CURRENT SWITCH COMBO                         |                                   |
| BO                                                                                                                                                             | ERW-SS                      | ENERGY RECOVERY WHEEL START/STOP         | OFF / ON      | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | HARDWIRED POINT TO CONTROLLED DEVICE                    |                                   |
| BO                                                                                                                                                             | EF-SS                       | EXHAUST FAN START/STOP                   | OFF / ON      | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | RELAY & AC CURRENT SWITCH COMBO                         |                                   |
| BV                                                                                                                                                             | SF-AL                       | SUPPLY FAN EC ALARM                      | NORM / ALARM  | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE                  |                                   |
| BV                                                                                                                                                             | EF-AL                       | EXHAUST FAN EC ALARM                     | NORM / ALARM  | 1 MIN. | 30 MIN        | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE                  |                                   |
| HW                                                                                                                                                             | RA-SD                       | RETURN AIR SMOKE DETECTOR                | NORM / ALARM  | -      | -             | -       | -                        | FIRE ALARM RELAY (BY DIV 28)                            |                                   |
| HW                                                                                                                                                             | MA-TL                       | MIXED AIR LOW LIMIT THERMOSTAT           | NORM / ALARM  | -      | -             | -       | -                        | LOW LIMIT THERMOSTAT                                    |                                   |
| HW                                                                                                                                                             | DA-PH                       | DISCHARGE AIR HIGH PRESSURE LIMIT SWITCH | NORM / ALARM  | -      | -             | -       | -                        | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |                                   |
| HW                                                                                                                                                             | MA-PL                       | MIXED AIR LOW PRESSURE LIMIT SWITCH      | NORM / ALARM  | -      | -             | -       | -                        | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |                                   |
| GENERAL NOTES                                                                                                                                                  |                             |                                          |               |        |               |         |                          |                                                         |                                   |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |                             |                                          |               |        |               |         |                          |                                                         |                                   |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |                             |                                          |               |        |               |         |                          |                                                         |                                   |
| BI                                                                                                                                                             | BINARY INPUT                |                                          |               |        |               |         |                          |                                                         |                                   |
| BO                                                                                                                                                             | BINARY OUTPUT               |                                          |               |        |               |         |                          |                                                         |                                   |
| BV                                                                                                                                                             | BINARY VIRTUAL POINT        |                                          |               |        |               |         |                          |                                                         |                                   |
| AI                                                                                                                                                             | ANALOG INPUT                |                                          |               |        |               |         |                          |                                                         |                                   |
| AO                                                                                                                                                             | ANALOG OUTPUT               |                                          |               |        |               |         |                          |                                                         |                                   |
| AV                                                                                                                                                             | ANALOG VIRTUAL POINT        |                                          |               |        |               |         |                          |                                                         |                                   |
| HW                                                                                                                                                             | HARD WIRED INTERLOCK/SAFETY |                                          |               |        |               |         |                          |                                                         |                                   |
| COS                                                                                                                                                            | CHANGE OF STATE             |                                          |               |        |               |         |                          |                                                         |                                   |

### RLF-2 POINTS LIST

| POINT DESCRIPTION |                             |                       |            | STARTUP TREND                                                                                                                                                  |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                       |  | NOTES                                                               |
|-------------------|-----------------------------|-----------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------|---------|------------------------------------------------|--|---------------------------------------------------------------------|
| TYPE              | NAME                        | DESCRIPTION           | UNITS      | FREQ                                                                                                                                                           | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                |  |                                                                     |
| BI                | RLF-ST                      | RELIEF FAN STATUS     | OFF / ON   | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                      |  | REFERENCE OUTSIDE AIR PRESSURE<br>4-10 mA/2-10 VDC, COORD. WITH VFD |
| BO                | RLF-SS                      | RELIEF FAN START/STOP | OFF / ON   | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                            |  |                                                                     |
| AI                | BLDG-P                      | BUILDING PRESSURE     | IN. W.C.,1 | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | VERY LOW AIR DIFFERENTIAL PRESSURE TRANSMITTER |  |                                                                     |
| AO                | RLF-SPD                     | RELIEF FAN SPEED      | %          | 1 MIN.                                                                                                                                                         | 30 MIN  | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE           |  |                                                                     |
|                   |                             |                       |            | GENERAL NOTES                                                                                                                                                  |         |               |         |                                                |  |                                                                     |
|                   |                             |                       |            | 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |         |               |         |                                                |  |                                                                     |
|                   |                             |                       |            | 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |         |               |         |                                                |  |                                                                     |
| BI                | BINARY INPUT                |                       |            |                                                                                                                                                                |         |               |         |                                                |  |                                                                     |
| BO                | BINARY OUTPUT               |                       |            |                                                                                                                                                                |         |               |         |                                                |  |                                                                     |
| BV                | BINARY VIRTUAL POINT        |                       |            |                                                                                                                                                                |         |               |         |                                                |  |                                                                     |
| AI                | ANALOG INPUT                |                       |            |                                                                                                                                                                |         |               |         |                                                |  |                                                                     |
| AO                | ANALOG OUTPUT               |                       |            |                                                                                                                                                                |         |               |         |                                                |  |                                                                     |
| AV                | ANALOG VIRTUAL POINT        |                       |            |                                                                                                                                                                |         |               |         |                                                |  |                                                                     |
| HW                | HARD WIRED INTERLOCK/SAFETY |                       |            |                                                                                                                                                                |         |               |         |                                                |  |                                                                     |
| COS               | CHANGE OF STATE             |                       |            |                                                                                                                                                                |         |               |         |                                                |  |                                                                     |



ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000987

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

CONSULTING ENGINEERS:

CIVIL / SURVEY  
ARCHITECTURAL  
MECHANICAL / PLUMBING  
ELECTRICAL / ENGINEERING

HOENER ASSOCIATES, INC. - ARCHITECTS

1807 PULASKI AVE  
ST. LOUIS, MISSOURI 63103  
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ORCHARD FARM SCHOOL DISTRICT

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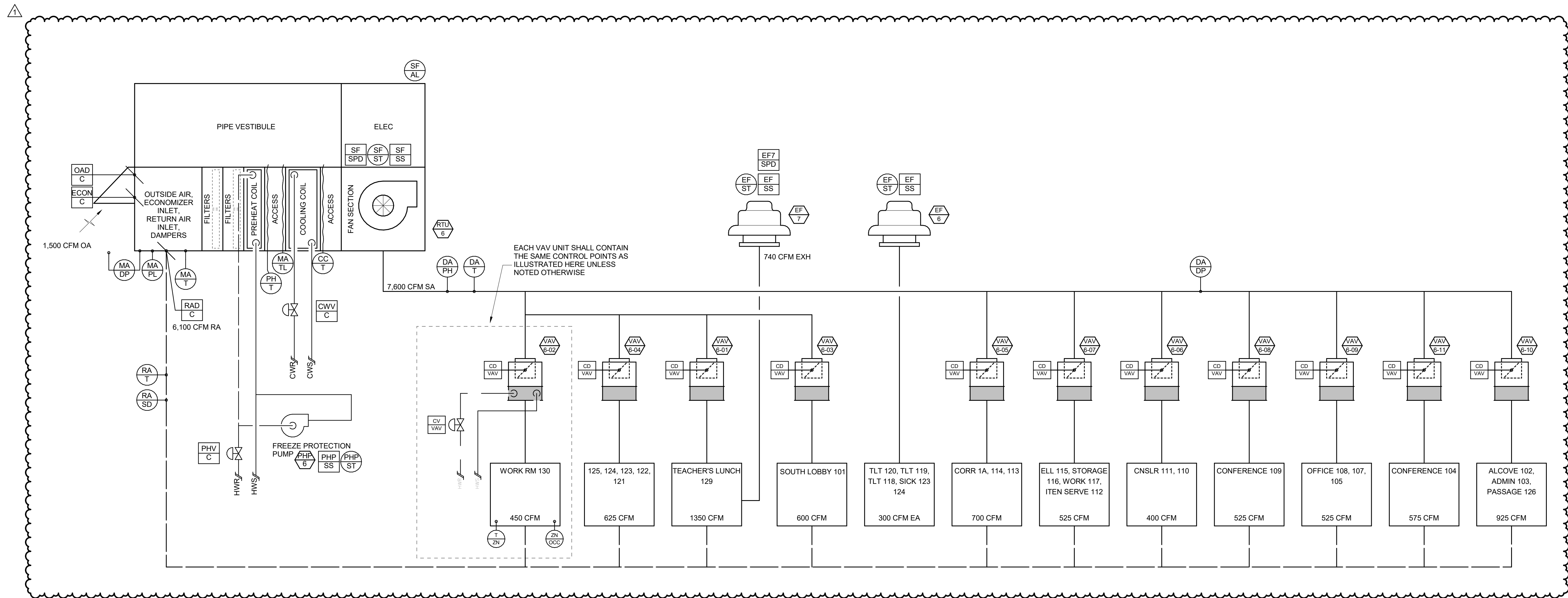
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SHEET NO.

M5.4  
SD: 49

RTU-5 AIR FLOW DIAGRAM





RTU-6 AIR FLOW DIAGRAM  
NO SCALE

| RTU-6 POINTS LIST                                                                                                                                              |        |                                             |               |        |               |         |         |                                                         |                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------------------------------------------|---------------|--------|---------------|---------|---------|---------------------------------------------------------|-----------------------------------|
| POINT DESCRIPTION                                                                                                                                              |        |                                             | STARTUP TREND |        | SERVICE TREND |         |         | FIELD DEVICE DESCRIPTION                                |                                   |
| TYPE                                                                                                                                                           | NAME   | DESCRIPTION                                 | UNITS         | FREQ   | ARCHIVE       | FREQ    | ARCHIVE | INSTRUMENT TYPE                                         | NOTES                             |
| GLOBAL POINTS (TO BE MAPPED...                                                                                                                                 |        |                                             |               |        |               |         |         |                                                         |                                   |
| AV                                                                                                                                                             | OA-T   | OUTSIDE AIR TEMPERATURE REFERENCE           | "F, 1         | -      | -             | -       | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AV                                                                                                                                                             | OA-H   | OUTSIDE AIR RELATIVE HUMIDITY REFERENCE     | % RH, 1       | -      | -             | -       | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AV                                                                                                                                                             | OA-DWP | OUTSIDE AIR DEW POINT REFERENCE             | "F, 1         | -      | -             | -       | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |
| AHU UNIT LEVEL CONTROL...                                                                                                                                      |        |                                             |               |        |               |         |         |                                                         |                                   |
| AI                                                                                                                                                             | CO-T   | COOLING COIL AIR TEMPERATURE                | "F, 1         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                                                                                                                                             | MA-T   | MIXED AIR TEMPERATURE                       | "F, 1         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                                                                                                                                             | PH-T   | PREHEAT AIR TEMPERATURE                     | "F, 1         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |
| AI                                                                                                                                                             | DA-T   | DISCHARGE AIR TEMPERATURE                   | "F, 1         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |
| AI                                                                                                                                                             | RA-T   | RETURN AIR TEMPERATURE                      | "F, 1         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |
| AI                                                                                                                                                             | DA-DP  | DISCHARGE AIR DIFFERENTIAL PRESSURE         | IN. W.C., 1   | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   | REFERENCE ZONE PRESSURE           |
| AI                                                                                                                                                             | MA-DP  | MIXED AIR DIFFERENTIAL PRESSURE             | IN. W.C., 1   | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   | REFERENCE OUTSIDE AIR PRESSURE    |
| AO                                                                                                                                                             | OAD-C  | MINIMUM OUTSIDE AIR DAMPER                  | % , 0         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                                                                                                                                             | ECON-C | ECONOMIZER DAMPER                           | % , 0         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                                                                                                                                             | RAD-C  | RETURN AIR DAMPER                           | % , 0         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |
| AO                                                                                                                                                             | SF-SPD | SUPPLY FAN SPEED                            | % , 0         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    | 4-10 mA/2-10 VDC, COORD. WITH VFD |
| AO                                                                                                                                                             | CWV-C  | COOLING COIL VALVE                          | % , 0         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                              |                                   |
| AO                                                                                                                                                             | PHV-C  | HEATING COIL VALVE                          | % , 0         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                              |                                   |
| BI                                                                                                                                                             | SF-ST  | SUPPLY FAN STATUS                           | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |
| BI                                                                                                                                                             | PHP-ST | PREHEAT COIL PUMP STATUS                    | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |
| BO                                                                                                                                                             | SF-SS  | SUPPLY FAN START/STOP                       | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | DRY CONTACT / RELAY                                     |                                   |
| BO                                                                                                                                                             | PHP-SS | PREHEAT COIL PUMP START/STOP                | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |
| BV                                                                                                                                                             | SF-AL  | SUPPLY FAN EC ALARM                         | NORM / ALARM  | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE                  |                                   |
| HW                                                                                                                                                             | RA-SD  | RETURN AIR SMOKE DETECTOR                   | NORM / ALARM  | -      | -             | -       | -       | FIRE ALARM RELAY (BY DIV. 28)                           |                                   |
| HW                                                                                                                                                             | MA-TL  | MIXED AIR LOW LIMIT THERMOSTAT              | NORM / ALARM  | -      | -             | -       | -       | LOW LIMIT THERMOSTAT                                    |                                   |
| HW                                                                                                                                                             | DA-PH  | DISCHARGE AIR HIGH PRESSURE LIMIT SWITCH    | NORM / ALARM  | -      | -             | -       | -       | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |                                   |
| HW                                                                                                                                                             | MA-PL  | MIXED AIR LOW PRESSURE LIMIT SWITCH         | NORM / ALARM  | -      | -             | -       | -       | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |                                   |
| MONITORED EQUIPMENT POINTS                                                                                                                                     |        |                                             |               |        |               |         |         |                                                         |                                   |
| BI                                                                                                                                                             | EF-ST  | EF-7 FAN STATUS                             | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |
| BI                                                                                                                                                             | BI     | BINARY INPUT                                |               |        |               |         |         |                                                         |                                   |
| BO                                                                                                                                                             | BO     | BINARY OUTPUT                               |               |        |               |         |         |                                                         |                                   |
| BV                                                                                                                                                             | BV     | BINARY VIRTUAL POINT                        |               |        |               |         |         |                                                         |                                   |
| AI                                                                                                                                                             | AI     | ANALOG INPUT                                |               |        |               |         |         |                                                         |                                   |
| AO                                                                                                                                                             | AO     | ANALOG OUTPUT                               |               |        |               |         |         |                                                         |                                   |
| HW                                                                                                                                                             | HW     | ANALOG VIRTUAL POINT                        |               |        |               |         |         |                                                         |                                   |
| COS                                                                                                                                                            | COS    | HARD WIRED INTERLOCK/SAFETY CHANGE OF STATE |               |        |               |         |         |                                                         |                                   |
| GENERAL NOTES                                                                                                                                                  |        |                                             |               |        |               |         |         |                                                         |                                   |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |        |                                             |               |        |               |         |         |                                                         |                                   |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS 'OFF' AND 'ON' STATE LABELS FOR POINT.                                                                                |        |                                             |               |        |               |         |         |                                                         |                                   |



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NEW ELEMENTARY SCHOOL - 2525 HWY B

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1 08/01/24 ADDENDUM #2

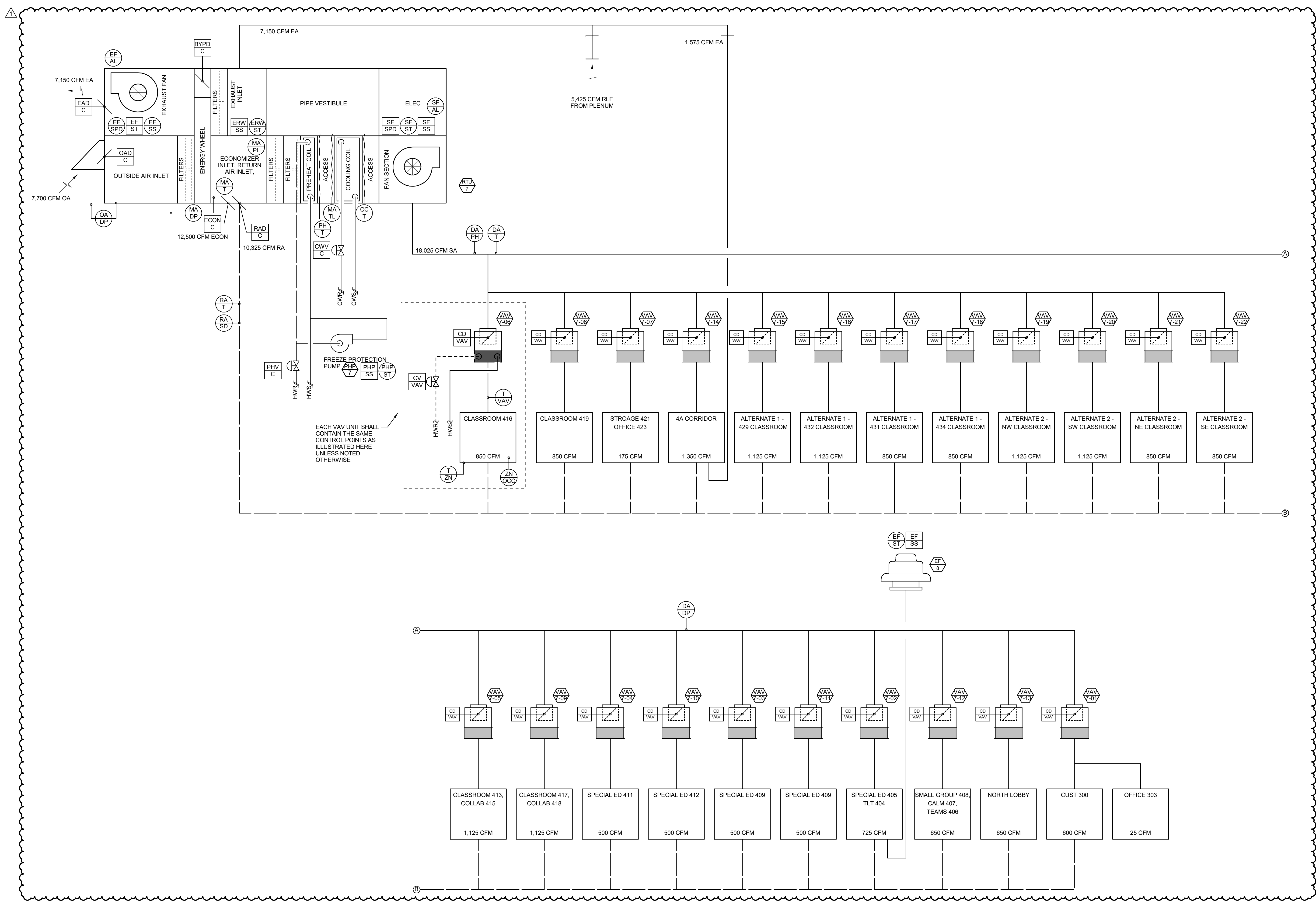
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SHEET NO.

M5.5  
SD: 50





RTU-7 AIR FLOW DIAGRAM  
NO SCALE

| RTU-7 POINTS LIST                                                                                                                                              |        |                                          |              |               |         |               |         |                                                         |                                   |       |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------------|--------------|---------------|---------|---------------|---------|---------------------------------------------------------|-----------------------------------|-------|--|
| POINT DESCRIPTION                                                                                                                                              |        |                                          |              | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                                |                                   | NOTES |  |
| TYPE                                                                                                                                                           | NAME   | DESCRIPTION                              | UNITS        | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                         |                                   |       |  |
| GLOBAL POINTS (TO BE MAPPED...)                                                                                                                                |        |                                          |              |               |         |               |         |                                                         |                                   |       |  |
| AV                                                                                                                                                             | OA-T   | OUTSIDE AIR TEMPERATURE REFERENCE        | °F.1         | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |       |  |
| AV                                                                                                                                                             | OA-H   | OUTSIDE AIR RELATIVE HUMIDITY REFERENCE  | % RH.1       | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |       |  |
| AV                                                                                                                                                             | OA-DWP | OUTSIDE AIR DWP POINT REFERENCE          | °F.1         | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |       |  |
| AHU UNIT LEVEL CONTROL...                                                                                                                                      |        |                                          |              |               |         |               |         |                                                         |                                   |       |  |
| AI                                                                                                                                                             | CC-T   | COOLING COIL AIR TEMPERATURE             | °F.1         | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |       |  |
| AI                                                                                                                                                             | MA-T   | MIXED AIR TEMPERATURE                    | °F.1         | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |       |  |
| AI                                                                                                                                                             | PH-T   | PREHEAT AIR TEMPERATURE                  | °F.1         | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |       |  |
| AI                                                                                                                                                             | DA-T   | DISCHARGE AIR TEMPERATURE                | °F.1         | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |       |  |
| AI                                                                                                                                                             | RA-T   | RETURN AIR TEMPERATURE                   | °F.1         | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |       |  |
| AI                                                                                                                                                             | DA-DP  | DISCHARGE AIR DIFFERENTIAL PRESSURE      | IN. W.C.1    | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   | REFERENCE ZONE PRESSURE           |       |  |
| AI                                                                                                                                                             | MA-DP  | MIXED AIR DIFFERENTIAL PRESSURE          | IN. W.C.1    | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   | REFERENCE OUTSIDE AIR PRESSURE    |       |  |
| AO                                                                                                                                                             | OAD-C  | MINIMUM OUTSIDE AIR DAMPER               | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |  |
| AO                                                                                                                                                             | ECON-C | ECONOMIZER DAMPER                        | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |  |
| AO                                                                                                                                                             | RAD-C  | RETURN AIR DAMPER                        | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |  |
| AO                                                                                                                                                             | EAD-C  | EXHAUST AIR DAMPER                       | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |  |
| AO                                                                                                                                                             | BYPD-C | WHEEL BYPASS AIR DAMPER                  | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |  |
| AO                                                                                                                                                             | CWV-C  | COOLING CONTROL VALVE                    | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                              |                                   |       |  |
| AO                                                                                                                                                             | PHV-C  | HEATING CONTROL VALVE                    | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                              |                                   |       |  |
| AO                                                                                                                                                             | SF-SPD | SUPPLY FAN SPEED                         | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    | 4-10 mA/2-10 VDC. COORD. WITH VFD |       |  |
| AO                                                                                                                                                             | EF-SPD | EXHAUST FAN SPEED                        | % 0          | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    | 4-10 mA/2-10 VDC. COORD. WITH VFD |       |  |
| BI                                                                                                                                                             | ERW-ST | ENERGY RECOVERY WHEEL STATUS             | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |       |  |
| BI                                                                                                                                                             | SF-ST  | SUPPLY FAN STATUS                        | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |       |  |
| BI                                                                                                                                                             | PHV-ST | PREHEAT FAN STATUS                       | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |       |  |
| BI                                                                                                                                                             | EF-ST  | EXHAUST FAN STATUS                       | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |       |  |
| BO                                                                                                                                                             | SF-SS  | SUPPLY FAN START/STOP                    | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |       |  |
| BO                                                                                                                                                             | PHV-SS | PREHEAT COIL PUMP START/STOP             | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |       |  |
| BO                                                                                                                                                             | ERW-SS | ENERGY RECOVERY WHEEL START/STOP         | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    |                                   |       |  |
| BO                                                                                                                                                             | EF-SS  | EXHAUST FAN START/STOP                   | OFF / ON     | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |       |  |
| BV                                                                                                                                                             | SF-AL  | SUPPLY FAN EC ALARM                      | NORM / ALARM | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE                  |                                   |       |  |
| BV                                                                                                                                                             | EF-AL  | EXHAUST FAN EC ALARM                     | NORM / ALARM | 1 MIN.        | 30 MIN  | 15 MIN        | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE                  |                                   |       |  |
| HW                                                                                                                                                             | RA-SD  | RETURN AIR SMOKE DETECTOR                | NORM / ALARM | -             | -       | -             | -       | FIRE ALARM RELAY (BY DIV 28)                            |                                   |       |  |
| HW                                                                                                                                                             | MA-TL  | MIXED AIR LOW LIMIT THERMOSTAT           | NORM / ALARM | -             | -       | -             | -       | LOW LIMIT THERMOSTAT                                    |                                   |       |  |
| HW                                                                                                                                                             | DA-PH  | DISCHARGE AIR HIGH PRESSURE LIMIT SWITCH | NORM / ALARM | -             | -       | -             | -       | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |                                   |       |  |
| HW                                                                                                                                                             | MA-PL  | MIXED AIR LOW PRESSURE LIMIT SWITCH      | NORM / ALARM | -             | -       | -             | -       | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |                                   |       |  |
| GENERAL NOTES                                                                                                                                                  |        |                                          |              |               |         |               |         |                                                         |                                   |       |  |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT. SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |        |                                          |              |               |         |               |         |                                                         |                                   |       |  |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |        |                                          |              |               |         |               |         |                                                         |                                   |       |  |
|                                                                                                                                                                | BI     | BINARY INPUT                             |              |               |         |               |         |                                                         |                                   |       |  |
|                                                                                                                                                                | BO     | BINARY OUTPUT                            |              |               |         |               |         |                                                         |                                   |       |  |
|                                                                                                                                                                | BV     | BINARY VIRTUAL POINT                     |              |               |         |               |         |                                                         |                                   |       |  |
|                                                                                                                                                                | AI     | ANALOG INPUT                             |              |               |         |               |         |                                                         |                                   |       |  |
|                                                                                                                                                                | AO     | ANALOG OUTPUT                            |              |               |         |               |         |                                                         |                                   |       |  |
|                                                                                                                                                                | AV     | ANALOG VIRTUAL POINT                     |              |               |         |               |         |                                                         |                                   |       |  |
|                                                                                                                                                                | HW     | HARD WIRED INTERLOCK/SAFETY              |              |               |         |               |         |                                                         |                                   |       |  |
|                                                                                                                                                                | COS    | CHANGE OF STATE                          |              |               |         |               |         |                                                         |                                   |       |  |



ALEX PUGH  
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ENGINEERING CORP.  
NO. 000987

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

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CIVIL SURVEY  
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MECHANICAL  
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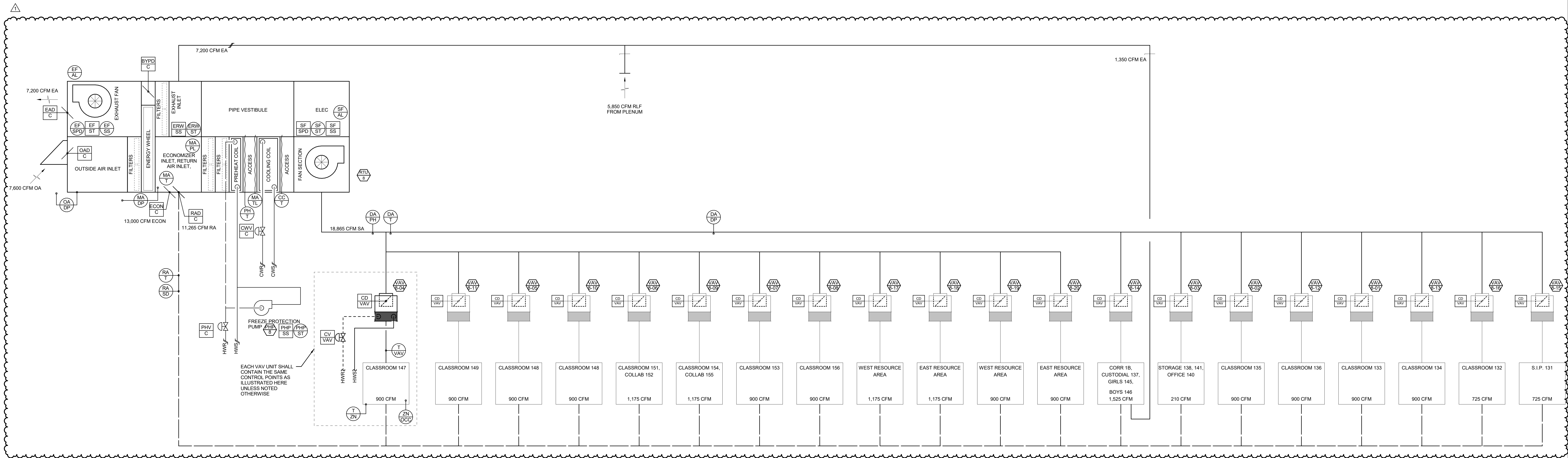
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SHEET NO.

M5.6  
SD: 51





RTU-8 AIR FLOW DIAGRAM  
NO SCALE

| RTU-8 POINTS LIST                                                                                                                                              |                             |                                          |              |               |         |               |         |                                                         |                                   |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------------------|--------------|---------------|---------|---------------|---------|---------------------------------------------------------|-----------------------------------|-------|
| POINT DESCRIPTION                                                                                                                                              |                             |                                          |              | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                                |                                   | NOTES |
| TYPE                                                                                                                                                           | NAME                        | DESCRIPTION                              | UNITS        | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                         |                                   |       |
| GLOBAL POINTS (TO BE MAPPED...                                                                                                                                 |                             |                                          |              |               |         |               |         |                                                         |                                   |       |
| AV                                                                                                                                                             | OA-T                        | OUTSIDE AIR TEMPERATURE REFERENCE        | "F, 1        | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |       |
| AV                                                                                                                                                             | OA-H                        | OUTSIDE AIR RELATIVE HUMIDITY REFERENCE  | % RH, 1      | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |       |
| AV                                                                                                                                                             | OA-DWP                      | OUTSIDE AIR DEW POINT REFERENCE          | "F, 1        | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                          |                                   |       |
| AHU UNIT LEVEL CONTROL...                                                                                                                                      |                             |                                          |              |               |         |               |         |                                                         |                                   |       |
| AI                                                                                                                                                             | CO-T                        | COOLING COIL AIR TEMPERATURE             | "F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |       |
| AI                                                                                                                                                             | MA-T                        | MIXED AIR TEMPERATURE                    | "F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |       |
| AI                                                                                                                                                             | PH-T                        | PREHEAT AIR TEMPERATURE                  | "F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE BENDABLE AVERAGING ELEMENTS            |                                   |       |
| AI                                                                                                                                                             | DA-T                        | DISCHARGE AIR TEMPERATURE                | "F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |       |
| AI                                                                                                                                                             | RA-T                        | RETURN AIR TEMPERATURE                   | "F, 1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DUCT TEMPERATURE SENSOR - FOR AIR HANDLING UNIT SYSTEMS |                                   |       |
| AI                                                                                                                                                             | DA-DP                       | DISCHARGE AIR DIFFERENTIAL PRESSURE      | IN. W.C., 1  | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   | REFERENCE ZONE PRESSURE           |       |
| AI                                                                                                                                                             | MA-DP                       | MIXED AIR DIFFERENTIAL PRESSURE          | IN. W.C., 1  | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | GENERAL PURPOSE AIR DIFFERENTIAL PRESSURE TRANSMITTER   | REFERENCE OUTSIDE AIR PRESSURE    |       |
| AO                                                                                                                                                             | OAD-C                       | MINIMUM OUTSIDE AIR DAMPER               | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |
| AO                                                                                                                                                             | ECON-C                      | ECONOMIZER DAMPER                        | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |
| AO                                                                                                                                                             | RAD-C                       | RETURN AIR DAMPER                        | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |
| AO                                                                                                                                                             | EAD-C                       | EXHAUST AIR DAMPER                       | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |
| AO                                                                                                                                                             | BYPD-C                      | WHEEL BYPASS AIR DAMPER                  | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DIRECT COUPLED ELECTRIC ACTUATOR                        |                                   |       |
| AO                                                                                                                                                             | CWV-C                       | COOLING CONTROL VALVE                    | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                              |                                   |       |
| AO                                                                                                                                                             | PHV-C                       | HEATING CONTROL VALVE                    | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | SEE CONTROL VALVE SCHEDULE                              |                                   |       |
| AO                                                                                                                                                             | SF-SPD                      | SUPPLY FAN SPEED                         | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    | 4-10 mA/2-10 VDC, COORD. WITH VFD |       |
| AO                                                                                                                                                             | EF-SPD                      | EXHAUST FAN SPEED                        | % , 0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    | 4-10 mA/2-10 VDC, COORD. WITH VFD |       |
| BI                                                                                                                                                             | ERW-ST                      | ENERGY RECOVERY WHEEL STATUS             | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |       |
| BI                                                                                                                                                             | SF-ST                       | SUPPLY FAN STATUS                        | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |       |
| BI                                                                                                                                                             | PHP-ST                      | PREHEAT COIL PUMP STATUS                 | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |       |
| BI                                                                                                                                                             | EF-ST                       | EXHAUST FAN STATUS                       | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                               |                                   |       |
| BO                                                                                                                                                             | SF-SS                       | SUPPLY FAN START/STOP                    | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                                     |                                   |       |
| BO                                                                                                                                                             | PHP-SS                      | PREHEAT COIL PUMP START/STOP             | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | RELAY & AC CURRENT SWITCH COMBO                         |                                   |       |
| BO                                                                                                                                                             | ERW-SS                      | ENERGY RECOVERY WHEEL START/STOP         | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE                    |                                   |       |
| BO                                                                                                                                                             | EF-SS                       | EXHAUST FAN START/STOP                   | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                                     |                                   |       |
| BV                                                                                                                                                             | SF-AL                       | SUPPLY FAN EC ALARM                      | NORM / ALARM | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE                  |                                   |       |
| BV                                                                                                                                                             | EF-AL                       | EXHAUST FAN EC ALARM                     | NORM / ALARM | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE                  |                                   |       |
| HW                                                                                                                                                             | RA-SD                       | RETURN AIR SMOKE DETECTOR                | NORM / ALARM | -             | -       | -             | -       | FIRE ALARM RELAY (BY DIV. 28)                           |                                   |       |
| HW                                                                                                                                                             | MA-TL                       | MIXED AIR LOW LIMIT THERMOSTAT           | NORM / ALARM | -             | -       | -             | -       | LOW LIMIT THERMOSTAT                                    |                                   |       |
| HW                                                                                                                                                             | DA-PH                       | DISCHARGE AIR HIGH PRESSURE LIMIT SWITCH | NORM / ALARM | -             | -       | -             | -       | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |                                   |       |
| HW                                                                                                                                                             | MA-PL                       | MIXED AIR LOW PRESSURE LIMIT SWITCH      | NORM / ALARM | -             | -       | -             | -       | MANUAL RESET AIR DIFFERENTIAL PRESSURE SWITCH           |                                   |       |
| GENERAL NOTES                                                                                                                                                  |                             |                                          |              |               |         |               |         |                                                         |                                   |       |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |                             |                                          |              |               |         |               |         |                                                         |                                   |       |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |                             |                                          |              |               |         |               |         |                                                         |                                   |       |
| BI                                                                                                                                                             | BINARY INPUT                |                                          |              |               |         |               |         |                                                         |                                   |       |
| BO                                                                                                                                                             | BINARY OUTPUT               |                                          |              |               |         |               |         |                                                         |                                   |       |
| BV                                                                                                                                                             | BINARY VIRTUAL POINT        |                                          |              |               |         |               |         |                                                         |                                   |       |
| AI                                                                                                                                                             | ANALOG INPUT                |                                          |              |               |         |               |         |                                                         |                                   |       |
| AO                                                                                                                                                             | ANALOG OUTPUT               |                                          |              |               |         |               |         |                                                         |                                   |       |
| AV                                                                                                                                                             | ANALOG VIRTUAL POINT        |                                          |              |               |         |               |         |                                                         |                                   |       |
| HW                                                                                                                                                             | HARD WIRED INTERLOCK/SAFETY |                                          |              |               |         |               |         |                                                         |                                   |       |
| COS                                                                                                                                                            | CHANGE OF STATE             |                                          |              |               |         |               |         |                                                         |                                   |       |



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NEW ELEMENTARY SCHOOL - 2525 HWY B

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HOENER ASSOCIATES, INC. - ARCHITECTS

ORCHARD FARM SCHOOL DISTRICT

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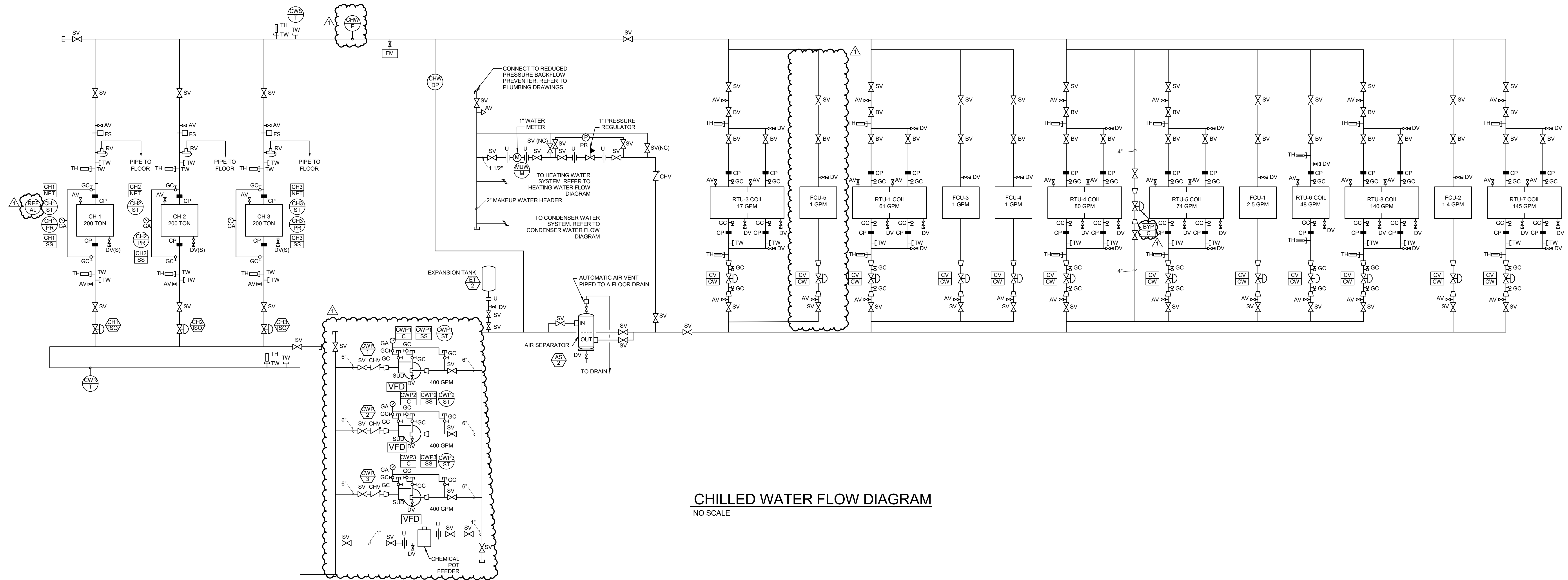
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CHECKED BY CW

SHEET NO.

M5.7  
SD: 52





CHILLED WATER FLOW DIAGRAM  
NO SCALE

| CHILLED WATER POINTS LIST                                                                                                                                      |                             |                                           |              |               |         |               |         |                                                  |  |                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------|--------------|---------------|---------|---------------|---------|--------------------------------------------------|--|------------------------------------------|
| POINT DESCRIPTION                                                                                                                                              |                             |                                           |              | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION                         |  | NOTES                                    |
| TYPE                                                                                                                                                           | NAME                        | DESCRIPTION                               | UNITS        | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE                                  |  |                                          |
| GLOBAL POINTS (TO BE MAPPED TO UNIT CONTROLLER)                                                                                                                |                             |                                           |              |               |         |               |         |                                                  |  |                                          |
| AV                                                                                                                                                             | OA-T                        | OUTSIDE AIR TEMPERATURE REFERENCE         | °F           | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                   |  |                                          |
| AV                                                                                                                                                             | OA-H                        | OUTSIDE AIR RELATIVE HUMIDITY REFERENCE   | % RH.1       | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                   |  |                                          |
| AV                                                                                                                                                             | OA-DWP                      | OUTSIDE AIR DEW POINT REFERENCE           | °F.1         | -             | -       | -             | -       | BAS POINT MAPPED TO CONTROLLER                   |  |                                          |
| CHILLER POINTS                                                                                                                                                 |                             |                                           |              |               |         |               |         |                                                  |  |                                          |
| AO                                                                                                                                                             | CH1-IS0                     | CHILLER 1 ISOLATION VALVE                 | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                   |  |                                          |
| AO                                                                                                                                                             | CH2-IS0                     | CHILLER 2 ISOLATION VALVE                 | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                   |  |                                          |
| AO                                                                                                                                                             | CH3-IS0                     | CHILLER 3 ISOLATION VALVE                 | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                   |  |                                          |
| AV                                                                                                                                                             | CH1-RLA                     | CHILLER 1 % RUN LOAD AMPS                 | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| AV                                                                                                                                                             | CH2-RLA                     | CHILLER 2 % RUN LOAD AMPS                 | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| AV                                                                                                                                                             | CH3-RLA                     | CHILLER 3 % RUN LOAD AMPS                 | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| AV                                                                                                                                                             | CH1-T                       | CHILLER 1 LEAVING WATER TEMPERATURE       | °F.1         | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| AV                                                                                                                                                             | CH2-T                       | CHILLER 2 LEAVING WATER TEMPERATURE       | °F.1         | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| AV                                                                                                                                                             | CH3-T                       | CHILLER 3 LEAVING WATER TEMPERATURE       | °F.1         | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| AV                                                                                                                                                             | CH1-SP                      | CHILLER 1 TEMPERATURE SETPOINT            | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| AV                                                                                                                                                             | CH2-SP                      | CHILLER 2 TEMPERATURE SETPOINT            | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| AV                                                                                                                                                             | CH3-SP                      | CHILLER 3 TEMPERATURE SETPOINT            | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| BO                                                                                                                                                             | CH1-SS                      | CHILLER 1 ENABLE                          | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE             |  |                                          |
| BO                                                                                                                                                             | CH2-SS                      | CHILLER 2 ENABLE                          | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE             |  |                                          |
| BO                                                                                                                                                             | CH3-SS                      | CHILLER 3 ENABLE                          | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE             |  |                                          |
| BV                                                                                                                                                             | CH1-AL                      | CHILLER 1 ALARM                           | NORM / ALARM | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| BV                                                                                                                                                             | CH2-AL                      | CHILLER 2 ALARM                           | NORM / ALARM | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| BV                                                                                                                                                             | CH3-AL                      | CHILLER 3 ALARM                           | NORM / ALARM | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | NETWORK INTERFACE TO CONTROLLED DEVICE           |  |                                          |
| CHILLED WATER SYSTEM POINTS                                                                                                                                    |                             |                                           |              |               |         |               |         |                                                  |  |                                          |
| AI                                                                                                                                                             | CW-DP                       | CHILLED WATER PLANT DIFFERENTIAL PRESSURE | PSI.1        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HYDRONIC DIFFERENTIAL PRESSURE TRANSMITTER       |  | LOCATED AT THE PLANT                     |
| AI                                                                                                                                                             | CWL-T                       | CHILLED WATER LOOP RETURN TEMP.           | °F.1         | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | INSERTION ELEMENT FLUID TEMPERATURE SENSOR       |  |                                          |
| AI                                                                                                                                                             | CWS-T                       | CHILLED WATER LOOP SUPPLY TEMP.           | °F.1         | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | INSERTION ELEMENT FLUID TEMPERATURE SENSOR       |  |                                          |
| AI                                                                                                                                                             | CHW-F                       | CHILLED WATER FLOW                        | GPM.0        | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | INSERTION ELECTROMAGNETIC FLUID FLOW MEASUREMENT |  |                                          |
| AI                                                                                                                                                             | MUW-M                       | MAKEUP WATER METER                        | GALLONS      | -             | 30 MIN. | -             | 1 WEEK  | WATER METER BY DIV. 23                           |  | TC CNTR. TO PROVIDE XDCR FOR INTEGRATION |
| AO                                                                                                                                                             | BYP-C                       | BYPASS VALVE COMMAND                      | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | CONTROL VALVES                                   |  |                                          |
| AO                                                                                                                                                             | CWP1-C                      | CHILLED WATER PUMP 1 SPEED COMMAND        | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE             |  | 4-10 mA/2-10 VDC. COORD. WITH VFD        |
| AO                                                                                                                                                             | CWP2-C                      | CHILLED WATER PUMP 2 SPEED COMMAND        | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE             |  | 4-10 mA/2-10 VDC. COORD. WITH VFD        |
| AO                                                                                                                                                             | CWP3-C                      | CHILLED WATER PUMP 3 SPEED COMMAND        | %0           | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE             |  | 4-10 mA/2-10 VDC. COORD. WITH VFD        |
| BI                                                                                                                                                             | CWP1-ST                     | CHILLED WATER PUMP 1 STATUS               | OFF / ON     | L             | 30 MIN. | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                        |  |                                          |
| BI                                                                                                                                                             | CWP2-ST                     | CHILLED WATER PUMP 2 STATUS               | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                        |  |                                          |
| BI                                                                                                                                                             | CWP3-ST                     | CHILLED WATER PUMP 3 STATUS               | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | FIXED TRIP CURRENT SWITCH                        |  |                                          |
| BI                                                                                                                                                             | REF-AL                      | REFRIGERANT MONITOR ALARM                 | NORM / ALARM | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | HARDWIRED POINT TO CONTROLLED DEVICE             |  |                                          |
| BO                                                                                                                                                             | CWP1-SS                     | CHILLED WATER PUMP 1 ENABLE               | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                              |  |                                          |
| BO                                                                                                                                                             | CWP2-SS                     | CHILLED WATER PUMP 2 ENABLE               | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                              |  |                                          |
| BO                                                                                                                                                             | CWP3-SS                     | CHILLED WATER PUMP 3 ENABLE               | OFF / ON     | 1 MIN.        | 30 MIN. | 15 MIN.       | 1 WEEK  | DRY CONTACT / RELAY                              |  |                                          |
| GENERAL NOTES                                                                                                                                                  |                             |                                           |              |               |         |               |         |                                                  |  |                                          |
| BI                                                                                                                                                             | BINARY INPUT                |                                           |              |               |         |               |         |                                                  |  |                                          |
| BO                                                                                                                                                             | BINARY OUTPUT               |                                           |              |               |         |               |         |                                                  |  |                                          |
| BV                                                                                                                                                             | BINARY VIRTUAL POINT        |                                           |              |               |         |               |         |                                                  |  |                                          |
| AI                                                                                                                                                             | ANALOG INPUT                |                                           |              |               |         |               |         |                                                  |  |                                          |
| AO                                                                                                                                                             | ANALOG OUTPUT               |                                           |              |               |         |               |         |                                                  |  |                                          |
| AV                                                                                                                                                             | ANALOG VIRTUAL POINT        |                                           |              |               |         |               |         |                                                  |  |                                          |
| HW                                                                                                                                                             | HARD WIRED INTERLOCK/SAFETY |                                           |              |               |         |               |         |                                                  |  |                                          |
| COS                                                                                                                                                            | CHANGE OF STATE             |                                           |              |               |         |               |         |                                                  |  |                                          |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |                             |                                           |              |               |         |               |         |                                                  |  |                                          |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |                             |                                           |              |               |         |               |         |                                                  |  |                                          |



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1 08/01/24 ADDENDUM #2

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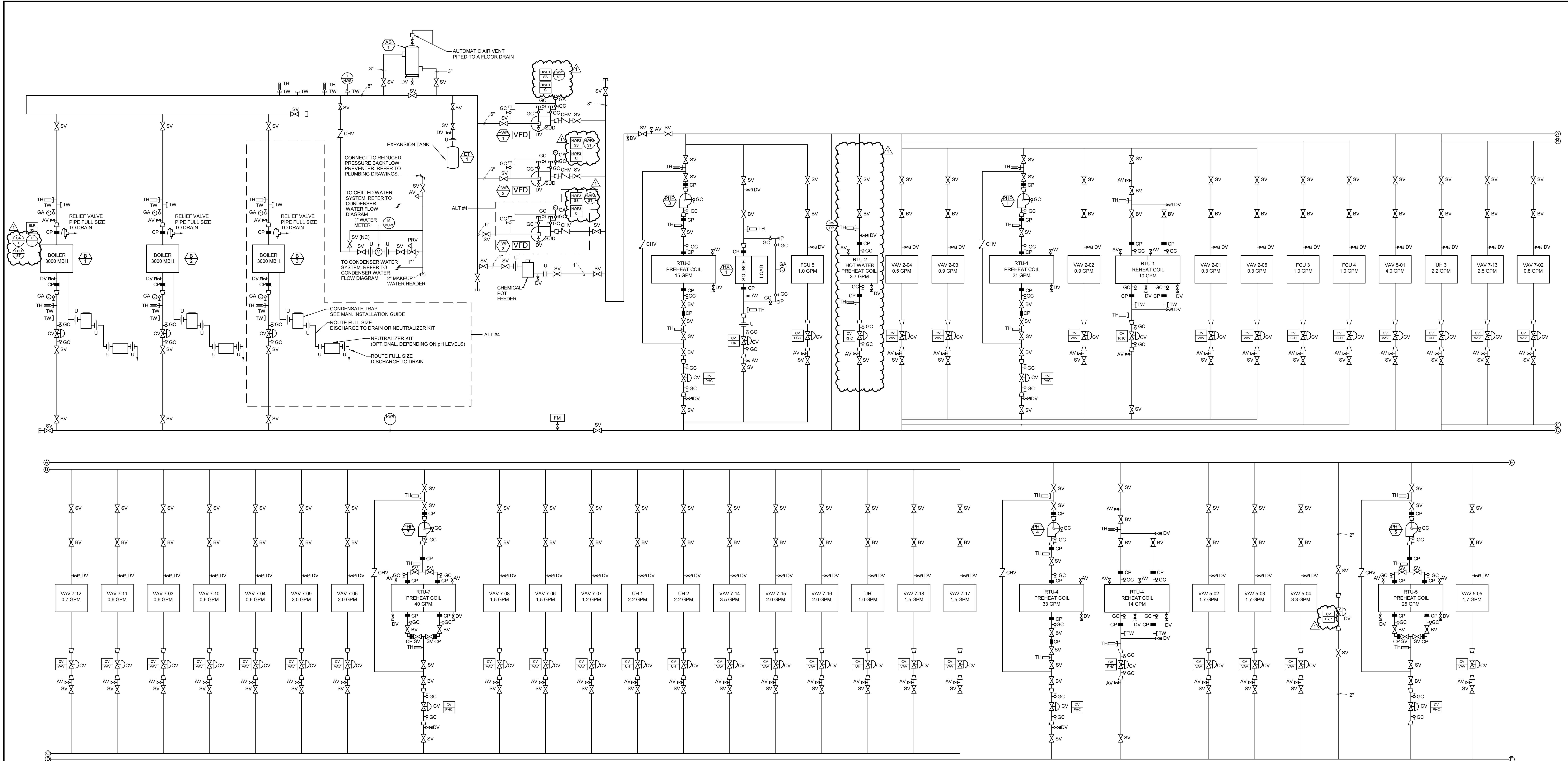
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|    |                      |                                                                                                                                                                                                                                                                           |
|----|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BI | BINARY INPUT         | <b>GENERAL NOTES</b><br>1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY.<br>2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT. |
| BO | BINARY OUTPUT        |                                                                                                                                                                                                                                                                           |
| BV | BINARY VIRTUAL POINT |                                                                                                                                                                                                                                                                           |
| AI | ANALOG INPUT         |                                                                                                                                                                                                                                                                           |





### HEATING WATER FLOW DIAGRAM

#### HEATING WATER POINTS LIST

| HEATING HOT WATER POINTS LIST                                                                                                                                  |                             |                                       |               |        |               |         |                          |                                                  |                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------|---------------|--------|---------------|---------|--------------------------|--------------------------------------------------|------------------------------------------------------------------------------------|
| POINT DESCRIPTION                                                                                                                                              |                             |                                       | STARTUP TREND |        | SERVICE TREND |         | FIELD DEVICE DESCRIPTION |                                                  | NOTES                                                                              |
| TYPE                                                                                                                                                           | NAME                        | DESCRIPTION                           | UNITS         | FREQ   | ARCHIVE       | FREQ    | ARCHIVE                  | INSTRUMENT TYPE                                  |                                                                                    |
| GLOBAL POINTS (TO BE MAPPED TO OTHER CONTROLLERS)                                                                                                              |                             |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| AI                                                                                                                                                             | OA-T                        | OUTSIDE AIR TEMPERATURE               | "F,1          | -      | -             | -       | -                        | OUTDOOR AIR TEMPERATURE SENSOR                   | CALCULATED FROM OA-T AND OA-H<br>CALCULATED FROM OA-T AND OA-H                     |
| AI                                                                                                                                                             | OA-H                        | OUTSIDE AIR RELATIVE HUMIDITY         | % RH,1        | -      | -             | -       | -                        | GENERAL PURPOSE OUTSIDE RELATIVE HUMIDITY SENSOR |                                                                                    |
| AV                                                                                                                                                             | OA-DWP                      | OUTSIDE AIR DWP POINT REFERENCE       | "F,1          | -      | -             | -       | -                        | SOFTWARE (VIRTUAL) POINT                         |                                                                                    |
| AV                                                                                                                                                             | OA-WB                       | OUTSIDE AIR WET BULB REFERENCE        | "F,1          | -      | -             | -       | -                        | SOFTWARE (VIRTUAL) POINT                         |                                                                                    |
| HOT WATER BOILER POINTS                                                                                                                                        |                             |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| AV                                                                                                                                                             | BSW-SP                      | BOILER SUPPLY WATER TEMP. SETPOINT    | "F,1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | HARDWIRED POINT TO CONTROLLED DEVICE             | FIELD INSTALL BOILER STAGING SENSOR                                                |
| AV                                                                                                                                                             | B1-T                        | BOILER 1 LEAVING WATER TEMPERATURE    | "F,1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE           |                                                                                    |
| AV                                                                                                                                                             | B2-T                        | BOILER 2 LEAVING WATER TEMPERATURE    | "F,1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE           |                                                                                    |
| AV                                                                                                                                                             | B3-T                        | BOILER 3 LEAVING WATER TEMPERATURE    | "F,1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE           |                                                                                    |
| AV                                                                                                                                                             | BSW-T                       | BOILER SUPPLY WATER TEMPERATURE       | "F,1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE           |                                                                                    |
| BO                                                                                                                                                             | BLR-SS                      | BOILER SYSTEM ENABLE                  | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | HARDWIRED POINT TO CONTROLLED DEVICE             |                                                                                    |
| BV                                                                                                                                                             | B1-CV                       | BOILER 1 ISOLATION VALVE              | CLOSED / OPEN | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE           |                                                                                    |
| BV                                                                                                                                                             | B2-CV                       | BOILER 2 ISOLATION VALVE              | CLOSED / OPEN | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE           |                                                                                    |
| BV                                                                                                                                                             | B3-CV                       | BOILER 3 ISOLATION VALVE              | CLOSED / OPEN | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE           | POSITION FEEDBACK                                                                  |
| BV                                                                                                                                                             | BLR-AL                      | BOILER SYSTEM SUMMARY ALARM           | NORM / ALARM  | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE           | POSITION FEEDBACK                                                                  |
| HOT WATER SYSTEM POINTS                                                                                                                                        |                             |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| AI                                                                                                                                                             | HWR-T                       | HOT WATER PLANT RETURN TEMP.          | "F,1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | INSERTION ELEMENT FLUID TEMPERATURE SENSOR       | LOCATED AT THE PLANT<br>CN TRN. TO PROVIDE XDR FOR INTEGRATION<br>GAME STORAGE 226 |
| AI                                                                                                                                                             | HWS-T                       | HOT WATER PLANT SUPPLY TEMP.          | "F,1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | INSERTION ELEMENT FLUID TEMPERATURE SENSOR       |                                                                                    |
| AI                                                                                                                                                             | HW-F                        | HOT WATER LOOP FLOW                   | GPM,0         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | INSERTION ELECTROMAGNETIC FLUID FLOW MEASUREMENT |                                                                                    |
| AI                                                                                                                                                             | HW-DP                       | HOT WATER PLANT DIFFERENTIAL PRESSURE | PSI,1         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | HYDRONIC DIFFERENTIAL PRESSURE TRANSMITTER       |                                                                                    |
| AI                                                                                                                                                             | MWM-M                       | MAKEUP WATER METER                    | GALLONS       | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | WATER METER BY DIV. 23                           |                                                                                    |
| AO                                                                                                                                                             | BYP-CV                      | BYPASS VALVE COMMAND                  | %,0           | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | CONTROL VALVES                                   |                                                                                    |
| AO                                                                                                                                                             | HWP1-C                      | HOT WATER PUMP 1 SPEED COMMAND        | %,0           | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | HARDWIRED POINT TO CONTROLLED DEVICE             |                                                                                    |
| AO                                                                                                                                                             | HWP2-C                      | HOT WATER PUMP 2 SPEED COMMAND        | %,0           | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | HARDWIRED POINT TO CONTROLLED DEVICE             |                                                                                    |
| AO                                                                                                                                                             | HWP3-C                      | HOT WATER PUMP 3 SPEED COMMAND        | %,0           | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | HARDWIRED POINT TO CONTROLLED DEVICE             |                                                                                    |
| AV                                                                                                                                                             | HW-SP                       | HOT WATER LOOP DP SETPOINT            | PSI,1         | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | SOFTWARE (VIRTUAL) POINT                         |                                                                                    |
| BI                                                                                                                                                             | EPO-ST                      | EMERGENCY PUSH BUTTON STATUS          | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | DRY CONTACT / RELAY                              | SEE ELECTRICAL DIAGRAMS                                                            |
| BI                                                                                                                                                             | HWP1-ST                     | HOT WATER PUMP 1 STATUS               | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | FIXED TRIP CURRENT SWITCH                        | ALTERNATE #4                                                                       |
| BI                                                                                                                                                             | HWP2-ST                     | HOT WATER PUMP 2 STATUS               | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | FIXED TRIP CURRENT SWITCH                        |                                                                                    |
| BI                                                                                                                                                             | HWP3-ST                     | HOT WATER PUMP 3 STATUS               | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | FIXED TRIP CURRENT SWITCH                        |                                                                                    |
| BO                                                                                                                                                             | HWP1-SS                     | HOT WATER PUMP 1 ENABLE               | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | DRY CONTACT / RELAY                              | ALTERNATE #4                                                                       |
| BO                                                                                                                                                             | HWP2-SS                     | HOT WATER PUMP 2 ENABLE               | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | DRY CONTACT / RELAY                              |                                                                                    |
| BO                                                                                                                                                             | HWP3-SS                     | HOT WATER PUMP 3 ENABLE               | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | DRY CONTACT / RELAY                              |                                                                                    |
| GENERAL NOTES                                                                                                                                                  |                             |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT. SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |                             |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |                             |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| BI                                                                                                                                                             | BINARY INPUT                |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| BO                                                                                                                                                             | BINARY OUTPUT               |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| BV                                                                                                                                                             | BINARY VIRTUAL POINT        |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| AI                                                                                                                                                             | ANALOG INPUT                |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| AO                                                                                                                                                             | ANALOG OUTPUT               |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| AV                                                                                                                                                             | ANALOG VIRTUAL POINT        |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| HW                                                                                                                                                             | HARD WIRED INTERLOCK/SAFETY |                                       |               |        |               |         |                          |                                                  |                                                                                    |
| COS                                                                                                                                                            | CHANGE OF STATE             |                                       |               |        |               |         |                          |                                                  |                                                                                    |



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NO. 000987

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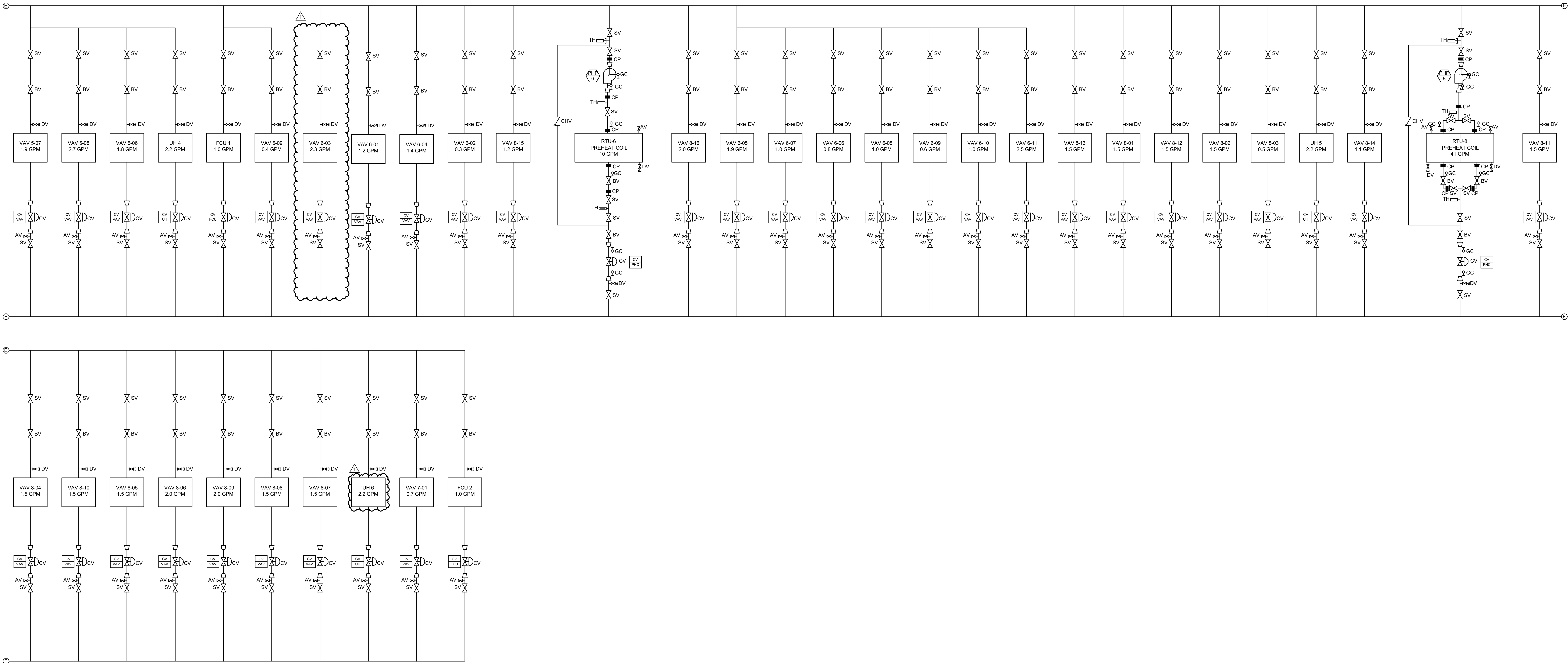
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HEATING WATER FLOW DIAGRAM





| MISCELLANEOUS POINTS LIST                                                                                                                                      |                             |                                        |              |               |         |               |         |                          |  |                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----------------------------------------|--------------|---------------|---------|---------------|---------|--------------------------|--|---------------------------------|
| POINT DESCRIPTION                                                                                                                                              |                             |                                        |              | STARTUP TREND |         | SERVICE TREND |         | FIELD DEVICE DESCRIPTION |  | NOTES                           |
| TYPE                                                                                                                                                           | NAME                        | DESCRIPTION                            | UNITS        | FREQ          | ARCHIVE | FREQ          | ARCHIVE | INSTRUMENT TYPE          |  |                                 |
| BV                                                                                                                                                             | GL-AL                       | GREASE INTERCEPTOR SERVICE ALARM       | NORM / ALARM | -             | -       | -             | -       | SOFTWARE (VIRTUAL) POINT |  | ALARM EVERY 6MO - USER ADJ.     |
| BV                                                                                                                                                             | FIL-AL                      | FILTER CHANGE ALARM                    | NORM / ALARM | -             | -       | -             | -       | SOFTWARE (VIRTUAL) POINT |  | ALARM EVERY 6MO - USER ADJ.     |
| BV                                                                                                                                                             | WS-AL                       | WATER SOFTENER SERVICE ALARM           | NORM / ALARM | -             | -       | -             | -       | SOFTWARE (VIRTUAL) POINT |  | ALARM EVERY 6MO - USER ADJ.     |
| BV                                                                                                                                                             | FRZ-AL                      | KITCHEN FREEZER HIGH TEMPERATURE ALARM | NORM / ALARM | -             | -       | -             | -       | ROOM TEMPERATURE SENSOR  |  | SEND ALARM FOR HIGH TEMPERATURE |
| BV                                                                                                                                                             | CLR-AL                      | KITCHEN COOLER HIGH TEMPERATURE ALARM  | NORM / ALARM | -             | -       | -             | -       | ROOM TEMPERATURE SENSOR  |  | SEND ALARM FOR HIGH TEMPERATURE |
| GENERAL NOTES                                                                                                                                                  |                             |                                        |              |               |         |               |         |                          |  |                                 |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |                             |                                        |              |               |         |               |         |                          |  |                                 |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |                             |                                        |              |               |         |               |         |                          |  |                                 |
| BI                                                                                                                                                             | BINARY INPUT                |                                        |              |               |         |               |         |                          |  |                                 |
| BO                                                                                                                                                             | BINARY OUTPUT               |                                        |              |               |         |               |         |                          |  |                                 |
| BV                                                                                                                                                             | BINARY VIRTUAL POINT        |                                        |              |               |         |               |         |                          |  |                                 |
| AI                                                                                                                                                             | ANALOG INPUT                |                                        |              |               |         |               |         |                          |  |                                 |
| AO                                                                                                                                                             | ANALOG OUTPUT               |                                        |              |               |         |               |         |                          |  |                                 |
| AV                                                                                                                                                             | ANALOG VIRTUAL POINT        |                                        |              |               |         |               |         |                          |  |                                 |
| HW                                                                                                                                                             | HARD WIRED INTERLOCK/SAFETY |                                        |              |               |         |               |         |                          |  |                                 |
| COS                                                                                                                                                            | CHANGE OF STATE             |                                        |              |               |         |               |         |                          |  |                                 |



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ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

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PLUMBING  
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PROJ. NO. 23-09B

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07-02-2024

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1 08/01/24 ADDENDUM #2

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SHEET NO.

M5.11  
SD: 56



| VARIABLE AIR VOLUME UNIT SCHEDULE                                                                                                                                                                      |            |                                   |                             |                        |                               |                               |                               |                        |                       |                        |             |             |              |                    |                   |       |              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------------------------|-----------------------------|------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------|-----------------------|------------------------|-------------|-------------|--------------|--------------------|-------------------|-------|--------------|
| UNIT<br>DESIG.                                                                                                                                                                                         | AHU<br>NO. | AREA SERVED                       | MANUFACTURER<br>& MODEL NO. | INLET<br>SIZE<br>(IN.) | DESIGN FLOW CONDITIONS        |                               |                               |                        | HEATING COIL DATA     |                        |             |             |              |                    |                   | NOTES |              |
|                                                                                                                                                                                                        |            |                                   |                             |                        | COOLING<br>MAX. FLOW<br>(CFM) | HEATING<br>MAX. FLOW<br>(CFM) | MINIMUM<br>MIN. FLOW<br>(CFM) | MAX. APD<br>(IN. W.C.) | HEATING<br>FLOW (CFM) | MIN. CAPACITY<br>(MBH) | EAT<br>(°F) | LAT<br>(°F) | EWTF<br>(°F) | MAX. FLOW<br>(GPM) | MAX. WPD<br>(FT.) |       | MIN.<br>ROWS |
| VAV 2-01                                                                                                                                                                                               | RTU-2      | 316 OFFICE, TABLE STORAGE         | TITUS DESV                  | 8                      | 175                           | 150                           | 150                           | 0.4                    | 150                   | 5                      | 55          | 85          | 130          | 0.5                | 5                 | 2     | 1.2          |
| VAV 2-02                                                                                                                                                                                               | RTU-2      | KITCHEN                           | TITUS DESV                  | 14                     | 1,600                         | 600                           | 600                           | 0.4                    | 600                   | 17                     | 55          | 80          | 130          | 1.7                | 5                 | 2     | 1.2          |
| VAV 2-03                                                                                                                                                                                               | RTU-2      | KITCHEN                           | TITUS DESV                  | 14                     | 1,600                         | 600                           | 600                           | 0.4                    | 600                   | 17                     | 55          | 80          | 130          | 1.7                | 5                 | 2     | 1.2          |
| VAV 2-04                                                                                                                                                                                               | RTU-2      | 312 DISH WASH, STORAGE            | TITUS DESV                  | 6                      | 225                           | 225                           | 225                           | 0.4                    | 175                   | 5                      | 55          | 80          | 130          | 0.5                | 5                 | 2     | 1.2          |
| VAV 2-05                                                                                                                                                                                               | RTU-2      | 317 DRY STORAGE                   | TITUS DESV                  | 6                      | 350                           | 350                           | 175                           | 0.4                    | 350                   | 10                     | 55          | 80          | 130          | 1.0                | 5                 | 2     | 1.2          |
| VAV 5-01                                                                                                                                                                                               | RTU-5      | 215 SENSORY, 227 OFF, 2A CORR, DZ | TITUS DESV                  | 12                     | 1,475                         | 1475                          | 1475                          | 0.4                    | 1,475                 | 41                     | 55          | 80          | 130          | 4.1                | 5                 | 2     | 1.2          |
| VAV 5-02                                                                                                                                                                                               | RTU-5      | 214 TECH                          | TITUS DESV                  | 12                     | 1,400                         | 800                           | 800                           | 0.4                    | 800                   | 22                     | 55          | 80          | 130          | 2.2                | 5                 | 2     | 1.2          |
| VAV 5-03                                                                                                                                                                                               | RTU-5      | 213 MUSIC                         | TITUS DESV                  | 12                     | 1,100                         | 800                           | 800                           | 0.4                    | 800                   | 22                     | 55          | 80          | 130          | 2.2                | 5                 | 2     | 1.2          |
| VAV 5-04                                                                                                                                                                                               | RTU-5      | 2B CORRIDOR                       | TITUS DESV                  | 10                     | 1,000                         | 1,000                         | 1000                          | 0.4                    | 1,000                 | 33                     | 55          | 85          | 130          | 3.3                | 5                 | 2     | 1.2          |
| VAV 5-05                                                                                                                                                                                               | RTU-5      | 2A CORRIDOR                       | TITUS DESV                  | 8                      | 600                           | 600                           | 600                           | 0.4                    | 600                   | 17                     | 55          | 80          | 130          | 1.7                | 5                 | 2     | 1.2          |
| VAV 5-06                                                                                                                                                                                               | RTU-5      | 206 ART                           | TITUS DESV                  | 12                     | 1,225                         | 885                           | 885                           | 0.4                    | 885                   | 34                     | 55          | 90          | 130          | 3.4                | 5                 | 2     | 1.2          |
| VAV 5-07                                                                                                                                                                                               | RTU-5      | 200 LIBRARY                       | TITUS DESV                  | 12                     | 1,200                         | 800                           | 800                           | 0.4                    | 800                   | 22                     | 55          | 80          | 130          | 2.2                | 5                 | 2     | 1.2          |
| VAV 5-08                                                                                                                                                                                               | RTU-5      | 200 LIBRARY & MEDIA ROOMS         | TITUS DESV                  | 12                     | 1,375                         | 800                           | 800                           | 0.4                    | 900                   | 35                     | 55          | 90          | 130          | 3.5                | 5                 | 2     | 1.2          |
| VAV 5-09                                                                                                                                                                                               | RTU-5      | 201 MEETING                       | TITUS DESV                  | 6                      | 175                           | 120                           | 60                            | 0.4                    | 120                   | 4                      | 55          | 85          | 130          | 0.4                | 5                 | 2     | 1.2          |
| VAV 6-01                                                                                                                                                                                               | RTU-6      | 129 TEACHERS LUNCH                | TITUS DESV                  | 12                     | 1,350                         | 425                           | 425                           | 0.4                    | 425                   | 12                     | 55          | 80          | 130          | 1.2                | 5                 | 2     | 1.2          |
| VAV 6-02                                                                                                                                                                                               | RTU-6      | 130 WORK ROOM                     | TITUS DESV                  | 8                      | 450                           | 100                           | 100                           | 0.4                    | 100                   | 3                      | 55          | 80          | 130          | 0.3                | 5                 | 2     | 1.2          |
| VAV 6-03                                                                                                                                                                                               | RTU-6      | SOUTH LOBBY                       | TITUS DESV                  | 8                      | 600                           | 600                           | 150                           | 0.4                    | 600                   | 23                     | 55          | 90          | 130          | 2.3                | 5                 | 2     | 1.2          |
| VAV 6-04                                                                                                                                                                                               | RTU-6      | NURSE'S SUITE                     | TITUS DESV                  | 8                      | 625                           | 625                           | 625                           | 0.4                    | 625                   | 17                     | 55          | 80          | 130          | 1.7                | 5                 | 2     | 1.2          |
| VAV 6-05                                                                                                                                                                                               | RTU-6      | 114 READING & 113 SPEECH          | TITUS DESV                  | 8                      | 700                           | 700                           | 700                           | 0.4                    | 700                   | 19                     | 55          | 80          | 130          | 1.9                | 5                 | 2     | 1.2          |
| VAV 6-06                                                                                                                                                                                               | RTU-6      | COUNSELORS' OFFICES               | TITUS DESV                  | 8                      | 400                           | 200                           | 100                           | 0.4                    | 200                   | 8                      | 55          | 90          | 130          | 0.8                | 5                 | 2     | 1.2          |
| VAV 6-07                                                                                                                                                                                               | RTU-6      | 115 ELL & 117 WORK ROOM           | TITUS DESV                  | 8                      | 525                           | 525                           | 525                           | 0.4                    | 525                   | 14                     | 55          | 80          | 130          | 1.4                | 5                 | 2     | 1.2          |
| VAV 6-08                                                                                                                                                                                               | RTU-6      | 109 CONFERENCE                    | TITUS DESV                  | 8                      | 525                           | 250                           | 150                           | 0.4                    | 250                   | 10                     | 55          | 90          | 130          | 1.0                | 5                 | 2     | 1.2          |
| VAV 6-09                                                                                                                                                                                               | RTU-6      | 105, 107, 108 OFFICES             | TITUS DESV                  | 8                      | 525                           | 150                           | 150                           | 0.4                    | 150                   | 6                      | 55          | 90          | 130          | 0.6                | 5                 | 2     | 1.2          |
| VAV 6-10                                                                                                                                                                                               | RTU-6      | 104 CONFERENCE                    | TITUS DESV                  | 8                      | 575                           | 250                           | 150                           | 0.4                    | 250                   | 10                     | 55          | 90          | 130          | 1.0                | 5                 | 2     | 1.2          |
| VAV 7-01                                                                                                                                                                                               | RTU-7      | ADMIN SUITE                       | TITUS DESV                  | 10                     | 925                           | 925                           | 925                           | 0.4                    | 925                   | 25                     | 55          | 80          | 130          | 2.5                | 5                 | 2     | 1.2          |
| VAV 7-01                                                                                                                                                                                               | RTU-7      | 301 OT/PT                         | TITUS DESV                  | 8                      | 625                           | 625                           | 625                           | 0.4                    | 625                   | 17                     | 55          | 80          | 130          | 1.7                | 5                 | 2     | 1.2          |
| VAV 7-02                                                                                                                                                                                               | RTU-7      | 405 SPECIAL ED                    | TITUS DESV                  | 8                      | 725                           | 500                           | 500                           | 0.4                    | 500                   | 14                     | 55          | 80          | 130          | 1.4                | 5                 | 2     | 1.2          |
| VAV 7-03                                                                                                                                                                                               | RTU-7      | 409 SPECIAL ED                    | TITUS DESV                  | 8                      | 500                           | 375                           | 375                           | 0.4                    | 375                   | 10                     | 55          | 80          | 130          | 1.0                | 5                 | 2     | 1.2          |
| VAV 7-04                                                                                                                                                                                               | RTU-7      | 411 SPECIAL ED                    | TITUS DESV                  | 8                      | 500                           | 375                           | 375                           | 0.4                    | 375                   | 10                     | 55          | 80          | 130          | 1.0                | 5                 | 2     | 1.2          |
| VAV 7-05                                                                                                                                                                                               | RTU-7      | 413 CLASSROOM                     | TITUS DESV                  | 10                     | 1,125                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 7-06                                                                                                                                                                                               | RTU-7      | 416 CLASSROOM                     | TITUS DESV                  | 10                     | 850                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 7-07                                                                                                                                                                                               | RTU-7      | 423 OFFICE                        | TITUS DESV                  | 6                      | 175                           | 90                            | 90                            | 0.4                    | 90                    | 2                      | 55          | 80          | 130          | 0.2                | 5                 | 2     | 1.2          |
| VAV 7-08                                                                                                                                                                                               | RTU-7      | 419 CLASSROOM                     | TITUS DESV                  | 10                     | 850                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 7-09                                                                                                                                                                                               | RTU-7      | 417 CLASSROOM                     | TITUS DESV                  | 10                     | 1,125                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 7-10                                                                                                                                                                                               | RTU-7      | 412 SPECIAL ED                    | TITUS DESV                  | 8                      | 500                           | 375                           | 375                           | 0.4                    | 375                   | 10                     | 55          | 80          | 130          | 1.0                | 5                 | 2     | 1.2          |
| VAV 7-12                                                                                                                                                                                               | RTU-7      | 406 TEAMS                         | TITUS DESV                  | 8                      | 650                           | 250                           | 215                           | 0.4                    | 250                   | 7                      | 55          | 80          | 130          | 0.7                | 5                 | 2     | 1.2          |
| VAV 7-11                                                                                                                                                                                               | RTU-7      | 410 SPECIAL ED                    | TITUS DESV                  | 8                      | 500                           | 375                           | 375                           | 0.4                    | 375                   | 10                     | 55          | 80          | 130          | 1.0                | 5                 | 2     | 1.2          |
| VAV 7-13                                                                                                                                                                                               | RTU-7      | NORTH LOBBY                       | TITUS DESV                  | 8                      | 650                           | 650                           | 650                           | 0.4                    | 650                   | 25                     | 55          | 90          | 130          | 2.5                | 5                 | 2     | 1.2          |
| VAV 7-14                                                                                                                                                                                               | RTU-7      | 4A CORRIDOR                       | TITUS DESV                  | 12                     | 1,350                         | 1350                          | 1350                          | 0.4                    | 1,350                 | 37                     | 55          | 80          | 130          | 3.7                | 5                 | 2     | 1.2          |
| VAV 7-15                                                                                                                                                                                               | RTU-7      | ALTERNATE 1 - 429 CLASSROOM       | TITUS DESV                  | 12                     | 1,125                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 7-16                                                                                                                                                                                               | RTU-7      | ALTERNATE 1 - 432 CLASSROOM       | TITUS DESV                  | 12                     | 1,125                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 7-17                                                                                                                                                                                               | RTU-7      | ALTERNATE 1 - 431 CLASSROOM       | TITUS DESV                  | 10                     | 850                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 7-18                                                                                                                                                                                               | RTU-7      | ALTERNATE 1 - 434 CLASSROOM       | TITUS DESV                  | 10                     | 850                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 7-19                                                                                                                                                                                               | RTU-7      | ALTERNATE 2 - NW CLASSROOM        | TITUS DESV                  | 12                     | 1,125                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 7-20                                                                                                                                                                                               | RTU-7      | ALTERNATE 2 - SW CLASSROOM        | TITUS DESV                  | 12                     | 1,125                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 7-21                                                                                                                                                                                               | RTU-7      | ALTERNATE 2 - NE CLASSROOM        | TITUS DESV                  | 10                     | 850                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 7-22                                                                                                                                                                                               | RTU-7      | ALTERNATE 2 - SE CLASSROOM        | TITUS DESV                  | 10                     | 850                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-01                                                                                                                                                                                               | RTU-8      | 133 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-02                                                                                                                                                                                               | RTU-8      | 135 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-03                                                                                                                                                                                               | RTU-8      | 140 OFFICE                        | TITUS DESV                  | 6                      | 210                           | 105                           | 105                           | 0.4                    | 105                   | 3                      | 55          | 85          | 130          | 0.3                | 5                 | 2     | 1.2          |
| VAV 8-04                                                                                                                                                                                               | RTU-8      | 147 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-05                                                                                                                                                                                               | RTU-8      | 148 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-06                                                                                                                                                                                               | RTU-8      | 151 CLASSROOM                     | TITUS DESV                  | 12                     | 1,175                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 8-07                                                                                                                                                                                               | RTU-8      | 153 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-08                                                                                                                                                                                               | RTU-8      | 156 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-09                                                                                                                                                                                               | RTU-8      | 154 CLASSROOM                     | TITUS DESV                  | 12                     | 1,175                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 8-10                                                                                                                                                                                               | RTU-8      | 150 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-11                                                                                                                                                                                               | RTU-8      | 149 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-12                                                                                                                                                                                               | RTU-8      | 136 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-13                                                                                                                                                                                               | RTU-8      | 134 CLASSROOM                     | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-14                                                                                                                                                                                               | RTU-8      | 1B CORRIDOR                       | TITUS DESV                  | 12                     | 1,525                         | 1,525                         | 1525                          | 0.4                    | 1,525                 | 42                     | 55          | 80          | 130          | 4.2                | 5                 | 2     | 1.2          |
| VAV 8-15                                                                                                                                                                                               | RTU-8      | 131 SIP                           | TITUS DESV                  | 8                      | 725                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-16                                                                                                                                                                                               | RTU-8      | 132 CLASSROOM                     | TITUS DESV                  | 8                      | 725                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-17                                                                                                                                                                                               | RTU-8      | ALTERNATE 3 - NW CLASSROOM        | TITUS DESV                  | 12                     | 1,175                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 8-18                                                                                                                                                                                               | RTU-8      | ALTERNATE 3 - SW CLASSROOM        | TITUS DESV                  | 12                     | 1,175                         | 725                           | 725                           | 0.4                    | 725                   | 20                     | 55          | 80          | 130          | 2.0                | 5                 | 2     | 1.2          |
| VAV 8-19                                                                                                                                                                                               | RTU-8      | ALTERNATE 3 - NE CLASSROOM        | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| VAV 8-20                                                                                                                                                                                               | RTU-8      | ALTERNATE 3 - SE CLASSROOM        | TITUS DESV                  | 10                     | 900                           | 550                           | 550                           | 0.4                    | 550                   | 15                     | 55          | 80          | 130          | 1.5                | 5                 | 2     | 1.2          |
| NOTES:<br>1. SEE SPECIFICATION FOR ROOM TEMPERATURE SENSOR TYPE.<br>2. MAXIMUM AIR PRESSURE DROP IS FOR THE ENTIRE ASSEMBLY.<br>3. PROVIDE WITH BOTTOM ACCESS DOOR<br>4. PROVIDE WITH 120V CONTROLS... |            |                                   |                             |                        |                               |                               |                               |                        |                       |                        |             |             |              |                    |                   |       |              |

| FAN SCHEDULE                                                                                           |                       |                              |                                                                                                   |                |               |                                                                                                                                                                                                                                                                                              |      |               |       |      |      |          |                    |             |       |
|--------------------------------------------------------------------------------------------------------|-----------------------|------------------------------|---------------------------------------------------------------------------------------------------|----------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------------|-------|------|------|----------|--------------------|-------------|-------|
| UNIT DESIG.                                                                                            | LOCATION              | SERVICE                      | MANUFACTURER & MODEL NO.                                                                          | FAN TYPE       | AIRFLOW (CFM) | FSP (IN. W.C.)                                                                                                                                                                                                                                                                               | RPM  | FAN DISCHARGE | MOTOR |      |      |          | UNIT CONTROL       | ACCESSORIES | NOTES |
|                                                                                                        |                       |                              |                                                                                                   |                |               |                                                                                                                                                                                                                                                                                              |      |               | BHP   | HP   | RPM  | VOLTS/PH |                    |             |       |
| EF-1                                                                                                   | KITCHEN ROOF          | KITCHEN HOOD                 | GREENHECK CUE-180HP-VG                                                                            | ROOF EXHAUSTER | 2200          | 1.75                                                                                                                                                                                                                                                                                         | 1355 | UBD           | 1.03  | 2    | 1590 | 480/3    | ECM, 0-10V         | 2,4,6,7     | A     |
| EF-2                                                                                                   | KITCHEN ROOF          | KITCHEN HOOD                 | GREENHECK CUE-180HP-VG                                                                            | ROOF EXHAUSTER | 2200          | 1.75                                                                                                                                                                                                                                                                                         | 1355 | UBD           | 1.03  | 2    | 1590 | 480/3    | ECM, 0-10V         | 2,4,6,7     | A     |
| EF-3                                                                                                   | KITCHEN ROOF          | DISHWASHER                   | GREENHECK CUE-100HP-VG                                                                            | ROOF EXHAUSTER | 300           | 1.00                                                                                                                                                                                                                                                                                         | 1699 | UBD           | 0.13  | 1/4  | 1725 | 115/1    | ECM, POTENTIOMETER | 2,4,6,7     | A     |
| EF-4                                                                                                   | MECH ROOF             | MECH RM EXHAUST              | GREENHECK G-180-VG                                                                                | ROOF EXHAUSTER | 3000          | 0.50                                                                                                                                                                                                                                                                                         | 933  | DBD           | 0.52  | 1    | 1000 | 480/3    | ECM, 0-10V         | 1,3,4,5,8   | -     |
| EF-5                                                                                                   | KILN RM ROOF          | KILN                         | GREENHECK G-140-VG                                                                                | ROOF EXHAUSTER | 1250          | 0.50                                                                                                                                                                                                                                                                                         | 1000 | DBD           | 0.20  | 1/2  | 1200 | 115/1    | ECM, 0-10V         | 1,2,3,4,7   | -     |
| EF-6                                                                                                   | ADMIN ROOF            | NURSE EXHAUST                | GREENHECK G-099-VG                                                                                | ROOF EXHAUSTER | 550           | 0.75                                                                                                                                                                                                                                                                                         | 1403 | DBD           | 0.13  | 1/4  | 1725 | 115/1    | ECM, POTENTIOMETER | 1,2,3,4,7   | -     |
| EF-7                                                                                                   | ADMIN ROOF            | KITCHEN HOOD                 | GREENHECK CUE-180HP-VG                                                                            | ROOF EXHAUSTER | 2200          | 1.75                                                                                                                                                                                                                                                                                         | 1355 | UBD           | 1.03  | 2    | 1590 | 480/3    | ECM, 0-10V         | 2,4,6,7     | A     |
| EF-8                                                                                                   | SPECIAL ED 405 ROOF   | RESTROOM EXHAUST             | GREENHECK G-085-VG                                                                                | ROOF EXHAUSTER | 550           | 0.50                                                                                                                                                                                                                                                                                         | 1499 | DBD           | 0.10  | 1/6  | 1725 | 115/1    | ECM, POTENTIOMETER | 1,2,3,4,7   | -     |
| EF-9                                                                                                   | CUSTOMAL 311 ROOF     | RESTROOM EXHAUST             | GREENHECK G-080-VG                                                                                | ROOF EXHAUSTER | 230           | 0.50                                                                                                                                                                                                                                                                                         | 1585 | DBD           | 0.06  | 1/10 | 1725 | 115/1    | ECM, POTENTIOMETER | 1,2,3,4,7   | -     |
| TF-1                                                                                                   | KITCHEN CEILING       | KITCHEN EXHAUST MAKEUP AIR   | GREENHECK SQ-160-VG                                                                               | INLINE         | 2200          | 1.25                                                                                                                                                                                                                                                                                         | 1310 | HM            | 0.78  | 2    | 1650 | 480/3    | ECM, 0-10V         | 4,5,8       | -     |
| TF-2                                                                                                   | KITCHEN CEILING       | KITCHEN EXHAUST MAKEUP AIR   | GREENHECK SQ-15-M2-VG                                                                             | INLINE         | 2200          | 1.25                                                                                                                                                                                                                                                                                         | 1310 | HM            | 0.78  | 2    | 1650 | 480/3    | ECM, 0-10V         | 4,5,8       | -     |
| TF-3                                                                                                   | STORAGE CEILING       | KILN EXHAUST MAKEUP AIR      | GREENHECK SQ-130-VG                                                                               | INLINE         | 1250          | 0.50                                                                                                                                                                                                                                                                                         | 1219 | HM            | 0.22  | 3/4  | 1725 | 115/1    | ECM, 0-10V         | 4,5,8       | -     |
| RLF-1                                                                                                  | CAFETERIA ROOF        | CAFETERIA RELIEF             | GREENHECK RE2-30-620-VG                                                                           | PROPELLER      | 3500          | 0.50                                                                                                                                                                                                                                                                                         | 802  | DBD           | 0.73  | 2    | 1050 | 480/3    | ECM, 0-10V         | 1,2,4,7     | -     |
| RLF-2                                                                                                  | CENTRAL CORRIDOR ROOF | BUILDING RELIEF              | GREENHECK RE2-48-413-VG                                                                           | PROPELLER      | 15,000        | 0.50                                                                                                                                                                                                                                                                                         | 776  | DBD           | 2.37  | 5    | 860  | 480/3    | ECM, 0-10V         | 1,2,4,7     | -     |
| RLF-3                                                                                                  | MAIN GYM              | GYM RELIEF / SHELTER EXHAUST | GREENHECK SQ-30-M2-VG                                                                             | INLINE         | 10,000        | 1.00                                                                                                                                                                                                                                                                                         | 714  | HM            | 2.59  | 5    | 800  | 480/3    | ECM, 0-10V         | 4,5,8       | -     |
| SF-1                                                                                                   | MAIN GYM              | SHELTER MODE VENTILATION AIR | GREENHECK SQ-27-M2-VG                                                                             | INLINE         | 10,000        | 1.50                                                                                                                                                                                                                                                                                         | 940  | HM            | 3.96  | 10   | 1222 | 460/3    | ECM, POTENTIOMETER | 4,5,8       | -     |
| FAN TYPE:<br>CENTRIFUGAL<br>IN-LINE CENTRIFUGAL<br>ROOF EXHAUSTER<br>PROPELLER FAN                     |                       |                              | FAN DISCHARGE:<br>UBD - UP BLAST DISCHARGE<br>DBD - DOWN BLAST DISCHARGE<br>HM - HORIZONTAL MOUNT |                |               | ACCESSORIES:<br>1. MOTORIZED BACKDRAFT DAMPER<br>2. ROOF CURB<br>3. PROVIDE WITH HOA CONTROLLER AND CONTROLS TRANSFORMER FOR POWERING 24V ISOLATION DAMPER<br>4. FACTORY MOUNTED DISCONNECT<br>5. RESTRAINED VIBRATION ISOLATORS<br>6. DRAIN<br>7. BIRDSCREEN<br>8. FLEXIBLE DUCT CONNECTION |      |               |       |      |      |          |                    |             |       |
| NOTES:<br>A. FAN SHALL BE UL 762 RATED FOR GREASE LADEN EXHAUST. PROVIDE WITH APPROPRIATE ACCESSORIES. |                       |                              |                                                                                                   |                |               |                                                                                                                                                                                                                                                                                              |      |               |       |      |      |          |                    |             |       |





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ENGINEERING CORP.  
NO. 000987

ST. CHARLES, MISSOURI

CIVIL / SURVEY  
ARCHITECTURAL  
STRUCTURAL  
MECH. / PLUMBING  
ELECTRICAL

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07-02-2024

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1 08/01/24 ADDENDUM #2

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SHEET NO.

M6.2  
SD: 58

AIR DEVICE SCHEDULE

| UNIT<br>DESIG. | SERVICE  | MANUFACTURER &<br>MODEL NO. | TYPE          | THROW     | NO. OF<br>SLOTS | NECK SIZE<br>(IN.) | FACE SIZE<br>(IN.) | FINISH | NOTES |
|----------------|----------|-----------------------------|---------------|-----------|-----------------|--------------------|--------------------|--------|-------|
| A              | SUPPLY   | TITUS TDC                   | LOUVERED FACE | SEE PLANS | -               | 6"0                | 24"x24"            | WHITE  | 1     |
| B              | SUPPLY   | TITUS TDC                   | LOUVERED FACE | SEE PLANS | -               | 6"0                | 24"x24"            | WHITE  | 1     |
| C              | SUPPLY   | TITUS TDC                   | LOUVERED FACE | SEE PLANS | -               | 10"0               | 24"x24"            | WHITE  | 1     |
| D              | SUPPLY   | TITUS 1700                  | SIDEWALL      | 1-WAY     | -               | 6"x6"              | 8"x8"              | WHITE  | 1     |
| E              | SUPPLY   | TITUS 1700                  | SIDEWALL      | 1-WAY     | -               | 10"x6"             | 12"x8"             | WHITE  | 1     |
| F              | SUPPLY   | TITUS 1700                  | SIDEWALL      | 1-WAY     | -               | 12"x10"            | 14"x12"            | WHITE  | 1     |
| G              | SUPPLY   | TITUS 1700                  | SIDEWALL      | 1-WAY     | -               | 14"x8"             | 16"x10"            | WHITE  | 1     |
| H              | SUPPLY   | TITUS DL                    | DRUM LOUVER   | 1-WAY     | -               | 16"x12"            | 18"x14"            | WHITE  | 1     |
| I              | SUPPLY   | ANEMOSTAT DJ 3-10           | NOZZLE        | JET THROW | -               | 11"x36"            | 13"x38"            | WHITE  | 1     |
| J              | RETURN   | TITUS TDC                   | LOUVERED FACE | -         | -               | 18"x18"            | 24"x24"            | WHITE  | 1     |
| K              | RETURN   | TITUS 1700                  | SIDEWALL      | -         | -               | 14"x8"             | 16"x10"            | WHITE  | 1     |
| L              | RETURN   | TITUS 1700                  | SIDEWALL      | -         | -               | 18"x12"            | 20"x14"            | WHITE  | 1     |
| M              | RETURN   | TITUS 1700                  | SIDEWALL      | -         | -               | 26"x16"            | 28"x18"            | WHITE  | 1     |
| N              | EXHAUST  | TITUS TDC                   | LOUVERED FACE | -         | -               | 6"0                | 24"x24"            | WHITE  | 1     |
| O              | EXHAUST  | TITUS TDC                   | LOUVERED FACE | -         | -               | 8"0                | 24"x24"            | WHITE  | 1     |
| P              | EXHAUST  | TITUS TDC                   | LOUVERED FACE | -         | -               | 16"0               | 24"x24"            | WHITE  | 1     |
| Q              | EXHAUST  | TITUS 1700                  | SIDEWALL      | -         | -               | 6"x6"              | 8"x8"              | WHITE  | 1     |
| R              | EXHAUST  | TITUS 1700                  | SIDEWALL      | -         | -               | 12"x6"             | 14"x10"            | WHITE  | 1     |
| S              | TRANSFER | TITUS TDC                   | LOUVERED FACE | -         | -               | 16"0               | 24"x24"            | WHITE  | 1     |
| T              | SUPPLY   | TITUS 1700                  | SIDEWALL      | 1-WAY     | -               | 18"x12"            | 20"x14"            | WHITE  | 1     |

NOTES:

- COLOR/FINISH TO BE COORDINATED WITH ARCHITECT.
- 1" FILTER RACK
- PROVIDE MERV8 FILTER WITH GRILLE

CONTROL DAMPER SCHEDULE

| UNIT<br>DESIGNATION | LOCATION             | SERVICE                     | MANUFACTURER<br>& MODEL NO. | NOMINAL SIZE<br>(W X H) (IN.) | AIRFLOW<br>(CFM) | TYPE     | BLADE TYPE  | BLADE<br>ORIENTATION | MAX. AIR<br>PRESSURE<br>DROP (IN. W.G.) | ACTUATOR     |              |        | POWER<br>(24V/120V) | NOTES |
|---------------------|----------------------|-----------------------------|-----------------------------|-------------------------------|------------------|----------|-------------|----------------------|-----------------------------------------|--------------|--------------|--------|---------------------|-------|
|                     |                      |                             |                             |                               |                  |          |             |                      |                                         | MANUFACTURER | TYPE         | ACTION |                     |       |
| CD-4.1              | RTU-4 SA DUCT        | STORM MODE SUPPLY ISOLATION | RUSKIN CD-36                | 36 X 36                       | 12,100           | PARALLEL | NON-AIRFOIL | HORIZONTAL           | 0.1                                     | BELIMO       | TWO-POSITION | NC     | 24V                 | 1,2   |
| CD-4.2              | SF-1 SA DUCT         | NORMAL MODE ISOLATION       | RUSKIN CD-36                | 36 X 36                       | 10,000           | PARALLEL | NON-AIRFOIL | HORIZONTAL           | 0.1                                     | BELIMO       | TWO-POSITION | NO     | 24V                 | 1,2   |
| CD-4.3              | SF-1 INTAKE DUCT     | SF-1 BACKDRAFT              | RUSKIN CD-IL35              | 36 X 36                       | 10,000           | PARALLEL | NON-AIRFOIL | HORIZONTAL           | 0.1                                     | BELIMO       | TWO-POSITION | NO     | 24V                 | 1,2   |
| CD-4.4              | RTU-4 RA DUCT        | STORM MODE RETURN ISOLATION | RUSKIN CD-36                | 36 X 36                       | 6,000            | PARALLEL | NON-AIRFOIL | HORIZONTAL           | 0.1                                     | BELIMO       | TWO-POSITION | NC     | 24V                 | 1,2   |
| CD-4.5              | RLF-1 DISCHARGE DUCT | RLF-3 ECONOMIZER            | RUSKIN CD-IL35              | 36 X 36                       | 10,000           | OPPOSED  | NON-AIRFOIL | HORIZONTAL           | 0.1                                     | BELIMO       | MODULATING   | NO     | 24V                 | 1,2   |



NOTES

- DAMPER MOUNTED VERTICALLY IN HORIZONTAL DUCT.
- DAMPERS TO BE ON EMERGENCY POWER

ACTION

- NO - NORMALLY OPEN  
NC - NORMALLY CLOSED

UNIT HEATER SCHEDULE

| UNIT<br>DESIG. | LOCATION                 | TYPE                | MANUFACTURER<br>& MODEL NO. | AIRFLOW<br>(CFM) | EAT<br>(°F) | TOTAL<br>CAPACITY<br>(MBH) | HEATING COIL DATA |             |             | THERMOSTAT<br>TYPE / LOCATION | MOTOR         |          | ELECTRICAL... |     | NOTES     |
|----------------|--------------------------|---------------------|-----------------------------|------------------|-------------|----------------------------|-------------------|-------------|-------------|-------------------------------|---------------|----------|---------------|-----|-----------|
|                |                          |                     |                             |                  |             |                            | FLOW<br>(GPM)     | EWT<br>(°F) | WPD<br>(FT) |                               | POWER<br>(HP) | VOLTS/PH | FLA           | MCA |           |
| UH-1           | NE CLASSROOM WING N EXIT | HORIZONTAL RECESSED | IEC DBY 12                  | 1200             | 70          | 30                         | 2.2               | 130         | 5           | REMOTE DDC SENSOR             | 0.17          | 120/1    | 4.8           | 5.4 | 1,2,3,4,5 |
| UH-2           | NE CLASSROOM WING E EXIT | HORIZONTAL RECESSED | IEC DBY 12                  | 1200             | 70          | 30                         | 2.2               | 130         | 5           | REMOTE DDC SENSOR             | 0.17          | 120/1    | 4.8           | 5.4 | 1,2,3,4,5 |
| UH-3           | CENTRAL CORRIDOR EXIT    | HORIZONTAL RECESSED | IEC DBY 12                  | 1200             | 70          | 30                         | 2.2               | 130         | 5           | REMOTE DDC SENSOR             | 0.17          | 120/1    | 4.8           | 5.4 | 1,2,3,4,5 |
| UH-4           | SW WING W EXIT           | HORIZONTAL RECESSED | IEC DBY 12                  | 1200             | 70          | 30                         | 2.2               | 130         | 5           | REMOTE DDC SENSOR             | 0.17          | 120/1    | 4.8           | 5.4 | 1,2,3,4,5 |
| UH-5           | SE WING N EXIT           | HORIZONTAL RECESSED | IEC DBY 12                  | 1200             | 70          | 30                         | 2.2               | 130         | 5           | REMOTE DDC SENSOR             | 0.17          | 120/1    | 4.8           | 5.4 | 1,2,3,4,5 |
| UH-6           | SE WING E EXIT           | HORIZONTAL RECESSED | IEC DBY 12                  | 1200             | 70          | 30                         | 2.2               | 130         | 5           | REMOTE DDC SENSOR             | 0.17          | 120/1    | 4.8           | 5.4 | 1,2,3,4,5 |

NOTES:

- PROVIDE UNIT MOUNTED FACTORY DISCONNECT SWITCH
- DDC CONTROLS. FIELD INSTALLED TEMPERATURE SENSOR AND CONTROLLER PROVIDED BY CONTROLS CONTRACTOR
- PROVIDE ECM MOTOR WITH DIAL FOR BALANCING.
- PROVIDE TAMPERPROOF CABINET OPTION.
- PROVIDE UNIT WITH INSULATED PANELS.

MECHANICAL EXPANSION TANK SCHEDULE

| UNIT DESIG. | LOCATION | SERVICE            | MANUFACTURER &<br>MODEL NO. | MIN. TOTAL<br>VOLUME<br>(GAL) | MIN. ACCEPTANCE<br>VOLUME (GAL) | MAXIMUM<br>PRESSURE<br>(PSI) | PRESSURE<br>CHARGE<br>(PSI) | INSTALLATION<br>TYPE | NOTES |
|-------------|----------|--------------------|-----------------------------|-------------------------------|---------------------------------|------------------------------|-----------------------------|----------------------|-------|
| ET-1        | MECH. RM | HEATING WATER LOOP | BELL AND GOSSETT B-300      | 67                            | 22.5                            | 60                           | 35                          | FLOOR VERTICAL       | -     |
| ET-2        | MECH. RM | CHILLED WATER LOOP | BELL AND GOSSETT B-130      | 30                            | 10                              | 60                           | 35                          | FLOOR VERTICAL       | -     |

GENERAL NOTES:

- REFER TO PLUMBING DRAWINGS FOR DOMESTIC EXPANSION TANK SCHEDULE.

AIR SEPARATOR SCHEDULE

| UNIT<br>DESIG. | LOCATION      | SERVICE       | MANUFACTURER &<br>MODEL NO. | FLOW<br>CAPACITY<br>(GPM) | MAX LINE<br>VELOCITY<br>(FPS) | CONNECTION<br>TYPE | NOTES |
|----------------|---------------|---------------|-----------------------------|---------------------------|-------------------------------|--------------------|-------|
| AS-1           | MECHANICAL_RM | HEATING WATER | SPIROTHERM VDN300FAM        | 140                       | 6                             | 3" FLANGED         | 1     |
| AS-2           | MECHANICAL_RM | CHILLED WATER | SPIROTHERM VDN300FAM        | 140                       | 6                             | 3" FLANGED         | 1     |

NOTES:

- PROVIDE WITHOUT STRAINER

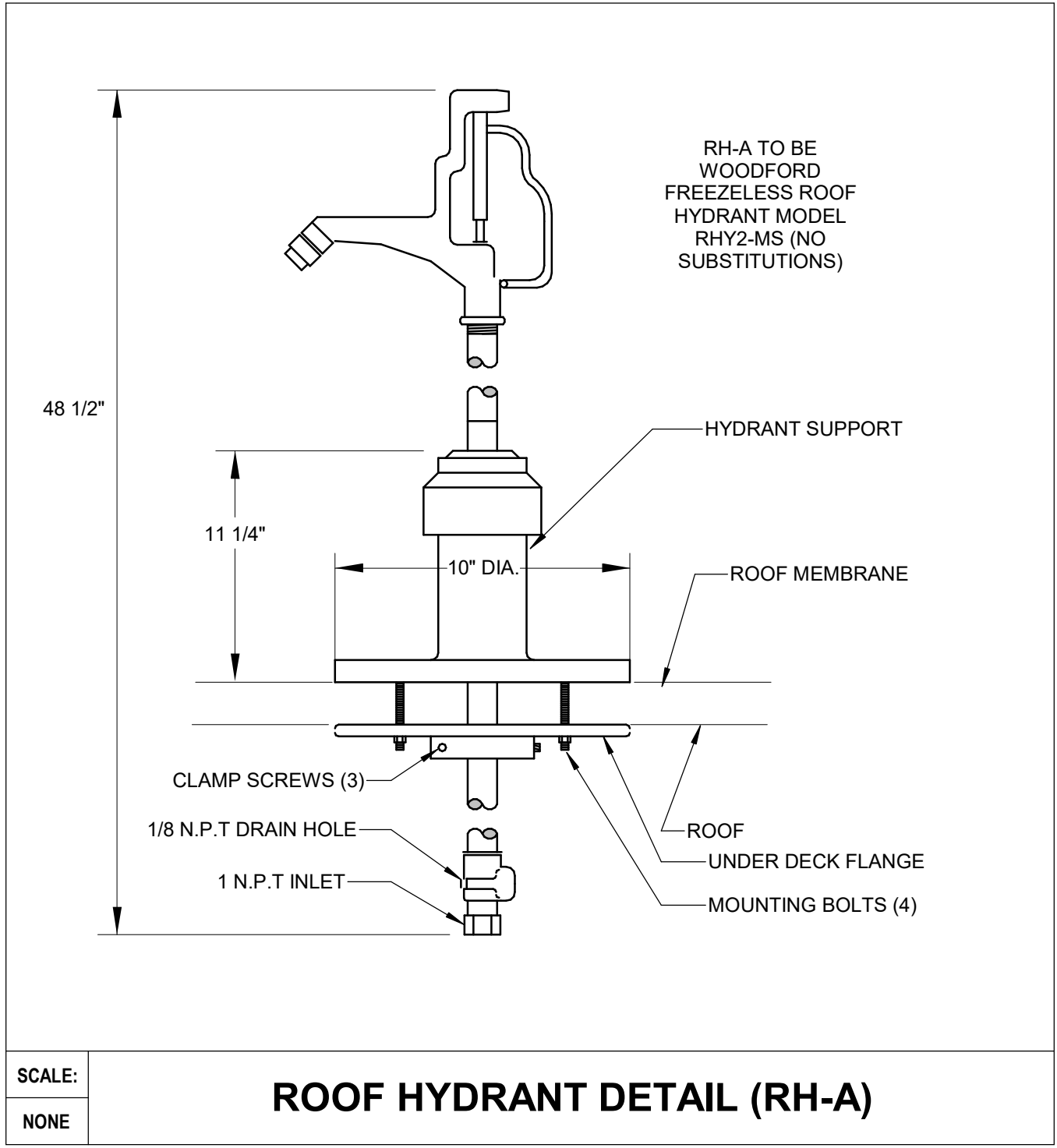
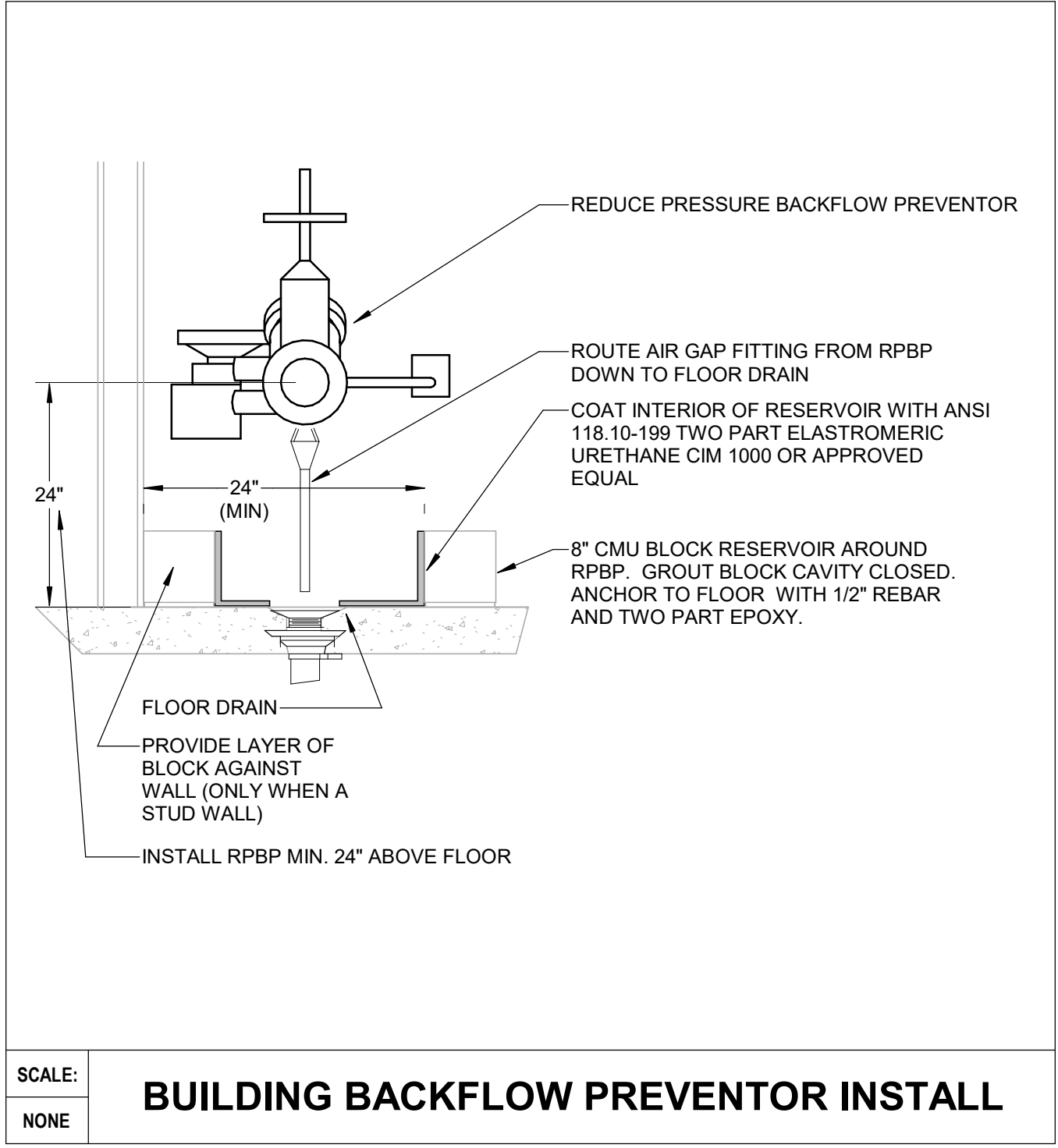
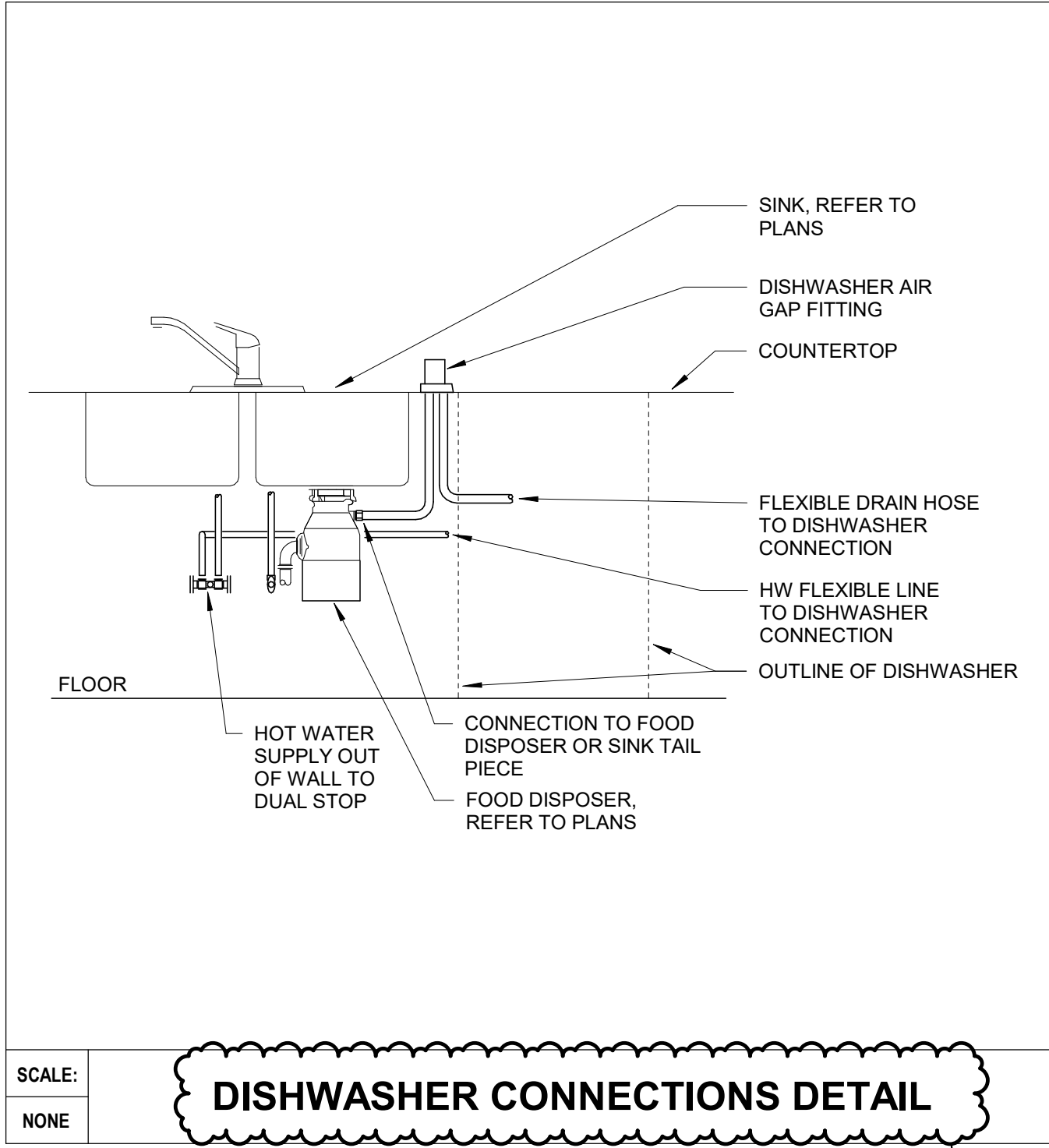
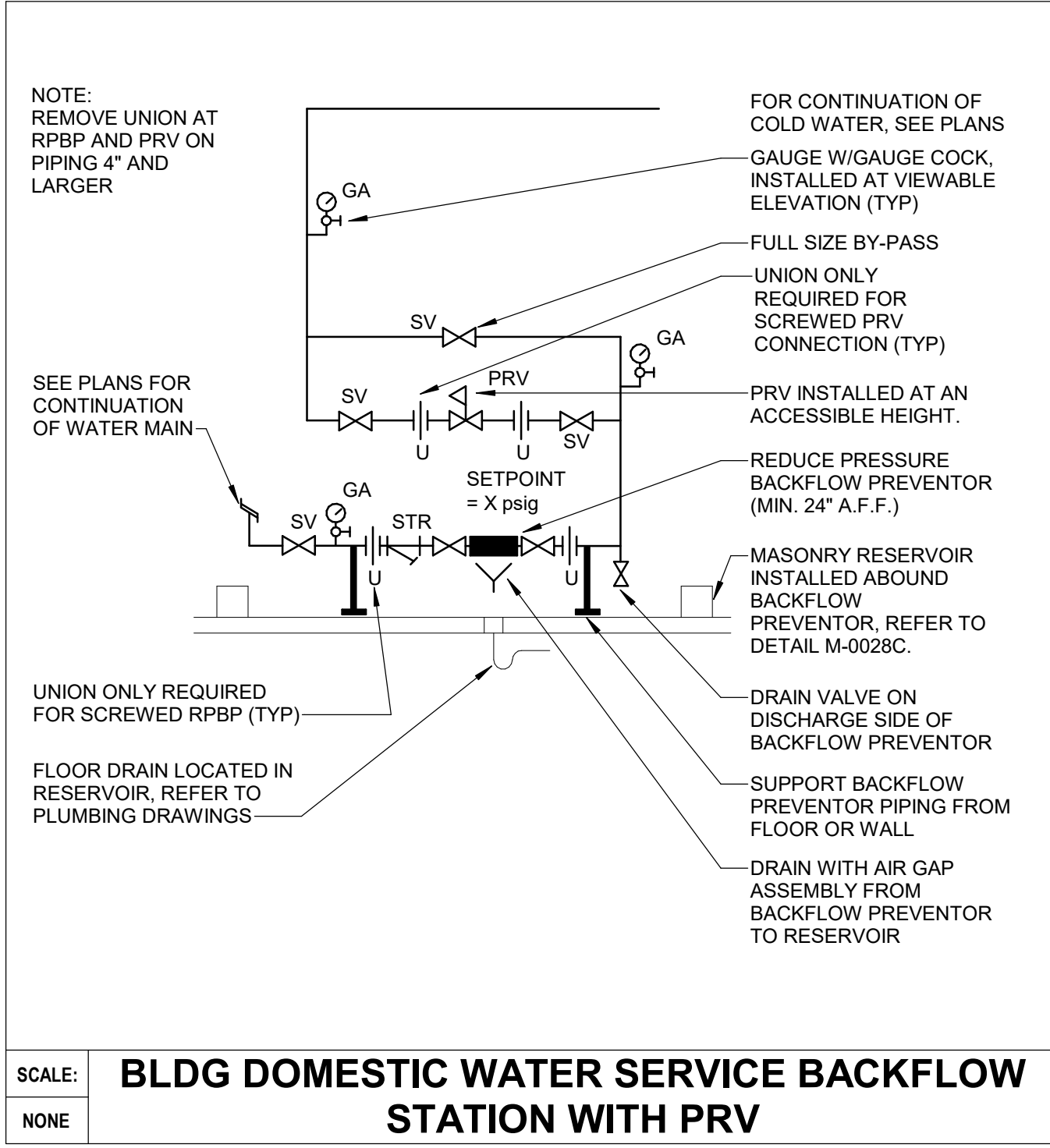
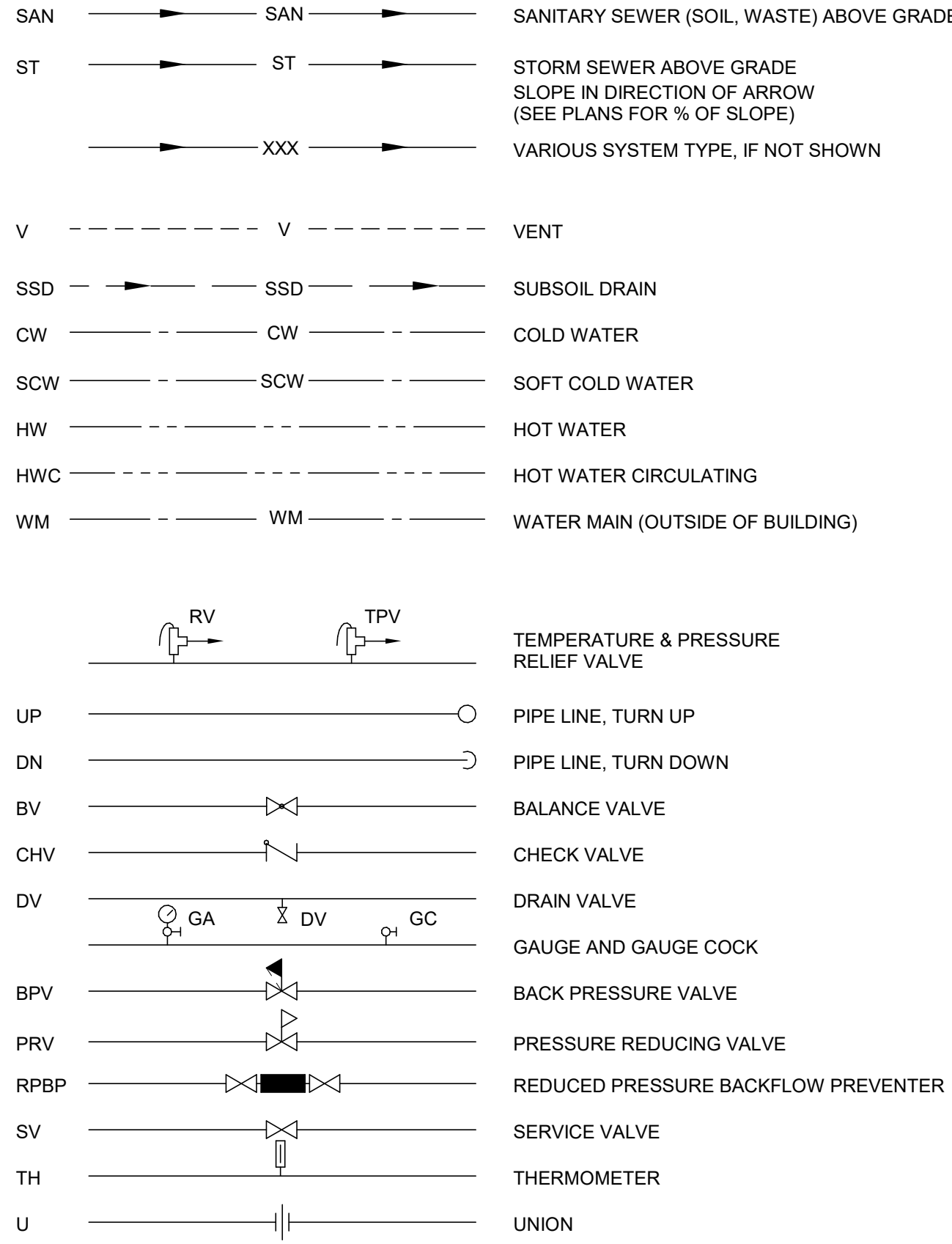






PLUMBING

|      |                                    |
|------|------------------------------------|
| AD   | AREA DRAIN                         |
| AP   | ACCESS PANEL                       |
| AW   | ACID WASTE                         |
| AV   | ACID VENT                          |
| BV   | BALANCE VALVE                      |
| CB   | CATCH BASIN                        |
| CS   | CUBIC FEET PER SECOND              |
| CO   | CLEANOUT                           |
| CUSP | CUSPIDS                            |
| CHV  | CHECK VALVE                        |
| CW   | COLD WATER                         |
| DF   | DRINKING FOUNTAIN                  |
| DI   | DEIONIZED WATER                    |
| DN   | DOWN                               |
| DS   | DOWNSPOUT                          |
| DSS  | DOWNSPOUT SPODE                    |
| DV   | DRAIN VALVE                        |
| DWH  | DOMESTIC WATER HEATER              |
| ET   | EXPANSION TANK                     |
| EW   | EYE WASH SYSTEM                    |
| EW   | ELECTRIC WATER COOLER              |
| EX   | EXISTING PIPING OR EQUIPMENT       |
| FD   | FLOOR CLEANOUT                     |
| FC   | FLANGE CONNECTION                  |
| FS   | FLOOR SINK                         |
| GA   | GAUGE                              |
| GC   | GAUGE COCK                         |
| HD   | HUB DRAIN                          |
| HW   | HOT WATER                          |
| HWC  | HOT WATER CIRCULATING              |
| IDW  | INDIRECT WASTE                     |
| INV  | INVERT                             |
| L    | LAVATORY                           |
| LV   | LOOP VENT                          |
| MH   | MANHOLE                            |
| MSB  | MOP SERVICE BASIN                  |
| NP   | NON-POTABLE COLD WATER             |
| NPH  | NON-POTABLE HOT WATER              |
| NPHC | NON-POTABLE HOT WATER CIRCULATING  |
| OD   | OVER FLOW DRAIN                    |
| ODS  | OVERFLOW DRAIN SYSTEM              |
| PRV  | PRESSURE REDUCING VALVE            |
| PW   | PURE WATER                         |
| RD   | ROUGH-IN (ONLY)                    |
| RI   | ROUGH-IN AND CONNECT               |
| RL&C | REVERSE OSMOSIS WATER              |
| RPBF | REDUCE PRESSURE BACKFLOW PREVENTER |
| S    | SOIL                               |
| SAN  | SANITARY SEWER                     |
| SBD  | SHOWER BASINS AND DRAIN            |
| SD   | SHOWER DRAIN                       |
| SH   | SHOWER HEAD                        |
| SS   | SERVICE SINK                       |
| SSD  | SUBSOIL DRAIN                      |
| ST   | STORM SEWER                        |
| SV   | SERVICE VALVE                      |
| TD   | TRENCH DRAIN                       |
| TH   | THERMOMETER                        |
| TT   | TEST TEE                           |
| U    | UNION                              |
| UR   | URINAL                             |
| V    | VENT                               |
| VTR  | VENT THROUGH ROOF                  |
| WC   | WASTE                              |
| WCO  | WATER CLOSET                       |
| WF   | WALL CLEANOUT                      |
| WH   | WASH FOUNTAIN                      |
| WM   | WATER MAIN                         |
| YCO  | YARD CLEANOUT                      |
| YD   | YARD DRAIN                         |



ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000937

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

ORCHARD FARM SCHOOL DISTRICT  
HOENER ASSOCIATES, INC. - ARCHITECTS  
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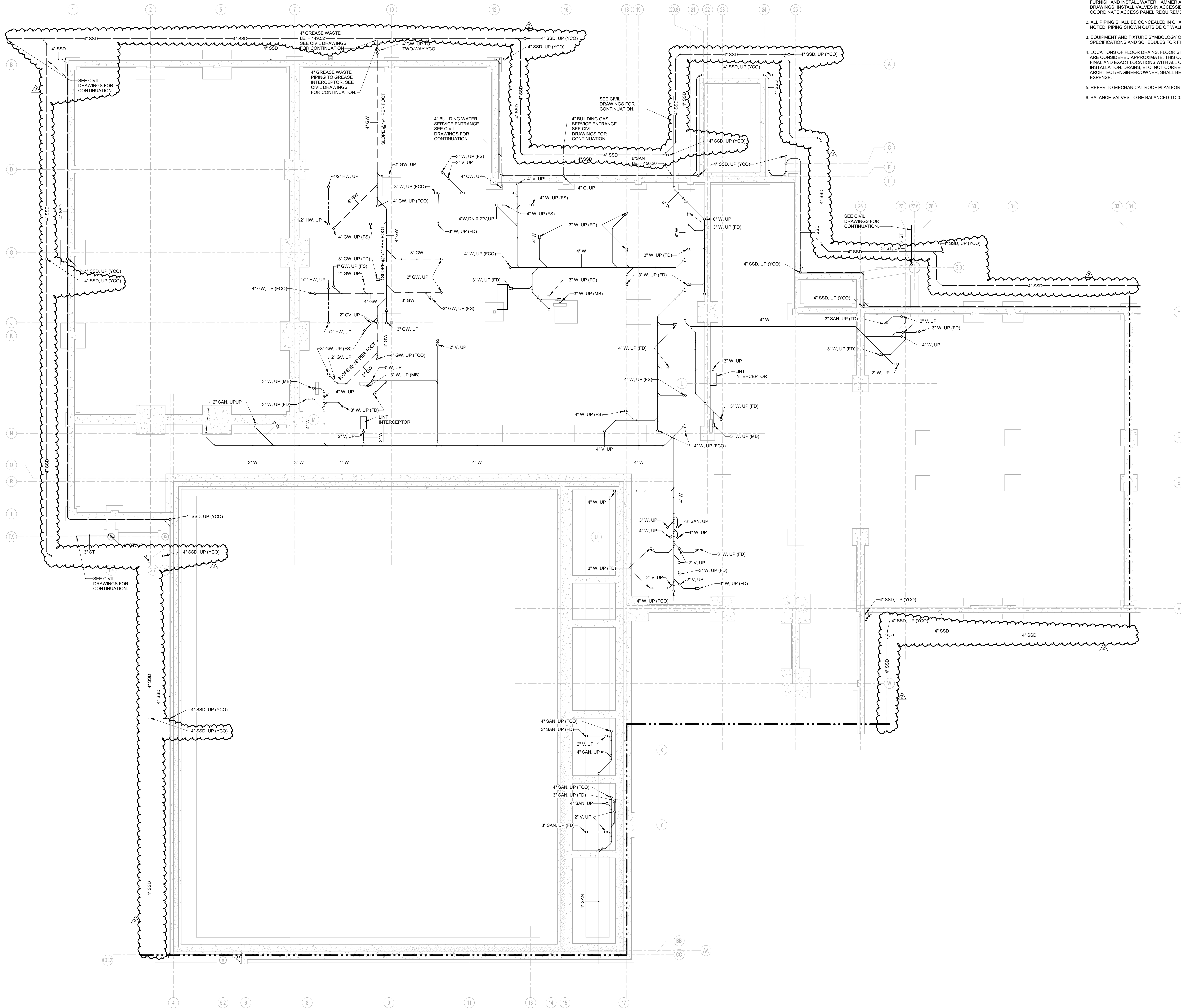
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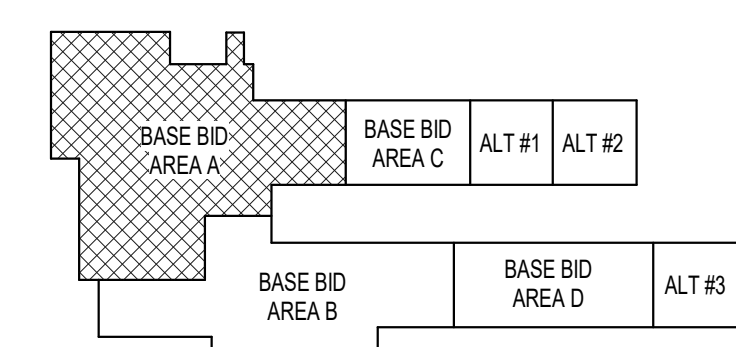
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- PLUMBING GENERAL NOTES:**
- FURNISH AND INSTALL SUPPLY STOP SHUT-OFF VALVES ON ALL FIXTURE WATER SUPPLY LINES. FURNISH AND INSTALL WATER HAMMER ARRESTORS PER PD WH201 AND AS INDICATED ON DRAWINGS. INSTALL VALVES IN ACCESSIBLE LOCATIONS. IF LOCATION IS NOT READILY ACCESSIBLE, COORDINATE ACCESS PANEL REQUIREMENTS WITH GENERAL CONTRACTOR.
  - ALL PIPING SHALL BE CONCEALED IN CHASE, WALL, CEILING, FLOORING, ETC. UNLESS OTHERWISE NOTED. PIPING SHOWN OUTSIDE OF WALL FOR CLARITY ONLY.
  - EQUIPMENT AND FIXTURE SYMBOLS ON PLANS MAY NOT REFLECT ACTUAL TYPE. REFER TO SPECIFICATIONS AND SCHEDULES FOR FIXTURE OR EQUIPMENT TYPE.
  - LOCATIONS OF FLOOR DRAINS, FLOOR SINKS, TRENCH DRAINS, ETC. INDICATED ON THESE DRAWINGS ARE CONSIDERED APPROXIMATE. THIS CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF FINAL AND EXACT LOCATIONS WITH ALL OTHER TRADES AND EQUIPMENT SUPPLIERS PRIOR TO INSTALLATION. DRAINS, ETC. NOT CORRECTLY LOCATED AS DETERMINED BY THE ARCHITECT/ENGINEER/OWNER, SHALL BE REMOVED AND RELOCATED AT THIS CONTRACTOR'S EXPENSE.
  - REFER TO MECHANICAL ROOF PLAN FOR PLUMBING ROOF ITEMS.
  - BALANCE VALVES TO BE BALANCED TO 0.5 GPM UNLESS OTHERWISE NOTED.

N  
UNDERSLAB PLAN - AREA A - PLUMBING  
SCALE: 1/8" = 1'-0"



KEY PLAN

ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000097

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

CONSULTING ENGINEERS:

HOENER ASSOCIATES, INC. - ARCHITECTS

ORCHARD FARM SCHOOL DISTRICT

PROJ. NO. 23-09B

DATE ISSUED

07-02-2024

DATE REVISION

1 07/23/24 ADDENDUM #1

2 08/01/24 ADDENDUM #2

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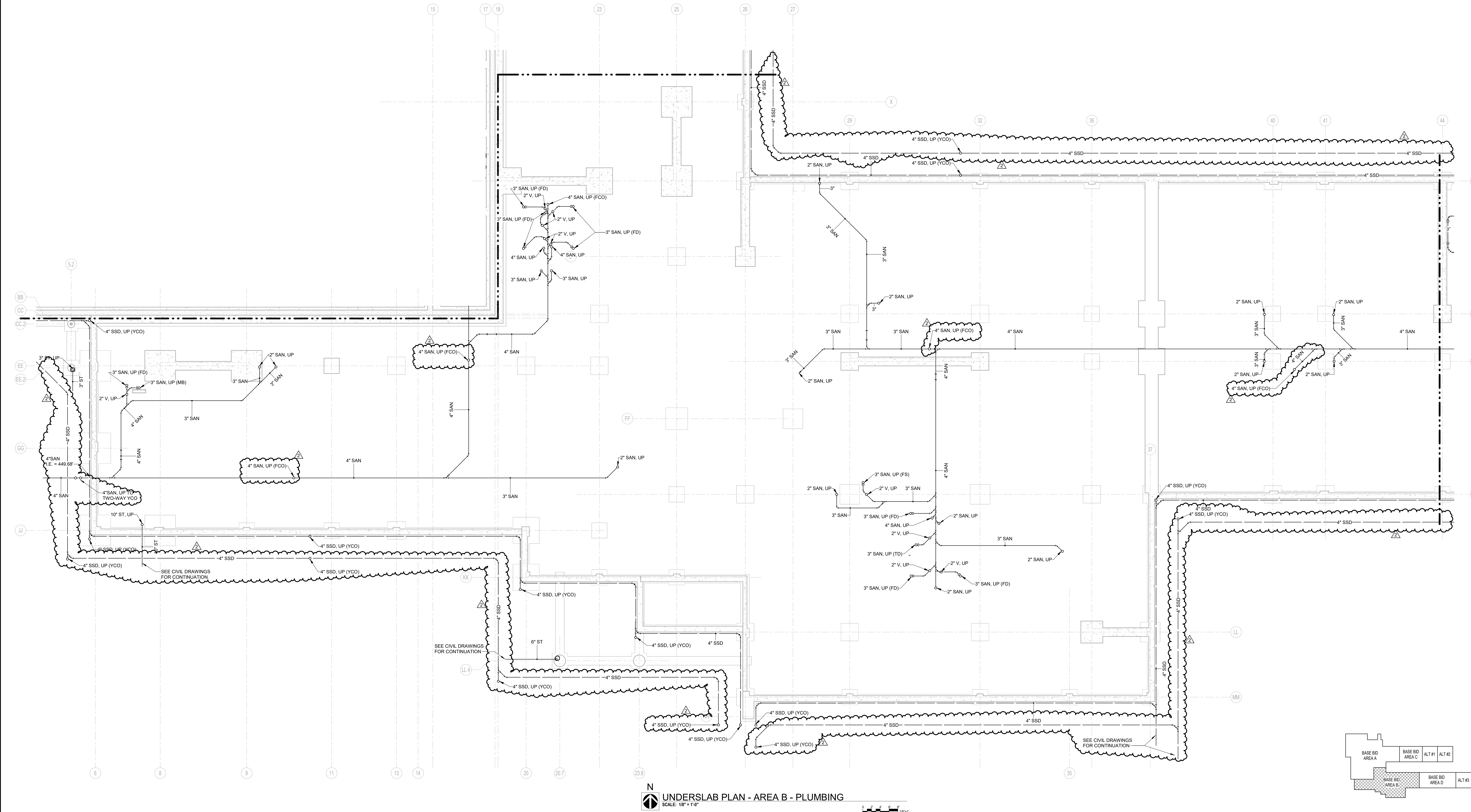
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P1.2

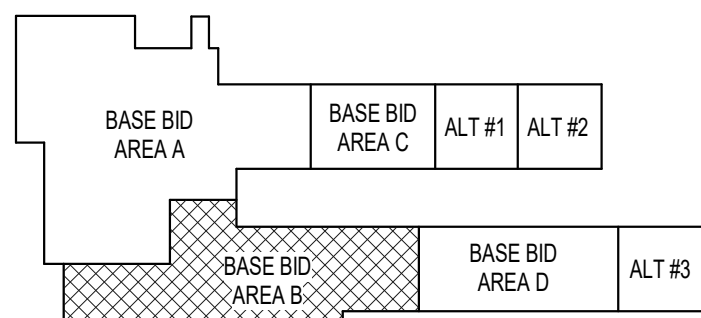
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UNDERSLAB PLAN - AREA B - PLUMBING  
SCALE: 1/8" = 1'-0"



KEY PLAN

- PLUMBING GENERAL NOTES:**
1. FURNISH AND INSTALL SUPPLY STOP SHUT-OFF VALVES ON ALL FIXTURE WATER SUPPLY LINES. FURNISH AND INSTALL WATER HAMMER ARRESTORS PER PDH201 AND AS INDICATED ON DRAWINGS. INSTALL VALVES IN ACCESSIBLE LOCATIONS. IF LOCATION IS NOT READILY ACCESSIBLE, COORDINATE ACCESS PANEL REQUIREMENTS WITH GENERAL CONTRACTOR.
  2. ALL PIPING SHALL BE CONCEALED IN CHASE, WALL, CEILING, FLOORING, ETC. UNLESS OTHERWISE NOTED. PIPING SHOWN OUTSIDE OF WALL FOR CLARITY ONLY.
  3. EQUIPMENT AND FIXTURE SYMBOLS ON PLANS MAY NOT REFLECT ACTUAL TYPE. REFER TO SPECIFICATIONS AND SCHEDULES FOR FIXTURE OR EQUIPMENT TYPE.
  4. LOCATIONS OF FLOOR DRAINS, FLOOR SINKS, TRENCH DRAINS, ETC. INDICATED ON THESE DRAWINGS ARE CONSIDERED APPROXIMATE. THIS CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF FINAL AND EXACT LOCATIONS WITH ALL OTHER TRADES AND EQUIPMENT SUPPLIERS PRIOR TO INSTALLATION. DRAINS, ETC. NOT CORRECTLY LOCATED AS DETERMINED BY THE ARCHITECT/ENGINEER/OWNER, SHALL BE REMOVED AND RELOCATED AT THIS CONTRACTOR'S EXPENSE.
  5. REFER TO MECHANICAL ROOF PLAN FOR PLUMBING ROOF ITEMS.
  6. BALANCE VALVES TO BE BALANCED TO 0.5 GPM UNLESS OTHERWISE NOTED.



ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000087

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

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PROJ. NO. 23-09B

DATE ISSUED

07-02-2024

DATE REVISION  
1 07/23/24 ADDENDUM #1  
2 08/01/24 ADDENDUM #2

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SHEET NO.

P1.3  
SD: 62





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DATE ISSUED

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DATE REVISION

1 07/23/24 ADDENDUM #1

2 08/01/24 ADDENDUM #2

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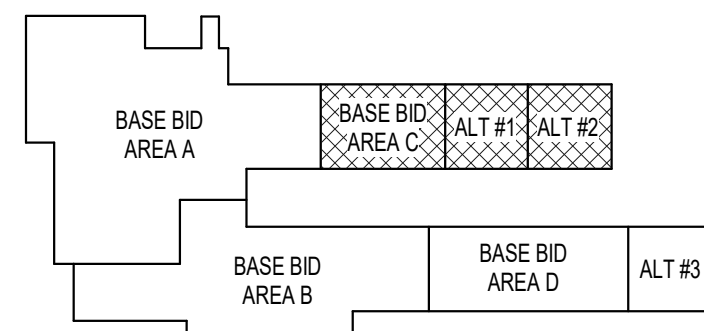
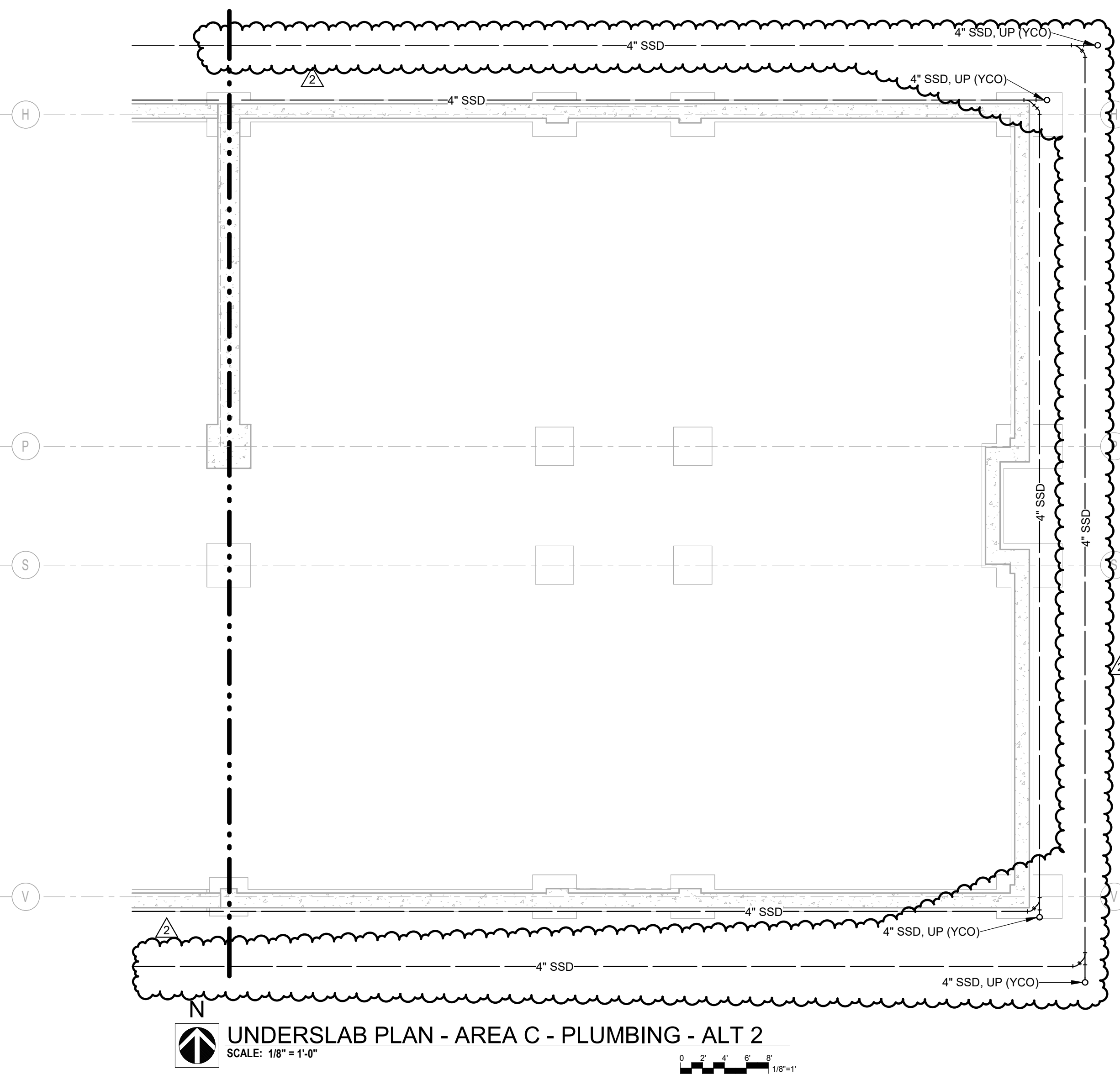
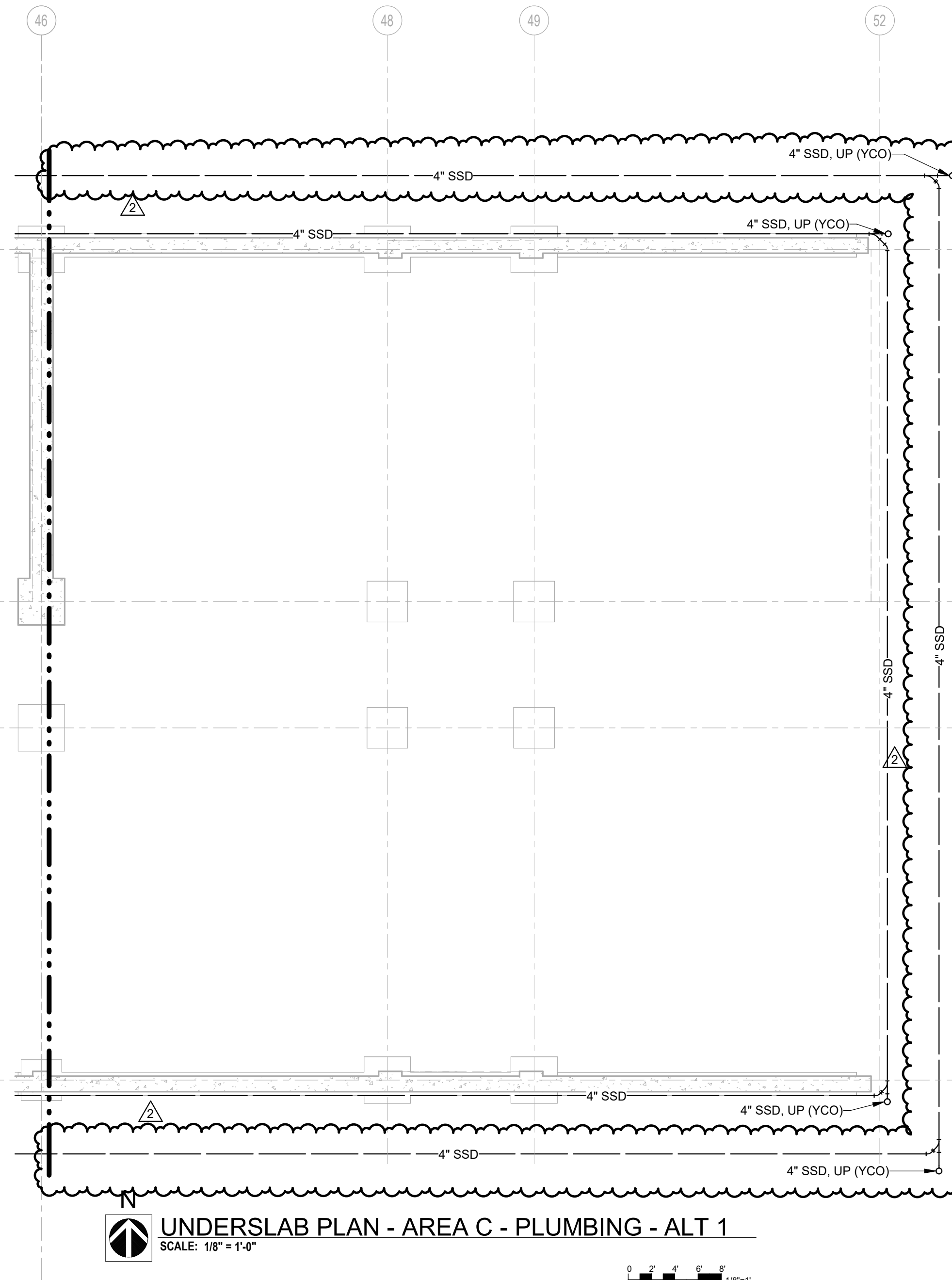
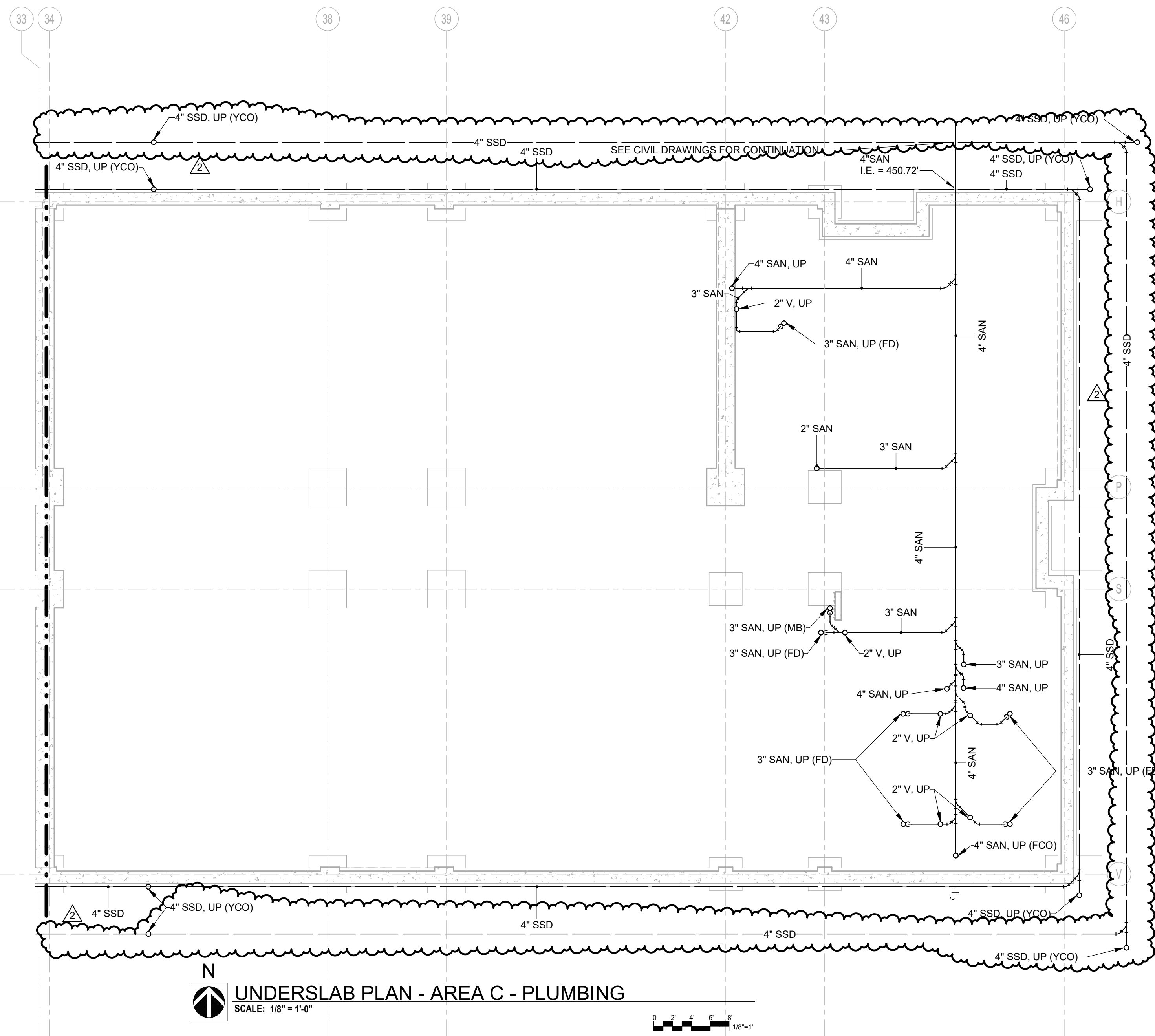
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SHEET NO.

P1.4  
SD: 63

#### PLUMBING GENERAL NOTES:

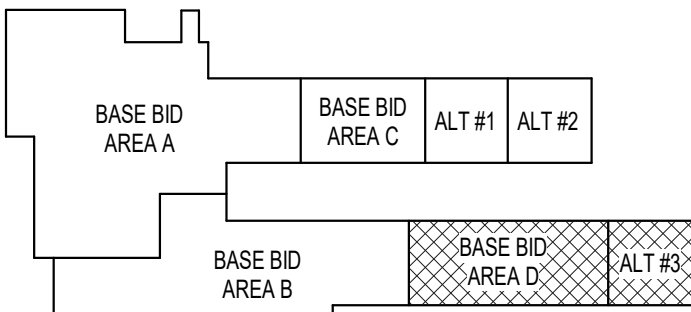
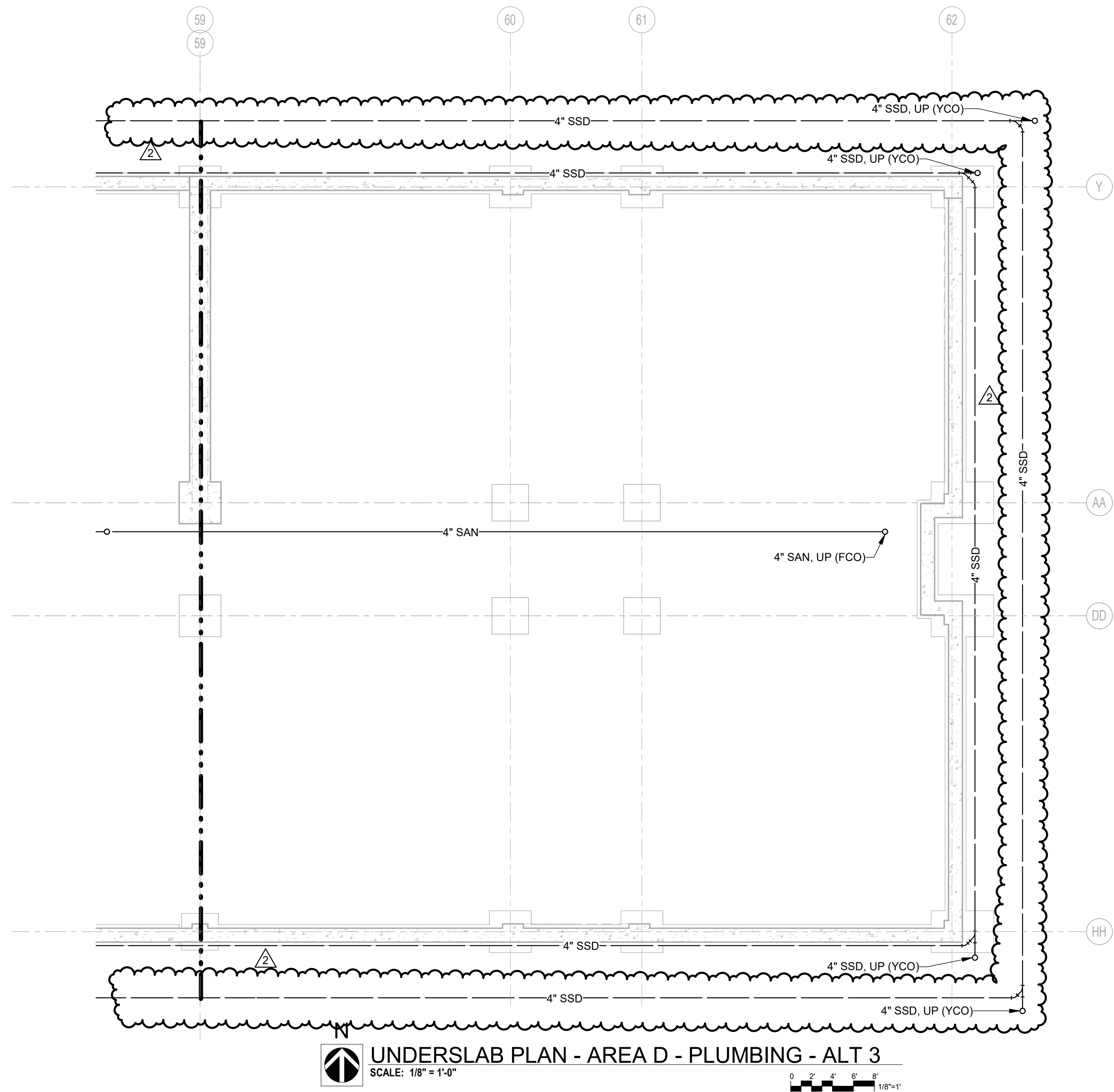
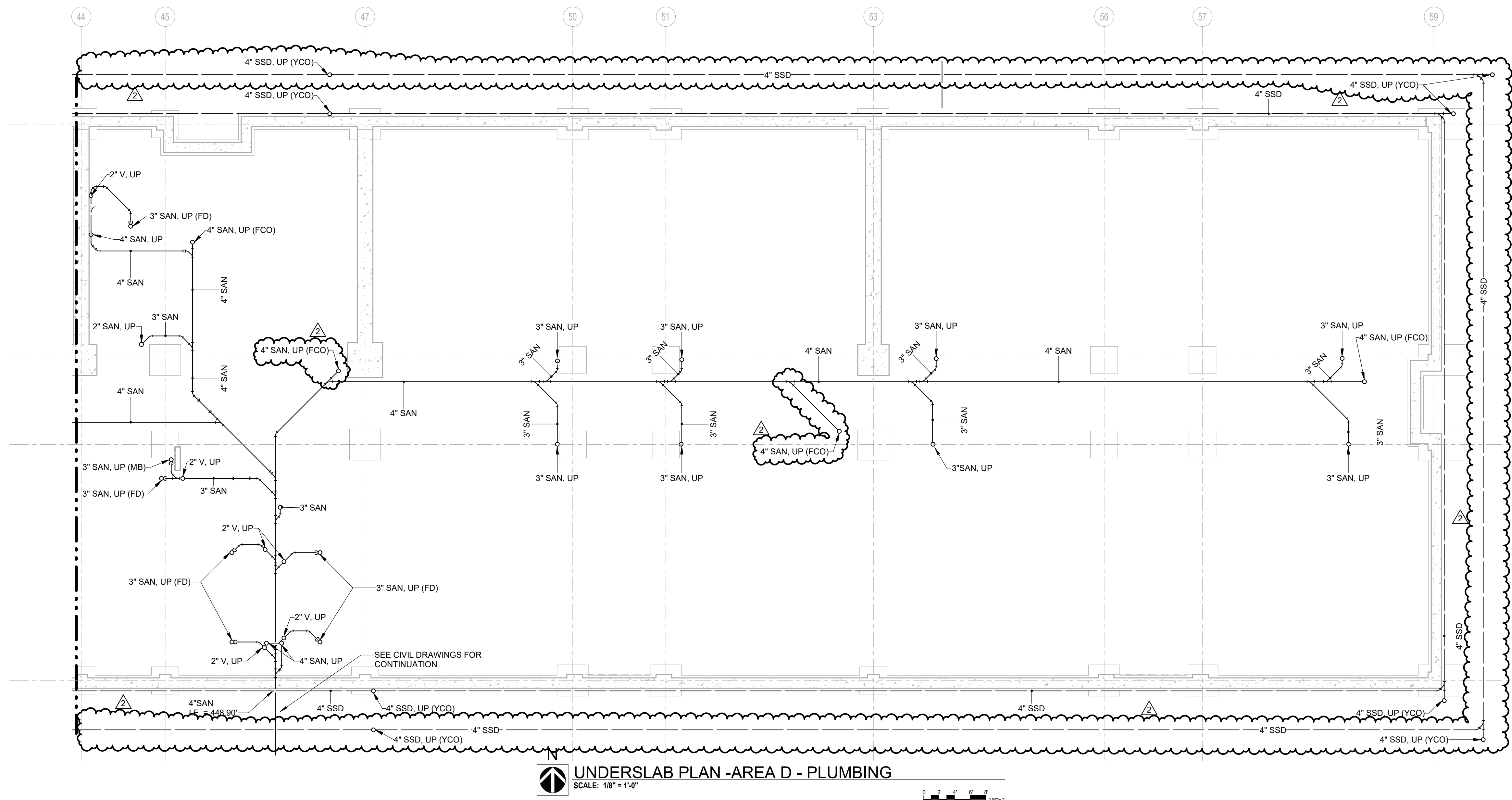
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KEY PLAN

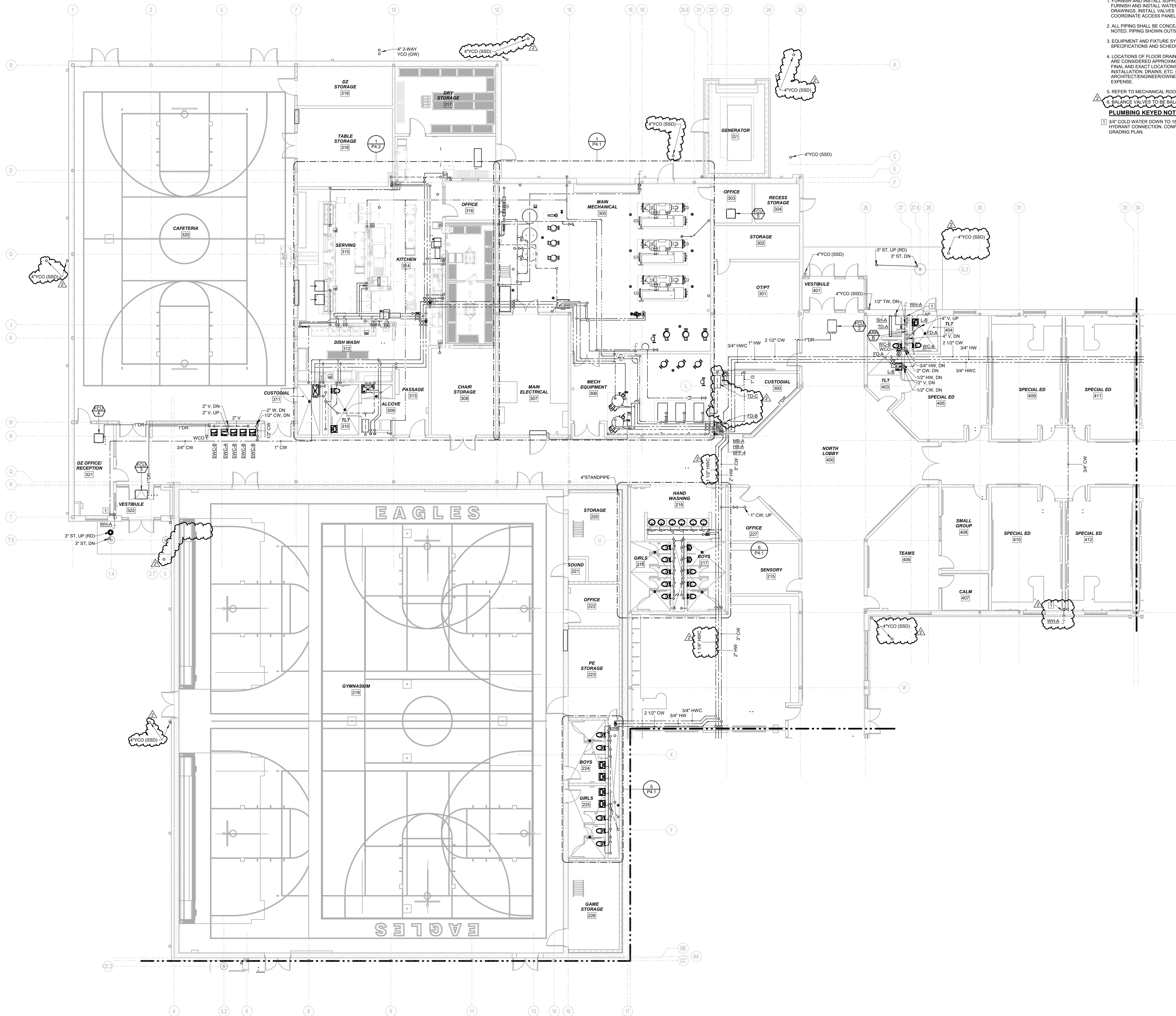


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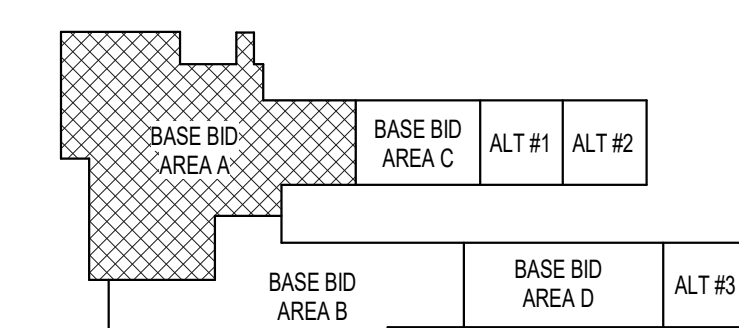
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| DATE ISSUED                                                                                                                                                                      |                                                                                                                              |
| 07-02-2024                                                                                                                                                                       |                                                                                                                              |
| DATE REVISION                                                                                                                                                                    |                                                                                                                              |
| 1 07/23/24 ADDENDUM #1                                                                                                                                                           |                                                                                                                              |
| 2 08/01/24 ADDENDUM #2                                                                                                                                                           |                                                                                                                              |
| DRAWN BY Author                                                                                                                                                                  |                                                                                                                              |
| CHECKED BY CW                                                                                                                                                                    |                                                                                                                              |
| SHEET NO.                                                                                                                                                                        |                                                                                                                              |
| P1.5                                                                                                                                                                             |                                                                                                                              |
| SD: 64                                                                                                                                                                           |                                                                                                                              |





- PLUMBING GENERAL NOTES:**
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- PLUMBING KEYED NOTES:**
- 1) 3/4\"/>

N  
FLOOR PLAN - AREA A - PLUMBING  
SCALE: 1/8" = 1'-0"



KEY PLAN

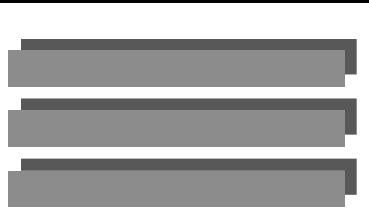


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LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000937

ST. CHARLES, MISSOURI

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07-02-2024

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1 07/23/24 ADDENDUM #1

2 08/01/24 ADDENDUM #2

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SHEET NO.

P2.2  
SD: 65





ALEX PUGH  
LICENSE #2011015789

ENGINEERING CORP.  
NO. 000987

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

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07-02-2024

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1 07/23/24 ADDENDUM #1

2 08/01/24 ADDENDUM #2

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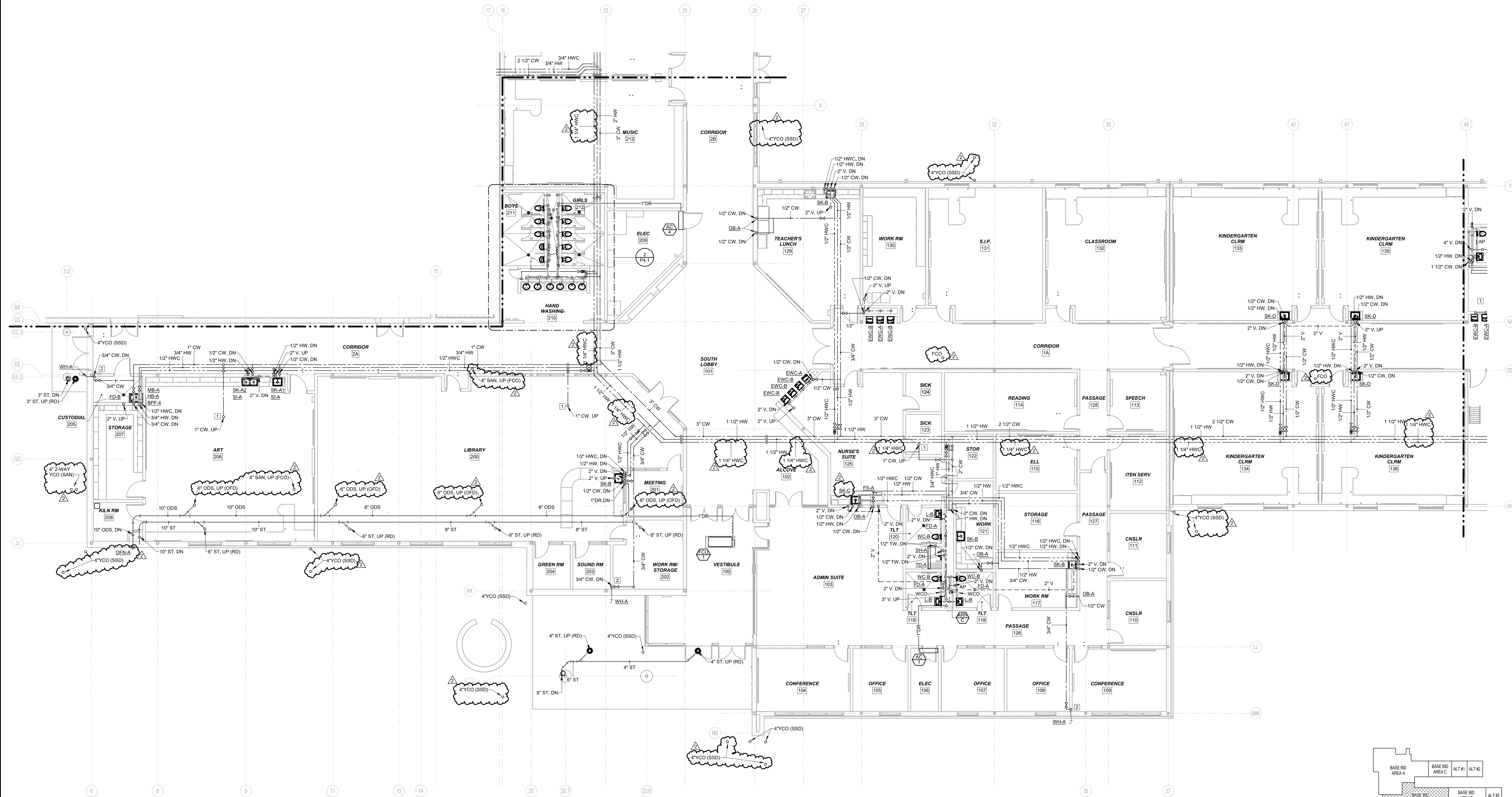
**P2.3**  
SD: 66

#### PLUMBING GENERAL NOTES:

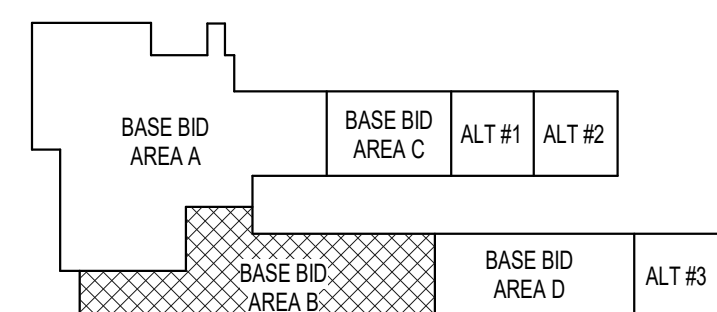
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#### PLUMBING KEYED NOTES:

- 1" COLD WATER UP TO ROOF-HYDRANT. RUN DRAIN FROM ROOF HYDRANT TO NEARBY MOP SINK, FLOOR SINK, OR STANDPIPE FOR AIR GAP DISCHARGE.
- 3/4" COLD WATER DOWN TO 18" ABOVE GRADE TO WALL HYDRANT CONNECTOR. CONFIRM ELEVATION WITH GRADING PLAN.



**FLOOR PLAN - AREA B - PLUMBING**  
SCALE: 1/8" = 1'-0"



**KEY PLAN**





CIVIL / SURVEY  
STRUCTURAL  
MECH / ELEC / PLUMB

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| 1 | 07/23/24 | ADDENDUM #1 |
| 2 | 08/01/24 | ADDENDUM #2 |

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P2.4  
SD: 67

## KEY PLAN

### FIRST FLOOR PLAN - AREA C - PLUMBING

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NEW ELEMENTARY SCHOOL - 2525 HWY B

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|   | DATE     | REVISION    |
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| 1 | 07/23/24 | ADDENDUM #1 |
| 2 | 08/01/24 | ADDENDUM #2 |

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SHEET NO.

P2.4  
SD: 67





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LICENSE #2011015789

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NO. 000937

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CIVIL / SURVEY  
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STRUCTURAL  
MECHANICAL / PLUMBING  
ELECTRICAL / FOOD SERVICE

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CONSULTING ENGINEERS:

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10707 PLUMMER AVE.  
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OFFICE: 314. 881.0855  
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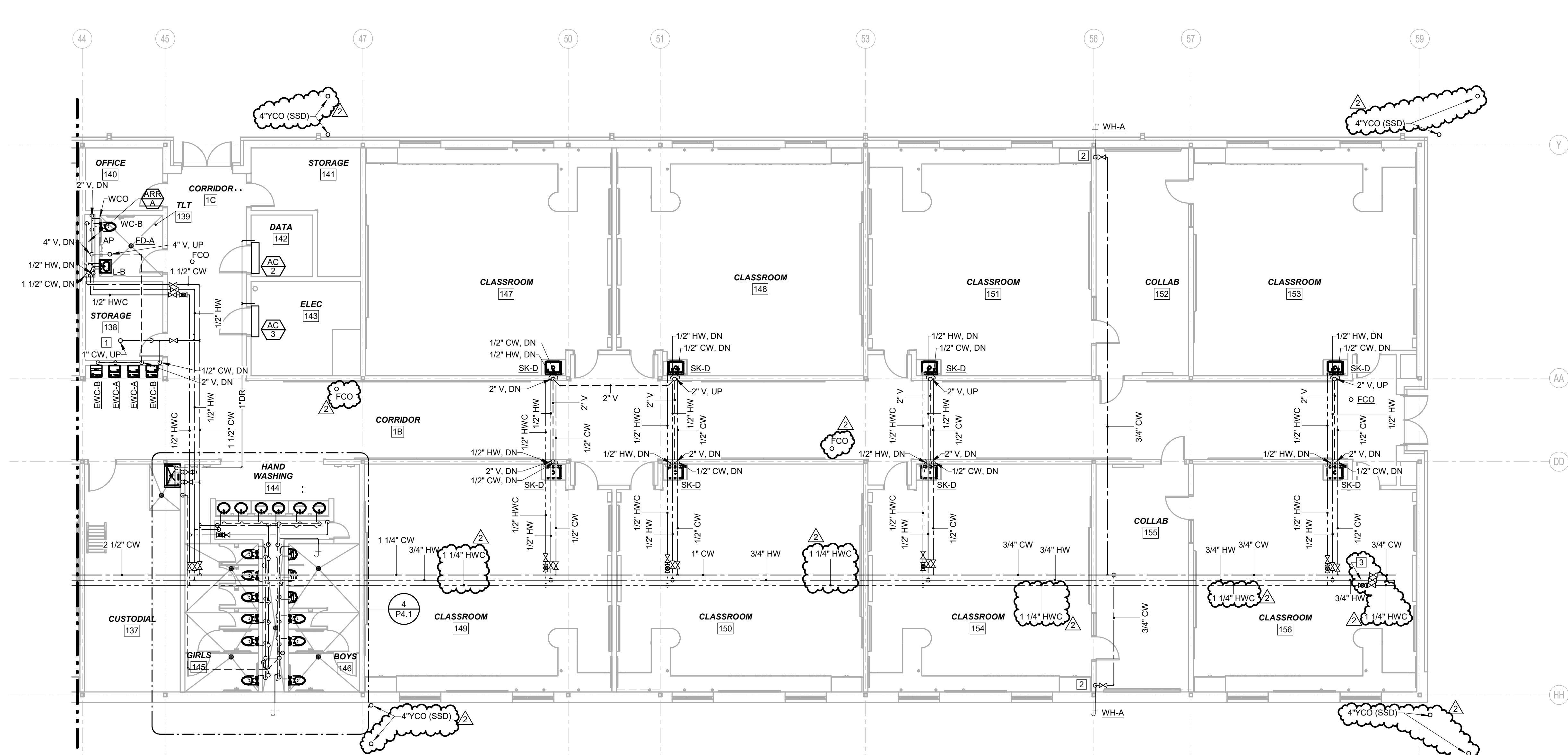
2 08/01/24 ADDENDUM #2

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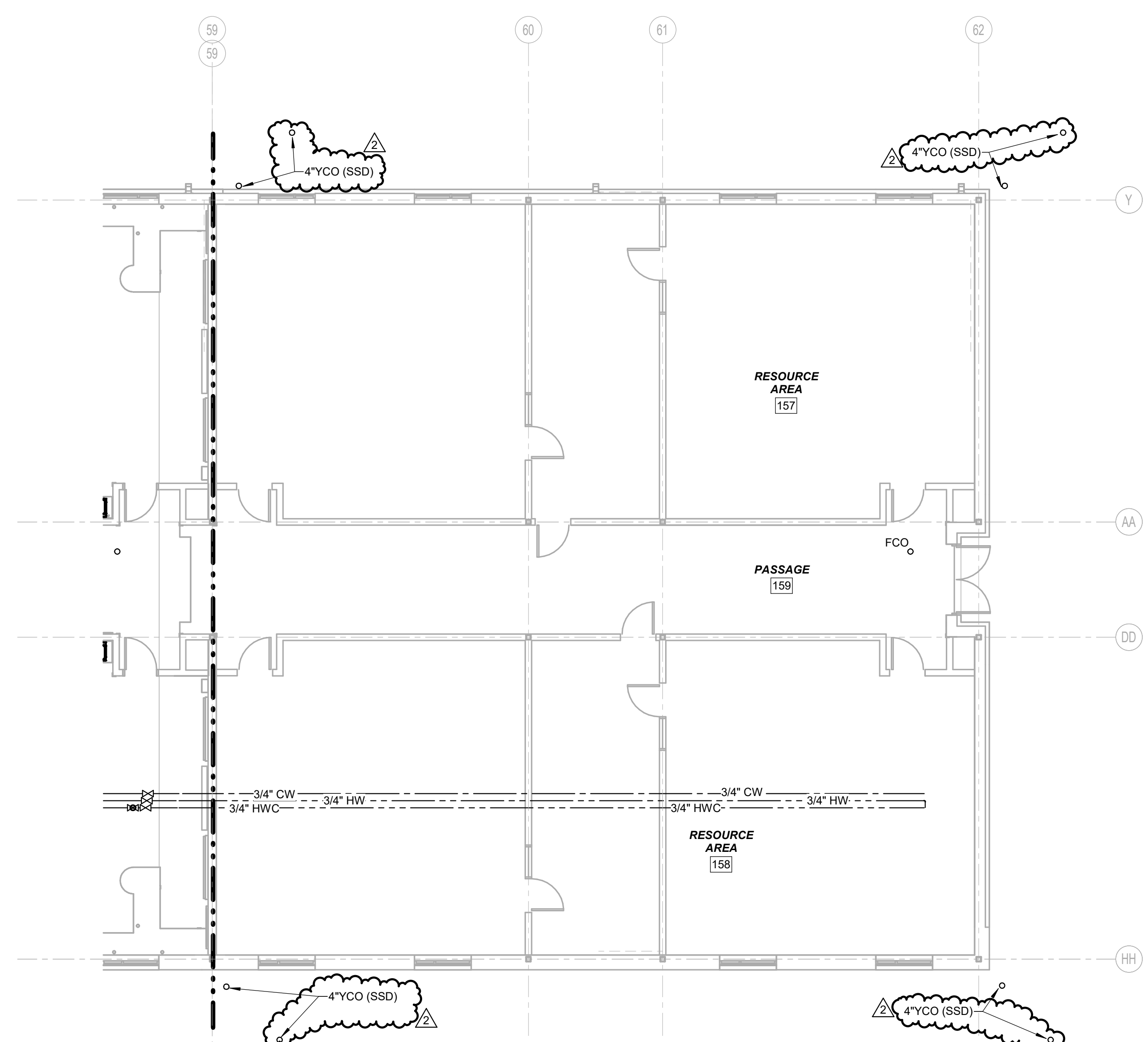
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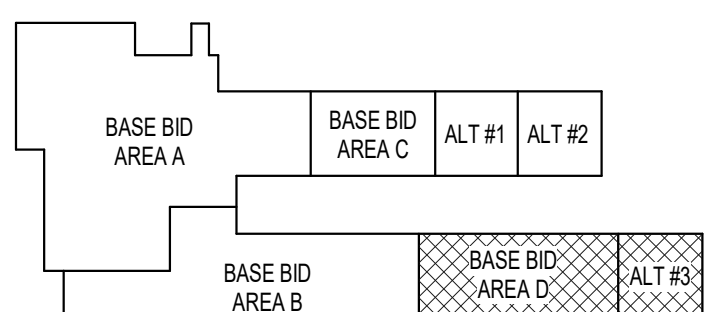
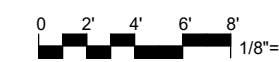
P2.5  
SD: 68



FLOOR PLAN - AREA D - PLUMBING  
SCALE: 1/8" = 1'-0"

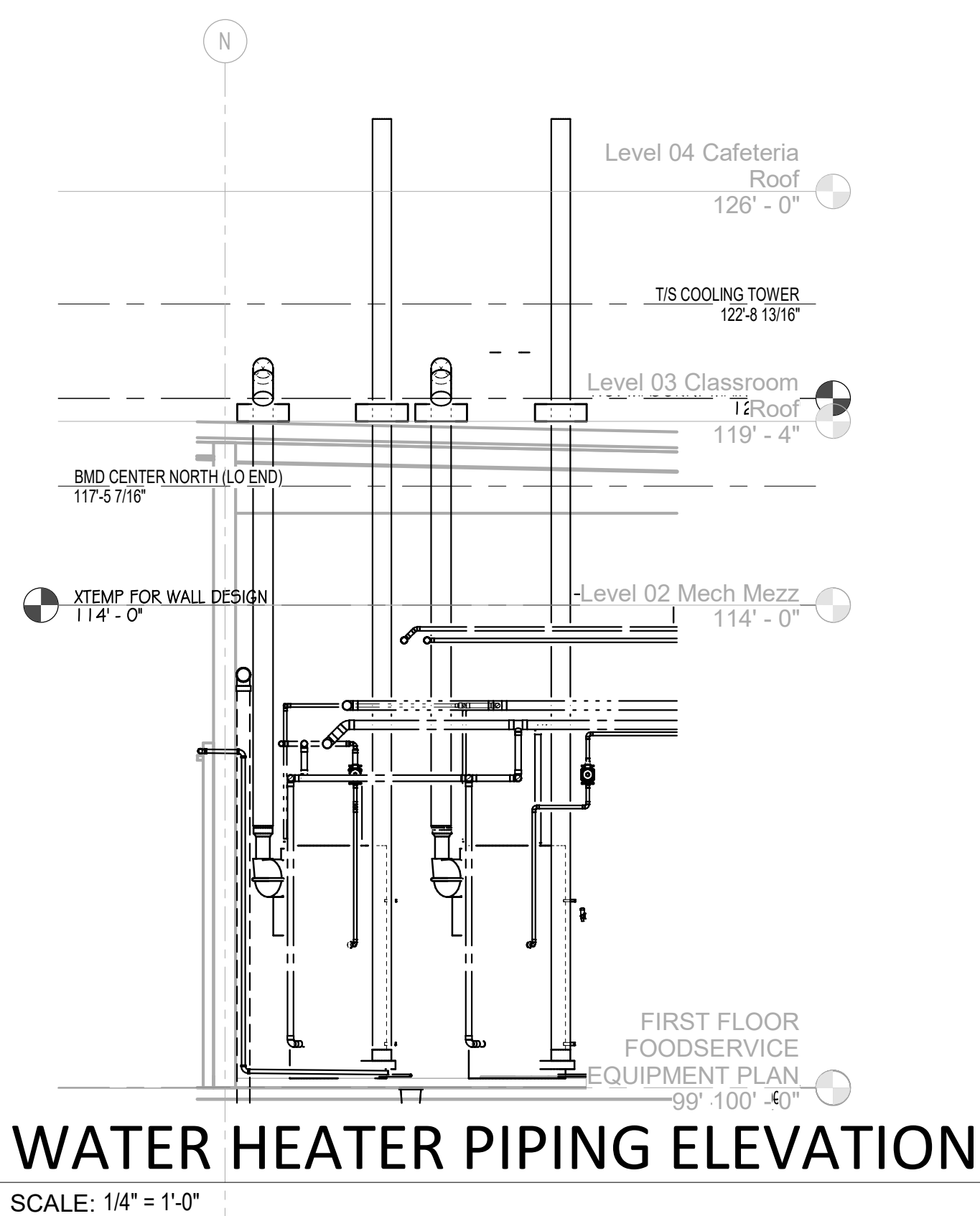


FLOOR PLAN - AREA D - PLUMBING - ALT 3  
SCALE: 1/8" = 1'-0"

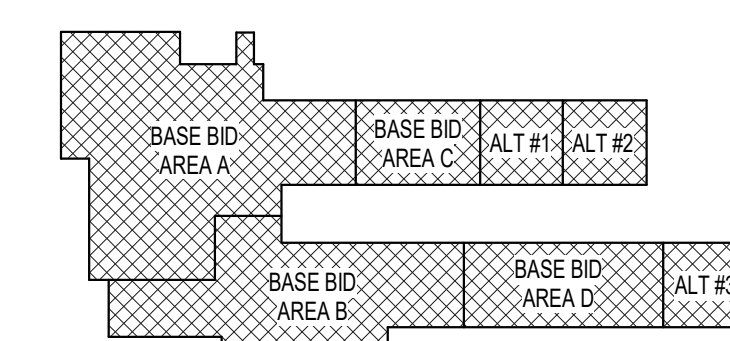
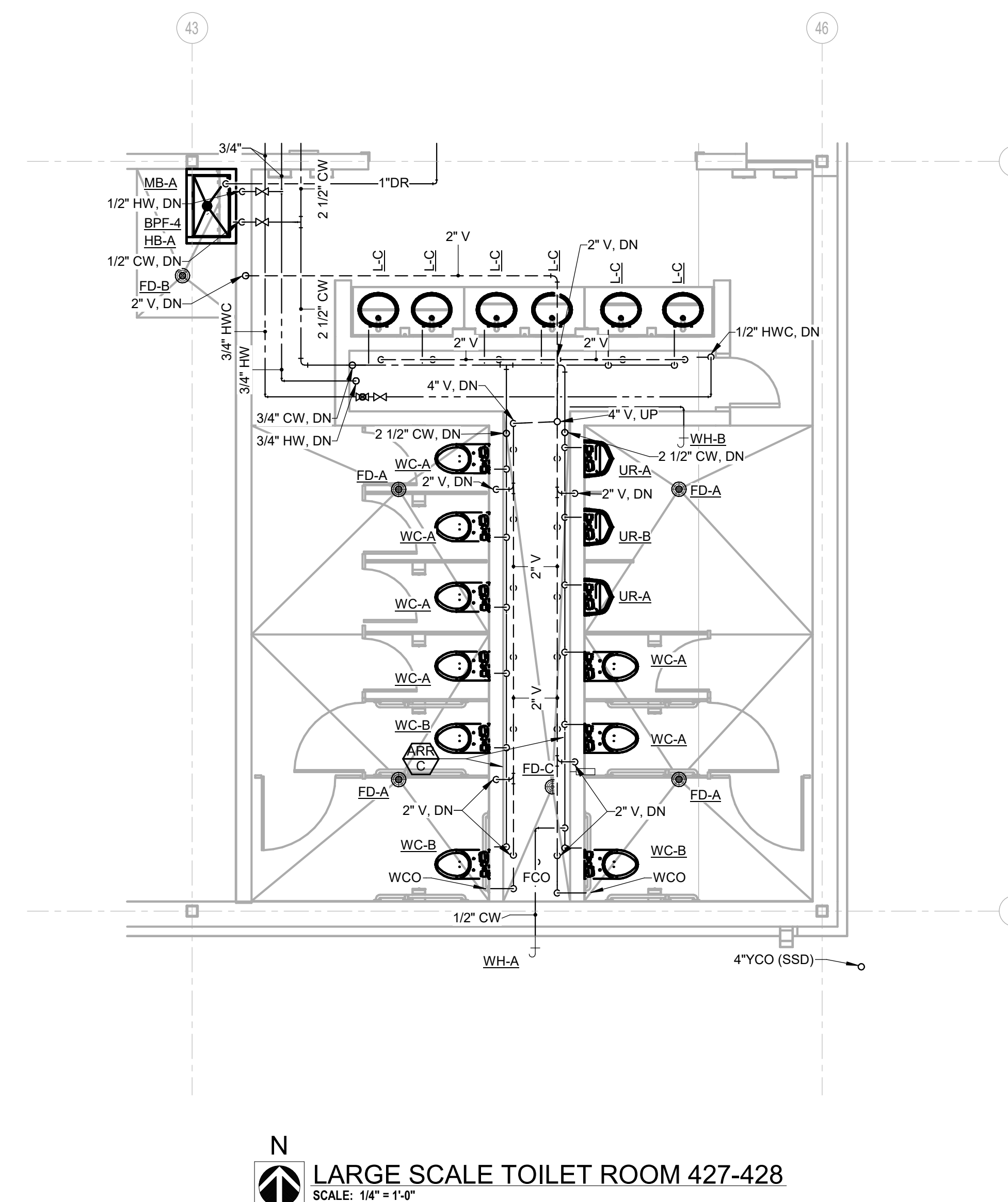
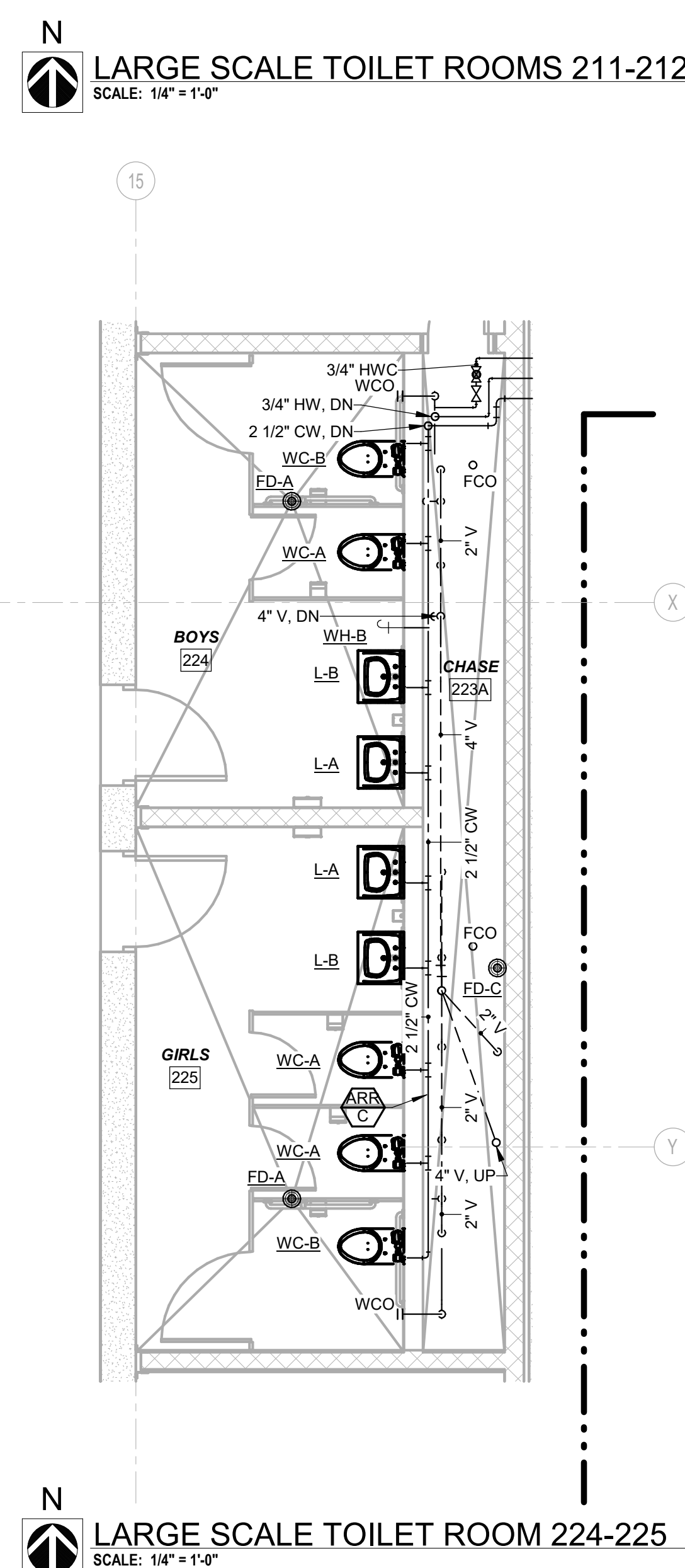
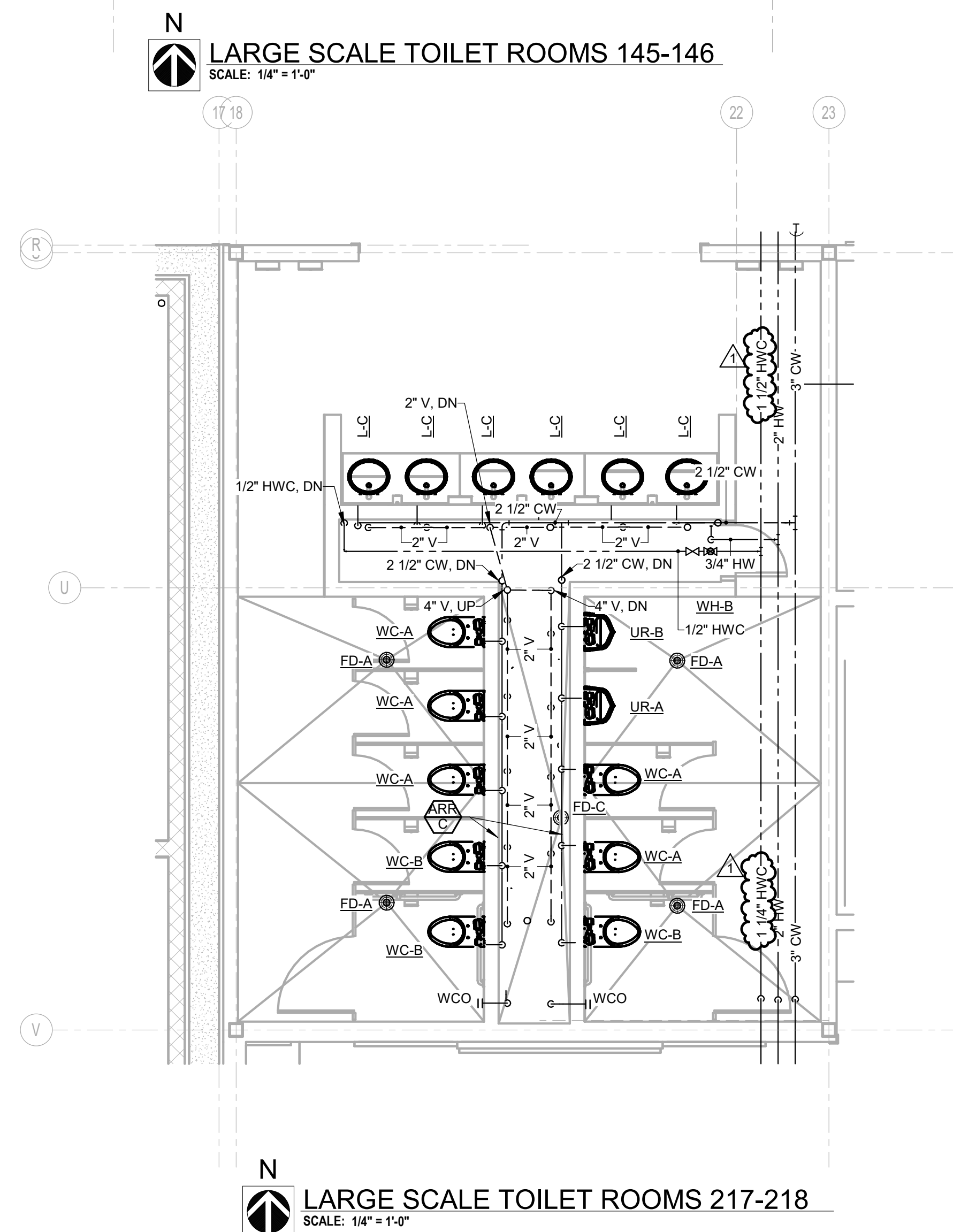
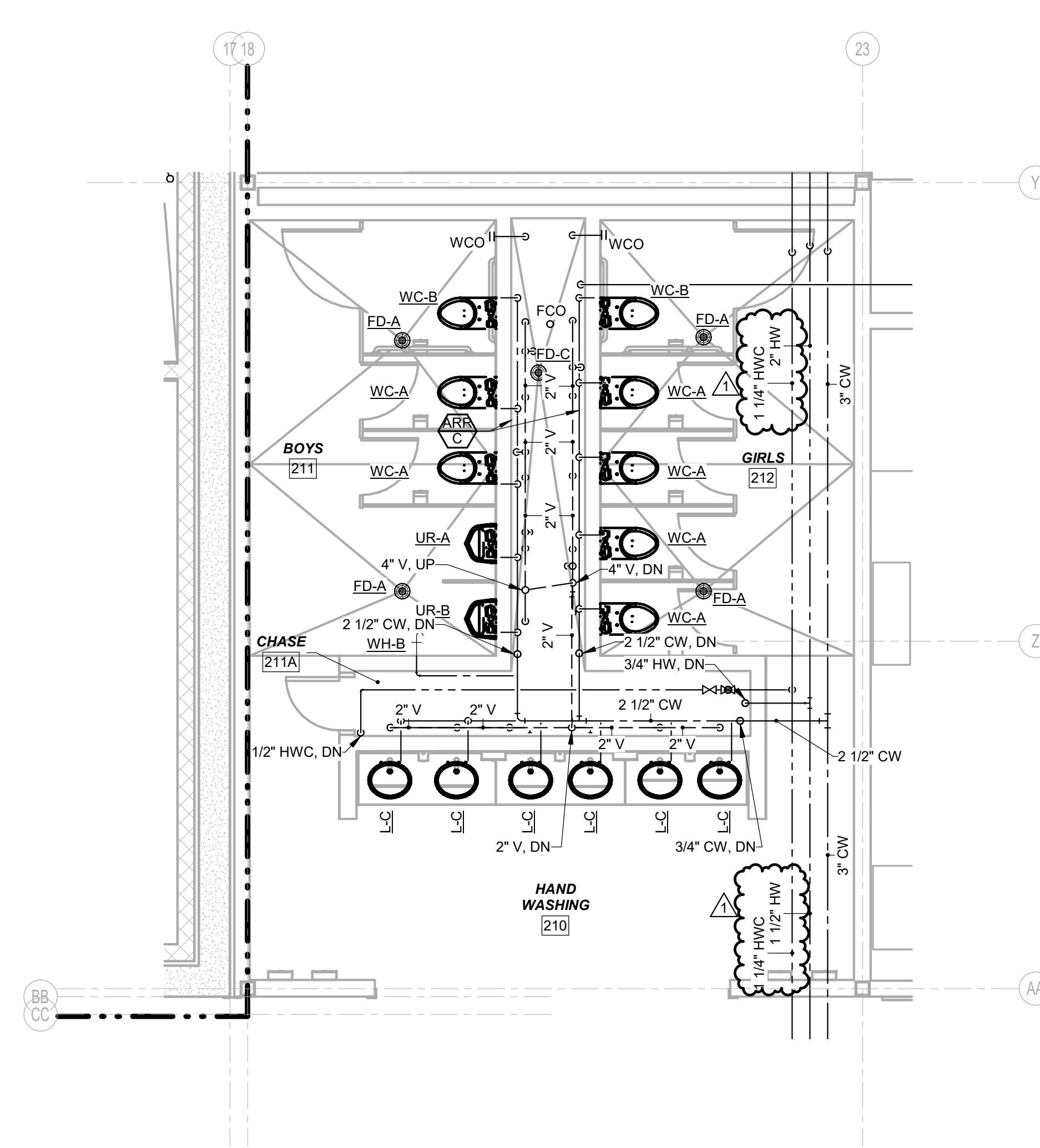
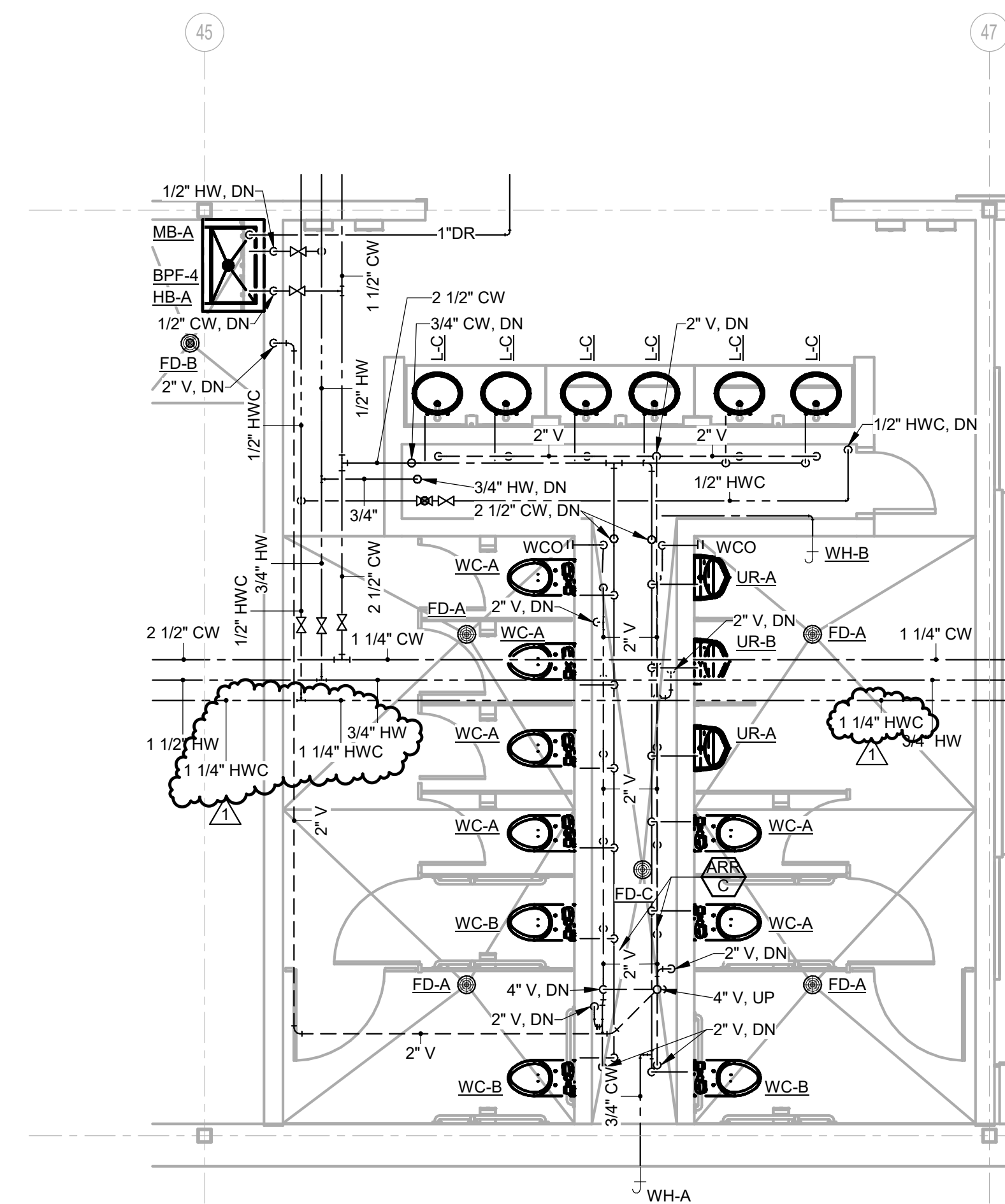
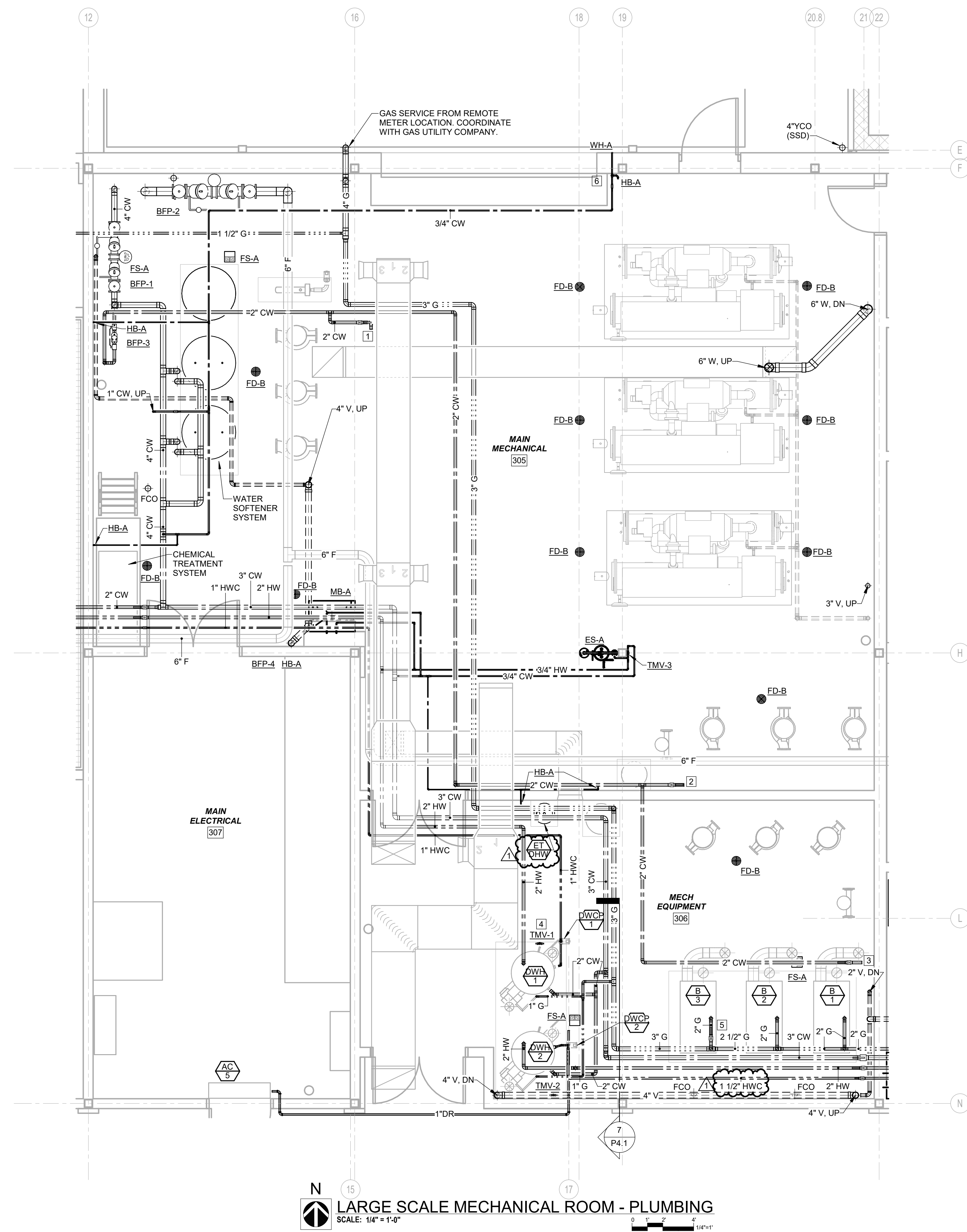


KEY PLAN





- PLUMBING KEYED NOTES:**
- 1" 2" MAKE-UP WATER TO CONNECT INTO CONDENSER WATER SYSTEM.
  - 2" 2" MAKE-UP WATER TO CONNECT INTO HEATING WATER SYSTEM.
  - 3" 2" MAKE-UP WATER TO CONNECT INTO CHILLED WATER SYSTEM.
  - 4" TMV-1 TO BE MOUNTED ON UNISTRUT AT 4'-0" A.F.F.
  - 5" BOILER B-3 TO BE INSTALLED UNDER ALT #4, UNDER BASE BID VALVE AND CAP GAS LINE FOR FUTURE CONNECTION.
  - 6" 3/4" COLD WATER DOWN TO 18" ABOVE GRADE TO WALL HYDRANT CONNECTION. CONFIRM ELEVATION WITH GRADING PLAN.



ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP. NO. 000957

ST. CHARLES, MISSOURI

CONSULTING ENGINEERS:

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ORCHARD FARM SCHOOL DISTRICT

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NEW ELEMENTARY SCHOOL - 2525 HWY B

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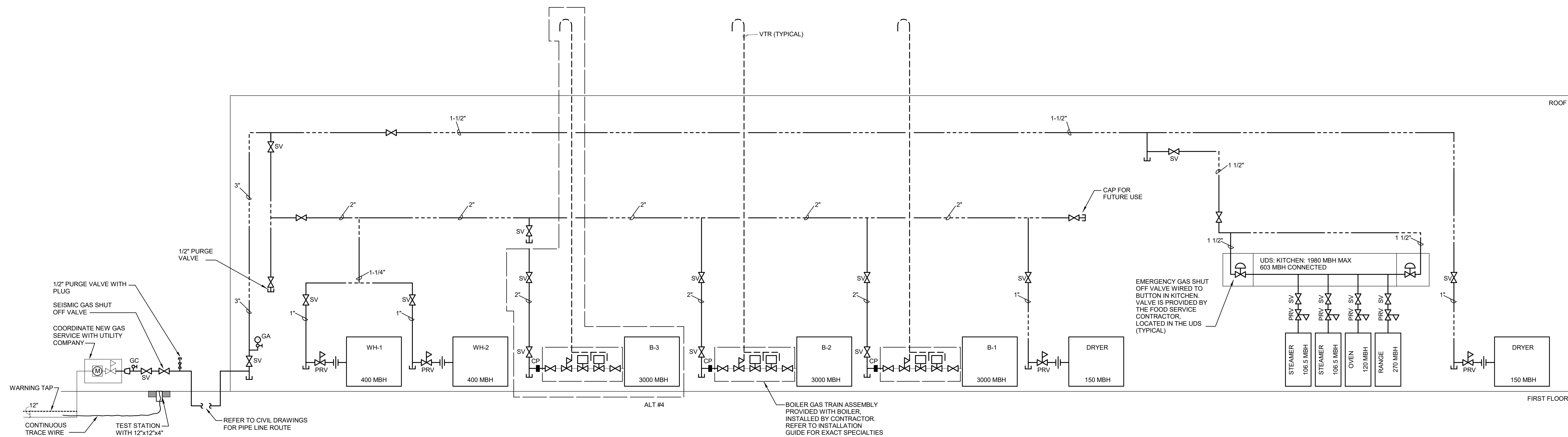
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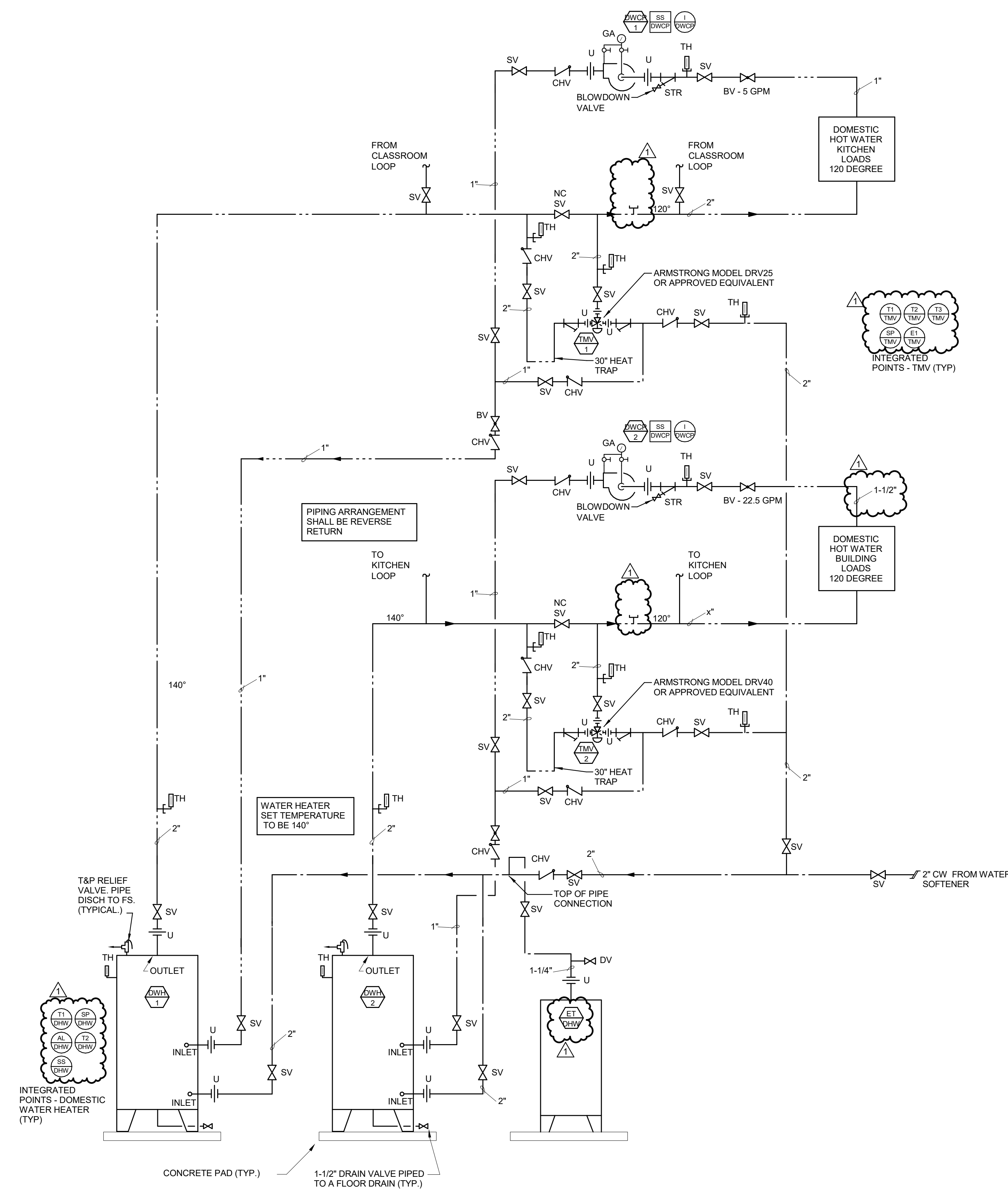
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**GAS FLOW DIAGRAM**  
NO SCALE

| PLUMBING POINTS LIST                                                                                                                                           |                            |                                          |               |        |               |         |                          |                                        |                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|------------------------------------------|---------------|--------|---------------|---------|--------------------------|----------------------------------------|------------------------------------------|
| POINT DESCRIPTION                                                                                                                                              |                            |                                          | STARTUP TREND |        | SERVICE TREND |         | FIELD DEVICE DESCRIPTION |                                        | NOTES                                    |
| TYPE                                                                                                                                                           | NAME                       | DESCRIPTION                              | UNITS         | FREQ   | ARCHIVE       | FREQ    | ARCHIVE                  | INSTRUMENT TYPE                        |                                          |
| INTEGRATED DOMESTIC HOT WATER BOILER POINTS (TYP 2)                                                                                                            |                            |                                          |               |        |               |         |                          |                                        |                                          |
| AV                                                                                                                                                             | DHW-T1                     | WATER HEATER LEAVING WATER TEMPERATURE   | "F.1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| AV                                                                                                                                                             | DHW-T2                     | WATER HEATER ENTERING WATER TEMPERATURE  | "F.1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| AV                                                                                                                                                             | DWH-SP                     | WATER HEATER WATER TEMPERATURE SET-POINT | "F.1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| BV                                                                                                                                                             | DWH-AL                     | WATER HEATER SYSTEM SUMMARY ALARM        | "F.1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| BV                                                                                                                                                             | DWH-SS                     | HOT WATER SYSTEM ENABLE                  | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| INTEGRATED MIXING VALVE POINTS (TYP 2)                                                                                                                         |                            |                                          |               |        |               |         |                          |                                        |                                          |
| AV                                                                                                                                                             | TMV-T1                     | MIXING VALVE ENTERING HW TEMPERATURE     | "F.1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| AV                                                                                                                                                             | TMV-T2                     | MIXING VALVE ENTERING CW TEMPERATURE     | "F.1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| AI                                                                                                                                                             | TMV-T3                     | MIXING VALVE LEAVING TEMPERATURE         | "F.1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| AV                                                                                                                                                             | TMV-SP                     | MIXING VALVE SETPOINT                    | "F.1          | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE |                                          |
| BV                                                                                                                                                             | TMV-E1                     | MIXING VALVE ERROR CODE                  | NORM / ALARM  | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | NETWORK INTERFACE TO CONTROLLED DEVICE | POINTS LIST DISPLAY INTEGER TO MATCH IOM |
| DOMESTIC HOT WATER PUMP POINTS (TYP 2)                                                                                                                         |                            |                                          |               |        |               |         |                          |                                        |                                          |
| BO                                                                                                                                                             | DWCP-SS                    | PUMP ENABLE                              | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | DRY CONTACT / RELAY                    |                                          |
| BI                                                                                                                                                             | DWCP-I                     | PUMP STATUS                              | OFF / ON      | 1 MIN. | 30 MIN.       | 15 MIN. | 1 WEEK                   | FIXED TRIP CURRENT SWITCH              |                                          |
| GENERAL NOTES                                                                                                                                                  |                            |                                          |               |        |               |         |                          |                                        |                                          |
| 1. FOR ANALOG POINTS, UNITS COLUMN HAS TWO COMPONENTS: FIRST VALUE INDICATES ENGINEERING UNITS FOR POINT, SECOND VALUE IS NUMBER OF DECIMAL PLACES TO DISPLAY. |                            |                                          |               |        |               |         |                          |                                        |                                          |
| 2. FOR BINARY POINTS, UNITS COLUMN LISTS "OFF" AND "ON" STATE LABELS FOR POINT.                                                                                |                            |                                          |               |        |               |         |                          |                                        |                                          |
| BI                                                                                                                                                             | BINARY INPUT               |                                          |               |        |               |         |                          |                                        |                                          |
| BO                                                                                                                                                             | BINARY OUTPUT              |                                          |               |        |               |         |                          |                                        |                                          |
| BV                                                                                                                                                             | BINARY VIRTUAL POINT       |                                          |               |        |               |         |                          |                                        |                                          |
| AI                                                                                                                                                             | ANALOG INPUT               |                                          |               |        |               |         |                          |                                        |                                          |
| AO                                                                                                                                                             | ANALOG OUTPUT              |                                          |               |        |               |         |                          |                                        |                                          |
| AV                                                                                                                                                             | ANALOG VIRTUAL POINT       |                                          |               |        |               |         |                          |                                        |                                          |
| HW                                                                                                                                                             | HARD WIRE INTERLOCK/SAFETY |                                          |               |        |               |         |                          |                                        |                                          |
| COS                                                                                                                                                            | CHANGE OF STATE            |                                          |               |        |               |         |                          |                                        |                                          |



**DWH-1 & 2 POTABLE - MECHANICAL 306  
HOT WATER SYSTEM FLOW DIAGRAM**  
NO SCALE



ALEX PUGH  
LICENSE #2011015789  
ENGINEERING CORP.  
NO. 000937

ST. CHARLES, MISSOURI

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ALEX PUGH  
LICENSE #20115789

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ST. CHARLES, MISSOURI

CIVIL / SURVEY  
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PLUMBING SCHEDULES

### MIXING VALVE SCHEDULE

| MARK  | SERVICE                    | MANUFACTURER / MODEL            | FLOW        |                   | LEAVING TEMPERATURE | NOTES |
|-------|----------------------------|---------------------------------|-------------|-------------------|---------------------|-------|
|       |                            |                                 | MINIMUM GPM | GPM @ 10 PSI LOSS |                     |       |
| TMV-1 | KITCHEN HOT WATER SERVICE  | ARMSTRONG DRV25                 | 2           | 31                | 120                 | -     |
| TMV-2 | BUILDING HOT WATER SERVICE | ARMSTRONG DRV40                 | 2           | 31                | 120                 | -     |
| TMV-3 | EMERGENCY EYE WASH         | LEONARD VALVE COMPANY TM-600-LF | 3           | 19                | 85                  | -     |

### DOMESTIC EXPANSION TANK SCHEDULE

| UNIT DESIG. | LOCATION      | SERVICE                    | MANUFACTURER & MODEL NO. | MIN. TOTAL VOLUME (GAL) | MIN. ACCEPTANCE VOLUME (GAL) | MAXIMUM PRESSURE (PSI) | PRESSURE CHARGE (PSI) | INSTALLATION TYPE | NOTES |
|-------------|---------------|----------------------------|--------------------------|-------------------------|------------------------------|------------------------|-----------------------|-------------------|-------|
| ET-DHW      | MECHANICAL RM | BUILDING HOT WATER SERVICE | AMTROL ST-80VC           | 53                      | 35                           | 100                    | 70                    | VERTICAL          | -     |

### ARRESTOR SCHEDULE

| DESIG. | MODEL NUMBER               | FIXTURE UNIT RATINGS | REMARKS |
|--------|----------------------------|----------------------|---------|
| ARR-A  | J.R. SMITH HYDROTROL #5005 | 1-11                 | -       |
| ARR-B  | J.R. SMITH HYDROTROL #5010 | 12-32                | -       |
| ARR-C  | J.R. SMITH HYDROTROL #5020 | 33-60                | -       |
| ARR-D  | J.R. SMITH HYDROTROL #5030 | 61-113               | -       |
| ARR-E  | J.R. SMITH HYDROTROL #5040 | 114-154              | -       |

### CIRCULATING PUMP SCHEDULE

| CIRCULATING PUMP SCHEDULE                                                                                                                  |                  |                                                |                             |            |               |               |     |            |      |          |       |   |
|--------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------------------------|-----------------------------|------------|---------------|---------------|-----|------------|------|----------|-------|---|
| UNIT<br>DESIG.                                                                                                                             | LOCATION         | DESCRIPTION                                    | MANUFACTURER &<br>MODEL NO. | TYPE       | PUMP DATA     |               |     | MOTOR DATA |      |          | NOTES |   |
|                                                                                                                                            |                  |                                                |                             |            | FLOW<br>(GPM) | HEAD<br>(FT.) | BHP | HP         | RPM  | VOLTS/PH |       |   |
| DWCP-1                                                                                                                                     | MECHANICAL PLANT | KITCHEN DOMESTIC HOT WATER LOOP CIRCULATION    | ARMSTRONG E13-2             | CIRCULATOR | 5             | 15            | -   | 1/6        | 3400 | 120/1    | RIB   | 1 |
| DWCP-2                                                                                                                                     | MECHANICAL PLANT | CLASSROOMS DOMESTIC HOT WATER LOOP CIRCULATION | ARMSTRONG E14-2             | CIRCULATOR | 12            | 35            | -   | 2/5        | 3300 | 120/1    | RIB   | 1 |
| <div>NOTES:</div> <div>1. PROVIDE LEAD FREE BRONZE PUMP BODY. ALL WETTED COMPONENTS TO BE LEAD FREE AND RATED FOR POTABLE WATER USE.</div> |                  |                                                |                             |            |               |               |     |            |      |          |       |   |

### INTERCEPTOR SCHEDULE

| DESIG. | DESCRIPTION        | MANUFACTURER    | MODEL   | FLOW RATE (GPM) | CAPACITY         | INLET | OUTLET | REMARKS                                                                                           |
|--------|--------------------|-----------------|---------|-----------------|------------------|-------|--------|---------------------------------------------------------------------------------------------------|
| GJA    | GREASE INTERCEPTOR | SCHIER PRODUCTS | GB-1000 | 100             | 1000 LBS. GREASE | 6"    | 6"     | PROVIDE SAMPLING PORT AND RISERS TO GRADE.<br>PROVIDE SAMPLING PORT AND RISERS TO FINISHED FLOOR. |
| SI-A   | SOLIDS INTERCEPTOR | JAY R SMITH     | 8714-SS | -               | -                | 2"    | 2"     |                                                                                                   |

### PLUMBING FIXTURE SCHEDULE

| UNIT DESIG. | FIXTURE DESCRIPTION                                           | ADA (YES/NO) | CARRIER (YES/NO) | TRIM                                                 | DRAIN/TRAP                         | SUPPLIES                         | FLOW RATE (GPM) | ACCESSORIES                           | VENT SIZE | COLD WATER SUPPLY | HOT WATER SUPPLY | TEMPERED WATER SUPPLY | NOTES  |
|-------------|---------------------------------------------------------------|--------------|------------------|------------------------------------------------------|------------------------------------|----------------------------------|-----------------|---------------------------------------|-----------|-------------------|------------------|-----------------------|--------|
| WC-A        | WATER CLOSET - WALL-HUNG                                      | NO           | YES              | AUTOMATIC HARDWIRED                                  | INTEGRAL                           | -                                | 1.6             | SEAT                                  | 2"        | 1-1/4"            | -                | -                     | -      |
| WC-B        | WATER CLOSET - WALL-HUNG (ADA)                                | YES          | YES              | AUTOMATIC HARDWIRED                                  | INTEGRAL                           | -                                | 1.6             | SEAT                                  | 2"        | 1-1/4"            | -                | -                     | 4      |
| UR-A        | URINAL - WALL-HUNG                                            | NO           | YES              | AUTOMATIC HARDWIRED                                  | INTEGRAL                           | -                                | 1.0             | -                                     | 2"        | 3/4"              | -                | -                     | -      |
| UR-B        | URINAL - WALL-HUNG (ADA)                                      | YES          | YES              | AUTOMATIC HARDWIRED                                  | INTEGRAL                           | -                                | 1.0             | -                                     | 2"        | 3/4"              | -                | -                     | 4      |
| L-A         | WALL-HUNG LAVATORY                                            | NO           | YES              | AUTOMATIC FAUCET HARDWIRED, SMALL GOOSENECK          | CHROME-PLATED P-TRAP               | LOOSE KEY ANGLE STOPS AND RISERS | 0.5             | -                                     | 2"        | 1/2"              | 1/2"             | -                     | 1      |
| L-B         | WALL-HUNG LAVATORY (ADA)                                      | YES          | YES              | AUTOMATIC FAUCET HARDWIRED, SMALL GOOSENECK          | CHROME-PLATED P-TRAP               | LOOSE KEY ANGLE STOPS AND RISERS | 0.5             | INSULATION KIT                        | 2"        | 1/2"              | 1/2"             | -                     | 1,4    |
| L-C         | COUNTERTOP LAVATORY                                           | YES          | NO               | AUTOMATIC FAUCET HARDWIRED, SMALL GOOSENECK          | CHROME-PLATED P-TRAP               | LOOSE KEY ANGLE STOPS AND RISERS | 0.5             | -                                     | 2"        | 1/2"              | 1/2"             | -                     | 1      |
| SK-A1       | SINK - SINGLE COMPARTMENT, COUNTERTOP, SIZE 1                 | YES          | NO               | LARGE GOOSENECK, WRISTBLADE HANDLES                  | CRUMB CUP AND CHROME-PLATED P-TRAP | LOOSE KEY ANGLE STOPS AND RISERS | -               | -                                     | 2"        | 1/2"              | 1/2"             | -                     | 2      |
| SK-A2       | SINK - DOUBLE COMPARTMENT, COUNTERTOP W/ INTEGRAL SPRAYER     | NO           | NO               | LARGE GOOSENECK, LEVER HANDLES WITH INTEGRAL SPRAYER | CRUMB CUP AND CHROME-PLATED P-TRAP | LOOSE KEY ANGLE STOPS AND RISERS | -               | -                                     | 2"        | 1/2"              | 1/2"             | -                     | 2      |
| SK-B        | SINK - SINGLE COMPARTMENT, COUNTERTOP, SIZE 1                 | YES          | NO               | LARGE GOOSENECK, WRISTBLADE HANDLES                  | CRUMB CUP AND CHROME-PLATED P-TRAP | LOOSE KEY ANGLE STOPS AND RISERS | -               | -                                     | 2"        | 1/2"              | 1/2"             | -                     | -      |
| SK-C        | SINK - SINGLE COMPARTMENT, COUNTERTOP, SIZE 2                 | YES          | NO               | LARGE GOOSENECK, WRISTBLADE HANDLES                  | CRUMB CUP AND CHROME-PLATED P-TRAP | LOOSE KEY ANGLE STOPS AND RISERS | -               | -                                     | 2"        | 1/2"              | 1/2"             | -                     | -      |
| SK-D        | SINK - SINGLE COMPARTMENT, COUNTERTOP, SIZE 3                 | YES          | NO               | LARGE GOOSENECK, WRISTBLADE HANDLES                  | CRUMB CUP AND CHROME-PLATED P-TRAP | LOOSE KEY ANGLE STOPS AND RISERS | -               | -                                     | 2"        | 1/2"              | 1/2"             | -                     | -      |
| MB-A        | MOP SINK BASIN                                                | NO           | NO               | VACUUM BREAKER RIGID SPOUT, LEVER HANDLES            | 3" CAST IRON                       | INTEGRAL                         | -               | SPLASH PANELS                         | 3"        | 1/2"              | 1/2"             | -                     | 3      |
| SH-A        | SHOWER: ADA DUAL OUTLET, INDIVIDUAL STALL                     | YES          | NO               | SIMMONS HYDRAPIPE W/ FIXED SHOWERHEAD & HANDWASHER   | TRENCH DRAIN                       | SHUT-OFF VALVES                  | -               | SOAP DISH, 30" BAR WITH SLIDE BRACKET | 2"        | 1/2"              | 1/2"             | -                     | -      |
| EW-A        | EMERGENCY EYEWASH                                             | YES          | NO               | -                                                    | -                                  | -                                | -               | -                                     | 2"        | -                 | -                | -                     | 1-1/4" |
| ES-A        | EMERGENCY SHOWER AND EYE/FACE WASH                            | YES          | NO               | EMERGENCY SHOWER AND EYE/FACE WASH                   | INTEGRAL                           | -                                | -               | -                                     | 2"        | -                 | -                | -                     | 5      |
| EW-C-A      | ELECTRIC WATER COOLER, BI-LEVEL, WALL-MOUNTED W/BOTTLE FILLER | YES          | YES              | -                                                    | CHROME-PLATED P-TRAP               | LOOSE KEY ANGLE STOPS AND RISERS | -               | -                                     | 2"        | 1/2"              | -                | -                     | -      |
| EW-C-B      | ELECTRIC WATER COOLER, BI-LEVEL, WALL-MOUNTED                 | YES          | YES              | -                                                    | CHROME-PLATED P-TRAP               | LOOSE KEY ANGLE STOPS AND RISERS | -               | -                                     | 2"        | 1/2"              | -                | -                     | -      |
| WH-A        | WALL HYDRANT - EXTERIOR WITH BOX                              | -            | NO               | -                                                    | -                                  | SHUT-OFF VALVE                   | -               | -                                     | -         | 3/4"              | -                | -                     | -      |
| WH-B        | WALL HYDRANT - INTERIOR                                       | -            | NO               | -                                                    | -                                  | SHUT-OFF VALVE                   | -               | -                                     | -         | 3/4"              | -                | -                     | -      |
| RH-A        | ROOF HYDRANT                                                  | -            | NO               | -                                                    | 1/2" DRAIN                         | SHUT-OFF VALVE                   | -               | -                                     | -         | 1"                | -                | -                     | 6      |
| HB-A        | HOSE BIB                                                      | -            | NO               | -                                                    | -                                  | SHUT-OFF VALVE                   | -               | -                                     | -         | 3/4"              | -                | -                     | -      |
| WMB-A       | WASHING MACHINE OUTLET BOX                                    | -            | NO               | -                                                    | 2" CAST IRON                       | SHUT-OFF VALVES                  | -               | WATER HAMMER ARRESTORS                | 2"        | 1/2"              | 1/2"             | -                     | -      |
| OB-A        | ICE MAKER OUTLET BOX                                          | -            | NO               | -                                                    | -                                  | SHUT-OFF VALVES                  | -               | WATER HAMMER ARRESTORS                | -         | 1/2"              | -                | -                     | -      |

#### NOTES

- PER IECC, THE MAXIMUM ALLOWABLE PIPING LENGTH FROM THE NEAREST SOURCE OF HOT WATER TO THE TERMINATION OF THE LAVATORY SUPPLY PIPE SHALL NOT EXCEED 2 FEET.
- PROVIDE WITH POINT-OF-USE SOLIDS INTERCEPTOR SIA.
- PROVIDE WITH BACKFLOW PREVENTER BFP-4. SEE DETAIL.
- COORDINATE ADA MOUNTING HEIGHT WITH ARCHITECT.
- REFER TO MECHANICAL ROOF PLANS FOR ROOF HYDRANT LOCATIONS.

GENERAL: FIXTURE MOUNTING ELEVATIONS SHALL BE COORDINATED WITH ARCHITECT. SEE SPECIFICATIONS FOR APPROVED MANUFACTURERS AND MODELS.

### DOMESTIC WATER HEATER SCHEDULE

| DOMESTIC WATER HEATER SCHEDULE                 |               |                    |                                        |           |                 |                     |          |         |                    |                       |           |                 |     |                 |       |
|------------------------------------------------|---------------|--------------------|----------------------------------------|-----------|-----------------|---------------------|----------|---------|--------------------|-----------------------|-----------|-----------------|-----|-----------------|-------|
| UNIT DESIG.                                    | LOCATION      | SERVICE            | MANUFACTURER & MODEL NO.               | FUEL TYPE | CAPACITY (GAL.) | MAXIMUM INPUT (MBH) | RECOVERY |         | MINIMUM EFFICIENCY | STACK DIAMETER        | VENT TYPE | ELECTRICAL DATA |     |                 | NOTES |
|                                                |               |                    |                                        |           |                 |                     | GAL / HR | °F RISE |                    |                       |           | VOLTS / PH      | MCA | NO. OF CIRCUITS |       |
| DWH-1                                          | MECHANICAL RM | KITCHEN HOT WATER  | PVI INDUSTRIES CONQUEST 40 L 130A-GCML | NG        | 130             | 400                 | 471      | 100     | 98%                | 4"                    | AD        | 120 / 1         | 11  | 1               | 1,2   |
| DWH-2                                          | MECHANICAL RM | BUILDING HOT WATER | PVI INDUSTRIES CONQUEST 40 L 130A-GCML | NG        | 130             | 400                 | 471      | 100     | 98%                | 4"                    | AD        | 120 / 1         | 11  | 1               | 1,2   |
| NOTES:                                         |               |                    |                                        |           |                 | FUEL TYPE           |          |         |                    | VENT TYPE             |           |                 |     |                 |       |
| 1. UNIT MOUNTED CONTROLLER                     |               |                    |                                        |           |                 | NG NATURAL GAS      |          |         |                    | AD AL 4C, DOUBLE WALL |           |                 |     |                 |       |
| 2. PROVIDE WITH CONDENSATE NEUTRALIZATION KIT. |               |                    |                                        |           |                 |                     |          |         |                    |                       |           |                 |     |                 |       |

### BACKFLOW PREVENTER SCHEDULE

| MARK  | SERVICE                      | MANUFACTURER / MODEL | PEAK FLOW (GPM) | MAX PRESSURE DROP (PSI) | SIZE | NOTES                                                     |
|-------|------------------------------|----------------------|-----------------|-------------------------|------|-----------------------------------------------------------|
| BFP-1 | BUILDING SERVICE             | WATTS LF9090SY       | 300             | 10                      | 4"   | -                                                         |
| BFP-2 | FIRE PROTECTION SERVICE      | AMES SERIES 2000SS   | 1000            | 5                       | 6"   | -                                                         |
| BFP-3 | HVAC MAKE-UP CONDENSER WATER | WATTS LF909M1AG-QT   | 75              | 10                      | 2"   | -                                                         |
| BFP-4 | CHEMICAL DISPENSER           | WATTS LF909-QT       | 13              | 14                      | 3/4" | LOCATED AT CHEMICAL DISPENSER AT MOP SINKS AND IN KITCHEN |
| BFP-5 | HVAC MAKE-UP CHILLED WATER   | WATTS LF909-QT       | 50              | 20                      | 1"   | -                                                         |
| BFP-6 | HVAC MAKE-UP HEATING WATER   | WATTS LF909-QT       | 50              | 20                      | 1"   | -                                                         |

### DRAIN SCHEDULE

| MAKR  | LOCATION                                    | BODY                                | STRAINER                             | TRIM                   | NOTES |
|-------|---------------------------------------------|-------------------------------------|--------------------------------------|------------------------|-------|
| FD-A  | ROUND FLOOR DRAIN - FINISHED FLOOR          | CAST IRON                           | NICKEL-BRONZE                        | -                      | -     |
| FD-B  | MECHANICAL ROOM FLOOR DRAINS                | CAST IRON                           | CAST IRON LOOSE SET TRACTOR STRAINER | -                      | -     |
| FD-C  | ROUND FLOOR DRAIN - UNFINISHED FLOOR        | CAST IRON                           | NICKEL-BRONZE                        | A.R.C. SEDIMENT BUCKET | -     |
| FS-A  | MECHANICAL ROOM FLOOR SINK                  | CAST IRON BODY WITH A.R.C. INTERIOR | A.R.C. CAST IRON GRATE               | -                      | -     |
| FS-B  | MECHANICAL ROOM FLOOR SINK                  | CAST IRON BODY WITH A.R.C. INTERIOR | NICKEL-BRONZE GRATE                  | A.R.C. SEDIMENT BUCKET | -     |
| FS-C  | MECHANICAL ROOM FLOOR SINK - ACID RESISTANT | CAST IRON BODY WITH A.R.C. INTERIOR | A.R.C. CAST IRON GRATE               | A.R.C. SEDIMENT BUCKET | -     |
| TD-A  | TRENCH DRAIN 5'                             | STAINLESS STEEL                     | STAINLESS STEEL                      | ADA GRATE              | -     |
| TD-B  | TRENCH DRAIN 2'                             | -                                   | -                                    | -                      | 2     |
| TD-C  | WASHING MACHINES                            | POLYPROPYLENE                       | STAINLESS STEEL                      | -                      | -     |
| OFD-A | OVERFLOW STORM DRAIN                        | CAST IRON                           | CAST IRON DOME                       | -                      | 1     |
| OFN-A | OVERFLOW ROOF DRAIN NOZZLE                  | STAINLESS STEEL                     | STAINLESS STEEL                      | -                      | 1     |
| RD-A  | STORM DRAIN                                 | CAST IRON                           | CAST IRON DOME                       | -                      | 1     |

#### NOTES

- REFER TO MECHANICAL ROOF PLANS FOR ROOF DRAIN LOCATIONS.
- TD-B FURNISHED BY KITCHEN CONSULTANT. TO BE INSTALLED BY PLUMBING CONTRACTOR.





**CONSULTING ENGINEERS:**  
BAX ENGINEERING  
CIVIL / SURVEY

**CONSULTING ENGINEERS:**

**HOENER ASSOCIATES, INC. - ARCHITECTS**

ORCHARD FARM SCHOOL DISTRICT

ALL DIMENSIONS MUST BE  
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FORE WORK IS EXECUTED.  
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PROJ. NO. 23-091

DATE ISSUED

07-02-2024

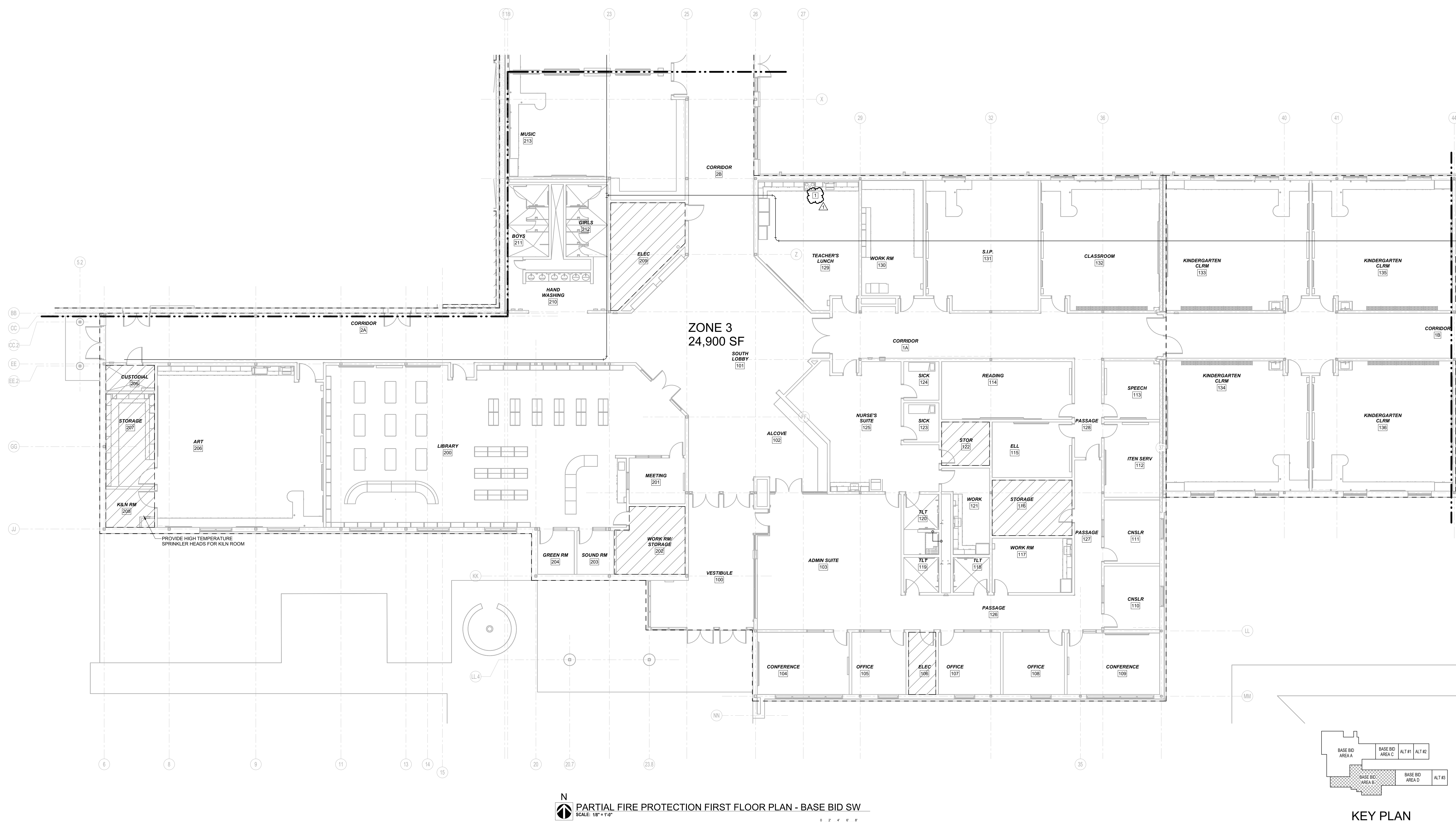
| DATE     | REVISION    |
|----------|-------------|
| 08/01/24 | ADDENDUM #2 |

DRAWN BY    Authc

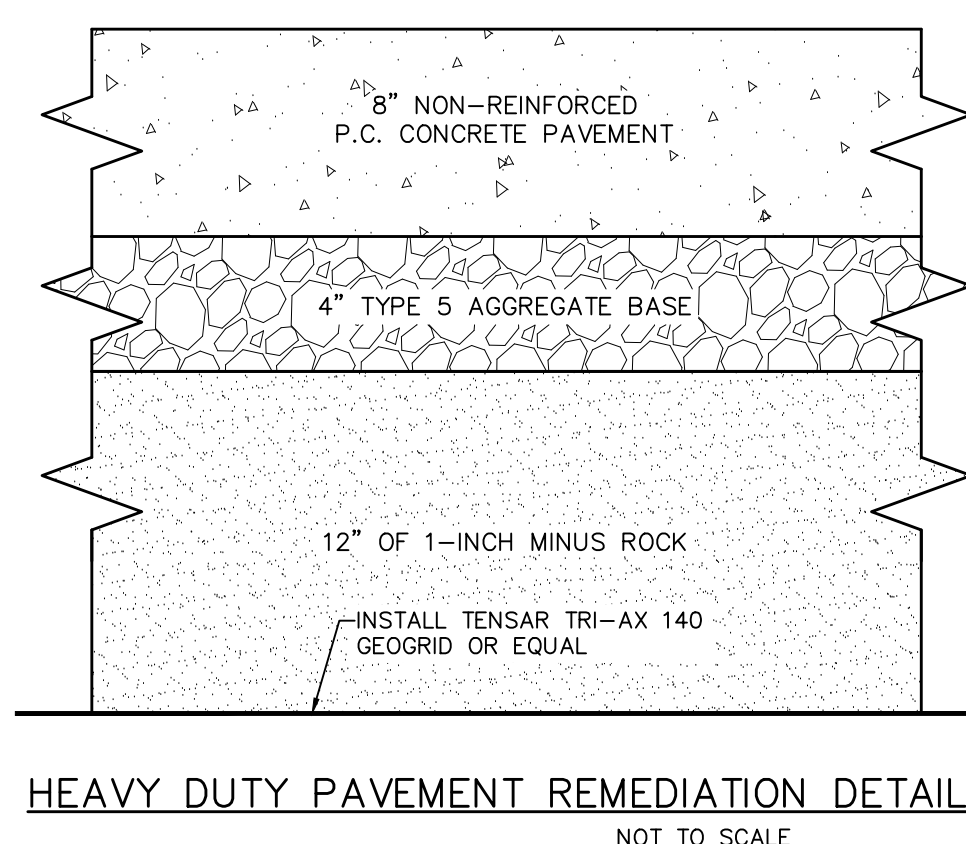
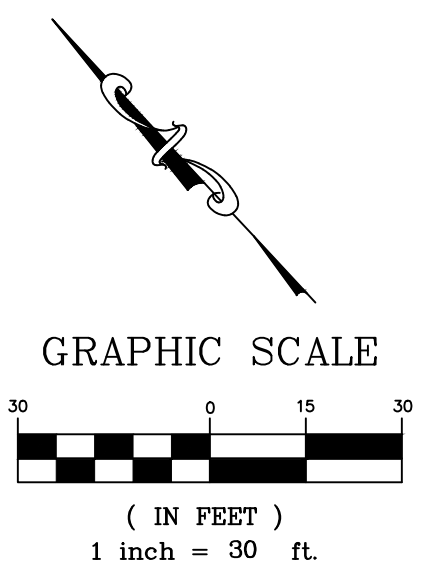
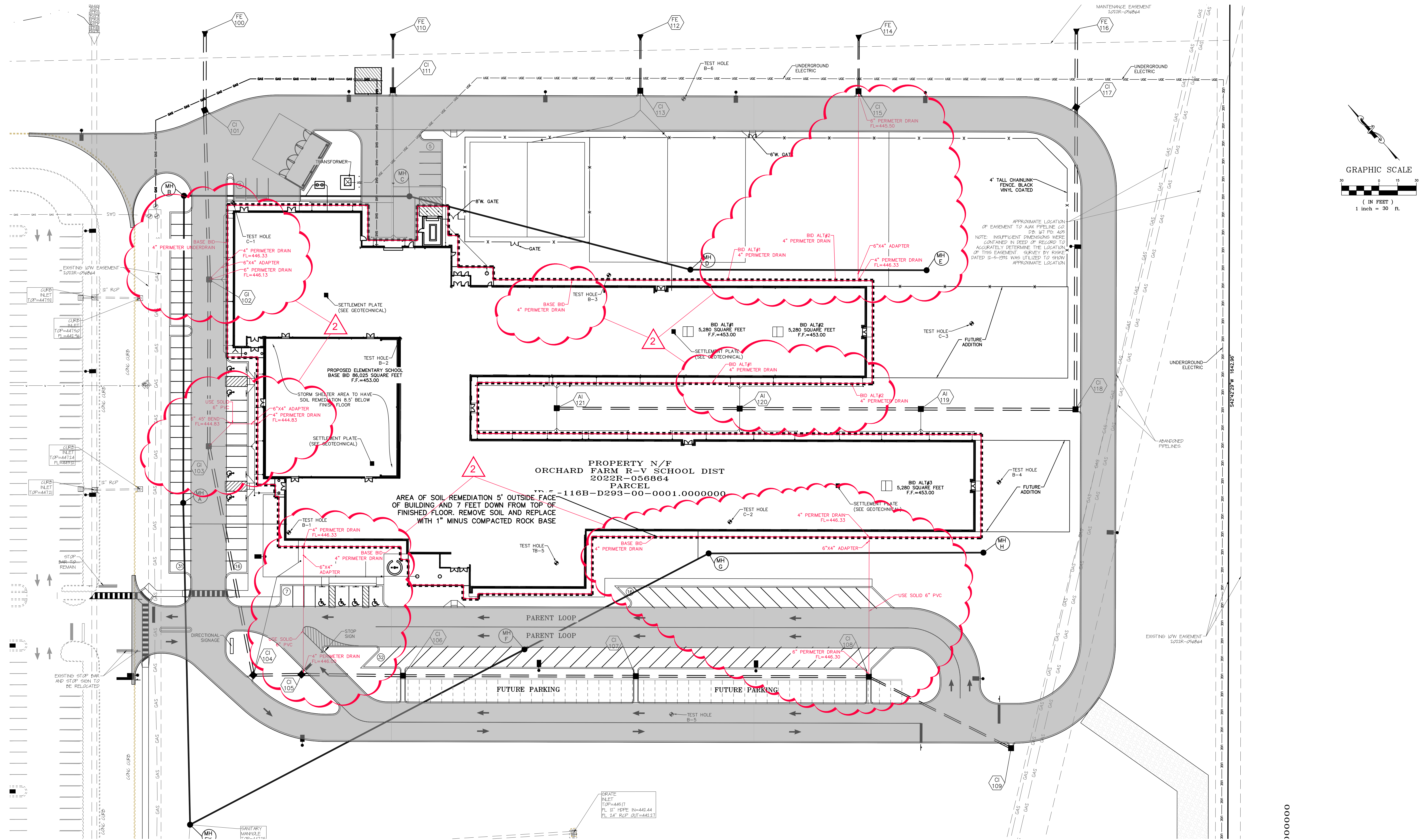
CHECKED BY CV

SHEET NO.

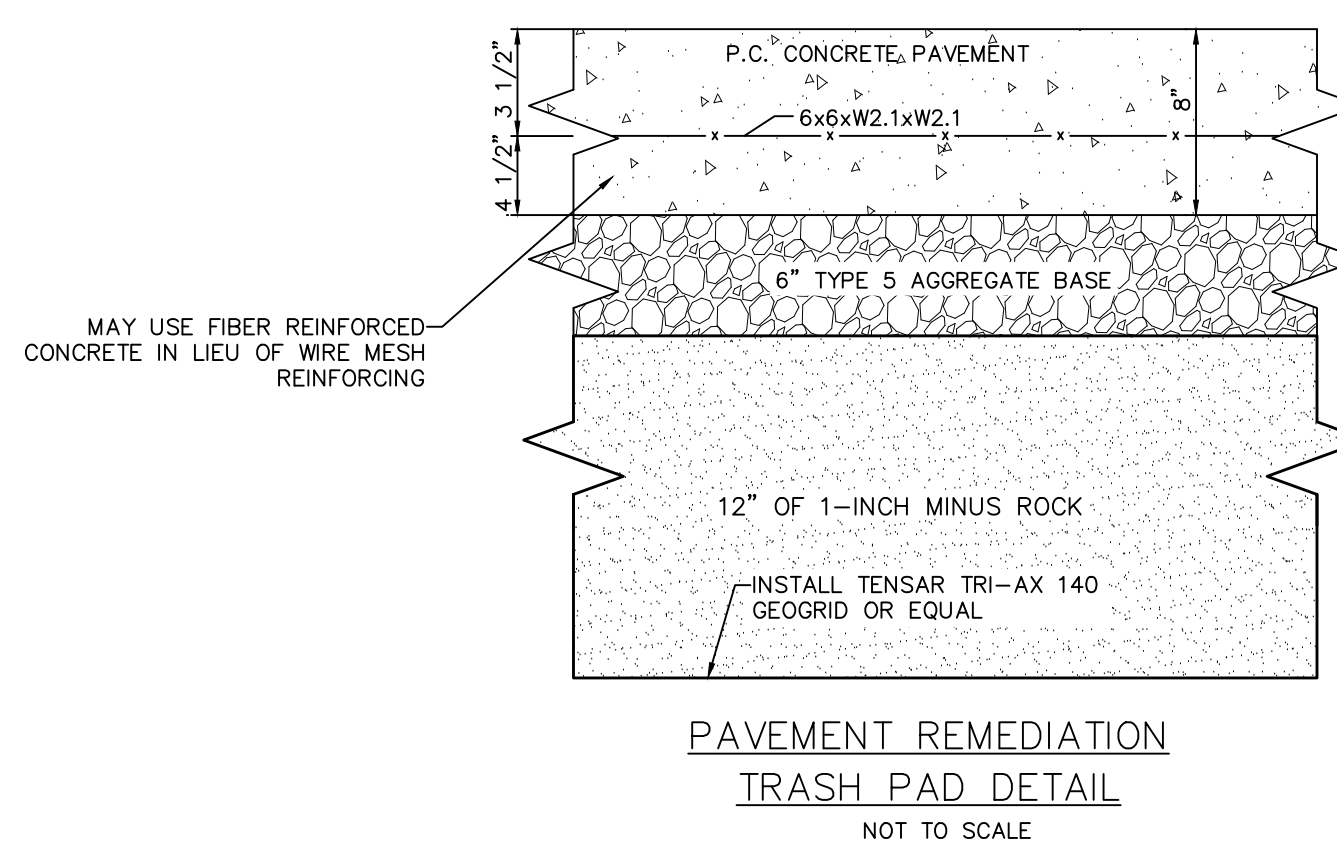
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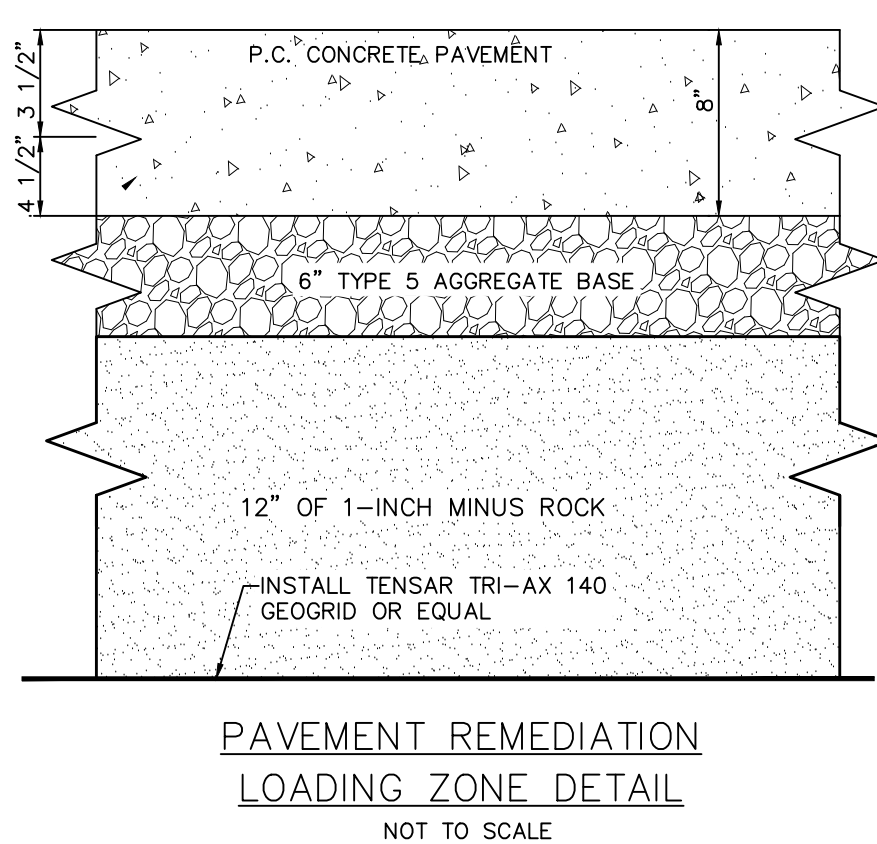




HEAVY DUTY PAVEMENT REMEDIATION DETAIL  
NOT TO SCALE



PAVEMENT REMEDIATION  
TRASH PAD DETAIL  
NOT TO SCALE



PAVEMENT REMEDIATION  
LOADING ZONE DETAIL  
NOT TO SCALE

- FIBER REINFORCED CONCRETE (USE AT TRASH PAD LOCATION IF NOT USING A WIRE MESH REINFORCEMENT)
- A. All material shall be in accordance with Modot Standard Specifications Division 1000, Material Details, unless otherwise noted.
1. Fibers: Fibrillated polypropylene fibers shall be added at a rate of one and a half (1.5) pounds per cubic yard. All fibers shall be measurable by weight. Fibers may be measured in bags, boxes or like containers with approval from the Owner. The containers shall be sealed by the fiber manufacturer, and shall have the weight contained therein clearly marked by the manufacturer. No fraction of container delivered unused or left over from previous work shall be used unless weighed. Fibers shall be added to the concrete mix and mixed according to the fiber manufacturer's recommendations.
2. Water-Reducers: An approved high range water-reducer admixture may be used. When a high range water-reducing admixture is used, the slump of the concrete, achieved with water, shall not exceed three (3) inches before the admixture is added to the concrete. After it is added to the concrete, slump may be a maximum of six (6) inches at the time of placement.
3. Other admixtures may be used only with the approval by Engineer.
- B. Mix Design:
1. Mix Approval: The Contractor shall submit a proposed mix design to the Owner for review and approval. The mix design shall be in accordance with the requirements of Modot Standard Specifications Section 501. The mixture shall be designed to develop a minimum strength of 4000 psi.
2. Admixtures: Any admixtures used shall be certified by the fiber manufacturer for compatibility with the fibers used in the concrete.
3. Mix Adjustments: The Contractor shall not make any mix design changes during placement of the UTW pavement without prior approval by Engineer.



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CLIFFORD L. HEITMANN  
LICENSE #E-2987  
ENGINEERING CORP.  
NO. 000655

NEW ELEMENTARY SCHOOL - 2525 HWY B

ORCHARD FARM SCHOOL DISTRICT  
HOENER ASSOCIATES, INC. - ARCHITECTS  
30707  
ST. LOUIS, MISSOURI 63109  
OFFICE: 314.781.9955  
HoenerArchitects.com

CONSULTING ENGINEERS:  
ENGINEERING  
ARCHITECTS  
MECHANICAL  
ELECTRICAL  
PLUMB  
FOUNDATION  
SOILS & FOUNDATIONS

PROJECT MANAGER:  
EDIT PER PROJECT

ST. CHARLES, MISSOURI

PROJ. NO. 23-09B

DATE ISSUED  
7-2-24

DATE REVISED

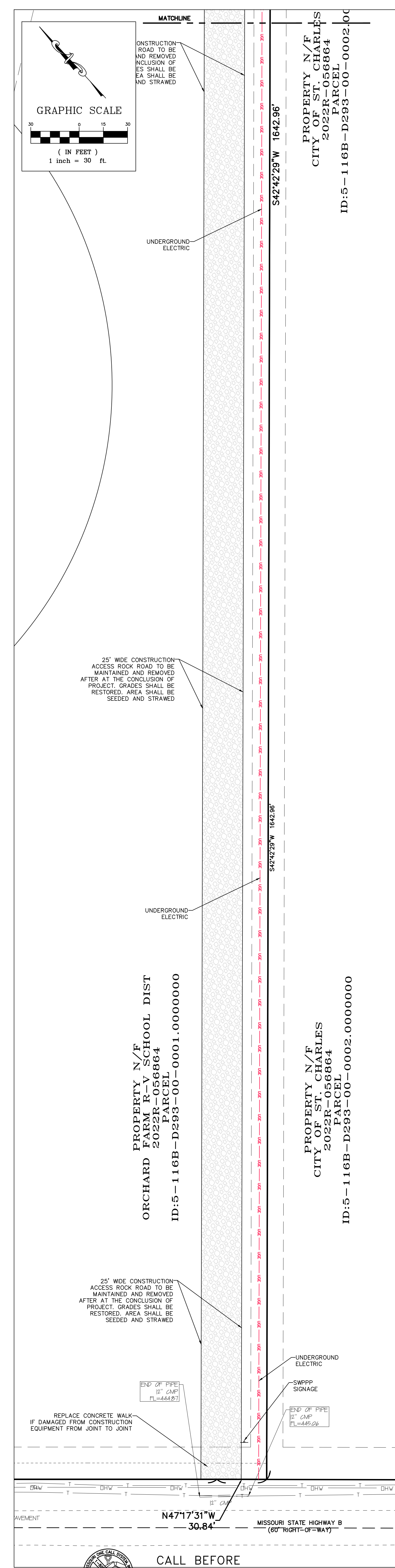
1 7-23-24 ADDENDUM 1  
2 8-01-24 ADDENDUM 2

DRAWN BY: SWR  
CHECKED BY: CLH  
SHEET NO.

C3.00  
SD-73

REMEDATION PLAN



[illegible]

REFER TO ELECTRICAL AND PLUMBING PLANS PROVIDED IN THE BID SET FOR FURTHER INSTRUCTIONS AS REQUIRED FOR SITE UTILITY INSTALLATIONS.

PROPERTY N/F  
CITY OF ST. CHARLES  
2022R-056864  
PARCEL  
ID: 5-116R-D293-00-0003 00000000

UTILITY PLAN

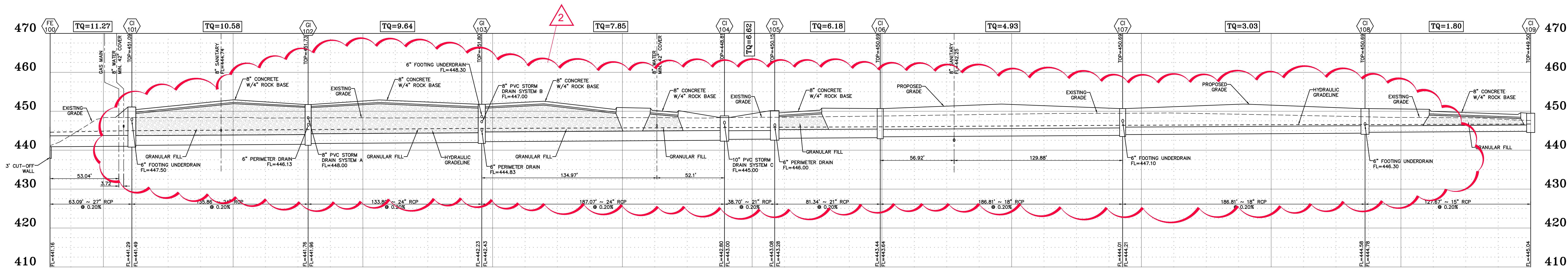
|                     |         |            |
|---------------------|---------|------------|
| CONTRACT NO. 23-09B |         |            |
| DATE ISSUED         |         |            |
| 7-2-24              |         |            |
| DATE REVISED        |         |            |
| 1                   | 7-23-24 | ADDENDUM 1 |
| 2                   | 8-01-24 | ADDENDUM 2 |

|   |         |            |
|---|---------|------------|
| 1 | 7-23-24 | ADDENDUM 1 |
| 2 | 8-01-24 | ADDENDUM 2 |

C3.20  
SD-74

UTILITY PLAN



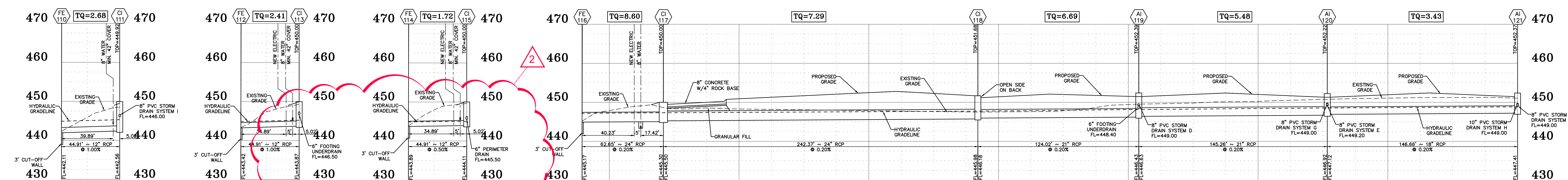


STORM PROFILE

HORIZONTAL SCALE: 1"=30'

VERTICAL SCALE: 1"=10'

FOR ALL SEWERS WITH A DESIGN GRADE OF LESS THAN 1% SLOPES SHALL BE VERIFIED PRIOR TO SURFACE RESTORATION



STORM PROFILE

HORIZONTAL SCALE: 1"=30'

VERTICAL SCALE: 1"=10'

STORM PROFILE

HORIZONTAL SCALE: 1"=30'

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STORM PROFILE

HORIZONTAL SCALE: 1"=30'

VERTICAL SCALE: 1"=10'

FOR ALL SEWERS WITH A DESIGN GRADE OF LESS THAN 1% SLOPES SHALL BE VERIFIED PRIOR TO SURFACE RESTORATION

| St Charles County Government<br>Hydraulic Review Output Data |         |       |     |           |           |        |          |             |           | \\VAULTSERVER\FileFolders\17000\17453D OFSD Elementary\Engineering\Hydraulics\17453D_HYDRAULIC_ANALYSIS.txt<br>7/1/2024<br>Calculations Under Full Flow |            |         |      |          |           |           |            |           |         |         |      |      |       |          |                           |
|--------------------------------------------------------------|---------|-------|-----|-----------|-----------|--------|----------|-------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|------|----------|-----------|-----------|------------|-----------|---------|---------|------|------|-------|----------|---------------------------|
| Upp Str                                                      | Low Str | PL    | S   | Upp FL LN | Low FL LN | PS     | Upp STEL | Depth HY GR | Upp HY EL | Low HY EL                                                                                                                                               | Hydr Grade | FR Head | VEL  | VEL Head | Junc Loss | Turn Loss | Curve Loss | STR Grade | Int Cap | DR Area | P.I. | Q    | TQ    | Pipe Cap | Remarks                   |
| 1                                                            | AI121   | AI120 | 147 | 18        | 447.41    | 447.12 | 0.20     | 452.37      | 3.53      | 448.84                                                                                                                                                  | 448.62     | 0.00110 | 0.16 | 1.94     | 0.06      | 0.06      | 0.00       | 0.00      |         |         |      | 3.43 | 3.43  | 4.70     |                           |
| 2                                                            | AI120   | AI119 | 145 | 21        | 446.92    | 446.63 | 0.20     | 452.22      | 3.67      | 448.55                                                                                                                                                  | 448.38     | 0.00120 | 0.17 | 2.28     | 0.08      | 0.00      | 0.00       | 0.00      |         |         |      | 2.05 | 5.48  | 7.09     |                           |
| 3                                                            | AI119   | CI118 | 124 | 21        | 446.43    | 446.18 | 0.20     | 452.39      | 4.24      | 448.15                                                                                                                                                  | 447.93     | 0.00180 | 0.22 | 2.78     | 0.12      | 0.00      | 0.00       | 0.00      |         |         |      | 1.21 | 6.69  | 7.09     |                           |
| 4                                                            | CI118   | CI117 | 242 | 24        | 445.98    | 445.50 | 0.20     | 451.68      | 3.94      | 447.74                                                                                                                                                  | 447.50     | 0.00100 | 0.24 | 2.32     | 0.08      | 0.00      | 0.00       | 0.00      |         |         |      | 0.60 | 7.29  | 10.12    |                           |
| 5                                                            | CI117   | FE116 | 63  | 24        | 445.30    | 445.17 | 0.21     | 450.00      | 2.68      | 447.32                                                                                                                                                  | 447.17     | 0.00140 | 0.09 | 2.74     | 0.12      | 0.00      | 0.06       | 0.00      |         |         |      | 1.31 | 8.60  | 10.37    | HW=447.17 (ITP)           |
| 6                                                            | CI109   | CI108 | 129 | 15        | 445.04    | 444.78 | 0.20     | 449.50      | 2.78      | 446.72                                                                                                                                                  | 446.59     | 0.00080 | 0.10 | 1.47     | 0.03      | 0.03      | 0.00       | 0.00      |         |         |      | 1.80 | 1.80  | 2.89     |                           |
| 7                                                            | CI108   | CI107 | 187 | 18        | 444.58    | 444.21 | 0.20     | 450.69      | 4.10      | 446.59                                                                                                                                                  | 446.44     | 0.00080 | 0.15 | 1.71     | 0.05      | 0.00      | 0.00       | 0.00      |         |         |      | 1.23 | 3.03  | 4.70     |                           |
| 8                                                            | CI107   | CI106 | 187 | 18        | 444.04    | 443.64 | 0.21     | 450.69      | 4.25      | 446.44                                                                                                                                                  | 446.01     | 0.00220 | 0.41 | 2.79     | 0.12      | 0.00      | 0.02       | 0.00      |         |         |      | 1.90 | 4.93  | 4.81     |                           |
| 9                                                            | CI106   | CI105 | 81  | 21        | 443.44    | 443.28 | 0.20     | 450.69      | 4.68      | 446.01                                                                                                                                                  | 445.89     | 0.00150 | 0.12 | 2.57     | 0.10      | 0.00      | 0.00       | 0.00      |         |         |      | 1.25 | 6.18  | 7.09     |                           |
| 10                                                           | CI105   | CI104 | 39  | 21        | 443.08    | 443.00 | 0.21     | 450.15      | 4.26      | 445.89                                                                                                                                                  | 445.82     | 0.00170 | 0.07 | 2.75     | 0.12      | 0.00      | 0.00       | 0.00      |         |         |      | 0.44 | 6.62  | 7.26     |                           |
| 11                                                           | CI104   | GI103 | 187 | 24        | 442.80    | 442.43 | 0.20     | 447.81      | 1.99      | 445.82                                                                                                                                                  | 445.60     | 0.00120 | 0.22 | 2.50     | 0.10      | 0.00      | 0.00       | 0.00      |         |         |      | 1.23 | 7.85  | 10.12    |                           |
| 12                                                           | GI103   | GI102 | 134 | 24        | 442.23    | 441.96 | 0.20     | 451.80      | 6.20      | 445.60                                                                                                                                                  | 445.29     | 0.00180 | 0.24 | 3.07     | 0.15      | 0.00      | 0.07       | 0.00      |         |         |      | 1.79 | 9.64  | 10.12    |                           |
| 13                                                           | GI102   | CI101 | 136 | 24        | 441.76    | 441.49 | 0.20     | 452.23      | 6.94      | 445.29                                                                                                                                                  | 444.97     | 0.00220 | 0.30 | 3.37     | 0.18      | 0.00      | 0.02       | 0.00      |         |         |      | 0.94 | 10.58 | 10.12    |                           |
| 14                                                           | CI101   | FE100 | 63  | 27        | 441.29    | 441.16 | 0.21     | 451.09      | 6.12      | 444.97                                                                                                                                                  | 444.89     | 0.00130 | 0.08 | 2.83     | 0.12      | 0.00      | 0.00       | 0.00      |         |         |      | 0.69 | 11.27 | 14.19    | HW=444.89 Emergency Storm |
| 15                                                           | CI115   | FE114 | 35  | 12        | 444.11    | 443.89 | 0.63     | 450.00      | 4.96      | 445.04                                                                                                                                                  | 444.89     | 0.00230 | 0.08 | 2.19     | 0.07      | 0.07      | 0.00       | 0.00      |         |         |      | 1.72 | 1.72  | 2.83     | HW= 444.89 ITP/Emergency  |
| 16                                                           | CI113   | FE112 | 35  | 12        | 443.87    | 443.42 | 1.29     | 450.00      | 4.80      | 445.20                                                                                                                                                  | 444.89     | 0.00460 | 0.16 | 3.07     | 0.15      | 0.15      | 0.00       | 0.00      |         |         |      | 2.41 | 2.41  | 4.05     | HW=444.89 Emergency Storm |
| 17                                                           | CI111   | FE110 | 40  | 12        | 442.56    | 442.11 | 1.13     | 449.92      | 4.62      | 445.30                                                                                                                                                  | 444.89     | 0.00570 | 0.23 | 3.41     | 0.18      | 0.18      | 0.00       | 0.00      |         |         |      | 2.68 | 2.68  | 3.79     | HW=444.89 Emergency Storm |



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CLIFFORD L. HEITMANN  
LICENSE #E-29817  
ENGINEERING CORP.  
NO. 000655

ST. CHARLES, MISSOURI

NEW ELEMENTARY SCHOOL - 2525 HWY B

PROJECT MANAGER:  
EDIT PER PROJECT

CONSULTING ENGINEERS:  
ARCHITECTS  
ENGINEERING  
SURVEYING  
ELECTRICAL  
PLUMBING  
MECHANICAL  
P.O. BOX 1000  
ST. CHARLES, MO 63301

ORCHARD FARM SCHOOL DISTRICT  
HOENER ASSOCIATES, INC. - ARCHITECTS  
707 S. MAIN ST.  
ST. LOUIS, MISSOURI 63109  
OFFICE: 314.781.9955



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PROJ. NO. 23-09B

DATE ISSUED

7-2-24

DATE REVISED

1 7-23-24 ADDENDUM 1

2 8-01-24 ADDENDUM 2

DRAWN BY SWR

CHECKED BY CLH

SHEET NO.

C6.00  
SD-75

STORM SEWER AND WATER LINE PROFILES



| LIGHTING CONTROL MATRIX                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               |            |            |              |         |                      |                    |        |           |          |                        |           |            |        |         |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------|--------------------|----------------------------|------------------------|------------------------|---------------------------|-------------|---------------|---------------|-----------------|---------------|------------|------------|--------------|---------|----------------------|--------------------|--------|-----------|----------|------------------------|-----------|------------|--------|---------|---------|-----------------|----------------|---------------|----|-----|----------|--------------------------------------------------------------------------------------------------------------------------------------|--|--|--|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MANUAL ON        | AUTO ON | AUTO-OFF (MINUTES) | PARTIAL OFF - NORMAL HOURS | AUTO OFF - AFTER HOURS | WALL OCCUPANCY/VACANCY | CEILING OCCUPANCY/VACANCY | WALL SWITCH | DIMMER SWITCH | SCENE CONTROL | OVERRIDE SWITCH | DIGITAL TIMER | FULL RANGE | MULTI-ZONE | STEP DIMMING | NON-DIM | DAY LIGHT HARVESTING | CONTINUOUS DIMMING | ON/OFF | TIME ON   | TIME OFF | ASTRONOMICAL           | PLUG LOAD | STANDALONE | ANALOG | NETWORK | DIGITAL | BAS INTEGRATION | AV INTEGRATION | SHADE CONTROL | ON | OFF | OVERRIDE |                                                                                                                                      |  |  |  |
| ROOM TYPE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | OCCUPANCY SENSOR |         |                    | CONTROL INTERFACE          |                        |                        | DIMMING TYPE              |             |               | DAY LIGHT CTL |                 | TIME CONTROL  |            |            | SYSTEM       |         |                      |                    |        | PHOTOCELL |          | ADDITIONAL INFORMATION |           |            |        |         |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| CORRIDORS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |         |                    |                            |                        |                        | 100 %                     |             |               |               |                 |               |            |            |              | X       |                      |                    |        | X         | X        | X                      |           |            |        | X       |         |                 |                |               |    |     |          | TIMECLOCK CONTROLLED. SWITCH OVERRIDE TO ACTIVATE 100% AFTER HOURS WITH 60 MINUTE TIME DELAY.                                        |  |  |  |
| KITCHEN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | X                |         |                    |                            |                        |                        |                           | X           |               |               |                 |               |            |            |              |         |                      |                    |        |           |          |                        |           | X          |        |         |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| STORAGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  | X       | 10 MIN.            |                            |                        | X                      |                           | X           |               |               |                 |               |            |            |              | X       |                      |                    |        |           |          |                        |           | X          |        |         |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| LIBRARY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | X                |         |                    |                            |                        |                        |                           |             | X             | X             | 100 %           |               | X          | X          |              |         |                      |                    |        |           | X        | X                      |           |            |        | X       |         | X               |                |               |    |     |          | TIMECLOCK CONTROLLED TO SWEEP LIGHTS AT TIME SPECIFIED BY OWNER. SWITCH OVERRIDE TO ACTIVATE 100% AFTER HOURS WITH 60 MINUTE TIME... |  |  |  |
| CAFETERIA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |         | 20 MIN.            | 10 MIN.                    |                        |                        |                           | X           | X             | 100 %         |                 | X             | X          |            |              |         |                      |                    |        | X         | X        | X                      |           |            |        | X       |         | X               |                |               |    |     |          | TIMECLOCK CONTROLLED TO SWEEP LIGHTS AT TIME SPECIFIED BY OWNER. SWITCH OVERRIDE TO ACTIVATE 100% AFTER HOURS WITH 60 MINUTE TIME... |  |  |  |
| GYM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | X                |         | 20 MIN.            |                            |                        |                        |                           |             | X             | X             |                 |               | X          | X          |              |         |                      |                    |        |           | X        | X                      |           |            |        | X       |         | X               |                |               |    |     |          |                                                                                                                                      |  |  |  |
| MUSIC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | X                |         | 20 MIN.            |                            |                        |                        |                           | X           | X             | X             |                 |               | X          | X          |              |         |                      |                    |        |           |          |                        |           |            |        | X       |         | X               |                |               |    |     |          |                                                                                                                                      |  |  |  |
| OFFICE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  | X       | 20 MIN.            |                            |                        | X                      |                           |             | X             |               |                 |               | X          |            |              |         |                      |                    |        |           |          |                        |           | X          |        |         |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| CLASSROOMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | X                |         | 20 MIN.            |                            |                        |                        |                           | X           | X             | X             |                 |               | X          | X          |              |         |                      |                    |        |           |          |                        |           | X          |        |         |         | X               |                |               |    |     |          |                                                                                                                                      |  |  |  |
| LAB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | X                |         | 20 MIN.            |                            |                        |                        |                           | X           | X             | X             |                 |               | X          | X          |              |         |                      |                    |        |           |          |                        |           |            |        | X       |         | X               |                |               |    |     |          |                                                                                                                                      |  |  |  |
| TECH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | X                |         | 20 MIN.            |                            |                        |                        |                           | X           | X             | X             |                 |               | X          | X          |              |         |                      |                    |        |           |          |                        |           |            |        | X       |         | X               |                |               |    |     |          |                                                                                                                                      |  |  |  |
| SMALL RESTROOM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  | X       | 20 MIN.            |                            |                        | X                      |                           | X           |               |               |                 |               |            |            |              | X       |                      |                    |        |           |          |                        |           | X          |        |         |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| LARGE RESTROOM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  | X       | 20 MIN.            |                            |                        |                        |                           | X           | X             |               |                 |               |            |            |              | X       |                      |                    |        |           |          |                        |           | X          |        |         |         |                 |                |               |    |     |          | HANDWASHING STATION TO BE CONTROLLED WITH CORRIDOR LIGHTING. LIGHTING IN TOILET AREAS TO BE OCCUPANCY SENSOR CONTROLLED.             |  |  |  |
| FAÇADE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               |            |            |              | X       |                      |                    |        | DUSK      | DAWN     | X                      |           |            |        | X       |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| CONFERENCE ROOM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | X                |         | 20 MIN.            |                            |                        |                        |                           | X           |               | X             |                 |               | X          | X          |              |         |                      |                    |        |           |          |                        |           | X          |        |         |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| VESTIBULE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | X                |         |                    |                            |                        |                        |                           |             |               |               | 100 %           |               |            |            |              |         | X                    |                    |        | X         | X        | X                      |           |            |        | X       |         |                 |                |               |    |     |          | TIMECLOCK CONTROLLED. SWITCH OVERRIDE TO ACTIVATE 100% AFTER HOURS WITH 60 MINUTE TIME DELAY.                                        |  |  |  |
| LOBBY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | X                |         |                    |                            |                        |                        |                           |             |               |               | 100 %           |               |            |            |              |         | X                    |                    |        | X         | X        | X                      |           |            |        | X       |         |                 |                |               |    |     |          | TIMECLOCK CONTROLLED. SWITCH OVERRIDE TO ACTIVATE 100% AFTER HOURS WITH 60 MINUTE TIME DELAY.                                        |  |  |  |
| ELECTRICAL / GENERATOR ENCLOSURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | X                |         |                    |                            |                        |                        |                           |             |               |               |                 |               |            |            |              | X       |                      |                    |        |           |          |                        |           |            |        |         |         |                 |                |               |    |     |          | SWITCH ONLY - SAFETY PRECAUTION                                                                                                      |  |  |  |
| MECHANICAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | X                |         |                    |                            |                        |                        |                           |             |               |               |                 | X             |            |            |              |         |                      |                    |        |           |          |                        |           |            |        |         |         |                 |                |               |    |     |          | 12 HOUR DIGITAL TIMER - SET FOR 1 HOUR STANDARD WITH BLINK WARNINGS SET FOR 2MIN. AND 1 MIN.                                         |  |  |  |
| DATAMDF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | X                |         |                    |                            |                        |                        |                           |             |               |               |                 |               |            |            |              |         |                      |                    |        |           |          |                        |           |            |        |         |         |                 |                |               |    |     |          | SWITCH ONLY - SAFETY PRECAUTION                                                                                                      |  |  |  |
| EXTERIOR PARKING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               |            |            | X            |         |                      |                    |        | DUSK      | DAWN     | X                      |           |            |        | X       |         |                 |                |               |    |     |          | LIGHTING SHALL BE DIMMED TO 50% BETWEEN THE HOURS OF 12AM - 6AM                                                                      |  |  |  |
| EXTERIOR FLAGPOLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               |            | X          |              |         |                      |                    |        | DUSK      | DAWN     | X                      |           |            |        | X       |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| EXTERIOR SIGNAGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               | X          |            |              |         |                      |                    |        | DUSK      | DAWN     | X                      |           |            |        | X       |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| EXTERIOR DOWNLIGHTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               | X          |            |              |         |                      |                    |        | DUSK      | DAWN     | X                      |           |            |        | X       |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| EXTERIOR WALLPACKS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               | X          |            |              |         |                      |                    |        | DUSK      | DAWN     | X                      |           |            |        | X       |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| EAGLE SIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               |            |            | X            |         |                      |                    |        | DUSK      | DAWN     | X                      |           |            |        | X       |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |
| GENERAL NOTES:<br>1. CONTROL DEVICE QUANTITIES SHOULD BE SELECTED FROM THE ELECTRICAL DRAWINGS, NOT THIS SPREADSHEET.<br>2. NETWORKING REQUIREMENTS TO BE DETERMINED BY EACH MANUFACTURER. SEE NETWORK COLUMN ABOVE. ALL AREAS DENOTED AS NETWORK SHALL BE CONNECTED TO LIGHTING CONTROL SYSTEM HEADEND ALLOWING FOR TIME BASED CONTROL NEEDS AND BAS INTEGRATION.<br>3. LIGHTING CONTROL MANUFACTURER SHALL INCLUDE THE FOLLOWING SITE VISITS TO SUPPORT CONSTRUCTION: A PRE-CABLING MEETING WITH EC AND ENGINEER PRIOR TO INITIAL ROUGH-IN, 2 FACTORY STARTUPS TO COINCIDE WITH PROJECT PHASING (IF APPLICABLE).<br>4. LIGHTING CONTROL MANUFACTURER SHALL INCLUDE 1HR OWNER TRAINING DURING EACH STARTUP VISIT.<br>5. LIGHTING CONTROLS MANUFACTURER SHALL INCLUDE A FOLLOW UP VISIT 3 MONTHS AFTER FINAL OCCUPANCY TO ADDRESS FINAL PUNCHLIST AND COMMISSIONING REPORT NEEDS. NOTICE SHALL BE GIVEN TO ENGINEER FOR SCHEDULING OF FOLLOW UP VISIT..... |                  |         |                    |                            |                        |                        |                           |             |               |               |                 |               |            |            |              |         |                      |                    |        |           |          |                        |           |            |        |         |         |                 |                |               |    |     |          |                                                                                                                                      |  |  |  |

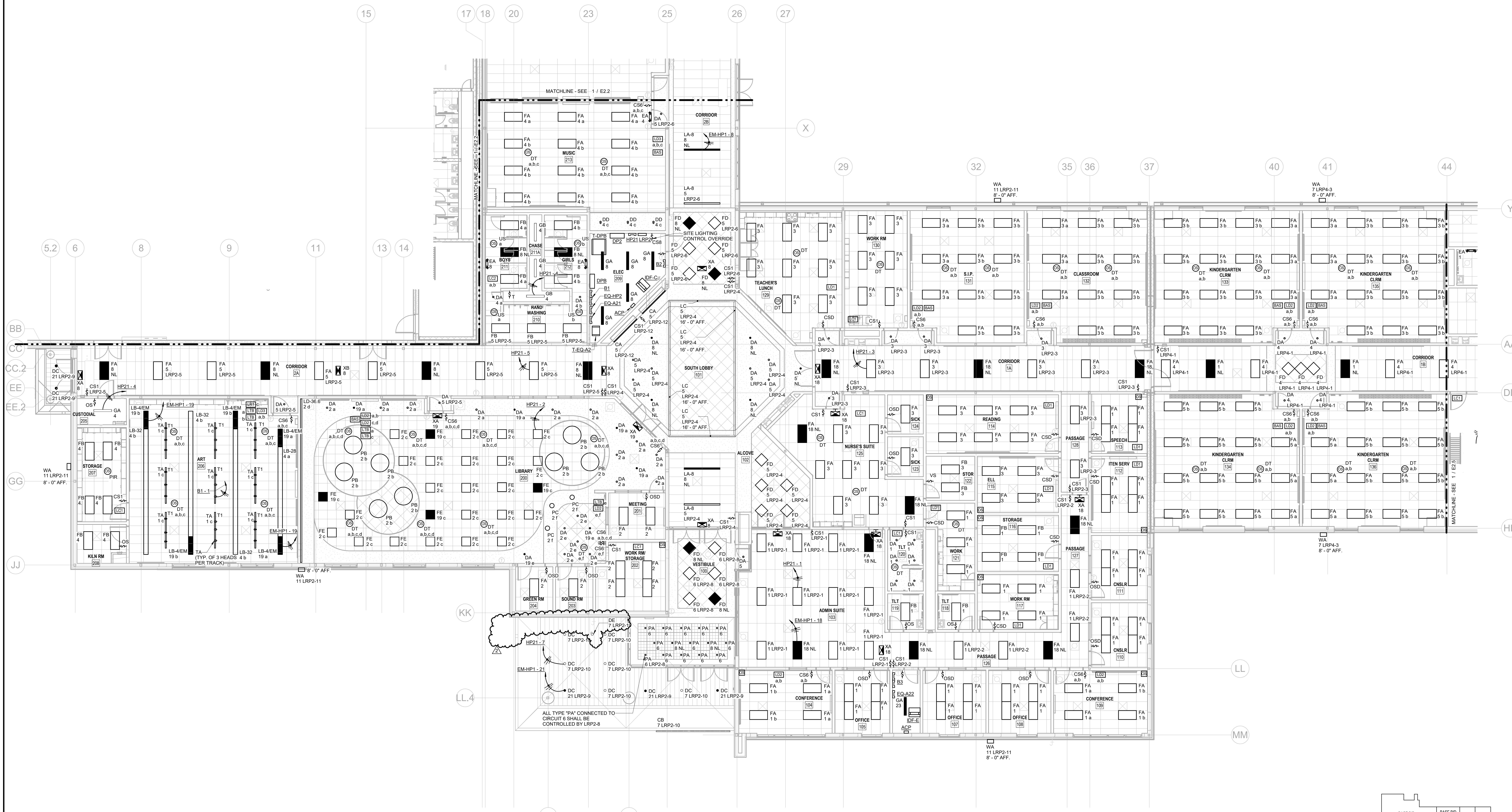
| LIGHTING CONTROL - RELAY PANEL SCHEDULE                                                                                                                                                                                                                                                                                                                                                                                        |              |            |                |                                             |            |                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------|----------------|---------------------------------------------|------------|-----------------------|
| RELAY PANEL...                                                                                                                                                                                                                                                                                                                                                                                                                 | RELAY NUMBER | PANEL NAME | CIRCUIT NUMBER | SPACE TYPE/ CONTROL DESCRIPTION             | RELAY TYPE | CONTROL LOCATION      |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R1           | MP1        | 1              | NORTH LOBBY 400                             | 277V, 1P   | WALL STATION OVERRIDE |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R2           | MP1        | 1              | NORTH CORRIDOR 2A                           | 277V, 1P   | WALL STATION OVERRIDE |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R3           | EM-HP1     | 17             | VESTIBULE 322                               | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R4           | EM-HP1     | 17             | GYM/CAFETERIA CANOPY                        | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R5           | MP1        | 35             | VESTIBULE 401                               | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R6           | EM-HP1     | 15             | VESTIBULE 401                               | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R7           | MP1        | 35             | NORTH MAIN CANOPY                           | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R8           | EM-HP1     | 15             | NORTH MAIN CANOPY                           | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R9           | MP1        | 31             | SITE POLES - DRIVE                          | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R10          | MP1        |                | SITE POLES - DRIVE                          | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R11          | MP1        | 33             | SITE POLES - DRIVE                          | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R12          | MP1        |                | SITE POLES - DRIVE                          | 277V, 1P   | ELECTRICAL ROOM #307  |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R13          | MP1        | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R14          | MP1        | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R15          | MP1        | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP1                                                                                                                                                                                                                                                                                                                                                                                                                           | R16          | MP1        | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R1           | HP21       | 1              | ADMIN SUITE 103                             | 277V, 1P   | WALL STATION OVERRIDE |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R2           | HP21       | 1              | PASSAGE 126 AND 127                         | 277V, 1P   | WALL STATION OVERRIDE |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R3           | HP21       | 3              | CORRIDOR 1A / PASSAGE 128                   | 277V, 1P   | WALL STATION OVERRIDE |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R4           | HP21       | 5              | SOUTH LOBBY 101 / ALCOVE 102                | 277V, 1P   | WALL STATION OVERRIDE |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R5           | HP21       | 5              | SOUTH CORRIDOR 2A                           | 277V, 1P   | WALL STATION OVERRIDE |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R6           | HP21       | 5              | CORRIDOR 2B                                 | 277V, 1P   | WALL STATION OVERRIDE |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R7           | EM-HP1     | 8              | VESTIBULE 100                               | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R8           | HP21       | 6              | VESTIBULE 100                               | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R9           | EM-HP1     | 6              | SOUTH MAIN CANOPY                           | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R10          | HP21       | 6              | SOUTH MAIN CANOPY                           | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R11          | HP21       | 11             | SOUTH WALLPACKS                             | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R12          | HP21       | 5              | SOUTH LOBBY DISPLAY CASE                    | 277V, 1P   | WALL STATION OVERRIDE |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R13          | HP21       | 9              | FLAG POLE LIGHTS                            | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R14          | HP21       | 8              | NORTH WALLPACKS                             | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R15          | HP21       | 12             | SITE POLES - PARKING                        | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R16          | HP21       |                | SITE POLES - PARKING                        | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R17          | HP21       | 14             | SITE POLES - PARKING                        | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R18          | HP21       | 13             | INTERNALLY LIT SCHOOL LOGO (VERIFY EXACT... | 277V, 1P   | ELECTRICAL ROOM #209  |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R19          | HP21       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R20          | HP21       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R21          | HP21       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R22          | HP21       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R23          | HP21       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP2                                                                                                                                                                                                                                                                                                                                                                                                                           | R24          | HP21       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP3                                                                                                                                                                                                                                                                                                                                                                                                                           | R1           | HP12       | 1              | CORRIDOR 4A                                 | 277V, 1P   | WALL STATION OVERRIDE |
| LRP3                                                                                                                                                                                                                                                                                                                                                                                                                           | R2           | EM-HP2     | 11             | NORTH WING ENTRANCE DOWNLIGHTS              | 277V, 1P   | ELECTRICAL ROOM #425  |
| LRP3                                                                                                                                                                                                                                                                                                                                                                                                                           | R3           | HP12       | 4              | NORTH WING WALLPACKS                        | 277V, 1P   | ELECTRICAL ROOM #425  |
| LRP3                                                                                                                                                                                                                                                                                                                                                                                                                           | R4           | HP12       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP3                                                                                                                                                                                                                                                                                                                                                                                                                           | R5           | HP12       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP3                                                                                                                                                                                                                                                                                                                                                                                                                           | R6           | HP12       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP3                                                                                                                                                                                                                                                                                                                                                                                                                           | R7           | HP12       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP3                                                                                                                                                                                                                                                                                                                                                                                                                           | R8           | HP12       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP4                                                                                                                                                                                                                                                                                                                                                                                                                           | R1           | HP22       | 4              | CORRIDOR 1B                                 | 277V, 1P   | WALL STATION OVERRIDE |
| LRP4                                                                                                                                                                                                                                                                                                                                                                                                                           | R2           | EM-HP3     | 3              | SOUTH WING ENTRANCE DOWNLIGHTS              | 277V, 1P   | ELECTRICAL ROOM #143  |
| LRP4                                                                                                                                                                                                                                                                                                                                                                                                                           | R3           | HP22       | 7              | SOUTH WING WALLPACKS                        | 277V, 1P   | ELECTRICAL ROOM #143  |
| LRP4                                                                                                                                                                                                                                                                                                                                                                                                                           | R4           | HP22       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP4                                                                                                                                                                                                                                                                                                                                                                                                                           | R5           | HP22       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP4                                                                                                                                                                                                                                                                                                                                                                                                                           | R6           | HP22       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP4                                                                                                                                                                                                                                                                                                                                                                                                                           | R7           | HP22       | #              | SPARE                                       | 277V, 1P   | --                    |
| LRP4                                                                                                                                                                                                                                                                                                                                                                                                                           | R8           | HP22       | #              | SPARE                                       | 277V, 1P   | --                    |
| GENERAL NOTES:<br>LIGHTING SHALL TURN ON AT 6 AM AND OFF AT 6 PM MON-FRI. SWITCH OVERRIDE AFTER HOURS TO TURN ON. TURN OFF AFTER 2 HRS. BLINK WARN ENABLED. NETWORK LIGHTING LOAD CONTROLLERS TO RELAY PANEL AS NECESSARY FOR TIME FUNCTIONS. PROVIDE LIGHTING CONTROLLER NETWORKED TO LOCAL LIGHTING RELAY PANEL. COORDINATE FINAL PROGRAMMING WITH ENGINEER AND OWNER. REFER TO LIGHTING PLANS FOR LOCATION OF RELAY PANELS. |              |            |                |                                             |            |                       |
| NOTES:<br>1. THROUGH THE USE OF DUAL RELAYS, SITE POLES SHALL REDUCE TO 50% OUTPUT AFTER HOURS.<br>2. SHADED EMERGENCY LIGHTING SHALL TRANSFER THROUGH EMERGENCY BYPASS.                                                                                                                                                                                                                                                       |              |            |                |                                             |            |                       |

| LUMINAIRE SCHEDULE                                                                                                                                                                                                                                                                                                                                             |                    |                                                     |                                                                                  |                                                       |          |              |       |     |              |                                    |                                                                                                                                                                                                                                                  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------|----------|--------------|-------|-----|--------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| TYPE                                                                                                                                                                                                                                                                                                                                                           | MANUFACTURER       | MODEL NUMBER                                        | APPROVED EQUALS                                                                  | DESCRIPTION                                           | VOLTAGE  | WATTAGE      | CCT   | CRI | DIMMING TYPE | MOUNTING                           | REMARKS                                                                                                                                                                                                                                          |  |  |
| CA                                                                                                                                                                                                                                                                                                                                                             | LED LINEAR         | XOOLINE-HYD-HD25-W9-35-X00X-OL-CL45-IP40            | LUMINI                                                                           | LINEAR ACCENT IN 45 DEGREE CHANNEL                    | 24V/ 277 | 7.6W/ FT     | 3500K | 90+ | 0-10V TO 10% | DISPLAY CASE                       | NO HOTPOTS OR LED DIODES SHALL BE VISIBLE. PROVIDE WITH DIMMING DRIVER IN ACCESSIBLE LOCATION. ALL REQUIRED CABLES FOR FULL OPERATION.                                                                                                           |  |  |
| CB                                                                                                                                                                                                                                                                                                                                                             | LUMENPULSE         | LOGN-7W-48V-XX-40K-80-WW-HFR-WAMN2-BRZ-UCTL         | EQUALS SHALL BE COORDINATED WITH ARCHITECT/ENGINEER PER APPROVED CANOPY SIGNAGE. | ADJUSTABLE FAÇADE LINEAR                              | 277      | 6.75W/ FT    | 3500K | 90+ | 0-10V TO 10% | WALL/ ARM SURFACE EXTERIOR SIGNAGE | LINEAR LIGHTING SHALL BE LOCATED BELOW LETTERING ON FACE OF CANOPY. COORDINATE EXACT LOCATION AT EACH CANOPY PRIOR TO ROUGH-IN. ENSURE WALL WASH OPTIC IS FACING WALL SIGNAGE. CONCEAL ALL EXPOSED WIRING AND CABLEING FOR A CLEAN INSTALLATION. |  |  |
| DA                                                                                                                                                                                                                                                                                                                                                             | PORTFOLIO          | LD4C15D010-EU4B10209035-4LBW1H                      | FOCAL POINT GOTHAM USAI LIGHTOUTLIER CARDL                                       | OPEN SELF-FLANGED DOWNLIGHT                           | 277      | 15           | 3500K | 90+ | 0-10V TO 1%  | RECESSED                           |                                                                                                                                                                                                                                                  |  |  |
| DB                                                                                                                                                                                                                                                                                                                                                             | PORTFOLIO          | LD4C15D010-EU4B10209035-4LBW1H LGSKT41IP66 - SHOWER | FOCAL POINT GOTHAM USAI LIGHTOUTLIER CARDL                                       | OPEN SELF-FLANGED DOWNLIGHT (GASKETED)                | 277      | 15           | 3500K | 90+ | 0-10V TO 1%  | RECESSED                           |                                                                                                                                                                                                                                                  |  |  |
| DC                                                                                                                                                                                                                                                                                                                                                             | PORTFOLIO          | LD6D30D010 EUGB30509035 6LBOW1H TRAMP LGSKT6IP66    | FOCAL POINT GOTHAM USAI LIGHTOUTLIER CARDL                                       | OPEN SELF-FLANGED DOWNLIGHT (GASKETED)                | 277      | 28           | 3500K | 90+ | 0-10V TO 1%  | RECESSED IN EXTERIOR CANOPY        | PROVIDE WITH CEILING SLOPE ADAPTER - TBD H5A6                                                                                                                                                                                                    |  |  |
| DD                                                                                                                                                                                                                                                                                                                                                             | PORTFOLIO          | LD4C15D010-EU4B10209035-4LBW1H SWN                  | FOCAL POINT GOTHAM USAI LIGHTOUTLIER CARDL                                       | OPEN SELF-FLANGED WALLWASH DOWNLIGHT                  | 277      | 15           | 3500K | 90+ | 0-10V TO 1%  | RECESSED                           |                                                                                                                                                                                                                                                  |  |  |
| DE                                                                                                                                                                                                                                                                                                                                                             | PORTFOLIO          | LD6A6 15 935 D010TE 6LAL 1 H LGSKT6IP66             | FOCAL POINT GOTHAM USAI LIGHTOUTLIER CARDL                                       | ADJUSTABLE SELF-FLANGED DOWNLIGHT (GASKETED)          | 277      | 20           | 3500K | 90+ | 0-10V TO 1%  | RECESSED IN EXTERIOR CANOPY        |                                                                                                                                                                                                                                                  |  |  |
| EA                                                                                                                                                                                                                                                                                                                                                             | DUAL-LITE          | EV2I                                                | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | EMERGENCY UNIT WALL PACK                              | UNV      | 3            | 4000K | N/A | N/A          | WALL                               | TWO ADJUSTABLE HEADS. SELF-TESTING.                                                                                                                                                                                                              |  |  |
| EB                                                                                                                                                                                                                                                                                                                                                             | DUAL-LITE          | EV2I-WGA1                                           | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | EMERGENCY UNIT WALL PACK                              | UNV      | 3            | 4000K | N/A | N/A          | WALL                               | TWO ADJUSTABLE HEADS. SELF-TESTING. PROVIDE WIRE GUARD                                                                                                                                                                                           |  |  |
| FA                                                                                                                                                                                                                                                                                                                                                             | DAY-BRITE          | 2FGX54L835-4-R-UNV-DIM                              | METALUX CRUZE LITHONIA VTL                                                       | 2X4 VOLUMETRIC TROFFER                                | 277      | 45.8         | 3500K | 80+ | 0-10V TO 10% | RECESSED                           |                                                                                                                                                                                                                                                  |  |  |
| FB                                                                                                                                                                                                                                                                                                                                                             | DAY-BRITE          | 2TG48L835-4-FS-02F-UNV-DIM - BOH                    | METALUX GRLED LITHONIA 2GTL                                                      | 2X4 LENSED TROFFER                                    | 277      | 34.5         | 3500K | 80+ | 0-10V TO 10% | RECESSED                           |                                                                                                                                                                                                                                                  |  |  |
| FC                                                                                                                                                                                                                                                                                                                                                             | DAY-BRITE          | 2TG54L835-4-FS-02F-UNV-DIM-2W - KITCHEN             | METALUX GRLED LITHONIA 2GTL                                                      | 2X4 LENSED TROFFER (GASKETED)                         | 277      | 41           | 3500K | 80+ | 0-10V TO 10% | RECESSED                           |                                                                                                                                                                                                                                                  |  |  |
| FD                                                                                                                                                                                                                                                                                                                                                             | DAY-BRITE          | 2FGXG39L835-2-R-UNV-DIM - CORRIDORS                 | METALUX CRUZE LITHONIA VTL                                                       | 2X2 VOLUMETRIC TROFFER                                | 277      | 30           | 3500K | 80+ | 0-10V TO 10% | RECESSED                           | RIBBED CENTER BASKET                                                                                                                                                                                                                             |  |  |
| FE                                                                                                                                                                                                                                                                                                                                                             | DAY-BRITE          | 2FGXG54L835-2-R-UNV-DIM - LIBRARY                   | METALUX CRUZE LITHONIA VTL                                                       | 2X2 VOLUMETRIC TROFFER                                | 277      | 43           | 3500K | 80+ | 0-10V TO 10% | RECESSED                           | RIBBED CENTER BASKET                                                                                                                                                                                                                             |  |  |
| GA                                                                                                                                                                                                                                                                                                                                                             | DAY-BRITE          | FSS440L840-UNV-DIM/FKR-126/FSSDEK                   | ACUTY ZL1N METALUX 4SNX WILLIAMS TFR                                             | 4FT ROUND FULL FROSTED LENSED STRIP                   | 277      | 30           | 4000K | 80+ | 0-10V TO 10% | SUSPENDED OR SURFACE               | WIDE DISTRIBUTION WITH END CAPS. PROVIDE CHAIN MOUNT HARDWARE IN ALL ROOMS WITH EXPOSED STRUCTURE CEILING. COORDINATE ROUGH-IN WITH ALL TRADES.                                                                                                  |  |  |
| GB                                                                                                                                                                                                                                                                                                                                                             | METALUX            | 4VT3-LD5-6-W-UNV-L840-CD1-U                         | ACUTY METALUX WILLIAMS                                                           | 4FT VAPORTIGHT                                        | 277      | 49           | 4000K | 80+ | 0-10V TO 10% | SUSPENDED OR SURFACE               |                                                                                                                                                                                                                                                  |  |  |
| GC                                                                                                                                                                                                                                                                                                                                                             | DAY-BRITE          | FSS45L840-UNV-DIM/FKR-126/FSSDEK                    | ACUTY ZL1N METALUX 4SNX WILLIAMS TFR                                             | 4FT ROUND FULL FROSTED LENSED STRIP                   | 277      | 41           | 4000K | 80+ | 0-10V TO 10% | SUSPENDED OR SURFACE               | WIDE DISTRIBUTION WITH END CAPS. PROVIDE CHAIN MOUNT HARDWARE IN ALL ROOMS WITH EXPOSED STRUCTURE CEILING. COORDINATE ROUGH-IN WITH ALL TRADES.                                                                                                  |  |  |
| HA                                                                                                                                                                                                                                                                                                                                                             | VISION ENGINEERING | VH83-12-90D-50K-SL-UPL50-CM                         | LUX DYNAMICS IK10                                                                | HIGHBAY                                               | 277      | 180          | 5000K | 80+ | 0-10V TO 10% | CABLE SUSPENDED                    | 5000K - DISTRICT STANDARD. COORDINATE EXACT MOUNTING HEIGHT WITH ARCHITECTURAL ELEVATIONS. PROVIDE WITH INDIRECT OPTIC AND FROSTED LENS                                                                                                          |  |  |
| LA                                                                                                                                                                                                                                                                                                                                                             | LEDALITE           | 3901 L935 300X 10XD1                                | FOCAL POINT AXIS FINELITE                                                        | RECESSED SLO LINEAR                                   | 277      | 10W PER L/F  | 3500K | 80+ | 0-10V TO 10% | RECESSED                           | REFER TO ARCHITECTURAL CEILING PLANS FOR CEILING TYPES AND EXACT LENGTH.                                                                                                                                                                         |  |  |
| LB                                                                                                                                                                                                                                                                                                                                                             | LEDALITE           | 7406 LBCOG TDEW                                     | FINELITE S18 PEERLESS PROPER                                                     | SUSPENDED DIRECT/INDIRECT RECT LINEAR                 | 277      | 7.1W PER L/F | 3500K | 80+ | 0-10V TO 10% | PENDANT                            | REFER TO ARCHITECTURAL CEILING PLANS FOR CEILING TYPES AND EXACT LENGTH.                                                                                                                                                                         |  |  |
| LC                                                                                                                                                                                                                                                                                                                                                             | FOCAL POINT        | FSM48W-FLFL-1000DN-1000UP-935K-2C-UNV-LD1-WM-4X2B   | LEDALITE AXIS FINELITE                                                           | CONTINUOUS DIRECT/INDIRECT CLERESTORY                 | 277      | 7.1W PER L/F | 3500K | 80+ | 0-10V TO 10% | WALL                               | REFER TO ARCHITECTURAL CEILING PLANS FOR CEILING TYPES AND EXACT LENGTH. CONTINUOUS INSIDE LIT CORNER.                                                                                                                                           |  |  |
| LD                                                                                                                                                                                                                                                                                                                                                             | LEDALITE           | 4908L-935-22-C-XX-D-E-1-N-W-C-C-A-S-3               | FOCAL POINT AXIS FINELITE                                                        | PERIMETER WALL SLOT                                   | 277      | 7.1W PER L/F | 3500K | 80+ | 0-10V TO 10% | WALL                               | REFER TO ARCHITECTURAL CEILING PLANS FOR CEILING TYPES AND EXACT LENGTH. LIBRARY                                                                                                                                                                 |  |  |
| PA                                                                                                                                                                                                                                                                                                                                                             | USAI               | CMSD8 XB 20X3 35K 65 X SX (STEM) UNV                | FOCAL POINT GOTHAM                                                               | SQUARE PENDANT DOWNLIGHT                              | 277      | 20           | 3500K | 90+ | 0-10V TO 10% | SUSPENDED                          | MOUNT BOTTOM OF LUMINAIRE PER ARCHITECTURAL ELEVATIONS.                                                                                                                                                                                          |  |  |
| PB                                                                                                                                                                                                                                                                                                                                                             | LUMENWERX          | POROPD1-48IN-ULO-34H-LED-90-7000-35                 | EQUALS SHALL BE COORDINATED WITH ARCHITECT/ENGINEER                              | 48IN FULLY LUMINOUS ROUND                             | 277      | 103          | 3500K | 90+ | 0-10V TO 10% | SUSPENDED                          | MOUNT BOTTOM OF LUMINAIRE PER ARCHITECTURAL ELEVATIONS.                                                                                                                                                                                          |  |  |
| PC                                                                                                                                                                                                                                                                                                                                                             | LUMENWERX          | POROPD1-12IN-ULO-34H-LED-90-7000-35                 | EQUALS SHALL BE COORDINATED WITH ARCHITECT/ENGINEER                              | 12IN FULLY LUMINOUS ROUND                             | 277      | 11           | 3500K | 80+ | 0-10V TO 10% | PENDANT                            | MOUNT BOTTOM OF LUMINAIRE PER ARCHITECTURAL ELEVATIONS.                                                                                                                                                                                          |  |  |
| SA                                                                                                                                                                                                                                                                                                                                                             | GARDCO             | P34-L-96L-900-CW-G2-AR-2-UNV-BZ                     | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | AREA LIGHT - SINGLE HEAD TYPE II                      | 277      | 225          | 5000K | 70+ | 0-10V        | POLE                               | PROVIDE WITH 28FT STRAIGHT SQUARE STEEL POLE. CAMPUS STANDARD (GARDCO SSS-08-4.7-25-2.01-075-B-2) REFER TO POLE BASE DETAIL ON SHEET E021                                                                                                        |  |  |
| SB                                                                                                                                                                                                                                                                                                                                                             | GARDCO             | P34-L-96L-900-CW-G2-AR-4-UNV-BZ                     | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | AREA LIGHT - SINGLE HEAD TYPE IV                      | 277      | 225          | 5000K | 70+ | 0-10V        | POLE                               | PROVIDE WITH 28FT STRAIGHT SQUARE STEEL POLE. CAMPUS STANDARD (GARDCO SSS-08-4.7-25-2.01-075-B-2) REFER TO POLE BASE DETAIL ON SHEET E021                                                                                                        |  |  |
| SC                                                                                                                                                                                                                                                                                                                                                             | GARDCO             | P34-L-96L-900-CW-G2-AR-5-UNV-BZ                     | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | AREA LIGHT - SINGLE HEAD TYPE V                       | 277      | 225          | 5000K | 70+ | 0-10V        | POLE                               | PROVIDE WITH 28FT STRAIGHT SQUARE STEEL POLE. CAMPUS STANDARD (GARDCO SSS-08-4.7-25-2.01-075-B-2) REFER TO POLE BASE DETAIL ON SHEET E021                                                                                                        |  |  |
| SD                                                                                                                                                                                                                                                                                                                                                             | NLS LIGHTING       | NV-F1-15-16L-25W-40K-UNV-KM-JBRK-ECL-BRZ            | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | FLAGPOLE FLOOR                                        | 277      | 25           | 4000K | 70+ | NON-DIMMING  | KNUCKLE J-BOX                      | REFER TO MOUNTING DETAIL ON SHEET SHEET E021. COORDINATE APPROVED LOCATION WITH CIVIL AND ARCHITECTURAL PRIOR TO ROUGH IN.                                                                                                                       |  |  |
| T1                                                                                                                                                                                                                                                                                                                                                             | WAC LIGHTING       | LT2146/8 / LI-WT                                    | --                                                                               | SINGLE CIRCUIT TRACK                                  | 120V     | --           | --    | --  | --           | --                                 | PROVIDE ALL ACCESSORIES NECESSARY FOR A COMPLETE TRACK LIGHTING SYSTEM. TRACK SHALL MATCH MANUFACTURER OF TRACK HEAD.                                                                                                                            |  |  |
| TA                                                                                                                                                                                                                                                                                                                                                             | WAC LIGHTING       | LTK-104L-LED-WT                                     | CONTECH                                                                          | LED MINI TRACK HEAD                                   | 120V     | 8W           | 3500K | 80+ | ELV TO 10%   | TRACK                              |                                                                                                                                                                                                                                                  |  |  |
| WA                                                                                                                                                                                                                                                                                                                                                             | GARDCO             | 121-16L-700-WNG4-4-BZ                               | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | EXTERIOR WALLPACK                                     | UNV      | 38           | 4000K | 70  | NON-DIMMING  | WALL SURFACE                       | COORDINATE EXACT MOUNTING HEIGHT WITH ARCHITECTURAL ELEVATIONS.                                                                                                                                                                                  |  |  |
| WAE                                                                                                                                                                                                                                                                                                                                                            | GARDCO             | 121-16L-700-WNG4-4-EBPC-BZ                          | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | EXTERIOR WALLPACK INTEGRAL BATTERY                    | UNV      | 38           | 4000K | 70  | NON-DIMMING  | WALL SURFACE                       | COORDINATE EXACT MOUNTING HEIGHT WITH ARCHITECTURAL ELEVATIONS.                                                                                                                                                                                  |  |  |
| XA                                                                                                                                                                                                                                                                                                                                                             | LITHONIA           | LQM S W 3 R MVOLT EL N SD M6                        | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | SINGLE FACE EXIT SIGN - THERMOPLASTIC                 | UNV      | 3            | RED   | N/A | N/A          | CEILING SURFACE                    | REFER TO ELECTRICAL PLANS FOR REQUIRED ARROWS/PLACEMENT.                                                                                                                                                                                         |  |  |
| XB                                                                                                                                                                                                                                                                                                                                                             | LITHONIA           | LQM S W 3 R MVOLT EL N SD M6                        | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | DOUBLE FACE EXIT SIGN - THERMOPLASTIC                 | UNV      | 3            | RED   | N/A | N/A          | CEILING SURFACE                    | REFER TO ELECTRICAL PLANS FOR REQUIRED ARROWS/PLACEMENT.                                                                                                                                                                                         |  |  |
| XC                                                                                                                                                                                                                                                                                                                                                             | LITHONIA           | LQM S W 3 R MVOLT EL N SD M6/ ELAWG1                | NOT APPLICABLE PROVIDE CAMPUS STANDARD                                           | DOUBLE FACE EXIT SIGN - THERMOPLASTIC WITH WIRE GUARD | UNV      | 3            | RED   | N/A | N/A          | CEILING SURFACE                    | REFER TO ELECTRICAL PLANS FOR REQUIRED ARROWS/PLACEMENT.                                                                                                                                                                                         |  |  |
| GENERAL NOTE:<br>LIGHT FIXTURE SUBSTITUTIONS TO THE BASIS OF DESIGN MUST BE EQUAL QUALITY, EQUAL PERFORMANCE, AND SUBMITTED 10 DAYS PRIOR TO BIDDING FOR PRE-APPROVAL.<br>REFERENCE DIVISION 01 - "GENERAL REQUIREMENTS" OF THE CONTRACT SPECIFICATIONS FOR PROCESS REQUIRED FOR PRE-APPROVAL. NO SUBSTITUTIONS WILL BE REVIEWED AFTER BASE-BIDS ARE ACCEPTED. |                    |                                                     |                                                                                  |                                                       |          |              |       |     |              |                                    |                                                                                                                                                                                                                                                  |  |  |

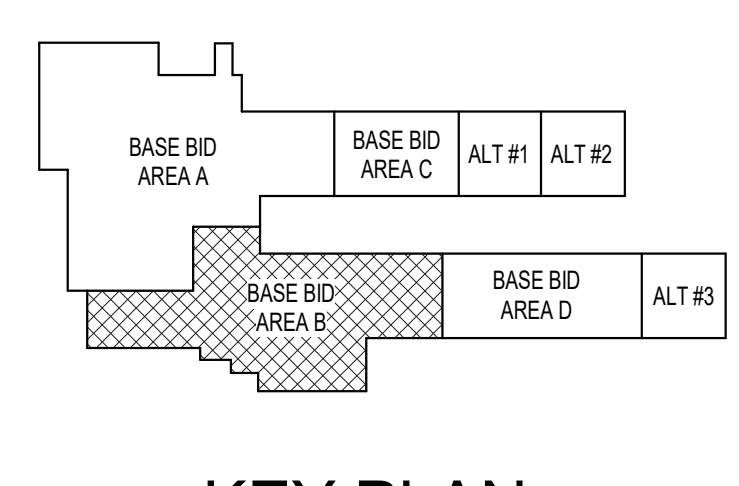


| EQUIPMENT |                                | MOTOR DATA        |                 | BRANCH CIRCUIT DATA |         | SOURCE DATA   |                                     | UNIT CONTROLS |          |                        |             | EQUIPMENT DISCONNECT |   |   |           | REMARKS     |      |          |             |   |   |   |                                                                      |
|-----------|--------------------------------|-------------------|-----------------|---------------------|---------|---------------|-------------------------------------|---------------|----------|------------------------|-------------|----------------------|---|---|-----------|-------------|------|----------|-------------|---|---|---|----------------------------------------------------------------------|
| EQUIP. ID | DESCRIPTION                    | HP / (KW) / (MCA) | VOLTAGE / PHASE | FEEDER SIZE         | SOURCE: | TYPE2 / POLES | OCF SWITCH FUSE SIZE or CB TRIP (A) | TYPE3         | OCF TYPE | SWITCH FUSE or CB TRIP | NEMA RATING | F                    | I | C | EQUIP. ID | SWITCH SIZE | POLE | OCF SIZE | NEMA RATING | F | I | C | E                                                                    |
| EF-1      | KITCHEN HOOD                   | 2 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | MP1     | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | EF-1      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| EF-2      | KITCHEN HOOD                   | 2 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | MP1     | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | EF-2      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| EF-3      | DISHWASHER                     | 1/4 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | K1      | CB / 1        | 20                                  | PWCP          | -        | -                      | -           | M                    | M | M | EF-3      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO DISHWASHER CONTROL PANEL |
| EF-4      | MECH RM EXHAUST                | 1 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | MP2     | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | EF-4      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| EF-5      | KLN                            | 1/2 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | B1      | CB / 1        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | EF-5      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| EF-6      | NURSE EXHAUST                  | 1/4 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | B3      | CB / 1        | 20                                  | RIB           | -        | -                      | -           | 1                    | E | E | EF-6      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| EF-7      | KITCHEN HOOD                   | 1 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | HP21    | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | EF-7      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| EF-8      | RESTROOM EXHAUST               | 0.1 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | AS      | CB / 1        | 20                                  | RIB           | -        | -                      | -           | 1                    | E | E | EF-8      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| EF-9      | RESTROOM EXHAUST               | 0.1 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | A1      | CB / 1        | 20                                  | RIB           | -        | -                      | -           | 1                    | E | E | EF-9      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| TF-1      | KITCHEN EXHAUST MAKEUP AIR     | 2 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | MP1     | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | TF-1      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| TF-2      | KITCHEN EXHAUST MAKEUP AIR     | 2 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | MP1     | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | TF-2      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| TF-3      | KLN EXHAUST MAKEUP AIR         | 3/4 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | B1      | CB / 1        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | TF-3      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| RLF-1     | DAFTERHALL RELIEF              | 2 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | MP1     | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | RLF-1     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| RLF-2     | BUILDING RELIEF                | 5 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | HP21    | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | RLF-2     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| RLF-3     | GYM RELIEF/FILTER EXHAUST      | 5 HP              | 480 / 3         | 3/12 1/12 GRD-3/4"  | EM-HP1  | CB / 3        | 20                                  | COAB          | NF       | -                      | 1           | E                    | E | E | RLF-3     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| SF-1      | SHELTER MODE VENTILATION AIR   | 10 HP             | 480 / 3         | 3/10 1/10 GRD-3/4"  | EM-HP1  | CB / 3        | 30                                  | COAB          | NF       | -                      | 1           | E                    | E | E | SF-1      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT. INTERCONNECT TO MOTORIZED DAMPER         |
| FOU-1     | MAIN ENTRANCE VESTIBULE 100    | 6 MCA             | 120 / 1         | 2/12 1/12 GRD-3/4"  | B3      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | FOU-1     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| FOU-2     | N ENTRANCE VESTIBULE 401       | 4 MCA             | 120 / 1         | 2/12 1/12 GRD-3/4"  | A1      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | FOU-2     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| FOU-3     | GYM ENTRANCE VESTIBULE 322     | 4 MCA             | 120 / 1         | 2/12 1/12 GRD-3/4"  | A1      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | FOU-3     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| FOU-4     | DZ OFFICE / RECEPT 321         | 2.75 MCA          | 120 / 1         | 2/12 1/12 GRD-3/4"  | A1      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | FOU-4     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| FOU-5     | MECHANICAL ROOM OFFICE         | 2.75 MCA          | 120 / 1         | 2/12 1/12 GRD-3/4"  | A1      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | FOU-5     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| UH-1      | NE CLASSROOM WING EXIT         | 5.4 MCA           | 120 / 1         | 2/12 1/12 GRD-3/4"  | A4      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | UH-1      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| UH-2      | NE CLASSROOM WING EXIT         | 5.4 MCA           | 120 / 1         | 2/12 1/12 GRD-3/4"  | A4      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | UH-2      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| UH-3      | CENTRAL CORRIDOR EXIT          | 5.4 MCA           | 120 / 1         | 2/12 1/12 GRD-3/4"  | B1      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | UH-3      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| UH-4      | SW WING W EXIT                 | 5.4 MCA           | 120 / 1         | 2/12 1/12 GRD-3/4"  | B1      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | UH-4      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| UH-5      | SE WING N EXIT                 | 5.4 MCA           | 120 / 1         | 2/12 1/12 GRD-3/4"  | B4      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | UH-5      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| UH-6      | SE WING E EXIT                 | 5.4 MCA           | 120 / 1         | 2/12 1/12 GRD-3/4"  | B4      | CB / 1        | 15                                  | TST           | -        | -                      | -           | M                    | M | M | UH-6      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| HWP-1     | HEATING WATER                  | 10 HP             | 480 / 3         | 3/10 1/10 GRD-3/4"  | MP2     | CB / 3        | 30                                  | PWCP          | -        | -                      | -           | M                    | M | M | HWP-1     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| HWP-2     | HEATING WATER                  | 10 HP             | 480 / 3         | 3/10 1/10 GRD-3/4"  | MP2     | CB / 3        | 30                                  | PWCP          | -        | -                      | -           | M                    | M | M | HWP-2     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| HWP-3     | HEATING WATER (ALTERNATE #4)   | 10 HP             | 480 / 3         | 3/10 1/10 GRD-3/4"  | MP2     | CB / 3        | 30                                  | PWCP          | -        | -                      | -           | M                    | M | M | HWP-3     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| CWP-1     | CHILLED WATER                  | 15 HP             | 480 / 3         | 3/8 1/10 GRD-3/4"   | MP2     | CB / 3        | 40                                  | PWCP          | -        | -                      | -           | M                    | M | M | CWP-1     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| CWP-2     | CHILLED WATER                  | 15 HP             | 480 / 3         | 3/8 1/10 GRD-3/4"   | MP2     | CB / 3        | 40                                  | PWCP          | -        | -                      | -           | M                    | M | M | CWP-2     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| CWP-3     | CHILLED WATER                  | 15 HP             | 480 / 3         | 3/8 1/10 GRD-3/4"   | MP2     | CB / 3        | 40                                  | PWCP          | -        | -                      | -           | M                    | M | M | CWP-3     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| CP-1      | CONDENSER WATER                | 15 HP             | 480 / 3         | 3/8 1/10 GRD-3/4"   | MP2     | CB / 3        | 40                                  | PWCP          | -        | -                      | -           | M                    | M | M | CP-1      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| CP-2      | CONDENSER WATER                | 15 HP             | 480 / 3         | 3/8 1/10 GRD-3/4"   | MP2     | CB / 3        | 40                                  | PWCP          | -        | -                      | -           | M                    | M | M | CP-2      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| CP-3      | CONDENSER WATER                | 15 HP             | 480 / 3         | 3/8 1/10 GRD-3/4"   | MP2     | CB / 3        | 40                                  | PWCP          | -        | -                      | -           | M                    | M | M | CP-3      | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| PHR-1     | RTU-1 PREHEAT COIL CIRCULATION | 1/6 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | A1      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | PHR-1     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| PHR-2     | RTU-1 PREHEAT COIL CIRCULATION | 1/6 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | A2      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | PHR-2     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| PHR-3     | RTU-1 PREHEAT COIL CIRCULATION | 1/6 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | A2      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | PHR-3     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| PHR-4     | RTU-4 PREHEAT COIL CIRCULATION | 2/5 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | B2      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | PHR-4     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| PHR-5     | RTU-5 PREHEAT COIL CIRCULATION | 1/6 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | B2      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | PHR-5     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| PHR-6     | RTU-6 PREHEAT COIL CIRCULATION | 1/6 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | B3      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | PHR-6     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| PHR-7     | RTU-7 PREHEAT COIL CIRCULATION | 2/5 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | B3      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | PHR-7     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| PHR-8     | RTU-8 PREHEAT COIL CIRCULATION | 2/5 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | B4      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | PHR-8     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| HXP-1     | HEAT EXCHANGER PUMP            | 2/5 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | A2      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | HXP-1     | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| DWCP-1    | DOMESTIC HOT WATER CIRCULATION | 1/6 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | A2      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | DWCP-1    | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| DWCP-2    | DOMESTIC HOT WATER CIRCULATION | 2/5 HP            | 120 / 1         | 2/12 1/12 GRD-3/4"  | A2      | CB / 1        | 20                                  | RIB           | -        | -                      | 1           | E                    | E | E | DWCP-2    | 20A TOG     | 1    | NF       | 1           | E | E | E |                                                                      |
| RTU-1     | NORTH GYM                      | 21 MCA            | 480 / 3         | 3/10 1/10 GRD-3/4"  | MP1     | CB / 3        | 30                                  | PWCP          | -        | -                      | -           | M                    | M | M | RTU-1     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| RTU-2     | KITCHEN ROOF                   | 46.9 MCA          | 480 / 3         | 3/8 1/10 GRD-3/4"   | MP1     | CB / 3        | 70                                  | PWCP          | -        | -                      | -           | M                    | M | M | RTU-2     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| RTU-3     | MECHANICAL ROOM                | 4 MCA             | 480 / 3         | 3/12 1/12 GRD-3/4"  | MP2     | CB / 3        | 20                                  | PWCP          | -        | -                      | -           | M                    | M | M | RTU-3     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| RTU-4     | MAIN GYM / STORM SHELTER       | 26 MCA            | 480 / 3         | 3/8 1/10 GRD-3/4"   | HP21    | CB / 3        | 35                                  | PWCP          | -        | -                      | -           | M                    | M | M | RTU-4     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| RTU-5     | LIBRARY WING                   | 20 MCA            | 480 / 3         | 3/10 1/10 GRD-3/4"  | HP21    | CB / 3        | 25                                  | PWCP          | -        | -                      | -           | M                    | M | M | RTU-5     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| RTU-6     | ADMIN WING                     | 12 MCA            | 480 / 3         | 3/12 1/12 GRD-3/4"  | HP21    | CB / 3        | 20                                  | PWCP          | -        | -                      | -           | M                    | M | M | RTU-6     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| RTU-7     | NORTH CLASSROOM WING           | 41 MCA            | 480 / 3         | 3/4 1/10 GRD-3/4"   | HP21    | CB / 3        | 60                                  | PWCP          | -        | -                      | -           | M                    | M | M | RTU-7     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| RTU-8     | EAST CLASSROOM WING            | 37 MCA            | 480 / 3         | 3/8 1/10 GRD-3/4"   | HP22    | CB / 3        | 50                                  | PWCP          | -        | -                      | -           | M                    | M | M | RTU-8     | BY OTHERS   | -    | -        | -           | M | M | E | FACTORY MOUNTED DISCONNECT                                           |
| CU-1      | ELECTRICAL 106 - ROOF          | 8.7 MCA           | 208 / 1         | 2/12 1/12 GRD-3/4"  | EQ-422  | CB / 2        | 20                                  | TST           | -        | -                      | -           | M                    | M | M | CU-1      | 30A         | 2    | 15A      | 3R          | E | E | E |                                                                      |
| AC-1      | ELECTRICAL 106                 | -                 | 208 / 1         | 2/12 1/12 GRD-3/4"  | CU-1    | CB / -        | -                                   | TST           | -        | -                      | -           | M                    | M | M | AC-1      | 30A         | 3    | 10A      | 1           | E | E | E |                                                                      |
| CU-2      | DATA 142 - ROOF                | 13.4 MCA          | 208 / 1         | 2/12 1/12 GRD-3/4"  | EQ-44   | CB / 2        | 20                                  | TST           | -        | -                      | -           | M                    | M | M | CU-2      | 30A         | 2    | 20A      | 3R          | E | E | E |                                                                      |
| AC-2      | DATA 142                       | -                 | 208 / 1         | 2/12 1/12 GRD-3/4"  | CU-2    | CB / -        | -                                   | TST           | -        | -                      | -           | M                    | M | M | AC-2      | 30A         | 3    | 10A      | 1           | E | E | E |                                                                      |
| CU-3      | ELECTRICAL 143 - ROOF          | 13.4 MCA          | 208 / 1         | 2/12 1/12 GRD-3/4"  | B4      | CB / 2        | 20                                  | TST           | -        | -                      | -           | M                    | M | M | CU-3      | 30A         | 2    | 20A      | 3R          | E | E | E |                                                                      |
| AC-3      | ELECTRICAL 143                 | -                 | 208 / 1         | 2/12 1/12 GRD-3/4"  | CU-3    | CB / -        | -                                   | TST           | -        | -                      | -           | M                    | M | M | AC-3      | 30A         | 3    | 10A      | 1           | E | E | E |                                                                      |
| CU-4      | ELECTRICAL 209 - ROOF          | 17 MCA            | 208 / 1         | 2/12 1/12 GRD-3/4"  | EQ-421  | CB / 2        | 20                                  | TST           | -        | -                      | -           | M                    | M | M | CU-4      | 30A         | 2    | 20A      | 3R          | E | E | E |                                                                      |
| AC-4      | ELECTRICAL 209                 | -                 | 208 / 1         | 2/12 1/12 GRD-3/4"  | CU-4    | CB / -        | -                                   | TST           | -        | -                      | -           | M                    | M | M | AC-4      | 30A         | 3    | 10A      | 1           | E | E | E |                                                                      |
| CU-5      | MAIN ELECTRICAL 307 - ROOF     | 13.4 MCA          | 208 / 1         | 2/12 1/12 GRD-3/4"  | A1      | CB / 2        | 20                                  | TST           | -        | -                      | -           | M                    | M | M | CU-5      | 30A         | 2    | 20A      | 3R          | E | E | E |                                                                      |
| AC-5      | MAIN ELECTRICAL 307            | -                 | 208 / 1         | 2/12 1/12 GRD-3/4"  | CU-5    | CB / -        | -                                   | TST           | -        | -                      | -           | M                    | M | M | AC-5      | 30A         | 3    | 10A      |             |   |   |   |                                                                      |





FLOOR PLAN - AREA B - LIGHTING  
SCALE: 1/8" = 1'-0"



- ### GENERAL NOTES
- SEE E2 SERIES SHEETS FOR LUMINAIRE SCHEDULE, LIGHTING CONTROL MATRIX, RELAY SCHEDULES, LIGHT FIXTURE MOUNTING DETAILS, AND LIGHTING CONTROL DIAGRAMS.
  - ELECTRICAL PANELBOARD DIRECTORIES SHALL BE LABELED WITH FINAL ROOM NUMBERS.
  - INSTALL 0-10V DIMMING CONTROL WIRING FROM DIMMING CONTROLS TO CORRESPONDING LIGHT FIXTURES. ALL CONTROL WIRES TO BE PLENUM RATED.
  - ELECTRICAL CONTRACTOR SHALL PROGRAM AND MASK OCCUPANCY SENSORS FOR DESIRED OPERATION.
  - ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR COORDINATION WITH ARCHITECT AND LIGHTING DESIGNER IN ADJUSTING LIGHTS AND PROGRAMMING SETTINGS FOR LIGHTING CONTROLS.
  - E.C. SHALL COORDINATE WITH OTHER TRADES, AND ADJUST LIGHTING LOCATIONS, MOUNTING HEIGHTS, AND MOUNTING METHODS TO PROVIDE A GOOD GENERAL LIGHTING LAYOUT/COVERAGE WITHIN MECHANICAL SPACES.
  - CONDUITS IN STORM SHELTER SHALL BE ROUTED AROUND PERIMETER, HIGH ON PRECAST WALLS. FOR LIGHTS, ROUTE CONDUIT TO EACH FIXTURE IN EACH BAY OF THE DOUBLE TEES.
  - WALL MOUNT DEVICES IN GYM TO BE RECESSED IN PRE-CAST WALLS. INSTALL ROUGH-IN CONDUIT AND BOXES AT FABRICATOR SHOP OF PRE-CAST WALL CONTRACTOR. PROVIDE ALL NECESSARY TRAVEL EXPENSES, COORDINATE SCHEDULING AND ROUGH-IN LOCATIONS TO ARCHITECT / ENGINEER FOR REVIEW.

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ORCHARD FARM SCHOOL DISTRICT

**PROJ. NO. 23-09B**

**DATE ISSUED**  
07-02-2024

**DATE REVISION**  
1 07-23-24 ADDENDUM #1  
2 08-01-24 ADDENDUM #2

**DRAWN BY NAM**

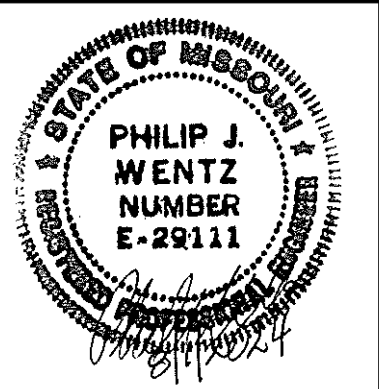
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**SHEET NO.**

**E2.3**

**SD:78**





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1 07-23-24 ADDENDUM #1

2 08-01-24 ADDENDUM #2

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SHEET NO.

E6.2

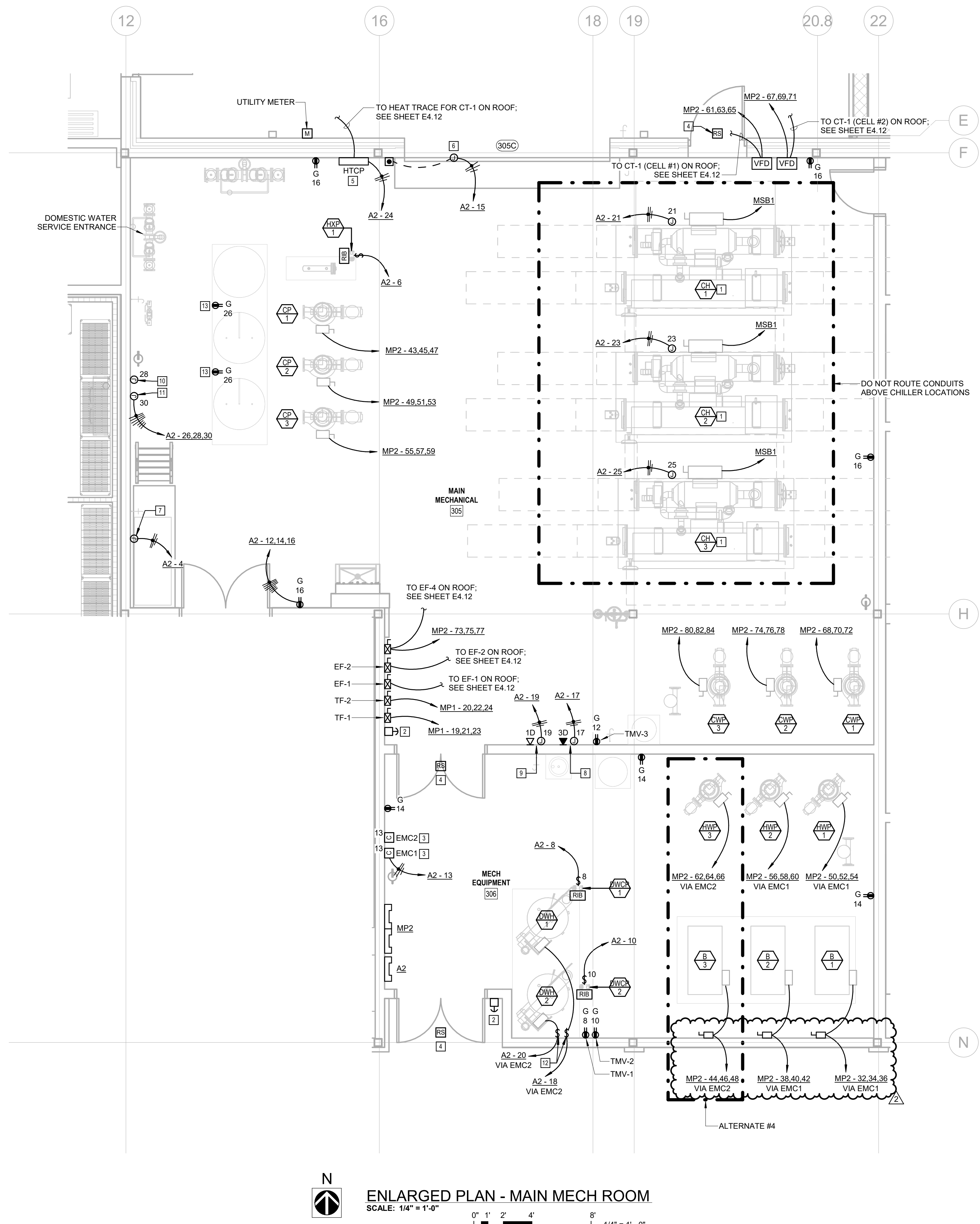
SD:79

### GENERAL NOTES

- COORDINATE ALL LOCATIONS, HEIGHTS AND REQUIREMENTS OF ROUGH-INS AND PATHWAYS, CONDUITS AND CABLE TRAY LOCATIONS WITH OWNER, ARCHITECT, CONSULTANTS, AND OTHER TRADES PRIOR TO ORDER AND INSTALLATION. PROVIDE NYLON GROMMETS ON EXPOSED ENDS OF ALL PATHWAY CONDUITS.
- FIRE SEAL ALL PENETRATIONS OF FIRE RATED ASSEMBLIES. SEAL ALL ROOF AND EXTERIOR WALL PENETRATIONS WEATHER TIGHT.
- PROVIDE UNISTRUT SUPPORT AS REQUIRED FOR ALL VFDs AND STARTERS.
- REFER TO MECHANICAL / ELECTRICAL INTERFACE ON E0.4" SERIES SHEETS FOR ADDITIONAL MECHANICAL EQUIPMENT INFORMATION: FEEDER SIZE, UNIT CONTROLS AND OVERCURRENT DETAILS.
- COORDINATE ALL BRANCH CIRCUITING AND FEEDER CONDUITS WITH MECHANICAL PIPING AND OTHER UTILITIES.

### KEYED NOTES:

- CONDUIT SHALL BE ROUTED OVERHEAD. DROP DOWN AT EQUIPMENT, AND TRANSITION TO JACKETED FLEXIBLE STEEL CONDUIT (SEAL TITE) FOR FINAL CONNECTION TO EQUIPMENT. VERTICAL CONDUIT TO BE GALVANIZED RIGID STEEL.
- INSTALL EMERGENCY "PUSH-OFF" PUSHBUTTON WITH STOPPER II COVER (STI #SS-2231 OR EQUAL) FOR BOILER EMERGENCY SHUT-DOWN. CUSTOM LABEL FOR PUSHBUTTON TO READ "BOILER EMERGENCY SHUT-DOWN". SEE BOILER SHUT-DOWN WIRING DIAGRAM ON SHEET E0.4" SERIES SHEETS FOR REFERENCE TO CONTROL POWER AND BOILER CONTACTOR.
- BOILER SHUT-DOWN CONTACTOR. SEE WIRING DIAGRAM ON E0.4" SERIES SHEETS.
- REFRIGERANT ALARM STROBE WITH PROTECTIVE COVER LOCATED OUTSIDE THE MECHANICAL ROOM.
- HEAT TRACE CONTACTOR PANEL. SEE E0.4" SERIES SHEETS FOR DETAILS.
- CONNECTION FOR MOTORIZED OVERHEAD COILING DOOR. INSTALL ASSOCIATED DOOR CONTROLLER, PUSH BUTTON STATION, AND SAFETY SENSORS FOR A COMPLETE INSTALLATION.
- 120V CONNECTION FOR CHEMICAL SYSTEM CONTROL PANEL.
- 120V CONNECTION AND DATA OUTLET FOR TEMPERATURE CONTROL PANEL. COORDINATE EXACT LOCATION WITH MECHANICAL DRAWINGS.
- 120V CONNECTION AND DATA OUTLET FOR REFRIGERANT ALARM PANEL. COORDINATE EXACT LOCATION WITH MECHANICAL DRAWINGS.
- TOWER MAKE-UP WATER METER. COORDINATE EXACT MOUNTING LOCATION IN THE FIELD. INTERCONNECT TO CHEMICAL FEED CONTROLLER. SEE WIRING DIAGRAM ON E0.4" SERIES SHEETS.
- BLOWNDOWN SOLENOID VALVE. COORDINATE EXACT MOUNTING LOCATION IN THE FIELD. INTERCONNECT TO CHEMICAL FEED CONTROLLER. SEE WIRING DIAGRAM ON E0.4" SERIES SHEETS.
- INSTALL HANDLE LOCKING GUARD (PASS & SEYMOUR 7801-P OR EQUAL) ON TOGGLE SWITCH.
- RECEPTACLE SHALL BE MOUNTED ON FREE STANDING UNI-STRUT.



**ENLARGED PLAN - MAIN MECH ROOM**  
SCALE: 1/4" = 1'-0"  
0' 2' 4' 8' 14" = 1'-0"