

**Date:** 01-15-2021

**To:** All Plan Holders

**Subject:** ADDENDUM NO. 5

**Project:** CENTER FOR MATERIALS AND MANUFACTURING  
SCIENCES, TROY UNIVERSITY MAIN CAMPUS-TROY ALABAMA

**Job #:** SSL# 18144  
BC# 2020416  
PSCA#: 006P



**From:** Cody Smith

The plans dated November 17, 2020 and Specifications dated November 2020 of the subject project, and any subsequent addenda are amended as follows: (Where there are conflicts between the plans and specifications and the addendum, this addendum shall govern)

**Item 1:** Refer to attached sheet AN1.0: notes revised.

**Item 2:** Refer to attached sheet LS2.0: Add Life Safety calculation hatch to legend

**Item 3:** Refer to attached sheet LS3.0:

- Add Life Safety calculation hatch to legend
- Add rated ceiling

**Item 4:** Refer to attached sheet L1.0: Add section marker

**Item 5:** Refer to attached sheet L3.0:

- Detail 2: Revise CMU location
- Detail 6, 7, 9: Updated Julius Blum product number

**Item 6:** Refer to attached sheet L4.0 Detail 2&3: Add caststone cap

**Item 7:** Refer to attached sheet L5.0:

- Detail 5 & 8: Add waterproofing
- Detail 1: Structural & Civil note

**Item 8:** Refer to attached sheet A1.1:

- Add wall/fur out
- Alter wall type/fire rating

**Item 9:** Refer to attached A2.0:

- Add/coord Structural Grid line
- Remove sink/casework from Basebid floor plan. Plumbing rough-in to remain in basebid.
- Rename Future restroom to Future Men's

**Item 10:** Refer to attached A2.0a:

- Add/coord Structural Grid line
- Add 3D printing lab casework elevation
- Remove sink/casework in Storage/Furniture Lab. Plumbing rough-in to remain as part of basebid.

**Item 11:** Refer to attached A2.1:

- Add/coord Structural Grid line
- Enlarge supply air chase, alter casework elevation
- Add fur out
- Remove unused chase(s)
- Remove Landscape detail marker
- Add floor slab / chase opening indicator "X"

**Item 12:** Refer to attached A2.2:

- Add/coord Structural Grid line
- Enlarge supply air chase, alter casework elevation
- Add fur out
- Remove unused chase(s)
- Add floor slab / chase opening indicator "X"

**Item 13:** Refer to attached A2.3:

- Add/coord Structural Grid line
- Move/Shrink supply air chase
- Add floor slab / chase opening indicator "X"

**Item 14:** Refer to attached A2.3a:

- Add/coord Structural Grid line
- Move/Shrink supply air chase, shift wall/door 1308
- Add floor slab / chase opening indicator “X”
- Remove section marker
- Add Casework elevation markers
- Detail 2: Plywood to be glued and screwed

**Item 15:** Refer to attached sheet A2.4:

- Add detail markers
- Remove ridge vent detail marker from hip
- Add Stack Vent Detail – Typical.
- Add lower roof/balustrade beyond

**Item 16:** Refer to attached Sheet A3.0 Finish Legend and Level 0 & 1 Base Bid Finish Schedule:

- **Replace** “ERC” under the Countertops in the FINISH SCHEDULE LEGEND to “ER”
- **Added** description of SS1 that states “Natural Quartz”
- **Added** description of SS2 that states “Solid Surfacing Window Sills”
- **Added** ‘Window Shades’ to Finish Schedule Legend. Describes what “SH1”
- **Added** note explaining “EXP” refers to “Exposed Ceiling”
- **Replaced** “SS1” under “Window, Sill” in BASE BID FINISH SCHEDULE LEVEL 0 & LEVEL 1 to “SS2.” All windowsills should be SS2.
- **Added** SC, Sealed Concrete, to ‘Stair 1’, Room 1008.
- **Added** SC, Sealed Concrete, to ‘Stair 2’, Room 1014.
- **Removed** ‘ACT’ from ceiling finish of Lobby 1100.
- **Replaced** ‘PNT5’ to show “PNT4” on the ceiling of Lobby 1100.
- **Replaced** ‘PNT3’ under “Ceiling Finish” with ‘EXP/PNT3’ for the Mechanical Testing Lab, Room 1101. This fully describes what is happening on the ceiling: exposed ceiling that is painted with PNT3.
- **Replaced** ‘PNT3’ under “Ceiling Finish” with ‘EXP/PNT3’ for Stair 2, Room 1106. This fully describes what is happening on the ceiling: exposed ceiling that is painted with PNT3.
- **Replaced** ‘DMEC2, DMEC3’ with ‘DMEC1, DMEC2’ for the Circulation, Room 1115. This fully describes what is happening on the ceiling: exposed ceiling that is painted with PNT3.
- **Replaced** ‘PNT3’ under “Ceiling Finish” with ‘EXP/PNT3’ for Stair 1, Room 1122. This fully describes what is happening on the ceiling: exposed ceiling that is painted with PNT3.
- **Replaced** ‘EPX’ under “Millwork, Casework, Lower” with ‘LC1’ for the Polymer processing Lab 1, Room 1124.
- **Added** “ER”, epoxy resin, under “Millwork, Countertop” to the Polymer Processing Lab 1, Room 1124.

**Item 17:** Refer to Sheet A3.1 Finish Schedule – Level 2 & 3 Base Bid:

- **Replaced** “SS1” under “Window, Sill” in BASE BID FINISH SCHEDULE LEVEL 2 & LEVEL 3 to “SS2.” All windowsills should be SS2.
- **Removed** “ACT1” under Ceiling Finish for Storage, Room 1202A.
- **Replaced** ‘PNT3’ under “Ceiling Finish” with ‘EXP/PNT3’ for Stair 2, Room 1204. This fully describes what is happening on the ceiling: exposed ceiling that is painted with PNT3.
- **Replaced** “?” with “SH1” under “Window, Shade” for Chromatography Analytical Lab, Room 1218.
- **Replaced** “?” with “SS2” under “Window, Sill” for Chromatography Analytical Lab, Room 1218.
- **Replaced** ‘PNT3’ under “Ceiling Finish” with ‘EXP/PNT3’ for Stair 1, Room 1220. This fully describes what is happening on the ceiling: exposed ceiling that is painted with PNT3.
- **Replaced** ‘PNT3’ under “Ceiling Finish” with ‘EXP/PNT3’ for Stair 2, Room 1305. This fully describes what is happening on the ceiling: exposed ceiling that is painted with PNT3.
- **Added** “SC” under “Floor, Finish” for Future Women’s, Room 1307.
- **Added** “SC” under “Floor, Finish” for Storage, Room 1308A.
- **Added** “SC” under “Floor, Finish” for Future Men’s, Room 1309.
- **Added** “SC” under “Floor, Finish” for Data, Room 1311.
- **Added** “SC” under “Floor, Finish” for Janitor, Room 1312.
- **Added** “SC” under “Floor, Finish” for Electrical, Room 1313.
- **Remove** Scale from Detail 4
- **Detail 1:** Raise Storefront sill

**Item 18:** Refer to Sheet A3.2 Finish Schedule – Level 0 & 3 Alternate:

- **Replaced** “SS1” under “Window, Sill” in BASEMENT ALTERNATE FINISH SCHEDULE to “SS2.” All windowsills should be SS2.
- **Replaced** “DMEC2” under “Floor, Finish” with “DMEC2, DMEC3” in 3D Printing, Room 1009.
- **Removed** “SH1” and “SS1” under “Window Sill and Shade” for Mechanical, Room 1010.
- **Added** “SC” under “Floor, Finish” for Elevator Room, Room 1011.
- **Added** “PNT4” under “Ceiling Finish” for Elevator Room, Room 1011.
- **Added** “SC” under “Floor, Finish” for Storage/Future Lab, Room 1015.
- **Replaced** “SS1” under “Window, Sill” in ATTIC ALTERNATE FINISH SCHEDULE to “SS2.” All windowsills should be SS2.
- **Replaced** ‘PNT3’ under “Ceiling Finish” with ‘EXP/PNT3’ for Office, Room 1301A.
- **Replaced** ‘PNT3’ under “Ceiling Finish” with ‘EXP/PNT3’ for Office, Room 1301B.



- **Replaced** 'PNT3' under "Ceiling Finish" with 'EXP/PNT3' for Office, Room 1301C.
- **Replaced** 'PNT3' under "Ceiling Finish" with 'EXP/PNT3' for Office, Room 1301D.
- **Replaced** 'PNT3' under "Ceiling Finish" with 'EXP/PNT3' for Office, Room 1301E.
- **Replaced** 'PNT3' under "Ceiling Finish" with 'EXP/PNT3' for Open Office, Room 1301F.
- **Replaced** 'PNT3' under "Ceiling Finish" with 'EXP/PNT3' for Board Room, Room 1303.
- **Replaced** "DMEC2" under "Floor, Finish" with "DMEC2, DMEC3" in Lab, Room 1304
- **Replaced** 'PNT3' under "Ceiling Finish" with 'EXP/PNT3' for Stair 2, Room 1305.
- **Replaced** 'PNT3' under "Ceiling Finish" with 'EXP/PNT3' for Stair 1, Room 1306.
- **Replaced** "DMEC2" under "Floor, Finish" with "DMEC2, DMEC3" in Lab, Room 1308.
- **Replaced** 'PNT3' under "Ceiling Finish" with 'EXP/PNT3' for Lab, Room 1308.
- **Added** "DMEC3" under "Floor, Finish" for Storage, Room 1308A.
- **Added** "RF1" (Rubber Flooring) under "Floor, Finish" for Elevator, Room 1310.

**Item 19:** Refer to attached sheet A3.3:

- Door elevation type change
- Add Door Schedule Note
- Add "Panel" to RG Alum Ext & R Alum Ext Door Type name

**Item 20:** Refer to attached sheet A3.4:

- Sill Detail update
- Add Door Schedule Note
- Change Door 1101 door height

**Item 21:** Refer to attached sheet A3.5:

- Change Triple Grid Muntin detail to flat bar on interior side
- Add Door Schedule Note
- Add Louver Type LD

**Item 22:** Refer to attached sheet A3.7:

- Raise Storefront Sill
- Update Storefront detail

**Item 23:** Refer to attached sheet A4.1a:

- Add Louver LD
- Add Elevation note

**Item 24:** Refer to attached sheet A4.2:

- Add Flashing Note
- Remove cast stone course
- Modify door muntin
- Add Louver LD
- Add Air Compressor Air Intake

**Item 25:** Refer to attached sheet A5.3:

- Modify wall section to add CMU
- Remove Cast stone below window sill

**Item 26:** Refer to attached sheet A5.4:

- Detail 1: Revise note 4" O.C. Max
- Add Note Trench Drain see civil
- Detail 2: Remove Grade line note

**Item 27:** Refer to attached sheet A5.5:

- Detail 1: Add metal stud framing, Add entry structural member
- Detail 2: Add/continue metal panel behind spandrel window

**Item 28:** Refer to attached sheet A5.6:

- Detail 1: Add metal stud framing, Modify window to slab detail. Modify beam location, Modify column foundation detail.
- Add Detail 4

**Item 29:** Refer to attached sheet A5.7:

- Detail 3: Add metal panel note.
- Detail 2: Modify Drain location, Add Structural note

**Item 30:** Refer to attached sheet A5.8:

- Detail 1: Remove Pilaster
- Detail 2: Add dimension, Modify note, Add Structural note

**Item 31:** Refer to attached sheet A5.9:

- Detail 6: Remove Cast stone under sill
- Detail 2: Add CMU

**Item 32:** Refer to attached sheet A5.10:

- Detail 3: Add dimensions

**Item 33:** Refer to attached sheet A5.13:

- Detail 3: Modify beam location
- Detail 2: Add structural angle
- Detail 5: Modify window sill to slab detail

**Item 34:** Refer to attached sheet A5.14:

- Detail 3: Replace Note
- Detail 5: Add Structural HSS

**Item 35:** Refer to attached sheet A5.15:

- Detail 3 & 7: Modify Structure

**Item 36:** Refer to attached sheet A5.16:

- Detail 1: Modify Detail
- Detail 4: Modify Structure

**Item 37:** Refer to attached sheet A5.17:

- Detail 4: Modify Louver

**Item 38:** Refer to attached sheet A6.1:

- Add floor slab / chase opening indicator “X”
- Add Elevation material tag

**Item 39:** Refer to attached sheet A6.2:

- Detail 5: Add rated soffit
- Detail 7: Modify wall section, Add note
- Detail 8: Modify Detail
- Detail 10: Modify Note

**Item 40:** Refer to attached sheet A6.3:

- Detail 10: Modify Note

**Item 41:** Refer to attached sheet A7.1:

- Detail 1: Return wood base to Storefront
- Detail 3: Add Detail markers
- Detail 5: Modify Wood Plinth
- Detail 4: Add Paint note, Add Terrazzo tag, Add fur out
- Detail 6: Modify Structure detail

**Item 42:** Refer to attached sheet A7.2: Add Detail 10

**Item 43:** Refer to attached sheet A8.0: Modify Detail 3

**Item 44:** Refer to attached sheet A8.1:

- Detail 1: Modify ACT layout
- Detail 2: Modify ACT layout, Add 2 Hour ceiling, Add Motorized shade Specific not tag

**Item 45:** Refer to attached sheet A9.1: Detail 1&2 Remove sink & casework – plumbing rough in to remain

**Item 46:** Refer to attached sheet A9.4: Add notes

**Item 47:** Refer to attached sheet A10.1:

- Detail 1: Add Gas to Lab utility marker, Add Display board locations

**Item 48:** Refer to attached Sheet A10.2:

- Modify Detail 1, 19, 18, and 20

**Item 49:** Refer to attached Sheet A10.3:

- Detail 2 & 11: Add note
- Modify Detail 4
- Detail 13: Add Glass board
- Add detail: 18, 19, and 20

**Item 50:** Refer to the Specifications ADVERTISEMENT FOR BIDS. **Delete** the first paragraph and **Replace** with the following:

Sealed proposals will be received by Troy University by the Purchasing Department of Troy University, at the Physical Plant Conference Room, located at 1 melton Carter Dr, Troy, Alabama 36081 until 2:00 PM CST for the base bids and 3:00 PM CST for all alternates on Tuesday, February 9, 2021 at which time they will be open and read.

**Item 51:** Refer to the Specifications Section 01 2300 Alternates: Para. 1.4.3 & 10: Clarification, If alternate is not taken the base bid shall include all plumbing rough-ins.

**Item 52:** Replace Specifications Section 07 1324 Pre-Applied Sheet Membrane Waterproofing with the attached. Updated spec footer.

**Item 53:** Refer to the Specifications Section 07 2500 Weather Barriers: Para. 2.09.A. **Replace** VP with **VPL** after Perm-A-Barrier.

**Item 54:** Replace Specifications Section 08 3100 Access Doors and Panels with the attached.

**Item 55:** Replace Specifications Section 08 5113 Aluminum Windows, Doors & Frames with the attached.

**Item 56:** Refer to Specification Section 08 7100 Door Hardware:

- Hardware Set 2.0: Update Bollard Post product number to BPG6DV.
- Hardware Set 28.0: OMIT door 1004 for set.

**Item 57:** Refer to Specification Section 01 1000 Summary, Para 1.01.E.:

- **Replace:** “The contractor shall begin the demolition of McCartha Hall within 10 days from notice to proceed and shall complete its demolition within 40 days from notice to proceed.”
- **With:** The contractor shall provide asbestos abatement submittal of McCartha Hall within 10 days from notice to proceed and shall begin demolition of McCartha Hall within 10 days upon completing asbestos abatement.

**Item 58:** Refer to Specification Section 09 6600 Terrazzo Flooring: Para. 1.03.A.5 OMIT

**Item 59:** Refer to Specification Section 06 4100 Architectural Plastic Laminate Casework: Para 2.06.A.5. & Addendum No. 2 Item 1: Upon further review Stevens Industries will not be considered an approved equal.

**Item 60:** Refer to Specification Section 12 3553 Wood Laboratory Casework: Para 2.1.C.c & Addendum No. 2 Item 2: Upon further review Stevens Industries will not be considered an approved equal.

**Item 61:** Refer to Specification Section 05 5000 Metal Fabrications: OMIT Para. 2.03.G. Metal Dumpster Gate per drawings.

**Item 62:** Add attached Specification Section 09 6519 Resilient Tile Flooring

**Item 63:** Refer to attached sheet C2.0:

- Revised location of where 6” fire sprinkler line enters building.
- Added 2-4” storm drain laterals from new building along south side building.

**Item 64:** Refer to attached Sheet E002:

- Changed ground and feeder size for panel CL1
- Added service ground note on generators
- Changed routing note for feed from generator to docking station

**Item 65:** Refer to attached Sheet E003:

- Added switched ceiling mounted duplex to legend
- Added chemical tank connection to legend

**Item 66:** Refer to attached Sheet E004:

- Added missing referenced note
- Added dedicated circuit for elevator machine room lighting

**Item 67:** Refer to attached Sheet E006:

- Moved light switch in Lab 1308

**Item 68:** Refer to attached Sheet E007:

- Added power connections for door controls at Future Lab 1009 and Mech 1010
- Added dedicated receptacle and circuit to elevator machine room
- Corrected labeling of transformers in Electrical 1005
- Added chemical tank connections
- Changed feeder size for GWP

**Item 69:** Refer to attached Sheet E008:

- Removed power connection for door controls in Shower Room 1116
- Added power connection for door controls in Chromatography Analytical Lab 1218 and Conference Room 1201

**Item 70:** Refer to attached Sheet E009:

- Added plug load controllers for furniture receptacles in Board Room 1303

**Item 71:** Refer to attached Sheet E010:

- Added door control conduit in Mech 1010 and Future Lab 1009
- Added stub up location of conduits entering from the site in Data 1007

**Item 72:** Refer to attached Sheet E011:

- Removed door control conduits in Shower Room 1116
- Added door control conduits in Chromatography Analytical Lab 1218 and Conference Room 1201

**Item 73:** Refer to attached Sheet E015:

- Added Access Control Detail

**Item 74:** Refer to attached Sheet E017:

- Changed MCB rating in Panel OLM
- Added breaker in Panel 0RA
- Added chemical tank breaker in panel 0LM

**Item 75:** Refer to attached Sheet E020:

- Changed mains to MLO in Panel OHM
- Changed breakers for GWP

**Item 76:** Refer to attached Sheet E022:

- Corrected circuit description for Panel OHRD in Switchboard SE

**Item 77:** Refer to attached Sheet E024:

- Changed breaker rating for Panel CL1 in Panel CH1
- Corrected circuit description for Tx 0LLS in Panel OHLS

**Item 78:** Refer to Specification Section 11 5313 Laboratory Fume Hoods and Related Products: Para 2.01 Add subparagraph:

3: EMERGENCY SHOWER

- a. Acceptable Manufacturer: WaterSaver
  - 1) Basis-of-Design Product: WaterSaver SSBF2160 Recessed Safety Station with Drain Pan, Recess Mounted Shower Head.

**Item 79:** Refer to attached Sheet S2.0 – Dimensions added or adjusted at east entrance foundation.

**Item 80:** Refer to attached Sheet S3.0 – East entrance dimensions adjusted. Beam spacing adjusted for revised mechanical openings through the floor.

**Item 81:** Refer to attached Sheet S4.0 – Beam spacing adjusted for revised mechanical openings through the floor.

**Item 82:** Refer to attached Sheet S5.0 - Beam spacing and some sizes adjusted for revised mechanical openings through the floor. Also plan notes 11 and 12 added. Section cut 86 added on east end.

**Item 83:** Refer to attached Sheet S6.0 – Section cuts added or sheet reference corrected on section cuts.

**Item 84:** Refer to attached Sheet S10.0 – Detail 22 revised to cap floor slab on top of footing.

**Item 85:** Refer to attached Sheet S11.0 – Wall dimensions adjusted by ½” of Details 29,30 and 31.

**Item 86:** Refer to attached Sheet S12.0 – Detail 46 edge condition revised.

**Item 87:** Refer to attached Sheet S13.0 – Stud work on Detail 47 adjusted slightly. Beam location adjusted slightly on S48. Edge of slab distance and condition revised on Detail 51.

**Item 88:** Refer to attached Sheet S15.0 – Slight adjustment to stud soffit framing on Detail 55.

**Item 89:** Refer to attached Sheet S16.0 – Exterior wall stud work revised on Detail 60 to match architectural sections. Side plates added for ridge beam connection on Detail 61.

**Item 90:** Refer to attached Sheet S18.0 – Wall dimensions adjusted by ½” on Details 76 and 77.

**Item 91:** Refer to attached Sheet S19.0 – Wall studs revised on Detail 81. Slab edge location adjusted on Detail 86.

**Item 92:** Refer to attached Sheet S20.0 – Ramp size and location adjusted in mechanical yard slab. Reinforcing and upper brick wall construction note revised on Detail B.

**Item 93:** Refer to attached Sheet T1.0:

- ADD Sheets M4.4, M5.4, M6.7, & P1.3

**Item 94:** Refer to attached Sheet T2.0:

- ADD Sheets M4.4, M5.4, M6.7, & P1.3

**Item 95:** Replace Sheet M1.3 with the attached Sheet M1.3.

**Item 96:** Replace Sheet M1.4 with the attached Sheet M1.4.

**Item 97:** Replace Sheet M1.5 with the attached Sheet M1.5.

**Item 98:** Replace Sheet M1.6 with the attached Sheet M1.6.

**Item 99:** Replace Sheet M1.7 with the attached Sheet M1.7.

**Item 100:** Replace Sheet M1.8 with the attached Sheet M1.8.

**Item 101:** Replace Sheet M1.9 with the attached Sheet M1.9.

**Item 102:** Replace Sheet M1.10 with the attached Sheet M1.10.

**Item 103:** Replace Sheet M1.11 with the attached Sheet M1.11.

**Item 104:** Replace Sheet M1.12 with the attached Sheet M1.12.

**Item 105:** Replace Sheet M2.0 with the attached Sheet M2.



**Item 106:** Replace Sheet M3.0 with the attached Sheet M3.0.

**Item 107:** Replace Sheet M3.1 with the attached Sheet M3.1.

**Item 108:** Replace Sheet M4.0 with the attached Sheet M4.0.

**Item 109:** Replace Sheet M4.2 with the attached Sheet M4.2.

**Item 110:** Replace Sheet M4.4 with the attached Sheet M4.4.

**Item 111:** Replace Sheet M5.4 with the attached Sheet M5.4.

**Item 112:** Replace Sheet M6.0 with the attached Sheet M6.0.

**Item 113:** Replace Sheet M6.7 with the attached Sheet M6.7.

**Item 114:** Replace Sheet P1.0 with the attached Sheet P1.0.

**Item 115:** Replace Sheet P1.3 with the attached Sheet P1.3.

**Item 116:** Replace Sheet P2.0 with the attached Sheet P2.0.

**Item 117:** Replace Sheet P3.0 with the attached Sheet P3.0.

**Item 118:** Replace Sheet P3.1 with the attached Sheet P3.1.

**Item 119:** Replace Sheet P3.2 with the attached Sheet P3.2.

**Item 120:** Replace Sheet P3.3 with the attached Sheet P3.3.

**Item 121:** Replace Specification Section 21 1550 Fire Protection with the attached Specification Section 21 1550 Fire Protection.

**Item 122:** Replace Specification Section 22 1510 Mechanical General Provisions with the attached Specification Section 22 1510 Mechanical General Provisions.

**Item 123:** Replace Specification Section 22 1540 Plumbing with the attached Specification Section 22 1540 Plumbing.

**Item 124:** Add Specification Section 22 1545 Laboratory Vacuum Air Piping.

**Item 125:** Add Specification Section 22 1546 Laboratory Compressed Air Piping Systems.

**Item 126:** Replace Specification Section 23 1570 Heating, Ventilation, and Air Conditioning with the attached Specification Section 23 1570 Heating, Ventilation, and Air Conditioning.

**Item 127:** Add Specification Section 23 1571 Stainless Steel Ductwork.

**Item 128:** Replace Specification Section 23 1592 Building Management Systems (BMS) and Temperature Control (ATC) Systems with the attached Specification Section 23 1592 Building Management Systems (BMS) and Temperature Control (ATC) Systems.

**Item 129:** Replace Specification Section 00 0102 Table of Contents with the attached Specification Section 00 0102 Table of Contents with the attached.

**End of Addendum No. 5**

## **SECTION 07 1324**

### **Pre-Applied Sheet Membrane Waterproofing**

#### **PART 1 — GENERAL**

##### **1.01 SUMMARY**

- A. The Work of this Section includes, but is not limited to, pre-applied sheet membrane waterproofing that forms an integral bond to poured concrete for the following applications:
  - 1. Vertical Applications: Membrane applied against soil retention system prior to placement of concrete foundation walls;
  - 2. Horizontal Applications: Membrane applied on prepared subbase prior to placement of concrete slabs.
- B. Related sections include, but are not limited to, the following:
  - 1. Section 31 2210 – Earthwork Geotechnical
  - 1. Section 03 0000 – Cast-In-Place Concrete

NOTE TO SPECIFIER: For vertical applications, coordinate with concrete formwork section to require one-sided wall forming system to minimize punctures to the sheet membrane waterproofing during formwork installation.

##### **1.02 SUBMITTALS**

- A. Submit manufacturer's product data, installation instructions and membrane samples for approval.

##### **1.03 REFERENCE STANDARDS**

- A. The following standards and publications are applicable to the extent referenced in the text.
- B. American Society for Testing and Materials (ASTM):
  - C 836 Standard Specification for High Solids, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
  - D 412 Standard Test Methods for Rubber Properties in Tension
  - D 570 Standard Test Method for Water Absorption of Plastics
  - D 903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
  - D 1876 Standard Test Method for Peel Release of Adhesives (T-Peel)
  - D 1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
  - D 3767 Standard Practice for Rubber - Measurements of Dimensions
  - D 5385 Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes
  - E 96 Standard Test Methods for Water Vapor Transmission of Materials
  - E 154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

##### **1.04 QUALITY ASSURANCE**

- A. Manufacturer: Sheet membrane waterproofing system shall be manufactured and marketed by a firm approved by manufacturer. i

- B. Installer: A firm which has at least 3 years experience in work of the type required by this section.
- C. Materials: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer.
- D. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include review of special details and flashing.
- E. Schedule Coordination: Schedule work such that membrane will not be left exposed to weather for longer than that recommended by the manufacturer.

### **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from weather, excessive temperature, and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.

### **1.06 PROJECT CONDITIONS**

- A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used. Proceed with installation only when the substrate construction and preparation work is complete and in condition to receive sheet membrane waterproofing.

### **1.07 WARRANTY**

- A. Sheet Membrane Waterproofing: Provide written ten year material warranty issued by the membrane manufacturer upon completion of work. See warranty at end of Section.

## **PART 2 — PRODUCTS**

### **2.01 MATERIALS**

- A. Pre-applied Integrally Bonded Sheet Waterproofing Membrane: PREPRUFE® 250 Membrane by GCP Applied Technologies ("GCP"), a 0.8 mm (0.030 in) nominal thickness composite sheet membrane comprising 0.5 mm (0.020 in.) of high density polyethylene film, and layers of specially formulated synthetic adhesive. The membrane shall form an integral and permanent bond to poured concrete to prevent water migration at the interface of the membrane and structural concrete. Provide membrane with the following physical properties: BASIS OF DESIGN or equal.

NOTE TO SPECIFIER: PREPRUFE® 250 can be installed at temperatures 25°F (-4°C) and above. For temperatures 25°F (-4°C) to 50°F (10°C), the use of PREPRUFE® LT Tape is required at all side laps when using PREPRUFE® 250 membrane.

PHYSICAL PROPERTIES FOR PREPRUFE® 300R (or 300LT) MEMBRANE:

Property	Test Method	Typical Value
Color		White
Thickness	ASTM D 3767	0.8 mm (0.030in.) nominal
Lateral Water Migration Resistance	ASTM D 5385 <sup>1</sup>	Pass at 55 m (180 ft.) of hydrostatic head pressure
Low Temperature Flexibility	ASTM D 1970	Unaffected at -23°C (-10°F)
Elongation	ASTM D 412 <sup>2</sup>	300%
Crack Cycling at -23°C (-9.4°F), 100 Cycles	ASTM C 836 <sup>5</sup>	Unaffected, Pass
Tensile Strength, film	ASTM D 412	27.6 MPa (4,000 lbs./in. <sup>2</sup> )
Peel Adhesion to Concrete	ASTM D 903 <sup>3</sup>	700 N/m (4.0 lbs./in.)
Resistance to Hydrostatic Head	ASTM D 5385 <sup>6</sup>	180ft. (55m)
Lap Adhesion	ASTM D 1876 <sup>4</sup>	700 N/m (4.0 lbs./in.)
Puncture Resistance	ASTM E 154	600N (135 lbs.)
Permeance	ASTM E 96 Method B	<0.1 perms ((5.74 ng/(Pa x s x m <sup>2</sup> )))
Water Absorption	ASTM D 570	0.5%

**Footnotes:**

1. Lateral water migration resistance is tested by casting concrete against membrane with a hole and subjecting the membrane to hydrostatic head pressure with water. The test measures the resistance of lateral water migration between the concrete and the blind side waterproofing membrane. A hydrostatic head pressure of 71 m (231 ft) of water is the limit of the apparatus.
2. Elongation of membrane is run at a rate of 50 mm (2 in.) per minute.
3. Concrete is cast against the protective coating surface of the membrane and allowed to cure (7 days minimum). Peel adhesion of membrane to concrete is measured at a rate of 50 mm (2 in.) per minute at room temperature.
4. The test is conducted 15 minutes after the lap is formed at a rate of 50 mm (2 in.) per minute.
5. Test conducted at -23°C (-9.4°F)
6. Hydrostatic head tests are performed by casting concrete against the membrane with a lap. Before the concrete sets a 3 mm (0.125 in.) spacer is inserted perpendicular to the membrane to create a gap. The cured block is placed in a chamber where water is introduced to the membrane surface up to a head of 71 m (231 ft) of water which is the limit of the apparatus.
  - B. Waterstop: ADCOR® hydrophilic waterstop by GCP Applied Technologies for non-moving concrete construction joints. See gcpat.com
  - C. Preformed Soil Retention Wall Tieback Cover: PREPRUFE® Tieback Cover by GCP Applied Technologies as a prefabricated detail for soil retention wall tiebacks.

- D. Tape for covering cut edges, roll ends, penetrations and detailing: PREPRUFE® Tape LT (for temperatures between 25°F (-4°C) and 86°F (+30°C)) and PREPRUFE® Tape HC (for use in Hot Climates, minimum 50°F (10°C))
- E. Miscellaneous Materials: accessories specified or acceptable to manufacturer of pre-applied waterproofing membrane.

## **PART 3 — EXECUTION**

### **3.01 EXECUTION**

- A. The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the Contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

### **3.02 SUBSTRATE PREPARATION**

- A. It is essential to create a sound and solid substrate to eliminate movement during the concrete pour. Substrates must be regular and smooth with no gaps or voids greater than 0.5 in. (12 mm). Grout around all penetrations such as utility conduits, etc. for stability.
  - 1. Horizontal Surfaces - The substrate must be free of loose aggregate and sharp protrusions. Avoid curved or rounded substrates. When installing over earth or crushed stone, ensure substrate is well compacted to avoid displacement of substrate due to traffic or concrete pour. The surface does not need to be dry, but standing water must be removed.
  - 2. Vertical Surfaces - Use concrete, plywood, insulation or other approved facing to sheet piling to provide support to the membrane. Board systems such as timber lagging must be close butted to provide support and not more than 0.5 in. (12 mm) out of alignment

### **3.03 INSTALLATION, HORIZONTAL APPLICATIONS**

- A. Strictly comply with installation instructions in manufacturer's published literature, including but not limited to, the following:
  - 1. Place the PREPRUFE® 250 membrane HDPE film side to the substrate with the clear plastic release liner facing towards the concrete pour. End laps should be staggered to avoid a build-up of layers.
  - 2. Leave the plastic release liner in position until overlap procedure is completed.
  - 3. Accurately position succeeding sheets to overlap the previous sheet 3 in. (75 mm) along the marked selvedge. Ensure the underside of the succeeding sheet is clean, dry and free from contamination before attempting to overlap.
  - 4. Peel back the plastic release liner from between the overlaps as the two layers are bonded together. Ensure a continuous bond is achieved without creases and roll firmly with a heavy roller.
  - 5. Completely remove the plastic liner to expose the protective coating. Any initial tack will quickly disappear.

### **3.04 INSTALLATION, VERTICAL APPLICATIONS**

- A. Strictly comply with installation instructions in manufacturer's published literature, including but not limited to, the following:

1. Where desired mechanically fasten the PREPRUFE® 250 membrane vertically using fasteners appropriate to the substrate with the clear plastic release liner facing towards the concrete pour. The membrane may be installed in any convenient length.
2. All mechanical fastening shall be through the selvedge using a small and low profile head fastener so that the membrane lays flat and allows firmly rolled overlaps.
3. Immediately remove the plastic release liner.
4. Ensure the underside of the succeeding sheet is clean, dry and free from contamination before attempting to overlap.
5. After placement roll firmly to ensure a watertight seal.
6. Overlap all roll ends and cut edges by a minimum 3 in. (75 mm) and ensure the area is clean and free from contamination, wiping with a damp cloth if necessary.
7. Allow to dry and apply PREPRUFE® Tape LT (or HC in hot climates) centered over the lap edges and roll firmly.
8. Immediately remove printed plastic release liner from the tape.

### **3.05 WATERSTOP INSTALLATION**

- A. Strictly comply with installation instructions in manufacturer's published literature, including but not limited to, the following:
  1. Secure ADCOR® hydrophilic waterstop using masonry nails 1½ in. - 2 in. (40 mm – 50 mm) long with a washer ¾ in. (20 mm) in diameter. Hilti EM6-20-12 FP8 shot fired fixings with ¼ in. (6 mm) nuts and ¾ in. (20 mm) diameter washers may also be used. Fixings should be spaced at a maximum of 12 in. (300 mm) centers with a minimum spacing that ensures proper contact to substrate.
  2. On irregular concrete faces, or on vertical surfaces, apply a ½ in. (12 mm) bead of ADCOR® Adhesive as bedding for ADCOR® hydrophilic waterstop.
  3. ADCOR® hydrophilic waterstop joints should overlap a minimum of 4 in. (100 mm), ensuring full contact between jointed pieces.

### **3.06 PROTECTION**

- A. Protect membrane in accordance with manufacturer's recommendations until placement of concrete. Inspect for damage just prior to placement of concrete and make repairs in accordance with manufacturer's recommendations.

**PROJECT WATERPROOFING WARRANTY**

**NAME OF PROJECT:** TROY UNIVERSITY CENTER FOR MATERIALS  
**AND** MANUFACTURING SCIENCES

**PROJECT LOCATION:** TROY, ALABAMA

**OWNER :** TROY UNIVERSITY

**DATE OF SUBSTANTIAL COMPLETION:** \_\_\_\_\_

**DATE OF EXPIRATION:** \_\_\_\_\_

- A. A. THE WATERPROOFING CONTRACTOR AND GENERAL CONTRACTOR DO HEREBY CERTIFY THAT THE BELOW SLAB VAPOR PROTECTION UNDERGROUND WATERPROOFING WORK INCLUDED IN THIS CONTRACT WAS INSTALLED IN STRICT ACCORDANCE WITH ALL REQUIREMENTS OF THE PLANS AND SPECIFICATIONS 07 1610 BELOW GRADE WATER PROOFING AND IN ACCORDANCE WITH APPROVED WATERPROOFING MANUFACTURER'S RECOMMENDATIONS FOR ALL SPECIFIED WARRANTY REQUIREMENTS.**
- A. B. THE WATERPROOFING CONTRACTOR AND GENERAL CONTRACTOR HEREBY GUARANTEE THE WATERPROOFING AND ASSOCIATED WORK INCLUDING BUT NOT LIMITED TO ALL UNDERGROUND VERTICAL AND HORIZONTAL WATERPROOFING TO BE WATER TIGHT AND FREE FROM ALL LEAKS AND MOISTER INTRUSION, DUE TO FAULTY OR DEFECTIVE MATERIALS AND WORKMANSHIP FOR A PERIOD OF TEN (10) YEARS, STARTING ON THE DATE OF SUBSTANTIAL COMPLETION OF THE PROJECT.**



- A. C.      **SUBJECT TO THE TERMS AND GENERAL CONTRACTOR CONDITIONS LISTED BELOW, THE WATERPROOFING CONTRACTOR SHALL SO GUARANTEE THAT DURING THE GUARANTEE PERIOD HE WILL, AT HIS OWN COST AND EXPENSE, MAKE OR CAUSE TO BE MADE SUCH REPAIRS TO, OR REPLACEMENTS OF SAID WORK, IN ACCORDANCE WITH THE WATERPROOFING MANUFACTURERS RECOMMENDATIONS AS ARE NECESSARY TO CORRECT FAULTY AND DEFECTIVE WORK AND/OR MATERIALS WHICH MAY DEVELOP IN THE WORK INCLUDING. ANTICIPATED LIFE OF THE WATERPROOFING SYSTEMS AND THE BEST STANDARDS APPLICABLE TO THE PARTICULAR WATERPROOFING TYPE IN VALUE AND IN ACCORDANCE WITH CONSTRUCTION DOCUMENTS AS ARE NECESSARY TO MAINTAIN SAID WORK IN WATERTIGHT CONDITIONS, AND FURTHER, TO RESPOND ON OR WITHIN SEVEN (7) CALENDAR DAYS UPON PROPER NOTIFICATION OF LEAKS OR DEFECTS BY THE OWNER.**
- i. 1.      **During the Guarantee Period, if the Owner allows alteration of the work by anyone other the Waterproofing Contractor or General Contractor, including cutting, patching and maintenance in connection with penetrations, and positioning of anything effecting the below grade waterproofing, this Guarantee shall become null and void upon the date of said alterations**
  - i. 2.      **Future building additions will not void this Guarantee, except for that portion of the future addition that might affect the work under this contract at the point of connection of the waterproofed areas, and any damage caused by such addition.**
  - i. 3.      **The Owner shall promptly notify the Waterproofing Contractor and the General Contractor of observed, known or suspected leaks, defects or deterioration, and shall afford reasonable opportunity for the Waterproofing Contractor to inspect the work, and to examine the evidence of such leaks, defects or deterioration.**

D. INCLUDED IN THIS WARRANTY ARE ALL REQUIRED REPAIRS AND  
RECONSTITUTING OF PHYSICAL FACILITY TO THE PROJECT AS A RESULT OF  
DAMAGE TO THE FACILITY DUE TO FAILURE OF THE ABOVE NOTED SYSTEMS AT NO  
ADDITIONAL COST TO OWNER.

IN WITNESS THEREOF, THIS INSTRUMENT HAS BEEN DULY EXECUTED  
THIS \_\_\_\_\_ DAY OF \_\_\_\_\_ (YEAR).

\_\_\_\_\_  
WATERPROOFING CONTRACTORS' AUTHORIZED SIGNATURE

\_\_\_\_\_  
COMPANY NAME

\_\_\_\_\_  
COMPANY ADDRESS

\_\_\_\_\_  
GENERAL CONTRACTOR'S AUTHORIZED SIGNATURE

\_\_\_\_\_  
COMPANY NAME

\_\_\_\_\_  
COMPANY ADDRESS

\_\_\_\_\_  
NOTARY PUBLIC

A. END OF SECTION

## SECTION 08 3100 - ACCESS DOORS AND PANELS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. **Wall and (Addendum 5)** ceiling access door and frame units.

#### 1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry
- B. Section 09 2116 - Gypsum Board Assemblies
- C. Section 09 9123 - Interior Painting: Field paint finish.
- D. Section [ ]: Mechanical components requiring access.

#### 1.03 REFERENCE STANDARDS

- A. ITS (DIR) - Directory of Listed Products current edition.

#### 1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Shop Drawings: Indicate exact position of each access door and/or panel unit.
- D. Manufacturer's Installation Instructions: Indicate installation requirements and rough-in dimensions.

#### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

### PART 2 PRODUCTS

#### 2.01 ACCESS DOORS AND PANELS ASSEMBLIES

- A. **Ceiling and Wall (Addendum 5)** Mounted Units:
  - 1. Location: As Required **(Addendum 5)**
  - 2. Material: Steel.
  - 3. Size in Ceilings: [as indicated or as required] inches ([ ] mm), unless otherwise indicated.
  - 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
  - 5. Tool-operated spring or cam lock; no handle.
  - 6. **Fire rating as required. (Addendum 5)**

#### 2.02 MANUFACTURERS

- A. Wall and Ceiling Access Doors:
  - 1. Acudor Products Inc: [www.acudor.com](http://www.acudor.com).
  - 2. Karp Associates, Inc: [www.karpinc.com](http://www.karpinc.com).
  - 3. Milcor by Commercial Products Group of Hart & Cooley, Inc: [www.milcorinc.com](http://www.milcorinc.com).
  - 4. Substitutions: See Section 01 6000 - Product Requirements.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that rough openings are correctly sized and located.

### **3.02 PREPARATION**

- A. Clean surfaces thoroughly prior to proceeding with this work.
- B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

### **3.03 INSTALLATION**

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.
- C. Position units to provide convenient access to concealed equipment when necessary.

### **END OF SECTION**

## **SECTION 08 5113 - ALUMINUM WINDOWS, DOORS & FRAMES**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Extruded aluminum fixed windows
  - 1. Factory glazing per requirements of glazing Section 08 8000
  - 2. Panning Trim
- B. Extruded aluminum doors and frames
  - 1. Factory glazing per requirements of glazing Section 08 8000
  - 2. Factory Glazing.
  - 3. Insulated Raised Panels
  - 4. Panning Trim

#### **1.02 RELATED REQUIREMENTS**

- A. Section 05 5000 - Metal Fabrications: Steel lintels.
- B. Section 06 1000 - Rough Carpentry: Rough opening framing.
- C. Section 07 2500 - Weather Barriers (Alternate): Perimeter air and vapor seal between window frame and adjacent construction.
- D. Section 07 9005 - Joint Sealers: Perimeter sealant and back-up materials.
- E. Section 08 8000 - Glazing.

#### **1.03 REFERENCE STANDARDS**

- A. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for windows, doors, and skylights 2011.
- B. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site 2015.
- C. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections 2009.
- D. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels 2013.
- E. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2012.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2015.
- G. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- H. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric] 2014.
- I. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2014.
- J. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric] 2013.
- K. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).

- L. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference 2015.
- M. ASTM F588 - Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact 2014.
- N. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic") 2002 (Ed. 2004).

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Preinstallation Meeting: Convene one week before starting work of this section.

#### **1.05 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions.
- C. Shop Drawings: Indicate opening dimensions, elevations of different types, framed opening tolerances, method for achieving air and vapor barrier seal to adjacent construction, anchorage locations, , and installation requirements.
- D. Samples: Submit two samples, 12 x 12 inch (300 x 300 mm) in size illustrating typical corner construction, accessories, and finishes.
- E. Certificates: Certify that windows meet or exceed specified requirements.
- F. Manufacturer's Installation Instructions: Include complete preparation, installation, and cleaning requirements.
- G. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- H. Mock Up:
  - 1. Provide full size window mockup (minimum window size to be 2'-0" x 3'-4") in project mockup - refer to section 04 2000.
  - 2. Install all required flashings, termination bars, sealants, panning trims, extruded sills, and other masonry/window accessories required by the contract documents.
  - 3. Mock up is intended to establish acceptable quality standards for exterior wall assembly and shall remain in place during the duration of the project.
  - 4. Mock up is to be separate from the work and may not be incorporated into the work.

#### **1.06 QUALITY ASSURANCE**

- A. Manufacturer and Installer Qualifications: Company specializing in fabrication of commercial aluminum windows of types required, with not fewer than three years of experience.
- B. Testing: Test each type and size of required window unit through a recognized testing laboratory or agency, in accordance with ASTM E 330 for structural performance, with ASTM E 283 for air infiltration and with both ASTM E 331 and ASTM E 547 for water penetration. In addition, provide certified test results indicating compliance with performance below.
  - 1. Air infiltration: Shall not exceed 0.18 CFM when tested per ASTM E283 at 50 miles per hour or 6.24 PSF.
  - 2. Water infiltration: No leakage when tested in accordance with ASTM E 331 and ASTM E 547 at 11 PSF.

C. Thermal Performance:

1. All exterior aluminum window Assemblies shall have a maximum U-value of .50 and a Assembly maximum solar heat gain coefficient of .25
2. All exterior aluminum swinging entrance doors shall have a maximum U-Value of .77 and an Assembly maximum SHGC Of .25.

**1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with requirements of AAMA CW-10.
- B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

**1.08 FIELD CONDITIONS**

- A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C).
- B. Maintain this minimum temperature during and 24 hours after installation of sealants.

**1.09 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a ten year period after Date of Substantial Completion for aluminum windows.
- C. Correct defective Work within a three year period after Date of Substantial Completion for aluminum doors.
- D. Provide ten year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- E. Provide fifteen year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.
- F. Provide manufacturer's three year warranty for all aluminum doors.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Windows:
  1. Basis of Design: Series G600 - Model G641 Standard windows interior panning set as manufactured by Peerless Windows. 3.25 " window depth with Historical exterior panning trim and extruded sill, or equal. .
- B. Doors:
  1. Basis of Design: Kawneer 500 series or equal.
    - a. Nominal 1" thick aluminum raised panels for glazing into the door glazing pocket, with raised panel design at both interior and exterior surfaces. Overall thickness of raised panel shall be no greater that the thickness of the door. Dimensions and profiles of the raised panel shall be as shown on the architectural drawings.
    - b. Nominal 1" thick aluminum raised panels for glazing into the door glazing pocket, with raised panel design at both interior and exterior surfaces. Overall thickness of raised panel shall be no greater than the thickness of the

door. Dimensions and profiles of the raised panel shall be as shown on the architectural details.

- c. 1 3/4" thick aluminum stile and rail door as shown on the drawings with raised interior and exterior panel with insulated core at base and glazed top with applied exterior mullions. Glazed lites shall be 1" insulated tempered glass with glazed in muntin grids on exterior.( refer to Section 08 8000 Glazing & Section and 087100 Door Hardware) . Provide 10" high bottom rail. Aluminum door frame to be equal to Kawneer 451 Thermal with exterior panning trim equal to Peerless 4914 and interior trim equal to Peerless 4179.

C. Insulated Raised Aluminum Panels (for Aluminum Entrance doors)

- 1. Basis of Design: Construction Services, Decatur, AL or Abrams Architectural Products, Austell, Georgia, or equal.
  - a. Nominal 1" thick aluminum raised panels for glazing into the door glazing pocket, with raised panel design at both interior and exterior surfaces. Overall thickness of raised panel shall be no greater than the thickness of the door. Dimensions and profiles of the raised panel shall be as shown on the architectural details.

D. Aluminum Windows:

- 1. Manko Windows
- 2. Peerless Windows (Basis of Design) Series G600 - Model G 641
- 3. Custom Windows
- 4. Wausau Windows
- 5. Graham Architectural Products
- 6. Substitutions: See Section 01 6000 - Product Requirements.

**2.02 PRODUCTS:**

A. Aluminum Windows:

- 1. Design as shown on window schedule with exterior applied muntin (refer to details on drawings). Window depth – not less than 3.25" no exceptions, main frame extrusion thickness – not less than .062". Refer to Glazing for SHGC and U Factor requirements and any specified glass performance and properties.
- 2. Accessories:
  - a. Exterior Panning trim to match Peerless 4914, or equal, with caulking return leg.
  - b. Interior Panning Set to match Peerless 4179, or equal.
  - c. Exterior Applied Muntin Grids: Provide 1-7/16" wide trapezoidal shaped extruded aluminum muntin grids, as indicated on drawings and approved by architect, at the exterior of all windows in lite patterns as shown on the plans. If muntin grids cannot be rolled to the radii required at "bullseye" or arch windows, the window manufacturer shall fabricate muntin grids from 3/8" thick aluminum flat plate material utilizing laser cut or CNC machined profile grids to match profiles of the conventional trapezoidal shaped muntin profile selected by the architect. It shall be the manufacturer's responsibility to assure that the CNC Machined muntins are compatible with the window system, including any provision for exterior glazing at spandrel areas. At "Window Type A" vision glazing provide interior flat stock and internal muntin



spacers neatly aligned with the exterior muntins to simulate true divided lites.

B. Aluminum Doors and Frames:

1. 1-3/4" deep stile and rails. Provide Sections with minimum wall sections of 0.125" thickness. Exterior Doors and 4' wide interior door stiles to be 5" wide to accommodate the finish hardware requirements. Bottom rail to be 10" high **equal to Kawneer 500**. Interior Doors less than 4' wide shall have doors stiles 3.5" wide. **Accomodate (Addendum 5)** the finish hardware requirements. **Bottom (Addendum 5)** rail to be 10" high **equal to Kawneer 350**. Exterior aluminum panels located at Entrance doors shall be fabricated from minimum .090" thick aluminum sheet with a "raised panel" design formed into the exterior face as detailed. The raised panel perimeter shall have a reveal as selected by the architect. The interior face shall be raised to "mirror the exterior. Overall thickness of panel at the perimeter where glazed into the window frame or door leaf shall be approximately 1.00" and panels shall not be any thicker than the surrounding door stile and rail. Panels shall be finished as specified using a 70% KYNAR based Fluoropolymer organic finish in accordance with AAMA 2605 in color as selected by the architect. Internal cavity shall be filled with expandable polyurethane foam or other core material as recommended by the panel manufacturer. Provide weatherstripping.
2. Door corners shall be accurately and securely joined by four 1/4" STAINLESS STEEL machine bolts threaded a minimum of 1" into splines of a tightly fitted shear block nested in and welded to both stile and rail.
3. Frame members, which function primarily as glass holding assemblies (sidelights and transoms), shall be anchored with standard frame clips and stainless steel machine screws. Glazing framing members and doors shall provide for fully resilient glass setting.
4. Aluminum window manufacturer shall provide **trapizoid shaped (Addendum 5)** extruded aluminum muntin grids and perimeter muntin bases to match the muntins as shown on drawings, which shall be applied at the exterior of glass surfaces. Door fabricator shall fabricate the muntin grids and all components and shall install/glaze the doors with the fabricated muntin system along with the specified glazing.
5. Hardware for entrance doors and frames: See door schedule and Section 08 7100 Finish Hardware.
6. Exterior Panning trim shall be equal to Peerless 4914 with **caulk return**. fabricated by the aluminum door fabricator and attached to the perimeter frames at the manufacturer's facility. Fit to frame as required.
7. Interior trim equal to Peerless 4179 profiled trim as required. Fit to frame as required.
8. Aluminum Framing;
  - a. Equal to Kawneer 451 T : 2" x 4 1/2" depth , refer to drawings.
  - b. Equal to Kawneer 450 : 1 3/4" x 4 1/2" depth, refer to drawings.

C. Performance Requirements:

1. Grade: AAMA/WDMA/CSA 101/I.S.2/A440 AW70.
2. Air Infiltration Test Pressure Differential: 6.24 pounds per square inch.

3. System Internal Drainage ( if required by design of the window): Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, or migrating moisture occurring within system.
- D. Fixed, Non-Operable Type:
  1. Construction: Thermally broken.
  2. Glazing: See section 08 8000.
  3. Exterior Finish: High performance organic coating. AAMA 2605.
  4. Interior Finish: High performance organic coating. AAMA 2605.

### **2.03 COMPONENTS**

- A. Fasteners: Stainless steel.
- B. Glazing Materials: As specified in Section 08 8000.
- C. Sealant and Backing Materials: As specified in Section 07 9005.
- D. Panning Trim:
  1. Provide on all doors and windows as specified.
- E. Sub Sill Flashing
  1. Provide sub sill flashing as indicated on the drawings. Refer to 07 6200.
  2. Provide end dams on all sub sill flashing.

### **2.04 MATERIALS**

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B. Sheet Aluminum: ASTM B209 (ASTM B209M), 5005 alloy, H12 or H14 temper.
- C. Concealed Steel Items: Profiled to suit mullion sections; galvanized in accordance with ASTM A 123/A 123M.

### **2.05 FABRICATION**

- A. Fabricate components with smallest possible clearances and shim spacing around perimeter of assembly that will enable window installation and dynamic movement of perimeter seal.
- B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
- C. Prepare components to receive anchor devices.
- D. Arrange fasteners and attachments to ensure concealment from view.
- E. Provide steel internal reinforcement in mullions as required to meet loading requirements.
- F. Factory glaze window units.
- G. Prior to fabrication, the Contractor shall obtain written approval from the Owner and Architect on the window color samples. Proceeding without written approval from both the Architect and Owner will be at the Contractor's risk.
- H. Prior to fabrication of windows, field measure and verify all applicable opening dimensions and conditions to ensure proper installation of window, trim, flashings, backer rods, sealants, and other accessories called for the in the Contract Documents.

### **2.06 FINISHES**

- A. Superior Performance Organic Coating System: AAMA 2605 multiple coat, thermally cured polyvinylidene fluoride system; color number 391A586 pure white/bone white .

Provide color samples to architect prior to manufacturing for written approval.

- B. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install windows in accordance with manufacturer's instructions.
- B. Install window assembly in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
- C. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- D. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
- E. Coordinate attachment and seal of perimeter air barrier and vapor retarder materials.
- F. Install operating hardware not pre-installed by manufacturer.
- G. Install glass and infill panels in accordance with requirements specified in Section 08 8000.
- H. Install perimeter sealant in accordance with requirements specified in Section 07 9005.

#### **3.02 TOLERANCES**

- A. Maximum Variation from Level or Plumb: 1/16 inches every 3 ft (1.5 mm/m) non-cumulative or 1/8 inches per 10 ft (3 mm/3 m), whichever is less.

#### **3.03 FIELD QUALITY CONTROL**

- A. Test installed windows for compliance with performance requirements for water penetration, in accordance with ASTM E1105 using uniform pressure and 66% pressure difference from that of lab test.
  - 1. The owner has the option of testing any or all windows for the first test
  - 2. The Contractor shall test 3 windows immediately after installation for compliance with performance requirements. Windows to be tested will be determined by Architect on site.
- B. Replace windows that have failed field testing and retest until performance is satisfactory.

#### **3.04 ADJUSTING**

- A. Adjust hardware for smooth operation and secure weathertight closure.

#### **3.05 CLEANING**

- A. Remove protective material from factory finished aluminum surfaces.
- B. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.
- C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.

### **END OF SECTION**

## **SECTION 09 6519 - RESILIENT TILE FLOORING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Resilient flooring.
- B. Installation accessories:
  - 1. Adhesives.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions: SCS FloorScore certification documentation.
- B. Section 01 7419 - Construction Waste Management and Disposal.
- C. Section 07 9200 - Joint Sealants.
- D. Section 07 9513 - Expansion Joint Cover Assemblies.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM D2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine 2017.
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- C. ASTM E662 - Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials 2019.
- D. ASTM F386 - Standard Test Method for Thickness of Resilient Flooring Materials Having Flat Surfaces 2017.
- E. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring 2019, with Editorial Revision (2020).
- F. ASTM F925 - Standard Test Method for Resistance to Chemicals of Resilient Flooring 2013 (Reapproved 2020).
- G. ASTM F970 - Standard Test Method for Measuring Recovery Properties of Floor Coverings after Static Loading 2017.
- H. ASTM F1514 - Standard Test Method for Measuring Heat Stability of Resilient Flooring by Color Change; 2003 (Reapproved 2013).
- I. ASTM F1515 - Standard Test Method for Measuring Light Stability of Resilient Flooring by Color Change; 2003 (Reapproved 2008).
- J. ASTM F2055 - Standard Test Method for Size and Squareness of Resilient Floor Tile by Dial Gage Method 2017.
- K. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes 2019a.
- L. ASTM F2199 - Standard Test Method for Determining Dimensional Stability of Resilient Floor Tile after Exposure to Heat; 2009 (Reapproved 2014).
- M. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 2019.

#### **1.04 SUBMITTALS**

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings.
- C. Manufacturer's documentation for flooring and accessories:

1. Technical Data.
  2. Installation and Maintenance.
  3. Warranty.
  4. Safety Data Sheets (SDS) for accessories.
- D. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
- E. Verification Samples: Submit two samples, 4 by 4 inch (100 by 100 mm) in size illustrating color and pattern for each resilient flooring product specified.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and that the material is of the correct style, color, quantity and run number(s).
- B. Store all materials flat and off of the floor in an acclimatized, weather-tight space between 65 to 85 degrees F (18 to 29 degrees C).
- C. Do not double stack pallets.

#### **1.06 FIELD CONDITIONS**

- A. Acclimate material at jobsite between 65 to 85 degrees F (18 to 29 degrees C) and 35 percent to 85 percent relative humidity for 48 hours prior to installation. Temperature and relative humidity should also be maintained at the same levels during installation, and after installation.
- B. Spread unopened cartons no more than 6 cartons high and at least 4 inches (101 mm) apart.
- C. Keep away from heating and cooling ducts and direct sunlight.
- D. Close areas to traffic during installation of flooring and accessories.

#### **1.07 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

#### **1.08 WARRANTY**

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Basis of Design: Nora Systems, Inc., 9 Northeastern Blvd., Salem, NH 03079;
- B. Substitutions: See Section 01 6000 - Product Requirements.

#### **2.02 RESILIENT TILE FLOORING**

- A. Nora Flooring (Refer to Finish Schedule)
1. Norament Satura
    - a. Arcturus 5116

#### **2.03 ACCESSORIES**

- A. Adhesives:
1. Dryfix 750

## **PART 3 EXECUTION**

### **3.01 EXAMINATION - SEE ALSO SECTION 01 7000.**

- A. Install flooring and accessories after other operations (including painting) have been completed.
- B. Acceptance of Conditions: Carefully examine all installation areas with installer/applicator present, for compliance with requirements affecting work performance.
  - 1. Verify that field measurements, product, adhesives, substrates, surfaces, structural support, tolerances, levelness, temperature, humidity, moisture content level, pH, cleanliness and other conditions are as required by the manufacturer, and ready to receive work.
- C. Verify that substrate is contaminant-free, including old adhesives and abatement chemicals.
- D. Test substrates as required by manufacturer to verify proper conditions exist.
- E. Verify that required floor-mounted utilities are in correct location.

### **3.02 PREPARATION**

- A. Prior to installation, the flooring installer should plan and attend an on-site construction meeting with the General Contractor, Architect and Property Owner to review all requirements and inspect site conditions as outlined in the manufacturer's installation document, as well as to review the requirements of ASTM F710 and any relevant building codes, or local, state, or national regulations.
- B. Flooring installation should not begin until all site conditions have been assessed, testing has been completed and subfloor conditions have been approved.
- C. Prepare per manufacturer's written instructions, Section 01 7000, and as follows:
  - 1. Prepare substrates to ensure proper adhesion of Luxury Vinyl Plank & Tile.

### **3.03 INSTALLATION**

- A. Installation per manufacturer's written instructions, Section 01 7000, and as follows:
  - 1. Layout shall be specified by Architect, Designer or End User.
  - 2. Follow layout and ensure installation reference lines are square.
  - 3. Field tiles shall be installed with directional arrows on back aligned in the same direction, or may be installed in quarter-turned fashion.
  - 4. Check cartons for and do not mix dye lots.
  - 5. Expansion Joints: Locate expansion, isolation, and other moving joints prior to installation.
    - a. Do not fill expansion, isolation, and other moving joints with patching compound nor cover with resilient flooring.
    - b. Install movement joint systems per manufacturer's instructions and per Section 07 9200 and Section 07 9513.
  - 6. Adhesives: Adhere flooring to substrate using the full spread method resulting in a completed installation without gaps, voids, raised edges, bubbles or any other surface imperfections.
    - a. Select appropriate adhesive, trowel and follow manufacturer's instructions.
    - b. Periodically spot-check transfer of adhesive to back of tile during installation.

- c. Roll floor with a 100 pound roller to ensure proper transfer of adhesive and bonding.
- d. Protect floor from traffic per manufacturer's instructions.
- e. Do not wet mop floor until the adhesive has properly set per written instructions.

### **3.04 CLEANING**

- A. Waste Management per Section 01 7000 and Section 01 7419, and as follows:
  - 1. Coordinate material reclamation program with manufacturer, if applicable.
    - a. Store and return cartons and pallets to manufacturer or recycler for reuse or recycling.
- B. Provide progress cleaning per manufacturer's written instructions, Section 01 7000, and as follows:
  - 1. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the work.
    - a. Clean and protect completed construction until Date of Substantial Completion.
    - b. During installation, remove wet adhesive from surface of flooring per manufacturer's instructions.
  - 2. Site: Maintain project site free of waste materials and debris.
- C. Provide final cleaning immediately prior to Date of Substantial Completion inspection per manufacturer's written instructions and Section 01 7000.
  - 1. Protection: Remove manufacturer's and other installed protection immediately prior to Date of Substantial Completion inspection, unless required otherwise.
  - 2. Clean floor with a neutral 6-8 pH cleaner.

### **3.05 PROTECTION**

- A. Protect materials from construction operations until Date of Substantial Completion or Owner occupancy, whichever occurs first.
  - 1. Protect finished floor from abuse and damage by using heavy non-staining kraft paper, drop cloths or equivalent. Use additional, non-damaging protective materials as needed.
  - 2. Light foot traffic on a newly installed floor can be permitted after 24 hours.
  - 3. Keep heavy traffic and rolling loads off the newly installed LVT flooring for 48 hours.
  - 4. Protect the floor from rolling loads by covering with protective boards.

### **END OF SECTION**

These specifications sections were prepared by and under the direct supervision of the Engineer of Record for this project.

Division– MECHANICAL

- 22 1510 Mechanical General Provisions
- 22 1540 Plumbing
- 22 1545 Lab Vacuum Air Piping
- 22 1546 Lab Compressed Air Piping
- 21 1550 Fire Protection
- 21 1560 Fire Protection Preaction System
- 23 1570 Heating, Ventilating & Air Conditioning
- 23 1571 Stainless Steel Ductwork
- 23 1592 Heating, Ventilating and Air Conditioning  
Building Automation System (BAS)



January 15, 2021





## **SECTION 21 1550 FIRE PROTECTION**

### **PART 1. GENERAL PROVISIONS**

- 1.1 General Provisions:** Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, and Division 21, 22 and 23 Specifications are applicable in full.
- 1.2 Qualifications of Contractor:** The system shall be installed by an approved contractor, holding a current and valid Alabama State Fire Marshall's Permit as a Certified Fire Protection Sprinkler Contractor, and with satisfactory experience on at least FIVE equivalent projects. Subcontractor shall provide resume demonstrating this experience in the submittal. Failure to do so will cause immediate rejection. **All hydraulic calculations and drawings shall be performed under the supervision and shall bear the seal of a registered engineer in accordance with Alabama State Fire Marshall's requirements.**
- 1.3 Scope:** Furnish all labor, material, equipment, design, service and supervision for and incidental to the installation of a sprinkler system complete as shown on the drawings and as specified herein. The system shall be installed complete, satisfactorily tested, and left ready for operation.
- The work includes, but is not necessarily limited to, the following:
- a. Connection to site fire line at a point approximately 5 ft. from the buildings, and extension of underground fire line into the buildings, including all necessary fees, permits, backflow preventers, valves, excavation, backfill, cutting and patching.
  - b. Installation of a complete sprinkler system throughout all areas of the building.
  - c. Installation of all other piping, fittings, hangers, sprinklers, valves, drains, sleeves, backflow preventers, escutcheons, devices and accessories required for complete system.
- 1.5 Work Not Included:** Electric Wiring, unless specified herein.
- 1.6 Codes, Ordinances and Regulations:** All work shall be in accordance with local, state and federal laws, codes, rules, regulations, and standards applicable to this particular class of work. Work shall also comply with the requirements of the City of Auburn Fire Department, the Owner's insurance Underwriter, the State of Alabama Fire Marshal and National Fire Protection Assoc. Standards No. 13-2013, 24-2002, and 101-2004. **Where later published editions of these referenced standards contain more stringent requirements, then the more stringent requirement shall apply.** In each of the NFPA standards referred to, the advisory provisions contained in the appendices shall be considered to be mandatory, as though the word "shall" had been substituted for the word "should".
- 1.7 Shop Drawings:** Within 30 days after award of contract, submit PDF shop drawings

and calculations, and 6 sets manufacturer's descriptive literature on all equipment and materials, to the Architect for approval. At the same time submit drawings, calculations, and descriptive literature to the Auburn Fire Department, and the Owner's insurance Underwriter. The contractor shall make all modifications and/or additions required to obtain the approval of shop drawings without extra cost to the Owner. The contractor shall deliver reviewed drawings and/or letters of comment from all above authorities to the Architect and obtain final approval of drawings before any work is begun.

Shop drawings shall show in detail dimensioned piping, valves, sprinklers, alarms, drains, hangers, etc. and all item as required by NFPA-13, and this section of the specifications. Outline all lights, ductwork, structure, and other obstructions on shop drawings to show proper coordination of all work. Locations of lines and rows of sprinkler heads shall be indicated by dimensions to walls and/or structural members, and the relationship to lights, ceilings, HVAC equipment, etc. indicated. Provide separate reflected ceiling plans showing all ceiling sprinkler locations and ceiling elements. As the work progresses, the drawings shall be coordinated with other trades and dimensions at the site verified. Drawings shall be revised as required by conditions at no additional cost to the owner.

- 1.8 As-Built Drawings:** Contractor shall maintain a set of drawings showing location and size of all piping, valves, and related items, both interior and exterior. On completion of work, contractor shall provide a set of mylar reproducible transparencies corrected to show all changes and noted "As-Built Drawings" together with two sets of blue line drawings to the Architect.
- 1.9 Site Inspection:** Bidders shall visit the site of the work before submitting bids and satisfy themselves as to the nature and scope of the work to be done. The submission of a bid shall be taken as evidence that the bidder is aware of all existing conditions. Later claims for additional labor, materials or equipment required for any difficulties or obstructions encountered shall not be recognized.

## **PART 2. MISCELLANEOUS REQUIREMENTS**

- 2.1 General Workmanship:** In general, all piping shall be concealed above all ceilings. Exposed piping shall be permitted only in mechanical areas, pipe chases, areas without ceilings, and areas specifically noted on the drawings. Cut all piping accurately to measurements established at site and work into place without springing or forcing properly clearing all windows, doors and other openings. Cutting structural members for passage of pipe will not be permitted. Route all pipe through existing walls in sleeves, core drill, cut, patch and repair existing walls as required for installation of piping. Ream all pipe to remove burrs. Make changes in direction and size with reducing fittings. Cap or plug open ends of pipe during installation to keep out foreign materials.

Refer to and carefully check the installation against all drawings and existing conditions, and note where walls, ceilings, beams and pipe shafts are furred or enclosed. Refer to and check with the contract drawings and existing conditions for the HVAC, plumbing and electrical work and work of other trades.

Install all piping to be concealed in ceiling or wall construction so as not to cause delay to other work, and to allow ample time for the necessary tests and approvals.

Install swing joints or expansion loops wherever necessary to allow for pipe expansion. Securely anchor pipes so that expansion can occur at these points.

All equipment shall be installed in strict accordance with the manufacturer's recommendations and with NFPA requirements.

- 2.2     Coordination:** For purposes of clearness and legibility, the drawings are essentially diagrammatic, and not intended to indicate all necessary piping, offsets, sprinklers, valves, or other required items. It shall be the responsibility of this contractor to install the system in such a manner as to conform to the structure, avoid obstructions, and observe proper clearances without extra cost to the Owner. Prefabricated piping does not preclude coordination with other trades. It shall be this contractor's responsibility to request and obtain all drawings of other trades work in areas where the contractor is involved, and to field check all work prior to any shop fabrication.

Piping shall be offset, relocated or resized or other piping and/or sprinklers shall be furnished as necessary to provide space for and coordination with other trades. The Architect does not assume responsibility for coordination by approval of shop drawings.

- 2.3     Field Supervision:** The contractor shall have a responsible representative of his organization at the site of the work for coordination of the system installation with other trades as early as is required by the progress of the work. Details of proposed departures from approved shop drawings due to field conditions shall be submitted to and receive written approval of the Architect prior to installation.

- 2.4     Layout of Heads:** The plans show the desired location of sprinklers in certain areas. Contractor shall make minor dimensional adjustments and/or provide additional heads as necessary to coordinate with building elements and sprinkler spacing regulations. Areas without sprinklers shown shall have sprinklers spaced by the contractor to meet NFPA requirements and these specifications. Alignment of heads within any room or area shall be within 1/2" and lines shall be parallel with or perpendicular to building walls and/or ceiling lines. Heads on suspended ceilings shall not occur in the same tile as light fixtures, diffusers, speakers, etc., nor shall they occur within 6" of the ceiling grid.

Position of sprinklers on ceilings shall be further adjusted as follows:

Lay-in tile areas: Heads shall be centered both ways in ceiling tile. In tiles that are scored, sprinklers shall be centered in one of the individual panels produced by the scoring. Center of tile alignment shall be accomplished by field-cutting two horizontal arm-over pipes to meet desired location (where space permits, same may be accomplished by use of return bends and single diagonal field-cut arm-over). Tolerance is 1/4" from center.

Plaster or gyp board ceilings: Heads shall align with and/or center between the centerline of other ceiling elements (lights, speakers, diffusers, etc.). Method of

alignment shall be field-cut arm-overs as specified under "center-of-tile" above.  
Tolerance is 1/4" from the centerline of and/or center between other ceiling elements

- 2.5 Joining of Pipe and Fittings:** Schedule 40 steel pipe shall be joined by screw joints in accordance with ANSI B2.1, by flanged joints, by shop-welded joints in accordance with the requirements of AWS D10.0, level AR-3, or by mechanical grooved fittings or couplings. Grooves may be rolled or cut and they shall be dimensionally compatible with the coupling.

Lightwall steel pipe shall be joined by shop-welded joints or by mechanical grooved fittings or couplings, as outlined above. Cut grooves shall not be used on lightwall pipe.

- 2.6 Underground Installation:** All underground piping shall be installed in accordance with NFPA-24. Depth of cover over piping shall be a minimum of 36". Joints shall be left exposed until all inspections and tests have been made.

Bends, plugs, tees, and hydrants shall be retained or blocked in accordance with the requirements of NFPA-24, the Local Water Authority, and Division 2 Specifications. Bearing surface of thrust blocks shall be sized to match soil conditions encountered, and all thrust blocks shall bear against undisturbed soil. The connection between the underground piping and the base of the riser shall be securely anchored with rods and clamps. Excavation, backfill, and street repair shall be as required by Division 2 Specifications and the Local authorities.

- 2.7 Drains and Test Connections:** Provide valved drain lines throughout the system to permit complete system drainage. All of the above to be as shown on the drawings and/or as required by codes and authorities. Discharge location of all drain and test lines required but not indicated on the contract drawings shall be subject to specific approval of the Architect.

- 2.8 Pipe Hangers:** Hanger installation methods to be per NFPA-13 and as called for herein. Provide intermediate supports and pipe support stands where necessary and as called for herein. Suspend from concrete or precast ceilings with drop-in anchors. **Bare, unprotected/uncoated steel or galvanized hangers, piping, brackets, supports, etc., are not allowed.** Clean and paint with two coats of black latex paint all exposed ferrous metal parts of hangers, unistrut and other assemblies used for supporting of any piping and plumbing related items in mechanical rooms, crawl space, above ceilings, etc. Include black steel pipe, uncoated pipe, hangers, brackets, etc. In lieu of painting, the Contractor may substitute factory painted, powder coated or epoxy coated items to prevent rusting of the items listed above. All paints and coatings shall comply with 25/50 smoke and flame spread requirements. Also, see specification section 22 1510, "Identification" for additional requirements.

- 2.9 Electric Switches:** Provide supervisory tamper switches for all valves controlling water supplies to the system, including post indicator valves in yard. Provide waterflow switches as indicated on the drawings. Coordinate with electrical contractor to insure that switch contacts and voltages are compatible with fire alarm system. **All control, interlock, interconnecting, monitoring and power wiring serving Dispatch Area 168 and its related spaces, and Data Room 164 shall be**

**a listed 2-hour electric circuit protective system as required by NEC 2017, Article 708 - Critical Operations Power Systems (COPS), Paragraph 708.14.**

- 2.10 Sleeves and Openings:** All piping passing through any partition, concrete, plaster, masonry, fire rated or non-fire rated, walls, floors, or partitions shall be provided with sleeves.
- 2.11 Firestopping:** Refer to Section 22 1510 for requirements. Note that Section 22 1510 firestopping specifications require firestopping of all penetrations regardless of wall/ceiling/floor construction. Refer to Division 1 for additional requirements. Where there is a conflict between Division 1 specifications and Division 15 specifications, the most stringent requirements shall govern, be applicable and shall be provided.  
Seal all openings in all walls, and ceilings with a U.L. listed through-penetration firestop sealant. Depth of sealant shall be sufficient to provide a fire rating equal to that of the penetrated structure or, in the case of non-fire rated assemblies, a minimum of 1-hour rating. See Section 21 1510 General Mechanical Provisions for additional firestopping requirements. **Note 21 1510 requires all penetrations, regardless of its rating, to be firestopped.**
- 2.12 Escutcheons:** Provide pipe escutcheons where exposed piping passes through walls, floors, or ceilings. Inside diameter shall fit around pipe, outside diameter shall cover sleeve.
- 2.13 Identification Signs:** Provide at all control, drain and test valves, and at other locations as suggested by NFPA and the authorities having jurisdiction, signs of approved design identifying function and noting special cautions. Submit for Architect's review and approval a list of all signs, noting sizes, materials, nomenclature and colors.
- 2.14 Tests:** All completed work shall remain uncovered if at all possible until required tests have been completed. However, in the event the project construction schedule requires it, the contractor shall make arrangements for prior tests on the portions of the work involved. The Architect and all inspection authorities shall be notified of tests five days in advance and shall be represented at such tests if they so desire.

All portions of the system shall be hydrostatically tested at 200 psi for 2 hours. Tests shall be repeated until work is proved tight at these pressures. Repair all defects disclosed by tests and replace defective materials. Caulking of screw joints will not be permitted. Test pressure is to be maintained by a small capacity pump to minimize water damage in the event of a break. Tests are to conform to the requirements of NFPA 13.

Operational tests of all signal initiating devices shall be conducted. Tests shall be performed by actual operation of the equipment, to which the device is attached, and devices shall be adjusted and tests repeated until performance is satisfactory and acceptable.

Records of all tests are to be provided to the Architect's and copies placed in the Owner's Operation and Maintenance Manuals. Contractor is to provide all labor and materials required for the tests, and assume all costs, including those for repair of damage caused to other work or equipment. Tests are to be performed only at such

- times that the ambient temperature throughout the test period will be high enough to prevent freezing in any portion of the system and to assure complete drainage afterward.
- 2.15 Inspections:** Upon completion of work, or at any time theretofore, inspection shall be made by the Architect or his representative and any corrections, changes, or removal of defective work required by them shall be made by the contractor. Final acceptance will not be made until all such required changes are accomplished.
- 2.16 Acceptance:** The operation of the equipment and the fire protection installation by the Owner does not constitute an acceptance of the work. The final acceptance is to be made only after the contractor has adjusted his equipment, demonstrated that it fulfills the requirements of the specifications, drawings, and all applicable authorities, and has furnished all the required certifications.
- 2.17 Service and Maintenance Instructions:** Service and maintenance instructions and demonstrations covering the necessary and recommended testing, operating and maintenance procedures for each type of system to the building maintenance personnel as directed by the Architect. Provide 3 sets of bound manuals containing for each piece of equipment the following materials:
- a. Manufacturer's descriptive literature
  - b. Operating and maintenance instructions
  - c. Parts list
  - d. As-installed control diagrams, including color-coded wiring diagrams for all electrical motor controlled connections and interlock connections with other mechanical equipment.
- 2.18 Clean-Up:** All refuse and debris accumulated from the system installation shall be removed by the contractor on a regular basis.
- 2.19 Guarantee:** The contractor shall guarantee the system and all components for a period of one year from the date of final acceptance against defects due to faulty materials or workmanship. Such defects arising shall be immediately corrected at no cost to the owner. Consult general requirements for detailed form and requirements.
- 2.20 Protection from Freezing:** Pipes, sprinklers, or risers in unheated spaces in the building shall be protected from freezing in accordance with the applicable methods outlined in NFPA-13. Provide heat tracing where indicated on plans or as required to protect piping from freezing. Heat tracing is required to be monitored through the fire alarm and building BAS System. Coordinate as required with all required sub-contractors including Technology Contractor.
- 2.21 Protection During Construction:** Provide as required by NFPA and local authorities.
- 2.22 Painting:** Clean and paint all piping in mechanical rooms, at main riser, and other areas where exposed to view. See General Mechanical specifications for additional requirements.
- 2.23 Cleaning:** All equipment, pipe, valves, fittings, and hangers shall be cleaned of

grease, oil, metal cuttings, sludge, and construction debris.

- 2.24 Piping Identification:** Identify all piping with Seton Snap-Around pipe line markers, or approved equal. Markers to be color-coded in accordance with ANSI standard A-13.1, bear name of pipe contents, and show direction of flow. Install markers at each valve, on each side where piping passes through walls and floors, and every 40 feet along continuous runs.
- 2.25 Spare Head Cabinet:** Provide at a location as directed by the Architect a spare sprinkler cabinet. Cabinet shall contain no less than two of each type, finish, and temperature rating of sprinkler used on the project, along with a wrench as required for each style. Total number of spare sprinklers provided shall not be less than the minimum set forth in NFPA-13.

### **PART 3. MATERIALS AND PRODUCTS**

- 3.1. General:** All materials and equipment shall be the standard catalogued products of manufacturers regularly engaged in the manufacture of such products. Similar types and items of equipment shall be produced by the same manufacturer. Unless otherwise noted, all materials and equipment shall be listed in the January 2008 Underwriter's Labs, Inc. Fire Protection Equipment Directory, and shall be the latest design of the manufacturer.

- 3.2. Piping:** Above ground piping shall be steel, ASTM-A795, A-53, or ASTM A-135, black or galvanized as required, in accordance with NFPA standards. Pipe 2-1/2" and larger shall be schedule 40), pipe 2" and smaller shall be schedule 40.

Underground piping shall be ductile iron, class 52, cement-lined, centrifugally cast, meeting the requirements of AWWA C-151. Joints shall be rubber gasket, slip-joint or mechanical-joint type.

- 3.3 Fittings:** Fittings for above ground piping shall be screwed, flanged, shop-welded, mechanical grooved or any combination thereof.

Screwed fittings shall be cast iron, 125 lb. class, black or galvanized as required, in accordance with ANSI B16.4; or malleable iron, 150 lb. class, black or galvanized as required, in accordance with ANSI B16.3

Flanged fittings shall be cast iron, short body, 125 lb. class, black or galvanized as required, in accordance with ANSI B16.1. Gaskets shall have a full face of 1/8" minimum thickness red sheet rubber. Flange bolts shall be hex head machine bolts with heavy semi-finished cadmium plated hex head nuts, having dimensions in accordance with ANSI B18.2.

Shop-welded fittings shall be steel, standard weight, black, in accordance with ANSI B16.9, ANSI B16.25, ASTM A-234, ANSI B16.5 or ANSI B16.11.

Mechanical grooved couplings or hole-cut branch connections shall be cast or malleable iron, 175 psi minimum working pressure with matching gasket.



Underground fittings shall be cast-iron, class 150, mechanical joint, in accordance with AWWA C-110 and C-111.

- 3.4** **Valves:** Gate valves 2" and smaller shall be bronze body, 175 psi working pressure, screwed ends, wedge disc, OS&Y pattern, Nibco T-104-0 or approved equal.

Butterfly control valves shall be ductile iron body, gear operated, with monitor switch adapter.

Ball drip valves shall be brass with stainless steel spring, Viking Model B-1 or approved equal.

Check valves 2-1/2" and larger shall be iron body, bronze mounted, 175 psi working pressure, flanged or grooved ends, rubber-faced disc.

Drain and test valves shall be bronze, globe or angle type, 300 psi, renewable rubber disc, United Brass Works figure 455 or 465 or approved equal.

Backflow preventers shall be double-check type matching Local Water Authority requirements.

- 3.5** **Electric Switches:** Tamper switches shall be OS&Y type, P.I.V. type, or butterfly type as required, containing at least one SPDT circuit switch set to operate within two revolutions of the valve control wheel or when the stem has moved no more than one-fifth of the distance from its normal position. Switch shall have a minimum rated capacity of 1 amp 125 volt, A.C. - .25 amp 24 volt D.C. The unit shall be arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting. Mounting shall not interfere with the normal operation of the valve.

Waterflow switch shall be vane-type with an instantly recycling retard adjustable from 0 to 60 seconds. Unit shall contain two SPDT circuit switches which transfer upon a minimum waterflow rate of 10 GPM. Switches shall have a minimum rated capacity of 7 amp, 125 volt A.C. - .25 amp, 24 volt D.C. Notifier series WFD, or approved equal. Unit shall be compatible with piping as regards to piping wall thickness.

- 3.6** **Hangers:** Hanger rings shall be zinc plated, adjustable swivel ring band-type, Gem F730 or approved equal. Beam clamps shall be malleable iron with cup-pointed set screw and jam nut, GEM F740 series or approved equal.

Drop-in anchors shall be zinc-plated steel, threaded to match rod size, Hilti HDI-3/8 or HDI-1/2 or approved equal.

- 3.7.** **Sleeves and Opening Sealants:** As specified in General Mechanical section.

- 3.8.** **Escutcheons:** Pipe escutcheons shall be one-piece chrome plated heavy brass or steel, minimum 18 gauge, with retaining setscrew.

- 3.9.** **Sprinklers:** Sprinkler heads shall be of the approved automatic spray-type, upright, pendent, or horizontal sidewall, as application requires. Orifice size shall be as required by hydraulic calculations; temperature rating shall be as required by thermal

conditions at the individual head location. Provide CONCEALED HEADS with cover plates for all sprinklers where installed in ceilings, cover plates shall be factory white or up to four custom colors. Coordinate custom colors with Architect, all cover plates shall be factory finished. Unless otherwise noted, types shall conform with the following requirements:

1. Upright: Reliable Model F1FR, bronze finish.
2. Pendant: Reliable Model F1FR with one (1) piece chrome plated with shallow escutcheon, Reliable Model F1FR with one (1) piece chrome plated cup assembly for recessed applications, Reliable Model F4FR with factory painted cover plate in color selected by Architect for concealed applications - provide (2) custom colors. Install in center of lift-out ceiling tiles. Recessed and semi-recessed sprinkler heads only to be used in normally unoccupied areas.
3. Sidewall: Reliable Model F1FR horizontal extended coverage with one (1) piece chrome plated escutcheon, Reliable Model G horizontal extended coverage with one (1) piece chrome plated cup for recessed applications, Reliable Model F1FR upright for upright applications.
4. Dry: Pendant Reliable Model F3QR with one (1) piece plated escutcheon, Reliable Model F3QR with one (1) piece chrome plates recessed cup for recessed applications, Reliable Model F3QR with factory painted cover plate in color selected by Architect for concealed applications.
5. Dry Sidewall: Reliable Model DH56 horizontal extended coverage with one (1) piece chrome plated escutcheon for recessed applications, Reliable Model DH56 horizontal extended coverage with factory painted cover plate in color selected by Architect for concealed applications.

- 3.10. **Sprinkler Head Guards:** Provide heavy duty guard for mechanical room sprinklers.

#### **PART 4. DESIGN CRITERIA**

- 4.1 **General:** All areas of the new Dormitories shall be protected by a sprinkler system. Design to be per NFPA-13. Underground portion of the systems shall be sized and run as shown on the drawings.
- 4.2 **Hydraulic Calculations:** Detailed hydraulic calculations shall be required. Calculations shall include allowances for valves, fittings, changes in direction of piping, elevation changes, and all other items as set forth in NFPA-13. The form of the calculations shall be in accordance with NFPA-13, and shall contain all information requested therein. Systems shall be hydraulically designed to meet the densities/remote areas of application as required. Calculations shall include a 15 percent safety margin (or greater if required by State or Local Authorities) below the supply curve.

- 4.3. **Water Supply:** Hydraulic design shall be based on the following estimated available water supply information.

Static - 48 psi  
Residual - 25 psi  
Flow - 671 GPM

Contractor shall verify above data by means of a flow test at site prior to final design and shall make any required adjustments without additional cost to owner. Tests with pressures higher than those stated above shall require specific approval before use.

**END OF SECTION**

## SECTION 22 1510

### GENERAL MECHANICAL PROVISIONS

#### PART 1. GENERAL

- 1.1. **General Requirements:** Division One is applicable in full hereto. Where the words, "provide", "furnish", "include" or "install" are used in the specifications and on the Drawings, it shall mean to furnish, install and test, complete and ready for operation as specified and required.

No materials or products that contain asbestos, formaldehyde, lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, shall be utilized.

Manufacturers not named in the specifications require prior approval. Follow procedures set forth in Division 1 of the specifications. All prior approvals shall be submitted through the Architect. Where substitutions are proposed, unless the Contractor states in writing, on a separate summary sheet in the front of the respective submittal, the differences of the substituted equipment or material, he shall be held responsible to replace such items any time discrepancies are found.

The Architect and Engineer shall interpret the meaning of the drawings and specifications and will reject all work and materials, which in their judgment, is not in full accordance therewith.

- 1.1. **Provision For Future Expansion And/or Installations:** Where piping, ductwork and equipment is indicated for use in future expansion of the building and/or for future installations within the building, the Contractor shall leave sufficient clear space and install the piping, ductwork and equipment in such manner that connections to the future building expansion and/or future installations within the building can be made without removing existing floors, walls, ceilings. The Contractor shall consult with the Architect whenever necessary for this purpose. Any piping stub-outs provided for future connections shall be arranged so that "dead legs" (i.e., pipe sections where there is no water circulation) are prevented. The termination point of any piping stub-out shall be as close to the main piping flow as physically possible. Where future branch lines must extend a distance greater than six (6) branch line pipe diameters or more than 18" from the main piping flow, a valved drain port or blind flange with a valved drain shall be provided at the end of the branch piping to allow periodic flushing.
- 1.2. **Spare Parts:** Manufacturer of any equipment specified shall have a wholesale outlet for readily available replacement parts in the nearest major USA city.

- 1.3. **Codes and Standards and Listings:** Unless specified otherwise, comply with all current editions of all referenced publications within these specifications and all current editions of applicable NFPA, ASME, OSHA, IBC, ASHRAE, ASTM, ASME, ANSI, SMACNA, Americans with Disabilities Act (ADA), 2010 ADA Standards for Accessible Design, with Local Building Codes, Mechanical Codes, Gas Codes, Plumbing Codes, ANSI/ASHRAE/IESNA Standard 90.1 (2013), International Energy Conservation Code (IECC), International Fuel Gas Code (IFGC), International Fire Code (IFC), Americans with Disability Act Accessibility Guidelines (ADA) and with all applicable local ordinances and codes. Equipment shall bear Underwriters Laboratories Inc. (UL) listing label, Canadian Standards Association (CSA) listing label or ETL approved rating. All electrical components and products shall also comply with the respective Code of Federal Regulations (CFR).

Where conflicts occur between a Code, Standard or Listing and the contract drawings or contract specifications, the most stringent requirements shall govern and be applied. Advisory provisions listed in all Codes referenced in the Contract Documents are mandatory and the word “should” shall be interpreted as “shall”.

- 1.4. **Permits:** Provide all permits, pay all fees and arrange for inspections as required by all applicable Governing Authorities. Furnish certificates of all inspections and approvals from all Governing Authorities. Provide additional materials, parts, methods, etc. and modify the work as required by Governing Authorities’ Inspections and Regulations. Correct all deficiencies required by Code officials at no additional cost to the Owner or the Owner’s Project Design Professionals.

The Plumbing or Mechanical Contractor, as applicable, shall arrange and pay for the State of Alabama Boiler and Pressure Vessel Safety Division inspector to visit job site to inspect water heater and/or boiler installation and obtain written approval and certification as required. Correct all deficiencies required by the Inspector without additional cost to the Owner or the Owner’s Project Design Professionals, using materials and methods, as directed by, the State of Alabama Boiler and Pressure Vessel Safety Division Inspector.

- 1.5. **Inspections:** It is the contractor’s responsibility to have the job ready for inspections when they are scheduled. If the project is not ready for the requested inspection and the Architect, any governmental agency or any other entity requires a re-inspection with the Engineer present, the contractor shall pay Zgouvas, Eiring & Associates a re-inspection fee of \$1,500. The payment shall be made directly to Zgouvas, Eiring & Associates 5 days prior to the scheduled re-inspection.

The Contractor shall also refer to Paragraph “Identification” in this Section of the specifications and note that identification shall be completed before certain inspections. **Failure to comply with the identification section of**

**the specification will be cause for cancellation of the inspection, and thus, requiring a reinspection fee.**

- 1.6. **Drawings:** The Architect and Engineer shall interpret the meaning of the drawings and specifications and will reject all work and materials, which in their judgment, is not in full accordance therewith. Where doubt arises as to the meaning of the plans and specifications, obtain the Architect's decision, in writing, before proceeding with parts affected; otherwise assume liability for damage to other work and for making necessary corrections to work in question.

All drawings are diagrammatic and are intended to quantify the materials specified and indicate their intended relationship to each other. The drawings and specifications are complementary, and work shown, but not specified, or specified, but not shown, shall be the same as though required by both

**DO NOT SCALE** the Plumbing, Fire Protection or HVAC drawings. In the interest of clearness, the work is not always shown to scale or exact location. Refer to Architectural drawings for dimensions and verify scale shown on the drawings. The various scales used on the drawings do not allow for all fittings, offsets and accessories that may be required to complete the work. Check all measurements, location of pipe, all required appurtenances for duct and piping, ducts, and equipment with the architectural and electrical drawings, and lay out work to fit in with ceiling grids, lighting and other parts. All wiring, piping, ductwork, etc., shall be concealed unless specifically specified otherwise. Adjust in the field as required to provide the optimum result to facilitate ease of service, efficient operation and best appearance.

The Contractor shall carefully examine the contract documents during the bidding phase. Any missing information in the contract documents that is required for obtaining accurate pricing shall be brought to the attention of the Architect, prior to bid date, so all may be clarified and/or corrected. Failure to identify and resolve the issues prior to bid shall require the Contractor to provide said items, complete, without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods specified by, and as directed by, the Owner's Design Professionals.

The Contractor shall carefully investigate the conditions that would affect the work to be performed and shall arrange such work as necessary to comply with the intent of the construction documents.

- 1.7. **Conflicts, Coordination and Changes:** If interferences or conflicts occur, the Architect shall decide which equipment shall be relocated regardless of which was first installed. In the interest of avoiding such conflicts, each Sub-Contractor who is using common space, etc., shall coordinate his work with all other trades and other parts of his own work. If, during this coordination, it is discovered that necessary or desirable changes should be made, advise the Architect, and secure his decision in writing. Do not fabricate any duct nor

install any pipe until all coordination has been accomplished.

Coordinate location of all Sections 21, 22 and 23 work with Division 16. Do not run piping, ductwork and similar Sections 21, 22 and 23 work in NEC dedicated service areas for electrical equipment, including above panel boards, starters, communication panels, control panels, telephone backboards, data panels and similar electrical elements.

- 1.8. **Coordination Drawings:** Follow procedures set forth in Division 1. Before starting work, submit for approval, coordination shop drawings showing proposed arrangement of equipment, all piping, ducts, floor drains, power requirements, and controls. As a minimum, submit detail layouts of potential conflicts at plumbing risers, equipment rooms, limited ceiling space, etc. Refer to subsequent Sections for additional specific requirements.

Coordinate with submission of shop drawings and refer questionable locations to Architect/Engineer for resolution prior to installation. Failure to coordinate all items, and correct non-conforming installed work, shall be provided at no additional cost to the Owner or the Owner's Project Design Professionals.

Failure to submit shop drawings will make the Contractor responsible for changes required to facilitate installation of, and the proper operation of, all systems at no additional cost to the Owner or the Owner's Project Design Professionals.

- 1.9. **Maintenance, Replacement and Service Access:** Locate equipment as shown on the plans. The Contractor shall install equipment, valves, piping, etc. with the maintenance, service and replacement access required by the Manufacturer of the respective installed item. All items shall be installed to provide maximum safety, service, replacement, and maintenance access.

All piping with valves, mechanical equipment and other items that may require maintenance, service or replacement, shall be located no more than 24" above the finished ceiling and no more than 14'-0" above finish floor in areas without ceilings, to ensure proper access.

Coordinate all questionable access or location of items that may present a problem, if installed as specified above, with the Engineer or the Architect's field representative prior to installing any item; else, relocation will be at the Contractor's expense once discovered.

- 1.10. **Warranty:** Refer to Division 1. Additionally, guarantee in writing to make good without cost any defects in materials and workmanship for one year following the date of substantial completion of the project as determined by the Architect, to include a minimum of five (5) years for all air conditioning equipment compressors. Provide free maintenance and service during the guarantee period. See other Sections 21, 22 and 23 Sections for additional

requirements for guarantee of air conditioning compressors, air filter replacement, sensor operated plumbing fixtures, etc.

- 1.11. **Submittal Data:** Within 25 days after award of the contract, submit for approval a **complete** schedule of material and equipment proposed. Variations from the specifications must be explicitly indicated in the submittal; otherwise it will be assumed the product will conform to the specifications in all respects. Include catalog data, scheduled capacities, fan curves, sound data, etc. **Partial or incomplete submittals will be held without review until the entire submittal package from the respective Contractor has been submitted.**

All submittals shall be separately bound in pdf format. Submittals shall be electronically indexed and tabbed. Refer to the Architectural General Conditions and Division 1 for the format required by the Architect.

A cover sheet shall be provided in the front of the submittal package which states, as a minimum, the Project name and location, the name of the Owner, the Architectural firm, the Engineering firm, the General Contractor, the Mechanical Contractor and each Contractors' point of contact, with phone number. A summary sheet shall be inserted at the beginning of each tabbed section to summarize the contents of each respective tabbed section. The summary sheet shall include any items that have been changed or removed due to Project cost constraints, addendums, or Value Engineering (VE). **Failure to include items changed or removed due to Project cost constraints, addendums or VE items that require an additional review by the Engineer will require the Contractor to reimburse the Engineer a minimum of \$500 for time involved to review the corrected submittal.**

Submittals shall include materials used, methods of installation, product manufacturer, equipment capacities, etc. HVAC equipment items shall follow the identical tabular format, category by category, nomenclature, etc., as shown on the HVAC equipment schedules. As a minimum, the summary sheet shall indicate the submitted values compared to each of the specified values. **Failure to provide the submittals in the format specified will be cause for automatic rejection without review.** Plumbing and Fire Protection submittals shall follow the identical procedure specified for the Mechanical Contractor

The General Contractor shall review and approve all submittals prior to submitting them to the Architect. **Submittals without the General Contractor's approval will be rejected without review.**

- 1.12. **Submittal Rejection and Resubmittal:** The Contractor shall carefully review the submittal data requirements specified above. Pay attention to specific items within the specifications that are cause for immediate rejection when submittals are not provided to the Engineer as specified. Any submittal or portions thereof that are rejected TWICE and resubmitted a third time for



review will require the Contractor to reimburse the Engineer for his time. The minimum fee for reviewing any item or submittal a third time is \$500.

- 1.13. **Site and Existing Conditions:** Bidders shall visit the site and become acquainted with all job conditions. Report to the Architect, prior to bid, any conditions that are required to accomplish the installation of all systems. Provide for required adjustments to complete the intent of the work. No consideration will be given after bid opening for alleged misunderstanding regarding job conditions, utility connections, permits, fees, etc.
- 1.14. **Line Locators:** Before proceeding with excavating or trenching, arrange with the Owner, all utility companies, and line locating firm(s) to describe and mark all the systems which might be damaged by construction operations.
- 1.15. **Phasing:** Interrupt existing services only at times approved by the Architect and the Owner. The General Contractor shall provide a written request to the Architect and the Owner for permission to interrupt services to the facility. The request shall be provided a minimum of seven (7) days prior to the desired date of the interruption. Hold interruptions to a minimum in duration and frequency.
- 1.17. **Record Documents:** Provide in such detail, as is set forth under General and Supplemental Conditions.

Additionally, keep an accurate record of changes made during construction. The respective Contractor shall take as-built measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping shall be shown on the drawings and dimensioned from fixed points.

The respective Contractor shall complete the Record Documents, using the As-Built Drawings from the General Contractor's construction site office. Transfer these changes to a set of reproducible copies of original drawings that the Architect will sell to Contractor at printing cost. The drawings will be provided to the Contractor "As Is". The final drawing set within the Record Documents shall be labeled "Record Documents" in the Title Block and shall not include "clouds" or other indications of the changes during the project process. The Contractor shall provide hard copies and an electronic set of all documented modifications to the contract documents.

The Contractor is responsible for providing and showing all changes to the drawings that are different from the original contract drawings, including but not limited to addendums, change-orders, VE items, RFI's, test reports, field observation/inspection reports, etc. Hard copy plans may be a set of reproducible copies of the final corrected contract drawings. When work is completed, submit corrected reproducible drawings to the Architect for record and include copies in the Owner's Operating and Maintenance Manual.

Record documents shall also be provided in PDF digital format on CD-R type CD(s). Include a CD of the documents in the Owner's Operating and Maintenance Manual.

Drawing files shall also be provided (as a minimum) in ACAD (AutoCAD) 2018 format. Verify ACAD Release version desired by the Owner and provide as requested. DXF or DWF files are not acceptable. If desired, the Contractor may obtain CAD files from the Engineer for a fee of \$100 per sheet. Prior to obtaining the files from the Engineer, the Contractor will be required to sign a letter of agreement pertaining to the use of the electronic files and the Contractor's responsibilities for the use of those electronic files. The ACAD files will be provided to the Contractor "As Is". The Contractor is responsible for providing and showing all changes to the drawings that are different from the original contract drawings, including but not limited to addendums, change-orders, VE items, RFI's, test reports, field observation/inspection reports, etc.

## **PART 2. WORK RELATED TO OTHER TRADES**

- 2.1. **Foundations and Supports:** The Plumbing, Fire Protection and Mechanical Contractor, as applicable, shall provide foundations, supports, etc. not specified under other Divisions, and as required to mount all items in a safe, sound, professional and structurally sound manner. The respective Contractor shall provide all supplemental steel between various types of structural members, including between bar joists, purloins, miscellaneous structural items, etc. as required for the item(s) proper support. All supports and related components and assemblies shall be sized for minimum of 300% (3 times) the anticipated load carried by the respective item. Where the Contractor has doubt as to proper supporting requirements, he shall consult with, and seek the guidance of, the Architect and the project Structural Engineer. Consult all contract documents pertaining to other trades to determine extent of their work.

Concrete pads for outside equipment are specified under other Sections. Concrete work shall meet requirements of Division 3. Respective Contractor shall provide all concrete pads not indicated or specified on the Architectural, Civil or Structural plans. Refer to the various equipment specifications for requirements in the absence of requirements by the various disciplines and provide as specified.

- 2.2. **Sleeves:** **Only one pipe is allowed in each sleeve.** Do not route multiple pipes through a singular pipe sleeve. Do not route control wiring through sleeves in partitions containing piping. Fit all pipes passing through walls, partitions, and floors (except slabs on grade construction) with sleeves. Sleeves shall be built-in as work progresses. Sleeves in existing construction shall be core drilled and firmly grouted in place.

**All holes made in the field shall be core drilled large enough to allow all sleeves and pipe insulation to continue uninterrupted, and to provide proper firestopping of the penetration as specified.**

Holes in floors or exterior walls above grade shall include a steel pipe sleeve grouted watertight. Sleeves for piping passing through exterior walls or exterior partitions that contain refrigerant piping or condensate shall be Schedule 40 PVC pipe, 1" larger in diameter than piping and piping covering. Suction and liquid lines routed through a singular pipe sleeve is acceptable only in this circumstance.

Sleeves for any piping passing through interior walls, floors or partitions above the ceiling shall be 16 gage galvanized steel, 1/2" larger in diameter than pipe or piping covering and shall extend a minimum of 2" on each side of the interior wall or partition and firestopped. **Do not route multiple pipes through pipe sleeves.** See plan details for additional requirements. A firestopping assembly shall be provided for all penetrations as specified below in Part "Miscellaneous Requirements", Paragraph "Firestopping".

Where any piping passes through interior walls or partitions located in the return air plenums or return air platforms, sleeves shall be galvanized as specified above. **NO COMBUSTIBLES ARE ALLOWED IN RETURN AIR PLENUMS.**

All floor sleeves, except slab on grade, shall be cast-in-place Schedule 40 steel pipe. Floor sleeves shall terminate 2" above finish floor or housekeeping pad as applicable, and flush on the bottom side of the concrete foundation as applicable.

Any pipe that passes through a below grade foundation wall shall be provided with a relieving arch, or a pipe sleeve pipe shall be built into the foundation wall. The sleeve shall be two pipe sizes greater than the pipe passing through the wall. Example: A 4" uninsulated pipe shall require a 6" sleeve. Piping installed through a foundation wall shall be structurally protected from any transferred loading from the foundation wall. The annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete or masonry wall. Sealant selected for the earth side of the wall shall be compatible with damp proofing/waterproofing materials that are specified in Architectural section of the specifications to be applied over the joint sealant.

- 2.3. **Access Panels and Doors:** Do not locate serviceable items above inaccessible, hard ceilings without written approval from the Architect. Coordinate all items locations with the Architectural ceiling plans before installing any items. Furnish access panels and doors to the General Contractor for installation for access to valves, controllers, actuators, motorized dampers, air vents, fume hood exhaust valves, exhaust valves,

VAV terminals, cleanouts, smoke detectors, fire dampers, smoke dampers and similar devices requiring maintenance access.

Doors/panels shall be suitable for wall or ceiling finish involved, 16" x 16" unless otherwise indicated or as required to permit removal of equipment and acceptable maintenance access. Access panels and doors shall be fire rated where rated assemblies are penetrated. Access panels and doors for items located outdoors shall be weatherproof.

Provide access doors/panels in all plenums behind outside air intake louvers and relief air louvers to facilitate cleaning of bird screens. Doors/panels in plenums at outside air intake louvers and relief air louvers shall be minimum 10" wide x full height of plenum. Refer to Sections 15400 and 15700 for additional requirements.

See specification section 15010, "Miscellaneous Requirements, Identification" for materials and methods required. Access panels and doors shall be as manufactured by Milcor, Philip Carey, Zurn, Mifab or other approved equivalent. The Architect must approve the use of, and type of, panels and doors to be installed in areas that are exposed to view or in finished areas. Exposed access panels and doors shall be factory cleaned and primed for painting in the field. Colors shall be as selected by the Architect. Refer to Architectural Section, Painting, for additional information.

Where device occurs above a lift-out acoustical ceiling panel, provide engraved plastic labels of type specified in "Miscellaneous Requirements, Identification" below.

In addition to identification of items above the ceiling, provide engraved plastic labels below the item, on the ceiling grid. Engraved plastic labels shall match ceiling grid color and be neatly glued to the ceiling grid adjacent to the ceiling tile that should be removed for access to the item. The label shall have engraved on it the item being identified and its designation as shown on the plans, valve chart, etc. Refer to Section "Identification" below for additional requirements.

- 2.4. Cutting and Patching:** Openings are to be laid out and built in. Where openings have not been laid out or built in, they shall be core drilled large enough to allow all sleeves and pipe insulation to continue uninterrupted. Holes in floors or exterior walls above grade shall include a steel pipe sleeve grouted watertight. Furnish detailed layout drawings to other trades in advance of their work. Failure to furnish layout shop drawings to General Contractor shall make the applicable

Mechanical/Plumbing/Fire Protection Contractor responsible to rebuild openings as directed by the Architect. Piping within walls or behind walls must be installed before wall is erected. Otherwise, walls, etc. affected must be reworked by trade which erected it at expense of the respective

Contractor. Chasing and cutting of new work will not be accepted.

- 2.5. **Painting and Finishing:** Clean and paint with two coats of black latex paint all exposed ferrous metal parts of hangers, Unistrut and other assemblies used for supporting of ducts (except duct straps/band hangers), piping and plumbing related items in mechanical rooms, crawl space, above ceilings, etc. Include black steel pipe, uncoated cast iron pipe, hangers, brackets, etc. Bare, unprotected/uncoated steel or galvanized hangers, brackets, Unistrut, supports, etc., are not allowed. In lieu of painting, the Contractor may substitute factory painted, powder coated or epoxy coated items to prevent rusting of the items listed above. All paints and coatings shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Also, see specification section, "Identification" for additional requirements.

Painting of ducts, piping, piping insulation, grilles, diffusers, and other surfaces in finished areas is specified in Architectural Section "Painting" or similar section. Refer to those sections for requirements. If not specified in other sections, paint as directed by the Architect. Where the Architectural specifications require items to be painted, the Contractor shall furnish it with a Manufacturer provided, factory applied prime coat.

Where factory finished items are marred, scratched, or damaged, replace the item, or upon approval from the Architect or Owner, refinish or touch-up as required to bring to a like new condition.

### **PART 3. EXCAVATION, TRENCHING & BACKFILLING**

- 3.1. **Broken Pavement:** In public streets or on the project site, backfill and repair to satisfaction of authorities having jurisdiction and the Architect.

### **PART 4. PIPE HANGERS AND SUPPORTS**

- 4.1. **General:** Provide factory fabricated pipe hangers and supports for all piping of type and size specified bolts, washers, etc. as required for a complete functional installation. Material items, methods and general requirements not covered in this specification shall be provided in strict accordance with current edition of Manufacturer's Standardization Society Specification MSS SP-58 and Manufacturer's Published Product Information.

All hangers, supports and related components and assemblies shall be sized for minimum of 300% (3 times) the anticipated load carried by the respective item. Where the Contractor has doubt as to proper supporting requirements, he shall consult with, and seek the guidance of, the Architect and the project Structural Engineer.

- 4.2. Painting:** Bare, unprotected/uncoated steel or galvanized hangers, brackets, supports, etc., are not allowed. Clean and paint with two coats of black latex paint all exposed ferrous metal parts of hangers, Unistrut and other assemblies used for supporting of any piping and plumbing related items in mechanical rooms, crawl space, above ceilings, etc. Include black steel pipe, uncoated cast iron pipe, hangers, brackets, etc. In lieu of painting, the Contractor may substitute completely factory painted, powder coated or epoxy coated items to prevent rusting of the items listed above. All paints and coatings shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Also, see specification section, "Identification" for additional requirements.
- 4.3. Spacing:** Install supports as required to prevent sags, bends or vibration. Provide additional building supports and attachments where support is required for additional concentrated loads, including valves, in-line pumps, flange guides, strainers, expansion joints and at all changes in direction of piping.

At no-hub pipe, support as specified below for cast iron piping.

In all cases, provide on all sides of, and within 6 inches of, all elbows, take-off fittings, joints, valves, any change in direction of item supported, at ends of branches over 5 feet long and on centers not exceeding the following:

<u>Piping Material</u>	<u>Pipe Size</u>	<u>Maximum Spacing</u>
Copper tubing	1 1/4" or less	6 ft. Horizontal 8 ft. Vertical
	1 1/2" or larger	8 ft. Horizontal 8 ft. Vertical
Steel pipe	All	6 ft. Horizontal 8 ft. Vertical
Cast Iron	All	4 ft. Horizontal 10 ft. Vertical

Where cast iron pipe is installed in 10ft. lengths, spacing may be increased to 8ft.

In addition to specified cast iron support requirements, provide additional support for cast iron pipe within 6" of each fitting on all sides of the fitting.

Schedule 40 PVC	All	4 ft Horizontal 8 ft. Vertical
Schedule 40 CPVC	1" or less	3 ft. Horizontal 5 ft. Vertical

Greater than 1"

4 ft. Horizontal  
6 ft. Vertical

For Schedule 40 PVC or CPVC pipe sizes 2" and smaller, a guide shall be installed midway between the required vertical supports. Such guides shall prevent pipe movement in a direction perpendicular to the axis of the pipe.

- 4.4. **At Typical Suspended Horizontal Pipe:** Painted, powder coated, or epoxy coated adjustable clevis or split-ring type equal to Elcen Fig. 12 or 10c. See part "Hanger Rods" below for limitations on use of clevis hangers.

Do not use clevis hangers for refrigerant piping. See refrigerant piping support requirements in Section 15700, Refrigerant Piping and Accessories.

Painted, powder coated, or epoxy coated items shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

- 4.5. **Sway Bracing:** For all drainage piping greater than 4 inches, restraints shall be provided for drainpipes at all changes in direction and at all changes in diameter greater than two pipe sizes. Braces, blocks, rodding and other suitable methods as required by the coupling manufacturer shall be utilized. Sway bracing shall be Eaton/Cooper B-Line Tolco Steel Pipe Clamps for Sway Bracing, transitional fittings, bracing, etc. as required for a complete sway braced assembly.

The entire bracing assembly shall be selected and sized by the Manufacturer. All components of the finished assembly shall be of a single manufacturer, resulting in a UL listed and FM approved sway bracing assembly. Eaton/Cooper B-Line is basis of design. Equivalents by Anvil International, Rilco Manufacturing Co and Piping Technology and Products will be considered.

- 4.6. **Manifolds and Parallel Runs:** At his option, Contractor may provide a painted; powder coated or epoxy coated Unistrut system complete with standard fittings, clamps and accessories required. Refer to "Hanger Rods" below for locations that require a Unistrut assembly. Furnish for approval proposed system components. Regardless of system used, piping insulation shall be continuous and not cut away for installation of clamps, etc.

Unistrut assemblies shall also be provided for refrigerant piping. Refer to Section 15700, Refrigerant Piping and Accessories for additional requirements.

- 4.7. **Where in Contact with Copper Pipe:** Same as above except assembly shall be copper plated.

- 4.8. **Hanger Rods:** Shall be mild steel, threaded as required. Rods shall be selected to carry the Use not smaller than 3/8" rods for pipe 2" and under, 1/2" rods for pipes 2 1/2" through 4", 3/4" rods for 5" through 12" and 1" rods for piping over 12", but generally as standard for the hanger selected. Support rods with threaded Underwriters' listed inserts, expansion shields or beam clamps shall be all galvanized. Beam clamps shall be equal to Elcen Fig. 34 or 36 with rod and eye end.

At bar joists, support from bottom chord at panel points. For piping over 6" provide supplemental steel angle supports and welding to span 3 joists when running parallel to joists and welded angle between two panel points for piping running perpendicular to joists. Concrete inserts shall be equal to Grinnell Figure 282.

Wherever piping hanger support rods heights exceed 36" length from top of the supported item to the structure above, Contractor shall provide a Unistrut support assembly and bracing of the assembly with minimum 1"x1"x1/4" angle iron or as required for the weight of the supported item, whichever is greater, and anchor to structure above to prevent swaying. Assembly shall be welded at connection to Unistrut and building structural assembly. Follow welding procedures set forth in the structural division of the specifications.

- 4.9. **Bracing:** Where hanger rods heights exceed 36", provide sway bracing as specified above in "Hanger Rods". Bracing shall be provided at each Unistrut assembly and attached to the building structural system.
- 4.10. **Approved Equivalents:** By Grinnell, Elcen, Stockham or Crane will be accepted.

## **PART 5. MISCELLANEOUS REQUIREMENTS**

- 5.1. **Materials and Equipment:** New and of best quality in every respect. Pipe and fittings shall conform to the ASTM Standard designated for pipe of each material. Equipment shall bear Underwriters Laboratories Inc. (UL) listing label, Canadian Standards Association (CSA) listing label or ETL approved rating.

All electrical components and products shall also comply with the respective Code of Federal Regulations (CFR). All pressure vessels shall be constructed and tested in accordance with applicable ASME Codes and shall bear ASME stamps unless specified otherwise. Minimum pressure rating shall satisfy job conditions.

Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer, however, the component parts of each unit need not be.



No materials or products that contain asbestos, formaldehyde, lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, shall be utilized.

Where conflicts occur between a Code, Standard, Listing and the contract drawings or contract specifications, the most stringent requirements shall govern and be applied.

- 5.2. Workmanship:** First class, premium and in accordance with best practice. Work shall be executed by experienced mechanics and shall present a neat and professional appearance. Exact location of pipe, duct, equipment, etc., shall be determined in field, considering work of other trades. Lines required to be sloped have right of way over those not required to be sloped. Lines whose elevations cannot be changed have right of way over lines whose elevations can be changed. Lines and equipment whose locations are dimensioned have precedence over lines and equipment not dimensioned. Except in unfinished areas and where specifically indicated on the drawings or approved in writing, ductwork, piping, conduit, wiring, and similar items shall be concealed in the construction.

Pipe shall be cut clean, properly reamed, threaded or soldered, erected plumb and secure. Make changes in pipe size with reducing fittings without the use of bushings. Install all equipment in accordance with manufacturer's recommendations. Absolute coordination is required with the other Contractors on the project before proceeding with installation of any system or item.

At all stages of installation, protect pipe openings, fixtures, ductwork, condenser coils and equipment against the entrance of foreign materials and from damage by the elements, mortar, paint, etc.. Plugs of rags, wool, cotton, waste or similar materials are not acceptable.

If air moving equipment must be used during construction, temporary filtration media with a Minimum Efficiency Reporting Value (MERV) of 8, as determined by ASHRAE 52.2, current edition, and shall be installed at each return air grille, return air register, exhaust grille, exhaust register, and unit return air inlet. ALL open portions of ductwork and equipment shall be covered with a self-adhesive film (not Visqueen) or airtight sheet metal caps to prevent the intrusion of contaminants.

All equipment openings, duct taps, duct take-offs, etc., shall be protected immediately after the tap, take-off, etc. has been fabricated in the field. In effect, there shall be no ductwork opening or equipment opening that is exposed to the ambient air. The material shall be a minimum of 3 mils thick and have a minimum tensile strength of 10 psi. It shall be waterproof and recyclable. Material shall be DuroDyne Dyn-O-Wrap or approved equivalent.

Where bare sheet metal is delivered unassembled to the job site, all ductwork

shall be covered and protected with Visqueen. After fabricating the duct in the field, the interior bare metal shall be wiped clean with a clean damp cloth before erection in the field. After erection, duct shall be protected as specified above. Any ductwork discovered to be unprotected as specified is subject to immediate rejection for use on this project.

- 5.3. **Testing Documentation:** Throughout the Sections 21, 22 and 23 specifications, there are various tests required. Provide the Architect written certification and results of all tests specified, including those indicating failure. The absence of written testing certification and results will be considered the same as if testing was never done. Include all testing documentation in the Operating and Maintenance Manuals.
- 5.4. **Factory Finishes:** Furnish to the Architect, color cards for standard and premium colors available. The Architect shall select color where choices exist. Provide Manufacturer's standard color where color choices are not available. Coordinate all color selections with appropriate Architectural specification sections.
- 5.5. **Expansion:** Provide for expansion and contraction of all piping, ductwork, etc. and make proper provisions so that excessive strain will not occur on piping, ductwork or other parts. Provide flexible connections for all piping and ductwork at all building expansion joints.
- 5.6. **Safety Provisions:** Provide covers or guards on all hot, moving and projecting items that could be construed as a hazard to occupants of the building or to service personnel.
- 5.7. **Cleaning and Adjusting:** Upon completion of work, clear all drains, traps, fixtures, ducts and pipe. Adjust all valves, remove rubbish and leave work in clean and excellent operating condition. Install final permanent type filters only after cleaning of building is completed.
- 5.8. **Escutcheons:** Where pipes pass through floors, walls and ceilings of finished rooms provide pressed chrome-plated brass or steel plates securely fastened in place. Pack penetrations with insulation or firestopping compound as required. Caulk pipe openings behind escutcheons to prevent passage of smoke and make vermin proof.
- 5.9. **Identification:** All above ceiling identification specified, including firestopping identification, shall be completed prior to the above ceiling inspection. All remaining identification shall be completed prior to the final inspection. Failure to comply with this provision will be cause for cancellation of the inspection with all costs of the re-inspection to be borne by the Contractor responsible. All identification shall follow nomenclature used on the plans.

All equipment, smoke detectors, smoke dampers, fire dampers, filter access

locations, access panels, access doors, motor starters, disconnects, thermostats, humidistats, sensors, other control systems components, control switches, and related devices shall be equipped with engraved laminated plastic nameplates, as described below. Filter access locations' identification shall include the size and number of filters required for that specific piece of equipment.

Permanently affixed warning labels shall be attached to all equipment, on a highly visible location on the equipment, which can be automatically started. The warning label shall read as follows: ***“CAUTION!! This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect switch to “OFF” position before servicing or attempting to work on equipment”.***

Permanently affixed warning labels shall be attached to all motor starters and all control panels which are connected to multiple power sources utilizing separate disconnect switches. The warning labels shall read as follows: ***“This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing or working on this item”.***

Access openings/panels/doors to fire dampers and smoke dampers shall be permanently identified on the exterior of the access panel and on the ceiling grid below by a label having letters not less than 3/4" in height and reading: ***“FIRE DAMPER – DO NOT OBSTRUCT ACCESS “ or “SMOKE DAMPER – DO NOT OBSTRUCT ACCESS “.***

Identify all access panels/doors to indicate item for which access is provided. Ex. Motorized damper, smoke detector, filters, valves, etc. Additionally, add the following to each access panel identifier: “ACCESS PANEL - DO NOT BLOCK”. Refer to Paragraph “Access Panels and Doors” above for additional requirements.

Labels shall be a minimum of 4" x 3" x 1/16" thick, laminated plastic labels (larger if needed) with 1" high x 1/4" stroke numerals and all capital letters to identify all equipment furnished under this Section. Labels attached to the ceiling grid shall be the same width as the ceiling grid it is attached. Properly adjust lettering height to fit within the smaller width label. Red with white lettering or white with red lettering as required for maximum contrast with color of the equipment. In finished areas where identification is attached to the ceiling grid, the Architect shall select colors of materials. Engrave equipment designation and numbers as shown on plan and drawings on upper half of tag, leaving lower half of tag for future engraving by Owner. Where equipment is typed (HP-A, HP-B, EF-A, etc.) rather than numbered (HP-1, HP-2, EF-1, etc.) the tag shall include the room number(s) of the area served. Room numbers shall be as designated by the Owner. In absence of Owner's room numbers, numbers shall be as indicated on the architectural plans. Each piece of equipment, item or device (in-line fan, VAV terminal,

access door, fire damper, etc.) located above the ceiling shall be identified with an engraved laminated label, of the type specified above, and neatly glued to the ceiling tile grid below the item. Neatly attach identification with permanent adhesive.

Where the tag, label or marker occurs in a plenum (return air) space, the plastic employed shall carry a Class A Flame Spread Rating per ASTM E-84, and shall meet ASTM D-635 (such as Westinghouse Micarta engraving stock). If plastic does not meet the Class A Flame Spread Rating per ASTM E-84, provide custom laser engraved, 0.029" thickness, red, 316 Stainless Steel. Sizes, letter heights, etc., and colors shall be as specified for the laminated plastic labels specified hereinbefore.

Identify all piping, including refrigerant piping, waste and vent piping, condensate drainage piping, sprinkler piping, and jacket of insulated pipe exposed to view and/or accessible through removable ceilings, attics or access panels, with Seton "Snap-Around" or Seton "Strap-Around" pipe line markers, Marking Services Inc (MSI) Series MS-970 or approved equivalent. Pipe labels may be flat strap-around markers with heavy duty nylon ties inside the facility. Provide stainless steel bands in lieu of nylon ties for outdoor applications.

The markers shall be color-coded in accordance with ANSI Standard A13.1 2015. Identification shall bear name of pipe contents and show direction of flow and in the case of gas/air systems, shall indicate pressure of the pipe contents. "Stick-on" type markers are unacceptable.

Install identification adjacent to all valves, flanges, fittings, elbows, change in piping direction, both sides of floor and wall penetrations, at each branch take-off and along all runs of pipe as required for proper identification, and not further apart than 15 feet on straight runs of piping. Gas piping identification shall be provided as specified above except intervals shall be a maximum of 6'-0" for straight runs of piping.

Provide piping identification in small areas (closets, storage rooms, etc.) above ceilings where partition walls go to the structure above. All piping identification shall be provided such that the Owner or maintenance personnel can remove any ceiling tile and visually identify any overhead piping with the specified identification markers. All plumbing system piping identification shall comply with IBC/IPC requirements.

Paint all exposed piping and jacket of insulated piping in Mechanical Rooms with two coats of enamel paint. The Contractor shall obtain ANSI A-13.1 2015 and comply with all requirements.

Paint all exposed piping and jacket of insulated piping in finished spaces with two coats of enamel paint. Paint color shall be as selected by the Architect.

Painting of the jacket of the insulated piping is not required where a protective aluminum jacket is specified. Refer to other parts of Sections 15400 and Section 15700 for piping requiring aluminum jacket.

All laboratory air piping and laboratory vacuum piping shall be identified in strict accordance with NFPA 99, Current Edition.

Fit all Plumbing dielectric unions and all gas valves and plumbing valves (except equipment service valves and sprinkler valves) with a custom laser engraved brass valve tag at each valve and include in specified valve chart. Number tags in sequence, starting with number 1; prefix the number with "P" for plumbing items. Tag shall be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4-inch-high stamped, black-filled service designation. All gas valve identification shall indicate gas pressure.

Fit all Mechanical (HVAC) dielectric unions and all Mechanical (HVAC) valves and Sprinkler valves with engraved laminated plastic valve tags firmly secured with brass jack-chain and S-hooks to valve yoke or stem (not handles) or adjacent pipe. Fabricate tags as 4" x 3" x 1/16" white plastic with beveled corners, engraved both sides with 1/2" high x 1/4" stroke red letters and numerals. Locate numbers at one edge of tag leaving room for future engraving by others. Number tags in sequence, starting with number 1; prefix the number with "M" for HVAC/Mechanical items.

In addition to valves identification specified, provide an engraved laminated label, of the type specified above, and glue to the ceiling tile grid below the valve for each valve concealed from view. Where there is more than one valve located within a span of eight (8) feet, above the ceiling, it is not necessary to provide multiple identifiers on the ceiling grid. It will be acceptable to place a single identifier on the ceiling grid reading as, "Valves". However, each valve above the ceiling is still required to have its own, individual valve tag and identified on the specified valve chart. Example: Over the toilets ceiling, there are multiple shut-off valves. The contractor may attach a single identifier that states, "water valves", or similar description, on the ceiling grid. Then, above the ceiling, each individual valve requires its own engraved valve brass tag as originally specified. The intent is to NOT have multiple individual identifiers for each valve exposed to view on the ceiling grid and thereby creating an undesirable appearance.

Provide a valve chart framed under glass or plastic which shows the number and location of each valve and type of service. Locate a valve chart in each equipment room and each janitor closet. Permanently attach each chart to the wall as directed by the Architect. Include a copy of the valve chart in the Owner's Operation and Maintenance Manuals.

Refrigerant lines to and from the various VRF System units shall be identified with plastic labels as specified for piping and provided at maximum fifteen (15) foot intervals. All branch controllers shall be identified with engraved

laminated plastic as specified below. Numbering of units shall follow nomenclature indicated on the plans and equipment schedule. Refrigerant piping identification shall be of the type specified for piping. VRF System will require custom factory fabricated labels. Handwritten labels are unacceptable.

- 5.10. **Firestopping:** Wherever pipes, ducts, hanger rods, etc. penetrate any type of construction that extends to the underside of the structure above it, **regardless if the wall, partition or floor is a rated assembly or not**, the space between the penetrating member and the building construction shall be sealed with a U.L. labeled/approved firestop assembly that provides an effective barrier against the spread of fire, smoke and gas, equal to the rating of the respective wall, partition or floor. Where partitions are not indicated as fire rated, the firestopping assembly used shall provide a minimum of one-hour resistance. All fire stop material employed on the project must be same brand throughout. Refer to Paragraph, "Pipe Sleeves", above for additional information and requirements. A firestopping assembly shall be as manufactured by Hilti, 3M, USG or other **pre-approved** Manufacturer

Where walls or partitions do not extend to the structure above, firestopping material is not required for the penetration. Instead, pack the respective openings with insulation and seal on both sides with material equal in characteristics of the penetrated partition.

At each through penetration, attach identification labels on both sides of the partition, floor, etc., to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Provide metal labels in areas used as return air plenums. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Additionally, secure to wall with metal thumbtack at each corner of the label. Labels shall be Hilti Firestop Identification Labels 00339611, 3M Sticker 98040056289 or approved equivalent. Firestop identification labels shall include the following information on labels:

1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Through-penetration firestop system designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop system manufacturer's name.
6. Installer's name.

Carefully coordinate work with types of construction encountered and with Par. Pipe Sleeves above.

- 5.11. **Delivery and Storage:** All equipment and materials delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants. See Section 15700 and this Section 15010 for additional requirements for ductwork and equipment.
- 5.12. **Dielectric Isolation:** Provide dielectric isolation where dissimilar metals are joined, at supports, etc. For pipe sizes 2" through 6", copper piping flanges shall be drilled to ANSI B 16.5 150/125 Standard and powder coated, with an EPDM insulator adhered to the plate steel flange protruding inside of the steel flange to prevent contact with the copper flange adapter. The copper component of the flange adapter shall be Third Party Classified by Underwriters Laboratories, Inc. Minimum working pressure shall be 300 psi at 272°F.

Wherever any bare metallic piping or conduit is in contact with externally insulated duct or bare sheet metal duct, there shall be dielectric separation provided. The Contractor shall provide 1/2" thickness, unslit AP Armaflex insulation of sufficient inside tubular diameter to snugly and completely cover the respective piping. The insulation shall extend the full length of the affected area. Where channel shapes are used, orient the open side, down. Refer to Section 15700, Part "Pipe and Miscellaneous Insulation Work" for AP Armaflex material specification.

**END OF SECTION**

## SECTION 22 1540

### PLUMBING

#### PART 1. GENERAL & MISCELLANEOUS

- 1.1. **General Provisions:** Section 22 1510 is applicable in full hereto. **No building materials or products that contain asbestos, formaldehyde, lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, shall be utilized.**
- 1.2. **Qualifications:** Shall be properly licensed and established as a Plumbing Contractor at location of the work and shall maintain locally adequate service facilities. He shall have had previous experience in the satisfactory installation of at least six (6) systems of this type, size and scope.
- 1.3. **Scope:** Include all equipment, material and labor required for a complete operating plumbing system even though every item involved is not indicated. Refer to architectural drawings and verify all plumbing fixtures, locations and mounting heights. Notify the architect prior to bid of any discrepancies. Do not attach any items to other trades' assemblies. Items shall be attached to building structural system.

Advisory provisions listed in all Codes referenced in the Contract Documents are mandatory. Where conflicts occur between a Code, Standard, the contract drawings or specifications, the more stringent requirements shall govern and be applicable.

Arrange and install piping systems sizes as shown, as close as practical, straight, properly supported and run as directly as possible forming right angles or running parallel with building lines, true to line and grade. Locate piping as high as practical and in parallel groups as close together as practical.

All piping shall be clean when it is installed. Before installation, it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from lying on the ground shall be removed. Any installed dirty piping will be cleaned. Any rusted piping shall have the rust removed and painted with compatible rustproof paint and shall comply with the requirements of ASTM E84 for flame spread and smoke development.

Manufacturers not named in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 of the specifications. All prior approvals shall be submitted through the Architect.

- 1.4. **Record Documents:** Provide in such detail, as is set forth under General and Supplemental Conditions and in Section 22 1510. Note that the Plumbing Contractor shall take as-built measurements, including all depths, inverts, etc., prior to commencement of backfilling operations. It will not be sufficient



to check off line locations. Definite measurements shall be taken for each line entering or leaving the facility. The location of buried piping shall be shown on the record drawings and dimensioned from fixed points.

- 1.5. Access Panels and Doors:** Do not locate serviceable items above inaccessible, hard ceilings without written approval from the Architect. Coordinate all items locations with the Architectural ceiling plans before installing any items. Furnish access panels and doors to the General Contractor for installation wherever required for access to valves, controllers, actuators, trap primer assemblies, water hammer arrestors, air vents and similar devices requiring maintenance access.

Doors/panels shall be suitable for wall or ceiling finish involved, 16" x 16" unless otherwise indicated or as required to permit removal of equipment and acceptable maintenance access. Access panels and doors shall be fire rated where rated assemblies are penetrated. Access panels and doors for items located outdoors shall be weatherproof.

Access panels and doors shall be as manufactured by Milcor, Philip Carey, Zurn, Mifab or other approved equivalent. The Architect must approve the use of, and type of, all panels and doors to be installed in areas that are exposed to view or in finished areas. Exposed access panels and doors shall be factory cleaned and primed for painting in the field. Colors shall be as selected by the Architect. Refer to Architectural Section, Painting, for additional information.

- 1.6. Warranty:** Guarantee work as set forth in Section 22 1510 and Division 1. Guarantee in writing to make good without cost any defects in materials and workmanship for one year following the date of substantial completion of the project as determined by the Architect, unless specified otherwise. Provide free maintenance and service during the guarantee period. Refer to other parts for additional requirements and extended warranty requirements.

- 1.7. Site Visits / Inspections:** It is the contractor's responsibility to have the job ready for inspections when they are scheduled. If the project is not ready for the requested inspection and the Architect, any governmental agency or any other entity requires a re-inspection with the Engineer present, the contractor shall pay Zgouvas, Eiring & Associates a re-inspection fee of \$1,500. The payment shall be made directly to Zgouvas, Eiring & Associates 5 days prior to the scheduled re-inspection.

The Contractor is cautioned to carefully review the extensive requirements of Paragraph "Identification" in Section 22 1510 of the specifications and note that **identification is required to be completed before certain inspections.**

- 1.8. Miscellaneous:** The Contractor shall carefully examine the contract documents during the bidding phase. Any missing information in the contract documents that is required for obtaining accurate pricing shall be brought to the attention of the Architect, **prior to bid date**, so all may be clarified and/or corrected. Failure to identify and resolve the issues prior to bid shall require

the Contractor to provide said items, complete, without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods specified by, and as directed by, the Owner's Design Professionals.

- 1.9. **Spare Parts:** Manufacturer of any equipment specified shall have a wholesale outlet for readily available replacement parts in the nearest major USA city.
- 1.10. **Electrical Work:** All electric power wiring required for installation of equipment under this Section is specified under Electrical Division. Plumbing Contractor shall furnish and install all controls and control wiring as specified or required to properly complete the installation. Control conduit is specified under Electrical Division or shown on electrical drawings; all other control conduit shall be provided under this Section of the work. Electrical work performed under this Section shall meet requirements set forth in the Electrical Division. Refer to Section 23 1570, Part 2, Electrical Work and Equipment for requirements not specified in Electrical Division.
- 1.11. **Submittals:** Refer to Section 22 1510 for **strict** requirements especially as it applies to Project cost constraints, addendums or Value Engineering (VE) items.
- 1.12. **Identification:** Refer to Section 22 1510 for identification requirements. **There are specific requirements prior to the above ceiling and final inspections, respectively, that are mandatory.** The identification section of the specification is extensive. The Contractor shall refer to Section 22 1510, review and provide all identification requirements specified. **Failure to comply with this provision will be cause for cancellation of the inspection with all costs of the re-inspection to be borne by the respective Contractor responsible.**
- 1.13. **Firestopping:** Refer to Section 22 1510 for requirements. **Note that Division 15 firestopping specifications require firestopping of all penetrations regardless of wall/ceiling/floor construction. Refer to Division 1 for additional requirements.** Where there is a conflict between Division 1 specifications and Division 15 specifications, the most stringent requirements shall govern, be applicable and shall be provided.
- 1.14. **Motors:** All motors, including air compressor and vacuum pump, furnished shall be designed, manufactured, and tested in accordance with the current applicable standards of NEMA, ANSI, IEEE, and ASTM. As a minimum requirement, all motors shall conform to the current applicable sections of NEMA Standard No. MG-1. Motors shall meet or exceed The Consortium for Energy Efficiency (CEE) Premium Efficiency full load efficiencies. All motors shall be listed under UL recognized component file as applicable. All motors shall be suitable for installation according to the requirements of NEC. Motors shall be wound for the specified voltage and a 1.5 service factor, 1750 RPM open drip proof construction unless otherwise shown or specified.

All motors shall be provided with overload protection and phase protection on

all legs. Do not run motors until correct overload elements are installed in starters, as applicable. Premium efficient motors shall be **warranted for 36 months** from date of substantial completion of the project, as determined by the Architect. Motors shall be by Allis Chalmers, General Electric Goulds, Louis Allis, and Westinghouse or approved equivalent. All motors serving outdoor equipment exposed to weather shall have TEFC motors meeting the requirements set forth previously.

**1.15. Bound and Framed Instructions: Two weeks before final inspection,** furnish three complete sets of operating and maintenance instructions, bound in hard cover, indexed and tabbed.

- a. The first sheet in the bound instructions shall be a listing of: The Owner/Project Title, Architect, Engineer, General Contractor and Subcontractor.
- b. Second page shall be a Table of Contents listing all products numbers in the order which they appear in the specifications and label the tab accordingly. Include all "P" numbers.
- c. Provide a summary page that lists each item with its respective warranty listed.
- d. All warranty information to be filled in by the Plumbing Contractor (Serial numbers, Model Numbers and any other information required by the Equipment Manufacturer).
- e. Local source of supply for parts and replacement, including names and telephone numbers of parts suppliers
- f. A general maintenance summary section shall be included. Provide a list of each piece of equipment using equipment designations as shown on the plans, and the routine maintenance procedures based on the respective manufacturer's recommended intervals. As a minimum, maintenance shall be grouped and individually tabbed to indicate maintenance operations required:
  1. Once a month
  2. Quarterly
  3. Once every six months
  4. Once a year
- g. Provide drawings of system and wiring diagrams, condensed operating instructions and include in binder. All components shall be numbered and identified on diagram.
- h. Record drawings of the Plumbing drawings in hard copy, PDF format and in ACAD ".dwg" format, on CD. Refer to Section 22 1510, Part 1, General, Paragraph, Record Drawings for additional requirements.
- i. Provide copy of Section 22 1540 Specifications
- j. Provide written results of all tests specified.
- k. Copies of all Site Visit / Inspection Reports including Contractor's written response that items listed were corrected.
- l. Provide domestic water samples testing and results specified.
- m. Provide copy of valve chart required in Section 22 1510, Identification. Include all dielectric unions on chart.

- n. All cleanouts and dielectric unions shall be indicated on record/as-built drawings.

Additionally, the Contractor shall provide all the aforementioned information, in digital Adobe Acrobat PDF format, on a CD-R CD. The PDF file shall be provided with an embedded index for each item specified. It shall appear in the left-hand window of the opened document so that the Owner or his maintenance personnel can "click" on the indexed item and move immediately to that specific item.

## **PART 2. TESTS**

- 2.1. **General:** Perform all tests in the presence of the Architect. Refer to Division One for Fuel, water and power required, therefore. In absence of specific testing procedure comply with code requirements and/or nationally acceptable industry standards. Furnish written reports of all tests results specified to Architect.
- 2.2. **Drainage and Vent System:** Plug all openings, fill entire system with water to point of overflow and hold for a minimum of twenty-four (24) hours without pressure loss before inspection. System shall remain full during the test without leakage. Each vertical stack with its branches may be tested separately, but any portion tested shall have minimum ten-foot head.
- 2.3. **Rainwater System:** Test same as drainage and vent systems.
- 2.4. **Water Supply System:** Test and secure acceptance of entire system before the piping or hot water storage heaters are insulated or otherwise concealed. Test as follows: disconnect and cap all outlets to plumbing fixtures and all other equipment not designed for the full test pressure. Fill the system with water; apply 150 psi hydrostatic pressure and hold for a minimum of twenty-four (24) hour period without pressure loss. Refer to Pex piping specification for testing pressure requirements. All piping throughout shall be tight under test. Water piping shall remain under normal water pressure during construction except when freezing weather is expected.
- 2.5. **Fixtures:** Test for soundness, stability of support and satisfactory operation.
- 2.6. **Gas System:** Apply 75 psi air test for a twenty-four (24) hour period without pressure loss through leakage. After completing pressure tests, and before testing a gas-contaminated line, purge line with nitrogen at junction with main line to remove all air and gas. Test before tanks, equipment, appliances, etc. are connected.
- 2.7. **Compressed Air:** Apply one hundred- and fifty-pounds air for 24 hours until proven tight.

### PART 3. SANITARY PIPING

**3.1. Scope:** Provide a system of soil, waste and vent piping connecting all plumbing fixtures, equipment, etc. to the house sewer, with **consolidated vent connections** extending through the building roof, all as shown on the drawings and as required for complete installation. All piping shall be concealed below grade, within walls, chases, above ceilings, etc., unless specifically noted otherwise. Waste and vent piping shall be sloped in accordance with the applicable codes. **Do not begin work until elevation of final connection point is verified and grading of entire system can be determined (even if final connection is specified under another Section).** Do not route the sewer line in the same trench with the domestic water line. Maintain a minimum of six (6) feet of separation between the two utilities. Rework existing waste roughing as required to facilitate renovation work as applicable.

**3.2. Utility Connection:** See Division 2. Make sanitary connection as indicated.

**3.3. Soil, Waste and Vent Piping Underground, Inside the Building Walls and to Points Outside the Building as Indicated:** Provide service weight hub-and-spigot cast iron soil pipe and fittings for underground service and hubless for above ground service, meeting ASTM A-74 for hub and spigot and ASTM A-888 for hubless, coated inside and out. Pipe exposed within the building shall be uncoated outside and left clean for painting. Fittings to receive screwed pipe arms shall be recessed drainage type. Soil and waste pipe shall have long sweep connections. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

Joints for hub and spigot pipe shall be made with compression gaskets meeting ASTM C-564. Joints for hubless pipe and fittings shall be equivalent to MG couplings meeting ASTM A-48 and C-564, or Anaco Husky SD 4000, super-duty, shielded couplings of Type 304 AISI stainless steel, meeting ASTM C1540 standard or equivalent by Ideal Tridon Heavy Duty HD or Mission Rubber Company, Heavy Weight, shielded.

**Option:** Contractor may use solid wall PVC schedule 40 DWV pipe and fittings meeting ASTM Standard D2665 and 1785 for above ground service and underground service with the following exceptions. Use cast iron as specified hereinbefore or PVDF (Polyvinylidene Fluoride) piping and fittings in areas used as return air plenums, return air platforms and where passing through or within a fire rated assembly.

PVDF piping and fittings, where specified and required, shall be Orion Super Blue PVDF (Polyvinylidene Fluoride) or equivalent products as manufactured by Enfield, Zurn, GEO or Fisher. The PVDF material shall conform to ASTM D3222 ASTM F1673, ASTM E-84 and UL 723. Pipe shall be marked with its UL Classification to indicate compliance with UL723 (ASTM E84). All fittings shall meet or exceed Schedule 40 dimensions.

All vents thru roof shall be cast iron pipe (minimum 12" both sides of the roof).

Secure the cast iron VTR to structure with heavy gauge 1-hole strap. **THE CAST IRON PIPING THROUGH THE ROOF DOES NOT APPLY TO GAS FIRED APPLIANCES. Vents through the roof for gas appliances shall be as specified for the appliance in its respective specification section.**

All floor drains shall have **cast iron** deep seal p-traps. Piping and fittings above the floor shall be solid wall PVC schedule 40 DWV pipe and fittings or PVDF as specified hereinbefore and with exceptions as noted.

**THE USE OF "CELLCORE" OR "FOAMCORE" TYPE PIPING IS EXPRESSLY FORBIDDEN.**

- 3.4. Acid-Resisting Soil, Waste, and Vent Piping:** All piping and fittings shall be a flame retardant, corrosive waste drainage system equal to Zurn Flame Retardant polypropylene Schedule 40 pipe and fittings. Provide fusion joints below slab and mechanical joints above the slab. Joints and piping installation shall be in strict accordance with manufacturer's recommendations. Pipe shall be marked with its UL Classification to indicate compliance with its required UL listing. Equal products as manufactured by Enfield, Orion and GSR will be accepted.

Acid resisting soil, waste and vent piping located in the return air plenum, return air platforms, and where passing through or within a fire rated assembly, shall conform to ASTM F1673, ASTM D3222, UL 723, ASTM E84 25/50 requirements for flame spread and smoke and made of **PVDF (Polyvinylidene Fluoride)**.

All PVDF pipe and fittings located below the slab shall be joined using fusion method. All PVDF pipe and fittings located above the slab shall be joined by no-hub mechanical joint method with plain end fittings and No-Hub couplings. Each No-Hub coupling shall have an outer band of 300 series stainless steel with 5/16" bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. The No-Hub joint shall conform to the requirements of ASTM F1673. PVDF piping shall be marked with its UL Classification to indicate compliance with UL723 (ASTM E84). All fittings shall meet or exceed Schedule 40 dimensions.

All PVDF piping and fittings installation shall be in strict accordance with the Manufacturer's recommendations. Piping and fittings shall be Orion Super Blue PVDF (Polyvinylidene Fluoride). Equivalent products as manufactured by Enfield, GEO, Zurn and Fisher will be accepted.

- 3.5. Laying Out Work:** Vents from any fixture, when connected to a vent line serving other fixtures, shall be extended at least 6 inches above flood level rim of highest of such fixtures to prevent use of vent lines as a waste. Make changes in direction by appropriate use of 45-degree Y's, 1/2 Y's, or long sweep 1/4, 1/6, 1/8 or 1/16 bends. Sanitary T's or short 1/4 bends may be used on vertical stacks or drainage lines where change in direction of flow is from horizontal to vertical; except that long-radiused TY's shall be used when two fixtures are installed back to back with common drain. Straight T's, Ells and

Crosses may be used on vent lines. Make no change in direction of flow greater than 90 degrees. Where different sizes of drainage pipe or fittings are connected use standard increasers and reducers of proper size. Do not reduce size of drainage piping in direction of flow. Drilling and tapping of house drains, soil, waste or vent pipes, and use of saddle hubs and bands are prohibited. **All plumbing vents through the roof shall be located a minimum of 10'-0" away from all outside air intakes.** Coordinate all plumbing vents locations with the HVAC plans.

- 3.6. **Hangers and Sway Bracing:** Refer to Section 22 1510 for requirements.
- 3.7. **Grading:** Uniform and not less than 1/8" PLF for pipe 4" and over, and not less than 1/4" PLF for 2" and 3" piping.
- 3.8. **Roof Flashing:** Roof penetrations are to be flashed by the roofing contractor, using materials as recommended by the roofing manufacturer and approved by the Architect. Coordinate work with Roofing Contractor. Offset vents as required to clear gravel guards and flashing courses. Extend vents 6" to 8" above roof level.
- 3.9. **Waste Arms:** Type K copper or IPS brass pipe typical; Schedule 40 PVC or IPS brass pipe at urinals.
- 3.10. **Test Fittings:** Not shown on the drawings; provide where required for partial tests.
- 3.11. **Ductile Iron Pipe:** Where noted on the drawings and for pipe sizes not available in hub-and-spigot provide ductile iron pipe and fittings meeting ANSI A21.50 (AWWA C150) Class 2. Install in accordance with pipe and fittings manufacturer's recommendations.

#### **PART 4. DRAINAGE SPECIALTIES**

- 4.1. **Manufacturers:** Except as noted, catalog numbers are from J.R. Smith. Equivalents by Josam, Sioux Chief, Zurn, Watts or Wade will be considered.
- 4.2. **Cleanouts:** Provide in sanitary piping at all changes in direction, at ends of branches, at intervals not exceeding 40 feet on straight runs, and elsewhere as shown. Cleanouts shall be full opening type and completely accessible without obstruction. Size same as lines in which they occur, but not larger than 4 inch. Tees and extensions shall be of same weight as soil pipe. Plugs countersunk or raised head type with lead-free seals. **Provide flashing clamps and flashing flanges in all areas where cleanouts are accessible from floor below or above, as applicable. All cleanouts shall be indicated on the record/as-built drawings.**

**In Tile Floors:** 4052L, adjustable, cast iron body with bronze plug and satin finished square scoriated nickel bronze top. Where soft tile occurs, provide 4172L recessed square nickel bronze cover.

**In Concrete Floors:** 4238L, adjustable head, cast iron head and ferrule with bronze plug, round loose-set scoriated tractor cover.

**In Outside Lines:** 4262L-NB cast iron head and ferrule with bronze plug. Terminate at grade in 18"x18"x12" deep concrete pad with tooled edges or flush in pavement as applicable.

**In Accessible Unfinished Spaces:** 4400 or 4511-S cast iron with bronze plug, as appropriate.

**In Finished Walls:** 4530S cast iron cleanout tee with bronze plug and 16 ga. stainless steel, flat, wall plate cover. Where distance from plug to finish wall will exceed 4 inches provide extension from sanitary tee to bring plug within 4 inches.

**In Terrazzo Floors:** 4192L, adjustable cast iron head and ferrule, bronze plug and round nickel bronze cover and rim.

**In Carpeted Floors:** 4032L-X, adjustable head, cast iron, round polished bronze top with carpet clamping device.

- 4.3. **Roof Drains:** Series 1010T-C-R or 1010T-E-R-C as required, lacquered cast iron drain with threaded outlet, removable dome, flashing clamp and deck clamp. Size outlets same as downspouts to which they connect.
- 4.4. **Typical Drains:** Size outlets same as pipe to which they connect. Install temporary closures during construction. Each drain connected to sanitary sewer shall have **cast iron** deep seal P-trap. Provide types as scheduled below. Where indicated on the drawings and elsewhere required by local and/or state Codes. Provide trap primer connection on floor drain and trap primer as specified below.

Where drains occur above finished spaces, furnish with clamping collar to secure waterproof membrane.

**Floor Drain (FD):** Series 2005B-05, -06, -08 (as required) two-piece cast iron drains with gasketed outlet and adjustable nickel bronze strainer and rim. Strainer tops for 2" drains 5" x 5", for 3" drains 6" x 6", for 4" drains 8" x 8". Provide trap primer connection as indicated on the plans.

**Shower Drain (SD):** Where not specified with the shower, provide Series 2005B-05, -06 NBSS (as required) with PO5 trap primer connection, two-piece cast iron drains with gasketed type outlet and adjustable stainless-steel strainer and rim. Provide clamping collar to secure waterproofing membrane. Strainer tops for 2" drains shall be 5" square; for 3" drains, 6" square; and for 4" drains, 8" square.

**Mechanical Room Drain (MFD):** Series 2230L cast iron drain with gasketed outlet, P05 trap primer connection, sediment bucket and cast iron grate.



**Area Drain (AD):** Series 2250L cast iron drain with gasketed outlet, sediment bucket and cast iron grate.

**Downspout Nozzles:** No. 1770 rough cast brass nozzles.

- 4.5. **Emergency Roof Drains:** Same as typical roof drains.

## **PART 5. RAINWATER, DRAINAGE SYSTEM**

- 5.1. **General:** Provide a system of roof drains, downspouts, emergency overflows, insulated, etc., as required and as shown on the Architectural and Plumbing plans and as required for proper drainage. All piping shall be concealed below grade, within walls, chases, above ceilings, etc., unless specifically noted otherwise. Refer to Section 22 1510 for hanger rods, hangers, spacing and sway bracing and similar requirements.

- 5.2. **Roof Drains, etc.:** Refer to Drainage Specialties.

- 5.3. **Piping Within Building:** Service weight cast iron pipe with joints, hangers, grading, etc. as specified for sanitary piping. First 18 inches of pipe immediately below roof drain shall be Schedule 40 galvanized steel with threaded connection to drain outlet or cast iron. Refer to Section 22 1510 for hanger rods, hangers, spacing, sway bracing and uni-strut support assembly requirements.

Use cast iron in areas used as return air plenums, return air platforms and where passing through or within a fire rated assembly.

**Option:** Contractor may use PVC schedule 40 DWV solid wall pipe and fittings meeting ASTM Standard D2665 and 1785 for above ground service and underground service except that turns to the vertical to 12" above the grade floor slab shall be constructed of service weight hub and spigot cast iron soil pipe and fittings as specified hereinbefore for sanitary piping. Use cast iron piping and fittings, as specified above in areas used as return air plenums, return air platforms or where passing through or within a fire rated assembly.

**THE USE OF "CELLCORE" OR "FOAMCORE" TYPE PIPING IS EXPRESSLY FORBIDDEN.**

- 5.4. **Flashing:** Use material as recommended by roofing contractor and approved by the Architect. Provide flashing for each drain extending at least eight (8) inches from clamping ring in all directions. Coordinate work with roofing contractor.
- 5.5. **Hangers and Sway Bracing:** Refer to Section 22 1510 for requirements.

- 5.6. **Insulation:** Insulate all horizontal rainwater piping above slab within the structure same as cold water piping, including emergency overflow piping. Insulate roof drain sumps and associated elbow, and trap same as piping.
- 5.7. **Emergency Overflow Drainage:** Piping same as rainwater drainage piping. Stub piping 2" above roof and provide flashing. Extend piping through wall and provide downspout nozzle.
- 5.8. **Downspout (Lamb's Tongue) Nozzle:** Provide Jay R Smith Model 1770 cast bronze nozzle with threaded outlet, wall flange and all items required for a complete installation
- 5.9. **Downspouts Thru Soffit:** Short lengths of galvanized steel pipe as detailed. Connect to roof drain and extend through soffit to sheet metal downspout against wall. Sheet metal downspout specified under Division 7.

## **PART 6. WATER PIPING**

- 6.1. **Scope:** Connect to water main as indicated and extend to all plumbing fixtures, hose bibbs, water heaters, etc.; and to HAC, kitchen, laboratory, laundry and special equipment as indicated or required. All piping shall be concealed below grade, within walls, chases, above ceilings, etc., unless specifically noted otherwise.

Refer to Section 22 1510 for hanger rods, hangers, spacing and uni-strut support assembly requirements.

- 6.2. **General Workmanship:** Cut accurately to measurements established at site and work into place without springing or forcing, clearing all openings, finished ceilings, etc. All piping not in an accessible attic that contain valves and other items which may require maintenance access shall be located no more than 24" above the finished ceiling and no more than 10'-0" in areas without ceilings. Piping located in attics shall be supported such that maintenance access can be accomplished without the use of a ladder.

Route all piping through previously built in sleeves and avoid excessive cutting or other weakening of the structure. Make changes in direction and size with fittings. Cap or plug open pipe ends during installation to keep out foreign material. Make connections carefully to ensure unrestricted flow, eliminate air pockets, and to permit complete drainage of the systems.

Supply piping to fixtures, faucets, hydrants, showerheads and flush valves shall be anchored to prevent movement. Install all buried piping with at least 36" of earth cover. Do not route the water line in the same trench with the sewer/sanitary piping. Maintain a minimum of six (6) feet of separation between the two utilities.

All piping below slab-on-grade construction shall be installed in plastic jacket equivalent to Plasti-sleeve, as manufactured by Plastic Products Co. of Stanton, California.

- 6.3. Freeze Protection:** Do not install piping or any device in spaces subject to freezing. Install piping within building insulation envelope.
- 6.4. Grading:** The Contractor shall consider pipe-grading requirements when coordinating pipe routing for the project. All piping shall be carefully installed to eliminate traps and pockets in pressurized lines. Where air pockets and traps cannot be avoided, provide valved hose connections for water traps and valved automatic air vents for air traps. Pipe slope shall be maintained throughout the project. Pressurized plumbing piping systems shall be sloped to drain points. Grade pipe upward from source to facilitate drainage and air relief. Where low points are required because of long runs or where sections may be valved off, provide with 3/4" globe valve and hose nipple for drainage at low point. **Make all connections to risers and fixtures from top of mains.**
- 6.5. Nipples:** Of same material as pipe in which they are installed; provide extra strong when unthreaded portion is less than 1 inch long.
- 6.6. Piping and Fittings:** ProPress or similar type joints and fittings are not allowed. Typical lines to be of copper tubing meeting ASTM B-88, Type "L" hard above ground and Type "K" soft below ground. Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth, No. 00 cleaning pads or wire brush. No acids shall be used to clean either pipe or fittings or as a flux in sweating joints. Make up joints with sweat fittings of wrought copper, and 0.25% of the total wetted surface area, lead free solder complying with ASTM B-32 and The Safe Drinking Water Act. Surfaces shall be prepared for soldering as required by ASTM B828. Do not make joints or branch connections below a slab on grade.
- 6.7. Hangers and Sway Bracing:** Refer to Section 22 1510 for requirements.
- 6.8. Utility Connection:** See Division 2. Make water connection as indicated.
- 6.9. Water Pressure:** Supply system is designed for static pressure of 50 to 75 psi. Gauge city water supply adjacent to building to verify that pressure is within those limits. Submit report in writing. Provide water pressure reducing valve, if required, to meet designed water pressure. See Water Piping Specialties for pressure reducing valve specification.
- 6.10. Disinfection:** New 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 or water purveyor 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. The pipe system shall be flushed with clean, potable water until dirty water does not appear at the points of outlet. The system or part thereof shall be filled with a

water/chlorine solution containing not less than 50 parts per million 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 not less than 200 parts per million of chlorine and allowed to stand for 3 hours. Following the required standing time, the system shall be flushed with clean potable water until the chlorine is purged from the system. Upon completion of the disinfection procedure, the Plumbing Contractor shall engage the services of the Alabama Department of Public Health Clinical Laboratories or a certified, licensed, testing laboratory to provide a bacteriological water analysis to include a standard heterotrophic plate count (HPC), microbial, bacterial, pathogens and coliform count. Test a minimum of two (2) samples of domestic water from two (2) separate locations within the facility. Test each sample for Coliform Present, Fecal Present and E. Coli present. Test locations shall be selected by the Architect and shall be noted on the Testing Laboratory's report. In addition to the two (2) locations required for testing, the supply line feeding a food cleaning area sink (if project contains a Kitchen) shall also be tested, thereby requiring a total of three (3) test locations. If the lab results indicate positive results for Total, Fecal, or E. Coli coliform per 100 ml respectively, or an HPC greater than 500 CFU/mL, the Contractor shall disinfect the system in its entirety, as specified above, and obtain new test results as outlined hereinbefore until levels are reached as required by AWWA C651 or AWWA C652.

**Prior to the final site visit**, the Contractor shall provide to the Architect, certified test results on the testing facility letterhead. The report shall indicate the name of the project, the locations from where the samples were taken, the testing laboratory findings and indication whether the water is safe for consumption. **No Certificate of Occupancy will be provided to the Owner without the required lab results indicating the potable water system is safe for consumption.**

- 6.11. **System Drainage:** Provide valves and hose nipple to allow for drainage of all risers and other system low points.

## **PART 7. WATER PIPING SPECIALTIES**

- 7.1. **General:** Seal the opening where the stem, nipple, etc., penetrates the insulation as required to maintain the continuity of the insulation and vapor barrier. All specialties in potable water distribution shall be certified "lead free" as required by Code, Regulations and Standards.

Provide a custom laser engraved brass valve tag at each valve and include in specified valve chart. Tag shall be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation.

- 7.2. **Unions:** 150 lb. rated; cast brass ground-joint type in copper pipe, galvanized malleable iron in wrought iron or galvanized pipe. Provide in all sizes of threaded pipe, and in sweat-jointed pipe over 1 inch, to facilitate easy repairs.

In such lines, install adjacent to water heaters, pumps, tanks, etc. into which piping is terminated; and on at least one side of valves, cocks, strainers, etc. and other devices that occur in piping runs.

- 7.3. **Dielectric Unions:** Provide dielectric unions between ferrous and non-ferrous piping as required, including piping and water heater stubs where different and stainless-steel water hammer arrestors. Dielectric unions shall be constructed using lead free materials as required by all Governmental Agencies, Codes and Standards and shall comply with ASTM 1545. Dielectric unions shall be Watts Series LF or equivalent by Mueller or Matco Norca. Where dielectric unions are installed, they shall be provided with factory fabricated brass tag. 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation. Indicate valve tags on the record drawings. **Contractor shall provide a ball valve on both sides of each dielectric union to allow for proper maintenance of the union.**

- 7.4. **Valves:** Provide where shown and/or specified, including all fixtures or equipment not furnished with stops. Arrange and install valves to be readily accessible for servicing. **All valves shall be bronze or heat-treated CW511L brass, lead free** and shall be the product of one American Manufacturer and shall meet the Buy American Act 41, USC 10a-10d as specified hereinbefore. Nibco units are basis of design. Equivalent valves by Jomar, Watts, Apollo, Kitz, or Mueller will be allowed unless specified otherwise below.

Where piping is insulated, provide thermal insulating T-handles with preformed holes for identification tags. Coordinate handle height requirement with specified insulation thickness. Provide height as required to clear insulation and properly operate without causing damage to piping insulation. All handles shall comply with UL 2043 and shall be UL listed for installation in air-handling spaces (return air plenums).

**Valve handles for piping up to 2" shall be Nibco Nib Seal, Jomar Long Neck T-Handle, Apollo Therma-Seal or Hammond/Milwaukee Valve Insulator MS.**

- 7.5. **Globe Valves 2" and Smaller:** Nibco #S-235-Y or Jomar Terminator G, bronze solder-type with replaceable disc, T-235-Y for threaded pipe, 150 WSP.
- 7.6. **Globe Valves Over 2":** Nibco F-718-Y iron body flanged type with replaceable disk, 125 WSP.
- 7.7. **Check Valves 2" and Smaller:** Nibco T-473-B or Jomar T-511G, bronze threaded, Y-Pattern swing check, 200 WSP.
- 7.8. **Check Valves Over 2":** Nibco F-918-B or Jomar F-571 iron body flanged type with bronze trim, 125 WSP.

- 7.9. **Ball Valves for Water Piping in Size 1/2" through 3"**: Valve shall be "Lead-Free" forged bronze or heat treated CW511L brass, 600 PSI CWP, 150 PSI WP, two-piece body, full port, blowout proof stem, stainless steel ball, stainless steel stem, PTFE seats and plastic covered handle. Valve shall meet NSF, ANSI, FM, UL and MSS SP-110 standards. Note that ball valves are also required on both sides of each dielectric union. Approved valve manufacturers are Nibco, Jomar, Watts, Apollo and Kitz.
- 7.10. **Strainers 2" and Smaller**: Crane No. 988-1/2, iron body screwed, Y-Pattern, 125 WSP sediment separators with a 20-mesh model screen.
- 7.11. **Strainers Over 2"**: Crane No. 989 1/2 of same construction as above. Equivalent strainers by Mueller, Chase, Nibco, Watts, Kitz or Jenkins will be approved.
- 7.12. **Thermometers**: Shall be high impact ABS case with 1/2" LCD digits and wide ambient formula, 1% accuracy, internal potentiometer for recalibration, with glass passivated thermistor, brass socket and in full conformance with ASME B40.3-1990 and Fed. Spec GG-T-321D and solar (self) powered. Thermometer shall be Weiss DVD6 or approved equivalent by Terice, Weksler, March or Maxwell Moore will be accepted. Stem height shall be as required to clear insulation thickness. Weiss is the basis of design.
- 7.13. **Pressure Gages**: Bourdon tube type, equivalent to Terice No. 600, each complete with cast aluminum case, lead free wetted parts, #870 vibration or pulsation snubber, #735 needle valve. Gage dials shall be not less than 4-1/2" and cases shall be of aluminum alloy. Furnish with suitable pressure ranges for each application. Equivalent products by Blue Ribbon, Weksler, Marsh or Terice will be accepted. Wetted parts shall be lead free.
- 7.14. **Wall Hydrants (Typical)**: Bronze, nickel plated, quarter turn, self-draining, non-freeze hydrant with hose connection, integral vacuum breaker, loose "T" handle key, stainless steel recessed box, with full 180°, polished bronze face, integral cylinder lock, and "Water" inscribed on the face. Seal all interior joints, seams, gasket seams/closures including around the hydrant box flange with an appropriate sealant recommended by a sealant manufacturer. Wall hydrant shall be JR Smith 5509 QT or approved equivalent. Install approximately 24 inches above finished grade.
- 7.15. **Wall Hydrants Inside the Building**: Woodford #MB224, or approved equivalent, with 14 Ga. Stainless steel door and fascia with polycarbonate handle, no lead, metal tee key and metal tee key lock with 34HF anti-siphon vacuum breaker with no spray back.
- 7.16. **Roof Hydrant**: Freezeproof, Woodford Model SRH-MS, or approved equivalent by J.R. Smith or Zurn, ASSE 1057 listed, with ASSE 1052 double check backflow preventer, 3/4" hose connection and manufacturer furnished mounting system.

- 7.17. **Water Hammer Arrestors (Shock Absorbers):** Certified by the American Society of Sanitary Engineers and in compliance with current edition of ASSE 1010, ANSI A112.26.1M, Plumbing and Drainage Institute Standard PDI-WH201, heavy-duty construction and designed for a minimum 150-PSI working pressure. Arrestors shall consist of a Type 304 stainless steel casing and bellows. The device shall be pre-charged and sealed at the factory. Install on both hot and cold-water branch lines in an upright position as close as possible to the valve or valves being served. Arrestors shall be installed at all solenoid, remote operated or quick closing valves and at each plumbing fixture or battery of plumbing fixtures as recommended by the Manufacturer. Plumbing Contractor shall provide a dielectric union at connection of this device to the copper water piping. Arrestors shall be Zurn Z1700, J.R. Smith Hydrotrol Series 5005-5050, Watts Series SS or MIFAB Series WHB.
- 7.18. **Automatic Drain Trap Primer Units Where Water Closets or Lavatories Occur:** Trap primers shall comply with International Plumbing Code and local codes. Allow for required modifications to meet local codes. Units shall be accessible for service. Provide required piping and drainage. Provide trap primer line to every floor drain and hub drain. Provide isolation valve for all trap primers. Trap primers shall be Sloan VBF-72-A1, Zurn 6000 or American Standard 6065.
- 7.19. **Automatic Electronic Drain Trap Primer Units:** Units shall be provided for all floor drains and indirect drains. Automatic electronic type trap primers shall be provided **ONLY** where there are no water closets or lavatories in the area. Units shall be lead-free and self-contained within a surface mounted panel on a partition wall above the ceiling. Housing shall be a NEMA 1, UL 50, 16-gauge steel enclosure. It shall contain a distribution unit with copper waterway, brass atmospheric vacuum breaker, transformer, brass ball type stop valve, slow closing solenoid valve with integral strainer, anti-scaling copper header, and complete with all required accessories. Where units are mounted on fire rated wall, it shall be within a fire rated housing. Units shall comply with International Plumbing Code and Local Codes. Allow for required modifications to meet local codes. Units shall be accessible for service. Provide required piping and drainage. Provide trap primer line to every floor drain, hub drain, floor sink, etc. as shown or required by Code. Provide isolation valve for each trap primer line. Unit shall be Zurn Series Z1020XL, Precision Plumbing Products, Inc. Series MPB-500-24V. Plumbing Contractor shall coordinate all power requirements with Electrician, prior to bid, and provide as required. Provide all required transformers, fittings, etc as required for a complete and functional installation.
- 7.20. **Pressure-Reducing Valve and Strainer:** Zurn/Wilkins 500XL-YSBR or equivalent by Apollo or Watts. Provide full size valved bypass around PRV, two pressure gauges, hose bibb and a valve and union on each side of PRV. Provide if required to meet designed water pressure (not to exceed 75 psi).
- 7.21. **Stop and Waste Valve:** Nibco Series 700.

- 7.22. **Backflow Preventer:** Provide in make-up water supply to boiler, heating water system make-up, boiler feed unit make-up line, therapeutic pools and elsewhere indicated or required by International Plumbing Code.

Units shall be Watts LF009 or equivalent by Apollo or Wilkins complete with strainer, double check valves and ball valves.

The backflow preventer shall be tested at job site by an individual certified by the American Backflow Prevention Association (ABPA). Testing procedure shall be as published in the Manual of Cross-Connection Control, Tenth Edition by the Foundation for Cross-Connection Control and Hydraulic Research. Furnish test results to the Architect. Testing results shall include the tester's name, ABPA certificate, certificate number and expiration date.

## **PART 8. LABORATORY SAFETY DEVICE SYSTEM**

- 8.1. **General:** The Plumbing Contractor shall furnish and install recessed, utility control panels and all required accessories for a complete and functional system. Plumbing Contractor shall be responsible for the furnishing and installation of all controls, power wiring, and control and interlock wiring, as specified or required to properly complete the installation. Provide to Electrical Contractor for installation all devices not requiring connections to utility piping systems. Control conduit shall be as specified in Electrical Division of the specifications and/or shown on electrical drawings. Minimum control conduit size shall be 1". All control conduit, power wiring, relays, transformers, contactors, etc. for this system, which are not shown on the electrical drawings or specified in the Electrical Division of the specifications, shall be provided under this Plumbing Section. Coordinate all requirements with the Electrical Sub-Contractor prior to bid. Plumbing contractor shall furnish all equipment. Plumbing Contractor shall install and make final connections to all piping systems. All wall mounted devices shall be mounted 46" A.F.F. to the center of the box (ADA height) unless shown otherwise. Electrical work performed under this Section shall conform to requirements set forth in the Electrical Division of the specifications and the National Electrical Code.

- 8.2. **Laboratory Utility Controller:** Contractor shall furnish and install recessed, utility control panel and all required accessories for a complete and functional system. Panel shall isolate the utility indicated via a key switch or in case of emergency, by operation of the emergency EPO button. Unit shall include a gas manifolded solenoid valve model "S" with ball valves, Y strainer and unions mounted horizontally in ceiling as shown on drawings. LED display and key lock for authorization control. Panel shall bear a UL label and comply with UL 61010-1 and NFPA 54 and have 3-year parts and labor warranty. Panel shall be manufactured by Isimet model LAV2 which controls gas. Flush mounted stainless steel key operated controller, 24 VDC with remote emergency cut off. Provide remote panic button as shown on drawing. Furnish fuel gas sensors at location shown on drawings. Manufacturer to provide factory authorized start up and report.



- 8.3. **Manufacturer:** The system shall be as Manufactured by Isimet Utility Safety Controls or approved equivalent by American Gas Safety Corporation or ASCO. Isimet is the basis of design.

## **PART 9. PIPE HANGERS AND SUPPORTS**

- 9.1. **General:** Refer to Section 22 1510. Refer to PEX-A requirements when applicable.
- 9.2. **Painting:** Clean and paint with two coats of black latex paint all exposed ferrous metal parts of hangers, Unistrut and other assemblies used for supporting of ducts (except duct straps/band hangers), piping and plumbing related items in mechanical rooms, crawl space, above ceilings, etc. Include black steel pipe, uncoated cast iron pipe, hangers, brackets, etc. **Bare, unprotected/uncoated steel or galvanized hangers, brackets, Unistrut, supports, etc., are not allowed.** In lieu of painting, the Contractor may substitute factory painted, powder coated or epoxy coated items to prevent rusting of the items listed above. All paints and coatings shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Also, see specification section, "Identification" for additional requirements.

## **PART 10. NATURAL GAS DISTRIBUTION SYSTEM**

- 10.1. **Scope:** Make house supply connection as indicated and extend to all gas fired equipment as well as other locations shown.
- 10.2. **Installation Generally:** In complete accordance with local gas code, requirements of local utility company, AGA, International Fuel Gas Code and NFPA Standard 54. Cut pipe accurately to measurements established at site and work into place without springing or forcing. Avoid runs through solid walls or floors. Route through previously built in sleeves and avoid excessive cutting or other weakening of the structure. Ream all pipes to remove burrs. Make changes in direction and size with fittings. Make take-offs from top or sides of mains, not from bottoms. Cap or plug open pipe ends during installation to keep out foreign material. Lay out and grade work (1/4" in 15 feet min.) to avoid trapped lines; where unavoidable provide 4-inch drip leg with removable cap at low point. Provide complete system testing per NFPA 54. Provide combination stop valve and insulating union at each point piping drops to underground or rises above grade from underground.

Gas pipe, tubing and fittings shall be clear and free from cutting burrs, defects in structure or threading, shall be thoroughly brushed, and chip and scale blown. Defects in pipe, tubing, and fittings shall not be repaired. Defective pipe, tubing, and fittings shall be replaced.

**Flare joints shall not be used.**

Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ANSI/ASME B1.20.1, Pipe Threads, General Purpose, Inch. Pipe with threads that are stripped, chipped, corroded, or otherwise damaged shall not be used. Where a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used.

Provide unions and hangers same as specified under Water Piping Specialties except AGA rated for natural gas. Refer to Section 22 1510 for pipe hangers, supports, rods and uni-strut requirements.

- 10.3. Interior and Above Grade Piping:** ASTM A53/A53M, Type as required by welding method, Grade B, seamless or ERW, Schedule 40 black steel pipe with black malleable iron screwed fittings for 2" and smaller, 2-1/2" and larger, ANSI B16.25/ASME B16.9 butt-weld. Welders shall be American Welding Society (AWS) certified. **Welders shall submit current AWS certificate** and shall affix AWS Certificate number and identification adjacent to each weld made.
- 10.4. Lines Installed Under Slab or In Any Unventilated Areas or Spaces:** Gas piping installed concealed in walls, chases, below slab on grade, or any unventilated area or spaces shall be installed in a Schedule 40 welded, airtight steel piping and vented to the outside atmosphere through the roof. Suitable internal spacers shall be provided. Inaccessible piping shall be all-welded connections. Socket type weld fittings may be used for gas piping within the airtight steel enclosure. Termination point of vented steel piping shall be a minimum of 10'-0" clear from all outside air intakes.
- 10.5. Electrical Bonding and Grounding:** The gas piping system shall be bonded to the electrical service grounding electrode system or, when provided, lightning protection grounding electrode system, at the point where the gas service enters the building, all as required by NFPA 54. The bonding jumper shall not be smaller than 4 AWG copper wire and shall be a maximum of 75 feet in length. Devices used for the bonding connection shall be listed for the application in accordance with ANSI/UL 467, Grounding and Bonding Equipment. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems. Bonding of gas piping systems is electrical work and shall be provided by a qualified licensed Electrical Contractor who is recognized by the Authority Having Jurisdiction as capable of doing such work. Point of connection shall comply with the current edition of NFPA 70, National Electric Code. **It is the responsibility of the Plumbing Contractor to engage a qualified, licensed Electrical Contractor to provide the bonding and grounding as specified. Coordinate prior to bid and provide as specified.**
- 10.6. Gas Valve and Connections:** Provide UL, CGA and AGA listed and approved, ASTM A-126, Class B, 200 PSI WOG, 125 PSI SWP, lubricated plug valve and pipe union in supply connection to each piece of equipment, Resun R-1430 semi-steel or equivalent for line sizes 2" and smaller.

Provide R-1431, UL, CGA and AGA listed and approved, ASTM A-126, Class B, 200 PSI WOG, 125 PSI SWP, Grade I, flanged, lubricated plug valve and pipe union in supply connection to each piece of equipment for line sizes over 2". Use flat face when connected to flat face companion flange

Where final connection is specified under another Section, cap off within 3 feet of input point.

Equivalents by Flowserve/Nordstrom or Homestead are acceptable.

Provide a custom laser engraved brass valve tag at each regulator identifying gas pressure and pipe contents. Tag shall be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation.

- 10.7. Gas Pressure Regulators:** Provide a regulator at each gas fired appliance/device. Standard service type gas regulators meeting job and Gas Company requirements with automatic safety shut-off valves, leak/vent limiting device, cast iron body, regulators meeting job and Gas Company requirements, with automatic safety shut-off valves equal to Security Corp, aluminum orifice and chromate covered casting, e-coated or primed with enamel topcoat and tamper proof seals. Verify supply (inlet) pressure prior to selecting regulators.

Regulator shall be equivalent to Security Corporation or equivalent by Sensus, Emerson/Fisher, Pietro Fiorentini or American as required by job conditions.

Provide a custom laser engraved brass valve tag at each regulator identifying gas pressure and pipe contents. Tag shall be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation.

- 10.8. Shutoff Valve:** Main gas shutoff valve controlling the gas piping system shall be easily accessible for operation and shall be installed in each service line as indicated, and protected from physical damage.

Provide a custom laser engraved brass valve tag at each regulator identifying gas pressure and pipe contents. Tag shall be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation.

## **PART 11. PIPE INSULATION**

- 11.1. General:** All work by experienced insulation subcontractor whose primary business is the installation of insulating materials in accordance with insulation manufacturers' recommendations. Piping shall be clean, dry and pressure tested before covering is applied. Size pipe hangers to fit insulated

pipe size. **No installation of pipe hangers for insulated piping will be allowed to be in contact with piping or penetrate the piping insulation. Piping insulation shall be continuous through partitions/sleeves and shall not be cut away for installation of clamps, etc.** Refer to details on plans and Section 22 1510, "Pipe Hangers and Supports" for additional requirements. Cover fittings, valves and flanges with insulation material as hereinafter specified to same thickness as adjacent pipe covering except screwed unions in hot piping and other specifically named items. Neatly bevel covering edges adjacent to unions and other points of termination and seal ends. All insulation material (including coatings, mastics, jackets and adhesives) shall have a composite flame spread rating not to exceed of 25 (with no fuel contributed and smoke developed) as determined by ASTM E-84, NFPA 255 and UL 723.

- 11.2. Scope:** Insulate all hot water and cold-water piping except that below grade and excluding plated brass fixture connections. All piping shall be routed within the building insulation envelope to prevent freezing. Insulate rainwater drainage system as noted in that Part. Insulate all p-traps located in return air plenums, horizontal overhead drain lines, including p-traps, from mechanical room floor drains, ice machine drains, cooler drains, condensate drainage piping located in return air platform plenums and other condensate receiving drains, to the respective riser same as cold water piping. Include all overhead floor drain sumps and vertical pipe connection.

Insulate the vacuum pump exhaust line and air compressor intake line same as specified for hot water pipe.

- 11.3. Insulation:** No installation of pipe hangers for insulated piping will be allowed to be in contact with piping or penetrate the piping insulation. Refer to details on plans for additional requirements. Size hanger loops to fit **over** insulation. Insulate with Owens-Corning SSL II with ASJ Max Fiberglass pipe insulation, thickness as shown below, thermal conductivity of  $k = 0.23 \text{ Btu-in/hr-ft}^2\text{-}^\circ\text{F}$  at  $75^\circ\text{F}$  mean temperature. Insulation shall comply with ASTM C547, ASTM C585, ASTM C1136, ASTM C795, NFPA 90A and 90B and be UL Labeled for Flame Spread Index of 25 or less and Smoke Developed Index of 50.

Adhere SSL by removing release paper after the insulation is installed on pipe and sealing the lap starting in the center of each section, working towards ends. Lap shall be pressurized by rubbing with a plastic sealing tool. Install 3" butt strips in the same manner at the joint between sections and at 3'-0" on center. Staple jacket flaps with nominal 3/4" wide stainless steel or Monel outward-clinching insulation staples on 8" centers. Insulation staples shall have a vapor retarder coating or covered with greater than 3 ply laminate jacket (less than 0.0001 perms) adhesive tape or vapor barrier mastic that conceals the entire staple.

Insulate all fittings and elbows with premolded fiberglass fittings containing **rigid** insulation of equal thickness and density of the adjacent piping and are UL Labeled for Flame Spread Index of 25 or less and Smoke Developed Index of 50.

In lieu of premolded PVC covers at elbows and fittings, which contain rigid insulation as specified hereinbefore, Contractor may at his option miter the insulation. Thereafter, seal staples and cover ends on both sides of fitting with butt strip, staple and seal staples with insulating sealant. Where applicable, finish open ends of sectional covering by rounding off with insulating cement, glass cloth and lagging adhesive.

Cold Water/Domestic Water Insulation thickness:  
All pipe sizes 1" thickness

Hot Water Insulation thickness:  
For pipe sizes up to 1-1/4" – 1.0" thickness  
For pipe sizes 1-1/2" to 6" – 1.5" thickness

- 11.4. Insulation for Piping Within Concrete Block Walls:** Insulate with 1" or 1.5" thickness insulation for the respective piping as specified above. Insulation shall be black, flexible foamed, elastomeric, closed cell pipe insulation with a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. It shall be GreenGuard certified tubular insulation with Microban antimicrobial protection. Insulation shall have a 'k' factor of not more than 0.26 at 90°F mean temperature and a water vapor transmission rate of 0.05 perm-inches or less. Slip insulation onto pipe prior to installation. **Longitudinal cutting of the insulation is prohibited. Do not stretch or bend insulation, nor slide insulation over sweat fittings.** Insulate sweat fittings with miter-cut pieces of insulation as recommended in Armaflex installation instructions, the same size as on adjacent piping. Seal all butt joints with Armaflex BLV, Black, low VOC, air drying contact adhesive. After gluing joints, wrap joint with 3" wide, 1/8" thick AP/Armaflex self-adhering tape. Insulation shall be AP Armaflex or equivalent by K-Flex or Aerocel AC EPDM.
- 11.5. Fittings:** Insulate with Fiberglas insulation mitered to fit snugly or with PVC covers with integral **rigid** fiberglass insulation of the same thickness and density as the adjacent pipe insulation. **Loose insulation in premolded covers is not allowed.** Premolded PVC covers shall have a flame spread index of 0-25 and a smoke developed index of 0-50 when tested in accordance with ASTM E84.
- 11.6. Exposed Ends:** Finish open ends of sectional covering by rounding off with cement, and sizing with fiberglass cloth jacket around the pipe and finish with Foster 30-36 mastic cement.
- 11.7. Partitions and Floors:** Refer to Section 22 1510 Pipe Sleeves. In any case, insulation shall extend through floors, partitions and walls and firestopped. Note that Section 22 1510, Firestopping, requires firestopping of all penetrations, regardless of rating. Refer to Section 22 1510, Firestopping, for specifics and additional requirements.

- 11.8. **Aluminum Jacket:** All piping insulation exposed to the elements, all piping exposed to view in mechanical rooms, janitor closets and similar spaces, and all piping located in crawl space shall be covered with a preformed, 20 mil (.02") thick, smooth finish, 3003 and 3105 series aluminum jacket conforming to ASTM B-209 standards. Fittings shall be 20-mil (.02") thick, die shaped, and smooth finish, Type 1100 aluminum jacket meeting ASTM C585. Provide 1/2" wide, 20-mil (.02") thick, Type 3003 aluminum bands on maximum 24" centers but not less than two bands per jacket section. Locate longitudinal lap of aluminum jacket on bottom for all horizontal piping. Seal jacket lap on bottom and make watertight with silicone caulk. The aluminum jacket shall extend and terminate a minimum of 12" inside the respective indoor space. Seal the penetration and ends of piping insulation weather tight. **VentureClad or similar product is prohibited.**
- 11.9. **Underground Hot Water Piping:** Insulate with 2" thickness Armstrong Armaflex or equivalent pipe insulation. Seal all joints with Armaflex 520 sealer and 1/8" thickness, 3" wide Armaflex tape.
- 11.10. **Electric Water Coolers:** Insulate drain connections and traps with 1/8" thick insulating tape by AP Armaflex, K-Flex or Aerocel AC EPDM or 1/2" thick fiberglass insulation as specified for piping insulation.
- 11.11. **Piping At Hangers and Unistrut:** For all piping, provide a preformed, pre-insulated 6" long saddle assembly consisting of an integral 22 gauge G-90 metal saddle for piping up to 1 1/2" and, 12" long integral 18 gauge G-90 saddle for piping up to 5". The assembly shall be a 360-degree section of 3.0 pcf density polyisocyanurate pipe insulation with a minimum of 45-psi compressive strength. The assembly shall have a 6-mil thickness, .01 perms rated industrial grade vapor retarder film. The insulation shield shall be 360-degree self-clamping and be integral with the insulation. The assembly shall also be provided with an insulation lock joint longitudinal seam. The assembly shall meet the requirements of ASTM D1622 for insulation density, ASTM C518 for thermal conductivity, ASTM D1621 for 50 PSI compressive resistance, and ASTM D374. The insulation jacket shall have a hazard rating not to exceed 25 flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E-84, NFPA 255 and UL 723. The assembly shall be Tru-Balance/Buckaroo's, Model 3300E or equivalent by Thermal Pipe Shields, Inc or Pipe Shields, Inc.
- 11.12. **Painting:** Paint exposed insulation after insulation is completed as specified in Section 22 1510.
- 11.13. **Identification:** Refer to Section 22 1510 for identification of piping systems.

## **PART 12. WATER HEATING EQUIPMENT**

- 12.1. **General:** Commercial heavy-duty heater(s), minimum 2" tall legs, circulating pump, controls, piping, accessories, shall bear an ASME stamp and arranged as shown on the drawings. Heater to be completely insulated and jacketed for

vertical installation. The jacket shall be a round heavy gauge galvanized steel assembly, primed and pre-painted on both sides with a minimum dry film thickness of 0.70 mills. Jacket shall have a full-length element access panel and a hinged control panel access door for safety. The jacketed tank assembly shall have an accessible drain. The tank shall be factory insulated with a 3 inch thick high-density non-CFC polyurethane foam to meet the minimum stand-by loss requirements of the latest edition of ASHRAE 90.1 Energy Efficiency Standards. Heater shall be provided with BACnet card as required to interface with the Campus wide BAS. Coordinate type required with BAS/ATC Contractor and provide as required.

- 12.2. Tank:** The tank shall be of standard construction in accordance with ASME Boiler and Pressure Vessel Code requirements and shall be stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. The tank shall be standard with a 150 psi working pressure for 5 through 50 gallon models and 125 psi working pressure for 65 through 120 gallon models. The tank shall be glass lined with vitreous glass enamel and fired at 1600°F to ensure a molecular fusing of glass and steel. A combined magnesium tank saver anode with a powered anode shall be installed in the tank for corrosion protection. A handhole clean-out shall be standard on all models to allow inspection and cleaning of the vessel. Tank inlet and outlet water connections shall be 1-1/2" NPT.
- 12.3. Heating Elements:** The immersion heating elements shall be low watt density with a sheath for long life. The heating elements shall mount in individual screw-in tank flanges. In accordance with U.L. requirements, water heaters with a current draw in excess of 120 amps shall be equipped with internal fusing. Capacity and power as indicated on plans.
- 12.4. Internal Wiring and Controls:** All field electrical wiring connections to the water heater shall be made to a main terminal block. All internal wiring shall be made to solderless terminal lug wiring connections. Wiring to be color coded for ease of servicing. An ASME rated temperature and pressure relief valve shall be provided with the water heater. The water heater shall be factory assembled, wired and tested. The entire water heater shall be U.L. Listed and provided with a 3-year limited warranty on the tank and a 1 year limited warranty on parts.
- 12.5. Immersion Thermostats and Contactors:** Heating elements shall be switched by a magnetic contactor(s) operated by a fused 120 volt control circuit with an advanced electronic control. The electronic control shall have an LCD readout which will display operational and diagnostic information. Standard features include: Low Water Cutoff, Element Sensing and Night Setback. The control shall be capable of supplying 180°F water. The control circuit shall use a built-in transformer to reduce line voltage to 120 volts for operation of the control circuit components. The control circuit shall include a manual reset safety hi-limit control to prevent over heating in the event of a component failure.

- 12.6. **Relief Valves:** Install (in accordance with USA Standard Z21.22) properly sized ASME approved T&P relief valves with copper overflow lines to floor drain as indicated.
- 12.7. **Circulating Pump:** Furnish and install, as shown on the plans an all lead-free bronze (0.25% or less lead content of all wetted surfaces) or stainless steel construction, pipe-mounted centrifugal pump with high efficiency ECM motor in eight (8) modes of control and stainless steel flanges. Pump shall be ETL or UL listed and be NSF 372 compliant. Provide a strap-on aquastat and wire to control the pump through a 7-day program clock which shall be programmed to the Owner's requested operating schedule. Clock shall be equivalent to Grasslin digital 2-72 with 24-hour minimum battery back-up power. Provide required control wiring. Pump power shall be as shown on the electrical plans. Pump shall be Armstrong Series Compass H or equivalent by Taco or Grundfos.
- 12.8. **Expansion Tank:** Provide diaphragm type with NSF liner, designed for 150 psig working pressure and shall bear an ASME stamp. Tank shall have a minimum acceptance as recommended by heater manufacturer. Expansion tank shall be supported at the wall by a QS-5 or QS-12 Quick Strap tank stainless steel and galvanized assembly as manufactured by HoldRite or approved equivalent.
- 12.9. **Heater Manufacturer:** Lochinvar Series CH (HP) or equivalent by Rheem, Bradford-White or approved equivalent by A.O. Smith. Lochinvar is the basis of design.

### **PART 13. VACUUM PUMP**

- 13.1. **General:** The laboratory vacuum system package shall be compliant with the NFPA 99 requirements for Risk Category 3 laboratory and Level 4 as defined by ASHRAE laboratory systems. The laboratory vacuum system is designed to create a suction system to remove unwanted fluids, gases and particles from laboratory working areas.. Each system is completely tested before shipment and include multiple vacuum pumps and associated equipment, AMSE air receiver and NEMA 12 multiplex control panel. Each pump shall be factory piped to a common intake manifold. Unit shall be provided with BACNET interface for monitoring and control via the University's Campus wide Network. Coordinate requirement with Section 23 15 92 contractor and provide as required. Provide all as required to accomplish the requirements of ASHRAE and NFPA 99.
- 13.2. **Rotary Vane Vacuum Pump:** The vacuum pump shall be of the rotary vane air cooled design. Pump shall be direct driven through a shaft coupling by a TEFC electric motor. Belt drives shall not be permitted. The vacuum pumps shall be mounted on vibration isolators. Each vacuum pump shall be air-cooled and have absolutely no water requirements. Each pump is equipped with a 5 micron inlet filter for removal of particulates. Lubrication shall be provided by an integral, fully recirculating oil supply that is filtered by an



automotive-type, spin-on oil filter. Non-recirculating (once-through) or partial re-circulating oil supply systems shall not be permitted. Each vacuum pump is supplied with ISO100 PAO synthetic oil. The oil separation systems shall be integral and shall consist of no less than three stages of internally installed oil and smoke eliminators through which the exhaust gas stream must pass. This system shall consist of bulk separation, oil mist elimination, and smoke elimination, and shall be capable of removing 99.9+ percent of all oil and smoke particles from the exhaust gas stream. Each vacuum pump shall include a built-in, antisuck-back valve, mounted at the pump inlet, and three sliding vanes. Each pump is initially filled with full synthetic oil for improved lubrication, longer life, and chemical resistance.

- 13.3. Motor:** The motor is continuous duty, C-face, TEFC type.
- 13.4. Receiver:** The system shall include an ASME rated air receiver. The tank shall be internally lined and come with a manual drain and sight gauge. Systems with Basic Controls are also equipped with a vacuum gauge. Receiver is plumbed so that system vacuum must pass through the air receiver prior to the pumps to provide additional protection for the pumps.
- 13.5. Control Panel:** The control system shall provide automatic lead/lag sequencing and automatic alternation of all pumps in order to equalize the amount of usage among the available vacuum pumps. The Basic NFPA Control Panel shall be and include a UL508A listed control panel in a NEMA 12 enclosure with accessories for each pump. Accessories shall include externally operable disconnect, magnetic starter with 3-leg overload protection, Hand/Off/Auto lighted selector switch, minimum run timer to prevent short cycling of the pump, and hour meter. Also provide Main power on light, timed lead/lag pump alternation, a low vacuum alarm with visual indication, and single control circuit transformer with fused primary and secondary protection. Provide dry contacts on a labeled terminal strip for remote alarm monitoring and an acknowledge pushbutton for horn silencing via the BAS interface as well as local. Control logic to start the lag pump automatically if the lead vacuum pump fails to operate. Panel shall be provided with single point power connection, vacuum switches for process control, system overload trip, high temperature conditions or low vacuum will result in visual alarm, high discharge air temperature shutdown alarm with visual and audible indicators and dry contacts is standard.
- 13.6. Warranty:** 5 years parts and labor starting on the date of substantial completion as established by the Architect.
- 13.7. Manufacturers:** Powerex, Qunicy and Ingersol Rand. Powerex is the basis of design.

**PART 14. ENCLOSED OIL-LESS SCROLL LABORATORY CLEAN DRY AIR  
SYSTEM**

- 14.3. General:** The laboratory compressed air system package shall be compliant with the NFPA 99 requirements for Risk Category 3 laboratory and Level 4 as defined by ASHRAE laboratory systems. Compressor shall be multiple scroll compressors mounted inside of a rigid steel sound enclosure. Enclosure shall have a powder coated finish and shall include sound deadening insulation. Noise levels shall not exceed 58 dba with all compressor units in operation. The system shall include enclosed scroll air compressor with VPD controller, vertical air receiver, desiccant dryer, filtration, dew point monitor, and pressure reducing valves, all mounted and plumbed together on a common steel skid. Unit shall be provided with BACNET interface for monitoring and control via the University's Campus wide Network. Coordinate requirement with Section 23 15 92 contractor and provide as required. Provide all as required to accomplish the requirements of ASHRAE and NFPA 99.
- 14.3. Compressor:** Each compressor shall be belt driven oil-less rotary scroll single stage, air-cooled, oil-less construction with absolutely no oil needed for operation. The rotary design shall not require any inlet or exhaust valves and shall be rated for 100% continuous duty.
- 14.3. Motor:** Premium efficient TEFC, 1800 RPM, 1.15 service factor.
- 14.3. Air-Cooled Aftercooler:** Air-cooled aftercoolers shall be provided for each compressor and shall be mounted integral to the compressor enclosure.
- 14.4. Moisture Separator:** A liquid separator with automatic condensate drain is provided at the final discharge of the air compressor and prior to the tank/dryer assembly.
- 14.5. Compressor Controls:** The controls shall be integrated with the compressor cabinet from the factory. A lighted on/off switch is provided along with a user friendly, touch screen, HMI type display panel. The controls will operate and continuously monitor the system and provide information and alarms to the user through the HMI display. Features include display of system pressure, pump run status, pump fault conditions (high temperature shutdown, motor overload fault), maintenance counters and warnings, system trends, and pump HOA control. System setup mode allows user to adjust system pressure setpoints, enable auto restart function, reset alarms, and reset maintenance counters. Compressor operation shall include the Powerex Variable-Pump-Drive control logic. Each compressor pump is automatically staged on or off individually based on actual system demand. Energy efficiency is maximized at all usage levels. Lead compressor status will rotate based on demand, as well as timed alternation to maintain equal run hours. Dry contacts are provided for remote monitoring of compressor fault conditions. The complete compressor assembly shall be UL/CSA Listed.

- 14.6. **Air Storage / Purification:** Complete pre-packaged assembly to include (1) 120 gallon vertical air receiver, (1) desiccant air dryer, (1) .01 micron coalescing final filter, (1) 1 micron final filter, Dew Point Monitor, and final line pressure regulator.
- 14.7. **Air Receiver:** 120 Gallon, Vertical, 200 psig, ASME code receiver with safety valve, pressure gauge, automatic electric timer drain valve and internal FDA approved coating to prevent corrosion.
- 14.8. **Desiccant Air Dryer / Filtration:** The twin-tower, heatless desiccant air dryer shall yield a pressure dew point of -40F. The dryer shall be installed and plumbed on a common steel skid to the air receiver. The dryer design shall be of the automatic pressure swing, heatless, regenerative type and shall include a solid-state cycle timer, reliable switching valve design, and purge muffler for quiet operation. Air filtration shall consist of 2 stages of filtration mounted and plumbed to the air dryer. The first stage of filtration shall include a .01 micron coalescing pre-filter with element change indicator and automatic condensate drain. The second stage shall include a 1 micron particulate filter with element change indicator
- 14.3. **Dew Point Monitor:** The system integrated monitor shall be equipped with a °C/°F/ LCD display dew point monitoring device. The dew point sensor shall be installed downstream of the pressure regulator assembly. Visual and audible alarms for high dew point shall be provided with dry contacts for remote monitoring.
- 14.4. **Manufacturers:** Powerex, Qunicy and Ingersol Rand. Powerex is the basis of design.

## **PART 15. FIXTURES SUPPORTS AND CONNECTIONS**

- 15.1. **General:** Verify exact size and location of water, vents, waste and supply connections from approved rough-in drawings and/or catalog data sheets. Allow for modifications required by the shop drawings without additional cost to the Owner or the Owner's Project Design Professionals.

All fixtures including lavatories, urinals, water closets, electric water coolers, etc., shall be securely fastened to the walls or floor. **Coordinate all mounting heights and fixture types required with Architectural plans prior to rough-in and ordering fixtures.**

- 15.2. **Wall Mounted Fixtures:** Support all wall mounted fixtures that are specified without carriers using 1/4" thick 6" high plates full length and width of fixture, mounted behind wall. Where fixtures are back to back on a solid wall, mount with bolts from fixture hanger to fixture hanger. Do not use toggle bolts or expansion bolts unless noted on the plans or specified.

Hangers for wall supported water closets are specified with fixtures.

Where fixtures are mounted on solid (single wythe) walls finished both sides, install fixtures with plated toggle bolts.

Where fixtures are mounted on wood or light gauge steel studs, employ pressure treated blocking of 2" x 12" nominal size well secured into stud line with non-corrosive, dielectric separation fasteners. Fit behind stud flanges, using especially placed studs as required.

Provide wall carriers where specified or required by the fixture Manufacturer.

Coordinate demolition and repairing of existing walls with General Contractor prior to bid to allow for installation of carriers as applicable.

- 15.3. Floor Connections:** Provide cast iron or galvanized malleable iron floor flanges at least 3/16" thick, screwed or caulked to drainage pipe. Bolt the connection and make tight to fixture with plumbing fixture setting compound, wax setting ring or polyethylene gasket flange. Offset flanges for water closets are not allowed.
- 15.4. Water Supply Connections:** Provide rigid, lead-free brass nipple from water riser to fixture stop valve threaded connections. Steel pipe is unacceptable. Exposed portion of nipple shall be chromium plated. **Stops' risers shall be lead-free, threaded with chrome over copper pipe. Quick connect fittings or braided supplies are not allowed.**
- 15.5. Waste Arms to Fixtures:** As specified hereinbefore. Where copper or brass pipe is specified, all joints downstream from the trap shall be soldered joints.

## **PART 16. LABORATORY ACID NEUTRALIZING TANK**

- 16.1. General:** Contractor shall furnish and install high-density polyethylene neutralization tank. Tank shall be rotationally molded seamless construction, with flanged top and bolt-down cover, as supplied by Ensfield Industrial Corporation. Tank shall be equivalent to Ensfield Neutrack #T0055, having 55-gallon capacity, complete with 4" inlet and outlet, and 2" vent connection. Tank to be 22" diameter x 36" high. Tank shall be installed in accordance with manufacturer's recommendations. Provide heavy-duty manhole (full size) extension to finished grade and set in finished concrete.

Contractor shall furnish and fill the tank prior to operation with approved neutralization agent such as limestone or marble chips, one to three inches in size, to a level just below the tank outlet. Water should be added to the tank after placement of neutralization agent.

Provide required anchors to prevent flotation.

## **PART 17. MISCELLANEOUS EQUIPMENT FURNISHED UNDER OTHER SECTIONS**

- 17.1. **General:** Equipment indicated hereunder is to be furnished and set in place under another Section of the Specifications (or is to be so provided under a separate contract). Verify exact size and location of water, vents, waste, supply and gas connections from approved rough-in drawings and/or catalog data sheets. All water and gas connections are to be complete with stop valves.

Allow for modifications required by the shop drawings without additional cost to the Owner or the Owner's Project Design Professionals.

- 17.2. **Laboratory Equipment:** Rough-in and make connections as shown on the architectural plans and the lab equipment plans

**Cup Sink:** Provide Brasscraft XR1720A supply with stop and acid-resisting waste pipe and fittings (faucet and trap are specified with sink).

**Fume Hood:** Same as cup sink, plus gas supply with cock.

**Compressed Air, Vacuum and Cock:** Make connections to items specified and required for all casework, wall plates, etc. as shown and specified on the Architectural plans and Lab Equipment plans.

- 17.3. **Lab Fixtures, Sinks and Fume Hoods:** All lab fixtures, sinks, fume hoods, etc. shall be furnished complete with faucets, drains, acid resisting traps, gas cocks, air cocks, vacuum outlets, air outlets, distilled water outlets, vacuum breakers, overflow drains and in general all control and operating trim by equipment and fixture supplier (See Lab Equipment Section).

The Plumbing Contractor shall rough-in; provide acid-resisting waste fitting from trap to sewer; provide service stop valves in all water supplies; gas cocks; other accessories, materials, labor and make all connections as required for a complete first class installation ready for operation. The Plumbing Contractor shall also install sinks in casework and assemble required piping, faucets, outlets and trim as outlined in Lab Equipment Section.

Refer to acid resistant piping requirements specified hereinbefore.

## **PART 18. SCHEDULED FIXTURES AND MISCELLANEOUS ITEMS**

- 18.1. **Acceptable Manufacturers:** Fixtures listed are from American Standard (AS) and Elkay Catalogs. Equivalent products by Toto, Kohler, Zurn, Beneke, Just or Sloan will be accepted. Where three (3) Manufacturers are listed for fixtures below, use only those Manufacturers. Manufacturers not listed require 7-day prior approval. All prior approvals shall be submitted through the Architect.

- 18.2. **Fixture Trim:** Exposed metal parts to be of heavy weight polished brass, heavily chromium plated, of best quality as regularly furnished by the plumbing fixture manufacturer. Provide stop valve in supply to all fixtures and equipment.
- 18.3. **Compliance with Americans Disabilities Act:** All ADA fixtures, faucets, flush valves, clearances, and installation shall comply with requirements of the Americans Disabilities Act.
- 18.4. **Guarantee:** Guarantee in writing to make good without cost any defects in materials and workmanship for five (5) years following the date of substantial completion of the project as determined by the Architect. Provide free maintenance and service during the guarantee period.

18.5. **Scheduled Items:**

**P – 1 Water Closet:** American Standard Madera 3451.001, EverClean, 1.6 GPF vitreous china, siphon jet, elongated bowl with 1-1/2" top spud, fully glazed trapway, china bolt caps, Zurn Z6000AV-WS1 flush valve and Bemis 1655SSCT white open-front seat with self sustaining stainless steel check hinge. Provide YJ chrome plated split-ring wall bracket for supply pipe.

**P – 2 (P-3 Same) ADA Water Closet:** American Standard Madera 3461.160, EverClean, 1.6 GPF 17" high vitreous china, siphon jet, fully glazed trapway, elongated bowl with 1-1/2" top spud, china bolt caps, Zurn Z6000-AV-WS1 flush valve and Bemis 1655SSCT white open-front seat with self sustaining stainless steel check hinge. Provide chrome plated YJ split-ring wall bracket for supply pipe. Coordinate flush valve installation with grab bar. Flush valve control/handle shall be mounted for use from the wide side of the toilet stall.

**P – 4 Urinal:** American Standard Allbrook 6550.001, 1.0GPF, vitreous china siphon jet, 3/4" top spud, flushing rim urinal, Zurn Z6003-AV-WS1 flush valve with vacuum breaker and Zurn series Z-1222 carrier. Provide chrome plated YJ split-ring wall bracket for supply pipe.

**P – 5 Lavatory:** American Standard Aqualyn 0476.028, size 20" x 17" vitreous china oval self-rimming lavatory with Delta 523LF-HDF faucet and drain, McGuire #LF2165 supplies with stop and McGuire 8872C, 1 1/4", 17 ga., chrome plated cast brass, seamless tubular wall bend, p-trap with neoprene gasketed cleanout and cast brass, chrome plated slip nuts and 17 ga. chrome wall escutcheon. Supplies shall be lead-free, AB1953 certified by recognized authority and bear manufacturer and testing mark. Provide lead-free mixing valve (ASSE 1070) with tempered water line to faucet. Mixing valve shall be provided with wall bracket, dual check valves and 40-mesh stainless steel screen. Mixing valve shall be Watts Series LFUSG-B-SC-M2 or approved equivalent. Insulate supplies, trap and drain with premolded ADA compliant protectors with internal fasteners as Manufactured by Truebro Lav Guard 2, Oatey/Dearborn or McGuire Pro-Wrap only.

**P – 6      Bi-Level Indoor Electric Water Cooler With Bottle Filler:** Elkay #LZSTLG8WSSK, filtered, bi-level, wall mounted, front and side bubbler push bar, electronic bottle filler sensor on lower unit, ADA and ICC A117.1 compliant with cane apron, stainless steel cabinet and receptor, safety bubbler and 5-year warranty. It shall provide 8 gal/hr of filtered water at 50°F based on 80°F inlet water and 90°F ambient temperature, per ASHRAE 18 testing. Unit shall be certified to UL 399 and CAN/CSA C22.2 No. 120 and NSF/ANSI 61 & 372 for lead free design. Furnish with 1-1/4" rough brass p-trap, 17-gauge brass tailpiece and waste with wheelless stop valve, concealed J.R. Smith 0834 floor mounted support, related 70085-86-6 support plates and base as required for applicable wall construction. Refer to Architectural plans for wall type. Provide three (3) 51300C WaterSentry Plus Replacement Filters, certified to NSF 42, NSF 53 and NSF 372 (Lead free) for each set of water coolers provided. Upon completion of the project, turn over replacement filters to Architect for transfer to Owner. Equivalent units by Halsey Taylor, Oasis or Murdock will be considered.

**P – 7      Mop Basin:** American Standard 7741.000 Florwell, acid resisting enameled cast iron corner model floor type service sink, complete with 8354.112 wall mounted faucet with offset shanks and integral stops, levered vandal resistant handles, vacuum breaker, integral check valves, adjustable wall brace, pail hook, 3/4" hose thread on spout, four foot rubber hose, hose bracket, Bradley 9933-00 combination utility shelf/broom holder and utility shelf constructed of 18 ga. 304 stainless steel with 16 ga. stainless steel gussets and hooks, 7745.811 rim guard, strainer for 3" screw connection, 304 stainless steel wall guards and silicone sealant at all points where basin meets wall and floor.

**P – 8      ADA Shower Unit:** Shower enclosure shall be equivalent to Comfort Designs model SST 3682 BF .625, solid surface finish, ADA compliant transfer shower with ADA compliant HDPE fold up seat, Stainless L-Bar, vertical bar and additional vertical bar required by ANSI A117.1, 2017. Outside dimensions shall be 42" x 37-1/2" x 82. Verify all dimensions with Architectural plans prior to ordering. Furnish no caulk drain and curtain rod. Equal units by Watermark or Aquarius will be considered.

Furnish Acorn 418 BBF(L or R) -W-LGB-1108-1-24-HHGB-C-HHC15 stainless steel recessed panel with thermostatic pressure balanced shower valve (T/P), 24" stainless steel grab bar (slide bar), hand held shower bracket, hand held shower with 60" stainless steel hose and in-line vacuum breaker.

When the shower is placed directly on a concrete floor (no tile), it shall be provided with a pre-leveled barrier free base.

All exposed trim, handles, drains, etc., shall be metal with polished nickel chrome plated surface.

**END OF SECTION**

## SECTION 22 1545

### PART 1 - LABORATORY VACUUM AIR SYSTEMS

#### 1.1 DESCRIPTION

A. Central Laboratory Vacuum Systems: This section describes the labor, equipment, and services necessary for and incidental to the installation of piped vacuum systems. System shall be installed started, tested, and ready for use. The scope of work shall include all necessary piping, fittings, valves, cabinets, station outlets and inlets, rough ins, gages, alarms including low voltage wiring, vacuum pumps, electric motors and starters, receivers, and all necessary parts, accessories, connections and equipment for a complete and operational system.

B. The contractor shall provide all elements and accessories required for a complete system according to the current edition of NFPA 99, Gas and Vacuum Systems.

C. **Vacuum air piping system and specialties for this facility shall be as required for a Level/Category 3 laboratory as defined by NFPA 99 and as it applies to laboratory vacuum air systems. NFPA 99 requirements shall take precedence over any specified item and shall be provided as required for NFPA 99 compliance.**

D. All necessary connections to owner and Contractor furnished equipment shall be made as required.

E. Electrical power and control wiring for vacuum pump(s), alarms wiring from equipment to alarm panels, and modular accessories associated with the system(s) shall be included as required by NFPA 99. All electric power wiring required for installation of equipment under this Section is specified under Electrical Division. This Contractor shall furnish and install all controls and control wiring as specified or required to properly complete the installation. Control conduit is specified under Electrical Division or shown on electrical drawings; all other control conduit shall be provided under this Section of the work. All control conduit, power wiring, relays, contactors, transformers, etc. which are required for this installation, which are not shown on the electrical drawings or specified in the Electrical Division of the specifications, shall be provided under this Section. Coordinate all requirements with the Electrical Sub-Contractor prior to bid. Electrical work performed under this Section shall meet requirements set forth in the Electrical Division and NFPA 99.

F. Pressure testing, cross connection testing and final testing per NFPA 99 shall be performed. Minimum vacuum system pressure testing shall be conducted at no less than 20 inches of mercury (Hg)

G. The Contractor shall retain a qualified third-party medical vacuum verifier acceptable to the Engineer and the Owner, and attest to final verification of the systems. The contractor shall make all corrections as determined by this third-party verifier, including additional testing as required to attain full certification at no additional time or cost to the Owner. The verifying company/agency shall provide Verifiers who are both ASSE Series 6030 certified and Medical Gas Professional Healthcare Organization (MGPHO) credentialed. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.



## 1.2 APPLICABLE PUBLICATIONS AND SPECIFICATIONS

A. Specifications Section 22 15 10 and 22 15 40 are applicable in full.

B. The publications listed below form a part of this specification to the extent referenced. The publications are referenced by the basic designation only and shall be versions in effect on November 2020.

B. American Society of Mechanical Engineers (ASME):

A13.1 ..... Scheme for the Identification of Piping Systems

B16.15 ..... Cast Copper Alloy Threaded Fittings: Classes 125 and 250

B16.22 ..... Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

B16.50 ..... Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings

ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at or more than 150 psig.

B40.100 ..... Pressure Gauges and Gauge Attachments

ASME Boiler and Pressure Code -

BPVC Section IX ..... Welding, Brazing, and Fusing Qualifications

C. American Society of Sanitary Engineers (ASSE):

6000 Series ..... Professional Qualifications Standard for Medical Gas Systems Personnel

D. American Society for Testing and Materials (ASTM):

B43 ..... Standard Specification for Seamless Red Brass Pipe, Standard Sizes

B687 ..... Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples

B819 ..... Standard Specification for Seamless Copper Tube for Medical Gas Systems

E. American Welding Society (AWS):

A5.8M/A5.8 ..... Specification for Filler Metals for Brazing and Braze Welding

B2.2/B2.2M ..... Specification for Brazing Procedure and Performance Qualification

F. Manufacturing Standardization Society (MSS):

SP-72 ..... Ball Valves with Flanged or Butt-Welding Ends For General Service

SP-110 ..... Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

- G. National Electrical Manufacturers Association (NEMA):  
ICS 6 ..... Industrial Control and Systems Enclosures
- H. National Fire Protection Association (NFPA):  
70 ..... National Electrical Code  
99 ..... Health Care Facilities Code

### 1.3 SUBMITTALS

- A. Refer to Section 22 15 10 for additional submittal requirements and format.
- B. Station Inlets: A letter from manufacturer shall be submitted stating that inlets are designed and manufactured to comply with NFPA 99. Inlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation. Coordinate requirements with Lab systems specified elsewhere in the construction documents.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Piping.
  - 2. Valves.
  - 3. Inlet and outlet cocks
  - 4. Valve cabinets.
  - 5. Gages.
  - 6. Station inlet and rough in assemblies.
  - 7. Alarm controls and/or panels.
  - 8. Pressure Switches.
  - 9. Manifolds.
  - 10. Vacuum Pump (Provide certified vacuum pump test data at startup.):
    - a. Vacuum Pump: Manufacturer and model.
    - b. Characteristic performance curves.
    - c. Vacuum pump operating speed (RPM).
    - d. Capacity: Free air delivered at indicated pressure (SCFM).
    - e. Type of bearings in vacuum pump.
    - f. Type of lubrication.
    - g. Type and adjustment of drive.
    - h. Electric motors: Manufacturer, frame and type.
    - i. Speed of motors (RPM).
    - j. Current characteristics and horsepower of motors.

- k. Receiver capacity and rating.
  - l. Air silencer: Manufacturer, type and model.
  - m. Air filters: Manufacturer, type, model and capacity.
  - n. Pressure regulators: Manufacturer and capacity.
- D. Station Inlets: Submit letter from manufacturer stating that inlets are designed and manufactured to comply with NFPA 99. Outlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation.

#### **1.4 QUALITY ASSURANCE**

A. Contractor shall include with submittals an affidavit attesting to compliance with all relevant paragraphs of NFPA 99 current edition. Personnel assembling Laboratory vacuum system shall meet NFPA 99, "Qualification of Installers" and hold Laboratory gas endorsements as under ASSE Standard Series 6000. The Contractor shall, on company letterhead, furnish documentation attesting that all installed piping materials were purchased cleaned and complied with the requirements of NFPA 99 and 5.1.10.2. Electrical Control systems and Alarms are to be UL listed as assemblies with label affixed. Vacuum controls are to be wired in accordance with NEC.

B. Equipment Installer: The equipment installer shall provide documentation at the submittal stage proving that the personnel installing the equipment meet the standards set by ASSE Standard Series 6000. Show technical qualifications and previous experience in installing Laboratory vacuum equipment on three similar projects. Submittals will be automatically rejected without review if NOT provided with this information. Submit names, phone numbers, and addresses of referenced projects. The equipment installer shall perform the following coordination functions:

1. Coordinate with other trades to ensure timely installations and avoid conflicts and interferences.
2. Coordinate and field verify with the metal stud partition installer and/or mason to ensure anchors, sleeves and similar items are provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.
3. Coordinate with the General Contractor to ensure Laboratory vacuum inlets, whether owner supplied or contractor supplied, in walls and all equipment is provided by the same Laboratory Vacuum Equipment Manufacturer.
4. The contractor shall coordinate with the Laboratory Vacuum System. Verifier to deliver a complete, operational, and tested installation ready for owner's use.

C. Equipment Supplier: The Equipment supplier shall demonstrate evidence of installing equivalent product at three installations similar to this project that has been in satisfactory and efficient operation for three years. Names, phone numbers, and addresses where the product is installed shall be submitted for verification.

D. Gas System Testing Organization: The Laboratory vacuum verifier shall show documentation proving that the gas verifier meets the standards set by ASSE Standard Series 6000. The testing shall be conducted by a party technically competent and experienced in the field of vacuum pipeline testing.

E. Names of three projects where testing of vacuum systems has been performed by the testing agency shall be provided. The name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification shall be included in the documentation.

F. The testing agency's detailed procedure shall be followed in the testing of this project and submitted to the Architect 10 working days prior to testing. In the testing agency's procedure documentation, include details of the testing sequence, procedures for cross connection tests, inlet function tests, etc., as required by NFPA 99.

G. Installation and Startup: The manufacturer shall provide factory authorized representatives to review the installation and perform the initial startup of the system. The factory authorized representatives shall submit a report to the Architect and to the Contractor. The Contractor shall make all corrections identified by the factory authorized representative at no additional cost or time.

H. Certification: The Final inspection documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits allowed by this specification.

I. Certification: The completed systems have been installed, tested, purged and analyzed in accordance with the requirements of this specification. Certification shall be submitted to Architect.

J. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections.

K. Brazing: As required by NFPA 99

L. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

M. Affidavit: A notarized affidavit from the verifier stating that the verifier undertakes to verify this project and thus agrees to disqualify themselves from supplying any equipment which shall be included in the scope of their verification. No verifier who supplies equipment shall be permitted to verify that equipment. Statement declaring that the vacuum system manufacturer has no fiduciary interest in the verifier and that the verifier is not an agent or representative of the vacuum system manufacturer. Statement declaring that the contractor has no fiduciary interest in the third party verifier and that the third party verifier has no fiduciary interest in the contractor.

N. Certification tests, verified and attested to by the certification agency, shall include the following:

(1) Verifying in accordance with the installation requirements.

(2) Testing and checking for leakage, correct zoning, and identification of control valves.

(3) Checking for identification and labeling of pipelines, station outlets, and control valves.

- (4) Testing for cross-connection, flow rate, system pressure drop, and system performance.
- (5) Functional testing of pressure relief valves and safety valves.
- (6) Functional testing of sources of supply.
- (7) Functional testing of alarm systems, including accuracy of system components.
- (8) Purge flushing of system and filling with specific source gases.
- (9) Testing for purity and cleanliness of source gases.
- (10) Testing for specific gas identity at each station outlet.

## **1.5 MAINTENANCE SUPPORT**

- A. The vacuum system equipment manufacturer shall demonstrate a national factory direct service capability able to perform major overhauls. The Laboratory vacuum equipment manufacturer shall provide factory direct preventative maintenance contract to the Owner for a period of 12 months from the date of substantial completion as determined by the Architect. The Laboratory vacuum equipment manufacturer shall provide formal maintenance training to the Owner's designated personnel. Training class shall be a minimum of 8 hours and shall take place at the facility using the installed equipment. Servicer shall be no more than 100 miles away, be capable of responding within 4 hours, and provide certified personnel to perform all work.
- B. The Contractor shall provide the Owner with two new complete sets of any special tools that are required to maintain the specified system. The Contractor shall provide the Owner with two sets of new Manufacturer recommended spare parts.

## **1.6 AS-BUILT DOCUMENTATION AND CLOSEOUT**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions. Refer to Section 22 1510 for additional requirements.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc and inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner shall be required to employ shall be inserted into the As-Built documentation. Refer to Section 22 1510 for additional requirements.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2018 provided on compact disk. Should the installing contractor engage the

testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

**D. Certification documentation shall be provided to Architect 10 working days prior to submitting the request for final inspection.** The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

**E.** Piping, valves, devices, panels, etc. shall be identified use type markers as specified in Section 22 15 10. Colors and background shall be as required by NFPA 99. Piping identification labels shall be applied at time of installation in accordance with NFPA 99. Supplementary color identification shall be in accordance with CGA Pamphlet C-9. Identification shall completely surround the circumference of the piping and, indicate direction of flow and pressure of the contents of the piping.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL PRODUCT REQUIREMENTS**

**A.** A single Laboratory Vacuum Equipment Manufacturer shall supply the Laboratory vacuum system(s) and equipment to include outlets, inlets, valves and gauges, valve boxes, panels, manifolds and vacuum sources.

### **2.2 PIPES, TUBES, AND FITTINGS**

**A.** Copper Tubing: Copper tubing shall be type "K" or "L", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ASME B16.22 or brazing fittings complying with ASME B16.50. The copper tubing size designated reflects nominal inside diameter. All tubing and fittings shall be labeled "ACR/OXY", "OXY", "OXY/MED", "ACR/MED", or "MED".

**B.** Brazing Alloy: The brazing alloy shall comply with AWS A5.8M/A5.8, Classification BCuP, greater than 538 degrees C (1000 degrees F) melting temperature. Flux shall be strictly prohibited for copper to copper connections.

**C.** Screw Joints: Screw joints shall use polytetrafluoroethylene (Teflon) tape.

**D.** Piping for vacuum systems shall be constructed of any of the following:

(1) Hard-drawn seamless copper tube:

a) ASTM B 88, Standard Specification for Seamless Copper Water Tube, copper tube (Types K, L, or M)

b) ASTM B 280, Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service, copper ACR tube

c) ASTM B 819, Standard Specification for Seamless Copper Tube for Medical Gas Systems, copper medical gas tubing (Type K or Type L)

**E.** Vacuum System Exhaust Line shall be ASTM B88 Type "K", "L" or "M", ASTM B280 Copper ACR tubing or ASTM B819 Type "K" or "L".

**F.** Memory metal couplings shall have temperature and pressure ratings not less than that of a brazed joint.

G. Piping identification labels shall be applied at time of installation in accordance with NFPA 99. Supplementary color identification shall be in accordance with CGA Pamphlet C-9. Identification shall completely surround the circumference of the piping and, indicate direction of flow and pressure of the contents of the piping.

H. Special Fittings: The following special fittings shall be permitted to be used in lieu of brazed joints:

1. Memory-metal couplings having temperature and pressure ratings joints not less than that of a brazed joint.
2. Listed or approved metallic gas tube fittings that, when made up, provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint.
3. Dielectric fittings where required by the manufacturer of special Laboratory equipment to electrically isolate the equipment from the piping distribution system.
4. Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable.

## **2.3 EXPOSED LABORATORY VACUUM PIPING**

A. Finished Room: Use iron pipe size (IPS) chrome plated brass or stainless steel piping for exposed laboratory and healthcare vacuum piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Owner or specified in other sections.

1. Pipe: ASTM B43, standard weight.
2. Fittings: Fittings shall comply with ASME B16.15 cast bronze threaded fittings with chrome finish (150 and 250 psig Classes).
3. Nipples: Nipples shall comply with ASTM B687, chromium-plated.
4. Unions: Unions shall comply with MSS SP-72, MSS SP-110, brass or bronze with chrome finish. Unions 2-1/2 inches and greater shall be flange type with approved gaskets.
5. Valves: Valves shall comply with MSS SP-72, MSS SP-110, brass or bronze with chrome finish.

## **2.4 VALVES**

General: Shall be as required by NFPA 99. Manufacturers shall be Allied Health Products, Beaconmeades, Squire-Cogswell/Aeros Instruments, Patton's Medical or **preapproved** equivalent.

A. Ball: Ball valves shall be in line, other than zone valves in cabinets.

1. 2-1/2 inches and less: Ball valves shall be bronze/ brass body, MSS SP-72 and MSS SP-110, Type II, Class 150, Style 1, with tubing extensions for brazed connections,

full ported, three piece or double union end connections, Teflon seat seals, full flow, 600 psig WOG minimum working pressure, with locking type handle.

2. 3 to 4 inches: Ball valves shall be bronze/ brass body, MSS SP-72 and MSS SP-110, Type II, Class 150, Style 1 with tubing extensions brazed to flanges, full ported, three-piece, double seal, Teflon seals, full flow, 600 psig WOG minimum working pressure, with locking type handle.

**B. Check:**

1. 3 inches and less: Check valves shall be brass and bronze body, straight through design for minimum pressure drop, spring loaded, self-aligning with Teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into body, 400 psig WOG minimum working pressure.

2. 4 inches and greater: Check valves shall be iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, 150 psig WSP with flow direction arrow permanently cast into body.

**C.** Zone valve in cabinet shall be ball valve with bronze/ brass body, double seal, three piece or double union end connections, replaceable Teflon seat seals, Teflon stem seal, 600 psig WOG, cold, non-shock gas working pressure or vacuum service to 29.5 inches Hg, blowout proof stem, one quarter turn of handle to completely open or close. Tubing extensions, factory brazed, pressure tested, cleaned for oxygen service shall be provided. A 1/8-inch NPT gauge port shall be provided for a 2 inch diameter monitoring gauge downstream of the shut-off valve. Zone valves shall be securely attached to the cabinet and provided with Type "K" copper tube extensions for making connection to system piping outside the cabinet. Zone valves shall be products of one manufacturer, and uniform throughout in pattern, overall size and appearance. Trim with color coded plastic inserts or color coded stick on labels. Valves shall be in cabinets such that cover window cannot be in place when any valve is in the closed position. Color coding for identification plates and labels shall be as required by NFPA 99.

## **2.5 VALVE CABINETS**

**A.** Valve cabinets shall be flush mounted, commercially available item for use with medical gas services, constructed from steel not lighter than 18 gage steel or extruded aluminum not lighter than 14 gage. The valve cabinets shall be rigidly assembled, of adequate size to accommodate all valve(s) and fittings indicated. Holes shall be predrilled to receive pipe connections. These pipe connections shall be made outside of the valve box. Anchors shall be provided to secure cabinet to wall construction. Openings in cabinet shall be sealed to be dust tight. Bottom of cabinet shall be located 4 foot 6 inches above finished floor (ADA height).

**B.** Engraved rigid plastic identification plate shall be mounted on the wall above or adjacent to the cabinet. Color code identification plate to match gas identification colors as indicated above. Identification plate shall be clearly visible at all times. Inscriptions shall be provided on plate to read in substance: "VALVE CONTROL SUPPLY TO ROOMS." The final wording shall be approved by the Architect and Owner.

**C.** Cover plate: The cover plate shall be fabricated from 18 gage sheet metal with satin chromed finish, extruded anodized aluminum, or 22 gage stainless steel. A cover window shall be provided of replaceable plastic, with a corrosion resistant device or lever secured to window for emergency window removal. The following shall be permanently painted or stenciled on window: "FOR EMERGENCY SHUT-OFF VALVES ONLY,



SHUT-OFF VALVES FOR PIPED GASES", or equivalent wording. The valve cabinet shall be configured such that it is not possible to install window with any valve in the closed position. Each valve shall have a pressure gauge upstream of valve and this pressure gauge shall be inside valve box.

D. Cabinets and isolation valves shall be located and piped as shown on the contract documents, and at a minimum, so as to allow the isolation of each smoke compartment separately. Each cabinet shall serve no more than one smoke compartment.

## **2.6 GAGES**

### **A. VACUUM GAGES:**

1. For vacuum line adjacent to source equipment the vacuum gages shall comply with ASME B40.100, vacuum gage type, size 4-1/2 inches, gage listed for vacuum, accurate to within 2-1/2 percent, with metal case. The vacuum gage range shall be 0 to 29.5 inches Hg. Dial graduations and figures shall be black on a white background, or white on a black background. Label shall be for vacuum service. A gage cock shall be installed. Dual scale gages shall be installed for vacuum system.

2. For vacuum service upstream of main shut-off valve: A 1-1/2 inches diameter gage shall be provided with steel case, bourdon tube and brass movement, dial range 0 to 29.5 inches Hg. Dual scale gages shall be provided for vacuum system.

## **2.7 STATION INLETS**

### **A. Vacuum Station Inlets:**

1. Station inlets shall be brass, stainless steel, or chromed metal non-interchangeable DISS connections for appropriate service to conform with CGA V-5 STANDARD FOR DIAMETER INDEX SAFETY SYSTEM (NONINTERCHANGEABLE LOW PRESSURE CONNECTIONS FOR MEDICAL GAS APPLICATIONS

2. The outlet station shall be made, cleaned, and packaged to NFPA 99 standards and shall be UL listed and CSA certified.

3. A coupler shall be provided that is non-interchangeable with other services, and leak proof under three times normal working pressure. Threaded DISS connector shall be per CGA standards

4. Each station inlet shall be equipped with an automatic valve to conform with NFPA 99. Valves shall be placed in the assembly to provide easy access after installation for servicing and replacement, and to facilitate line blow-out, purging, and testing.

5. Each inlet shall be securely fastened to structure and provide each with a capped stub of sufficient length of tubing for connection to supply tubing. Stub tubing shall be labeled for appropriate service. Rough in shall be indexed and gas specified latch valve with non-interchangeable safety keying with color coded gas service identification.

6. Completion kits (valve body and face plate) shall be installed for the remainder of required tests.

## **2.8 STATION INLET ROUGH-IN**

A. Station inlet rough in shall be flush mounted, and protected against corrosion. Rough in shall be anchored securely to unit or wall construction.

B. The modular cover plate shall be constructed from die cast plate, two-piece 22 gage stainless steel or 16 gage chromium plated metal, secured to rough in with stainless steel or chromium plated countersunk screws. The latch mechanism shall be designed for one handed, single thrust mounting and one handed fingertip release of secondary equipment.

C. Permanent, metal or plastic, identification plates shall be provided securely fastened at each inlet opening, with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked on enamel background. Color coding for identification plates shall be as required by NFPA 99.

## **2.10 VACUUM SWITCHES**

A. Vacuum switches shall be general purpose, contact or mercury type, allowing both high and low set points, with contact type provided with a protective dust cover. The vacuum switch shall have an adjustable range set by inside or outside adjustment. Vacuum switches shall activate when indicated by alarm requirements. One orifice nipple (or DISS demand check valve) shall be used for each sensor switch.

## **2.11 LABORATORY VACUUM SYSTEMS**

A. Refer to other specifications for vacuum pump.

B. The following accessories shall be factory piped in all brass piping and pre-wired to ensure proper operation of each vacuum unit:

1. Solenoid valves with manual bypass.
2. Strainers.
3. Anti-siphon fitting.
4. 1 GPM flow control valves for liquid ring vacuum pumps.
5. Inlet check valves suitable for vacuum service.
6. Shut-off valves.
7. Vacuum relief valve.
8. Gage glass on reservoir tank and receiver tank.

C. Control: For control of the unit, the following shall be included in a NEMA 12 pre-wired control panel factory mounted on the receiver. Panel shall be equipped with HOA switches and indicating lights along with the following:

1. Combination circuit breaker type magnetic across-the-line starters to provide overload and under voltage protection.
2. 115 volt control transformers.

3. Minimum run timers.
  4. Vacuum switches factory mounted and preset.
  5. Electric time alternator circuit to automatically switch the operation of each pump.
  6. Audible and visual alarm circuit with silence and reset button to activate when a pump starts out of sequence.
  7. Vibration isolators and flexible connections.
- C. The vacuum pumps shall be individually tested and test results shall be submitted to the Architect.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. The installation shall be performed in strict accordance with NFPA 99 brazing procedures shall be as detailed in NFPA 99. Brazing shall be performed only by brazers qualified under NFPA 99. Where piping runs underground, the installation shall be made in accordance with NFPA 99. The Contractor shall provide certification of the installers at the submittal stage. Submittals will not be reviewed without this certification.
- B. Contractor shall furnish 4 inches high concrete housekeeping pads. The contractor shall furnish inertia bases in lieu of housekeeping pads where the equipment installed is not factory isolated by the manufacturer. Anchor bolts shall be cast into bases
- C. Cast escutcheon shall be installed with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- D. Open ends of tube shall be capped or plugged at all times or otherwise sealed until final assembly to prevent infiltration of any foreign matter.
- E. Piping shall be cut square and accurately with a tube cutter (**sawing is prohibited**) to measurements determined at place of installation. The tubing shall be reamed to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. The tubing shall be worked into place without springing or forcing. The tubing shall be bottomed in socket so there are no gaps between tube and fitting. Care shall be exercised in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease from being introduced into the tubing. Where contamination has occurred, material shall be no longer suitable for vacuum service. The contractor shall provide new replacement sealed tube sections.
- F. Piping shall be supported with pipe trays or hangers at intervals defined in NFPA 99. **Piping shall not be supported by other piping.** Isolation of copper piping from dissimilar metals shall be of a firm, positive nature. **Duct tape or similar type materials is prohibited as an isolation material.**
- G. Valves and other equipment shall be rigidly supported to prevent strain on tube or joints.
- H. Piping exposed to physical damage shall be protected.
- I. During any brazing operation, the interior of the pipe shall be purged continuously with oil free, dry nitrogen NF, following the procedure in NFPA 99. At the

completion of any section, all open pipe ends shall be capped using an EXTERNAL cap. The flow of purged gas shall be maintained until joint is cool to touch. The use of flux is prohibited when making of joints between copper to copper pipes and fittings.

J. Threaded joints in piping systems shall be avoided whenever possible. Where unavoidable, make up the male threads with polytetrafluoroethylene (such as Teflon) tape. Liquid sealants are prohibited.

K. Tubing shall not be bent. Fittings shall be used in all change of direction or angle.

L. After installation of the piping, but before installation of the outlet valves, blow lines clear using nitrogen NF per NFPA 99.

M. **Pipe labeling shall be applied during installation process and not after installation is completed.** Size of legend letters shall be in accordance with ASME A13.1.

N. After initial leakage testing is completed, the piping shall be allowed to remain pressurized with testing gas until testing agency performs final tests.

O. Penetrations:

1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked partitions, or floors, fire stopping shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified hereinbefore. Clearances between raceways and openings with the fire stopping material shall be completely filled and sealed.

2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and made watertight with sealant.

P. A vacuum gage 1-1/2 inch diameter shall be installed in line downstream of each valve located in a zone valve cabinet.

Q. Zone valves shall be provided in cabinets and a minimum one zone valve assembly for each 18 outlets.

R. Piping shall be labeled with name of service, identification color and direction of flow. Where non-standard pressures are piped, pressure shall be labeled. Labels shall be placed at least once every (12 feet) of linear run. A label shall additionally be placed immediately on each side of all wall or floor penetrations. Pipe labels shall be self-adhesive vinyl type or other water resistant material with permanent adhesive colored in accordance with NFPA 99 and shall be visible on all sides of the pipe. Each master alarm signal shall be labeled for function after ring out. Each zone valve shall be labeled and each area alarm labeled for the area of control or surveillance after test. Labels shall be permanent and of a type approved by the Engineer.

S. Alarms and valves shall be labeled for service and areas monitored or controlled. Valves shall be labeled with name and identification color of the gas and direction of flow.

### 3.2 INSTALLER TESTING

A. Prior to declaring the lines ready for final verification, the installing contractor shall strictly follow the procedures for verification as described in NFPA 99 as it applies

to Level/Category 3 laboratory and attest in writing over the notarized signature of an officer of the installing company the following;

1. That all brazing was conducted by brazers qualified to ASSE Standard Series 6000 and holding current medical gas endorsements.
2. That all brazing was conducted with nitrogen purging. (Procedure per NFPA 99).
3. That the lines have been blown clear of any construction debris using oil free dry nitrogen or air are clean and ready for use. (Procedure per NFPA 99).
4. That the assembled piping, prior to the installation of any devices, maintained a test pressure 1 1/2 times the standard pressures listed in NFPA 99 without leaks.
5. That after installation of all devices, the pipeline was proven leak free for 24 hours at a pressure 20 percent above the standard pressures listed in NFPA 99.
6. That the systems have been checked for cross connections and none were found. (Procedure per NFPA 99)
7. That the manufacturer has started up vacuum pumps and manifolds, and that they are in operating order.

B. Four originals of the affidavit, shall be distributed; (2) to the Architect, (1) to the general contractor, and (1) to the verifier.

### **3.3 VERIFIER TESTING**

A. Prior to handing over the systems to the Owner, the contractor shall retain a verifier acceptable to the engineer of record and Owner who shall follow strictly the procedures for verification as described in NFPA 99 and, NFPA 99 as it applies to Level/Category 3 laboratory. Provide a written report and certificate bearing the notarized signature of an officer of the verification company on company letterhead which contains at least the following:

1. An affidavit bearing the notarized signature of an officer of the verification company stating that the verification company is not the supplier of any equipment used on this project or tested in this report and that the verification contractor has no relationship to, or pecuniary interest in, the manufacturer, seller, or installer of any equipment used on this project or tested in this report.
2. A listing of all tests performed, listing each source, outlet, valve and alarm included in the testing.
3. An assertion that all tests were performed by a Laboratory Vacuum System Certified Medical Gas or vacuum Verifier or by individuals qualified to perform the work and holding valid qualifications to ASSE 6030 and under the immediate supervision of a Verifier. Include the names, credential numbers and expiration dates for all individuals working on the project.
4. A statement that equipment used was calibrated at least within the last six months by a method traceable to a National Bureau of Standard Reference and enclosing certificates or other evidence of such calibration(s). Where outside laboratories are used in lieu of onsite equipment, those laboratories shall be named and their original reports enclosed.

5. A statement that where and when needed, equipment was re calibrated during the verification process and describing the method(s) used.
  6. A statement that the systems were tested and found to be free of debris to a procedure per NFPA 99.
  7. The flow from each inlet when tested to a procedure per NFPA 99.
  8. A statement that the systems were tested and found to have no cross-connections to a procedure per NFPA 99.
  9. A statement that the systems were tested and found to be free of contaminants to a procedure per NFPA 99.
  10. Statement that all local signals function as required under NFPA 99 and as per the relevant NFPA 99 sections relating to the sources.
  11. A listing of local alarms, their function and activation per NFPA 99.
  12. A listing of master alarms, their function and activation, including pressures for high and low alarms per NFPA 99.
  13. A listing of area alarms, their function and activation pressures per NFPA 99.
  14. A statement that the sources include all alarms required by NFPA 99.
  15. A statement that all valves and alarms are accurately labeled as to zone of control.
- B. Perform and document all cross-connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with NFPA 99 and the procedures set forth in pre-qualification documentation.
- C. Verify that the systems, as installed, meet or exceed the requirements of NFPA 99, this specification, and that the systems operate as required.
- D. Piping purge test: As required by NFPA 99. Retest until all tests pass at no additional time or cost to the Owner or his design professionals.
- E. Inlet flow test:
1. Test all inlets for flow. Perform test with the use of an inert gas as described in CGA P-9.
  2. Needle valve vacuum inlets shall draw no less than 1.0 SCFM with adjacent inlet flowing, at a dynamic inlet pressure of 12 inches Hg, and a static vacuum of 3 inches Hg.
  3. Vacuum inlets shall draw no less than 3.0 SCFM with adjacent inlet flowing, at a dynamic inlet pressure of 12 inches Hg, and a static vacuum of 15 inches Hg.

### **3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for eight hours to instruct the Owner's Personnel in operation and maintenance of the system.
- B. Training and demonstration shall be recorded on standard format DVD and included in the Owner's O&M manual.

### **3.5 WARRANTY AND GUARANTEE**

#### **Warranty**

A. Warranty shall be expressly complete, include all components of the system and be the responsibility of the Laboratory Gas Systems Manufacturer of record only. Warranties limiting the responsibility of the Laboratory Gas Systems Manufacturer for any system component or which pass through the Laboratory Gas Systems Manufacturer to another manufacturer are not acceptable.

B. Warranties shall include on site repairs including travel, labor and parts. Warranties requiring return of equipment for adjustment are not acceptable.

C. All Laboratory gas pipeline components shall be warranted by the Laboratory Gas Systems Manufacturer of record for a minimum of twelve months from the date of substantial completion as determined by the Architect.

#### **END OF SECTION**

## SECTION 22 15 46

### LABORATORY COMPRESSED AIR PIPING SYSTEMS

#### PART 1 - GENERAL

##### 1.1 GENERAL

- A. This section describes the labor, equipment, and services necessary for and incidental to the installation of piped laboratory air systems. System shall be installed started, tested, and ready for use. The scope of work shall include all necessary piping, fittings, valves, cabinets, station outlets and inlets, rough ins, gages, alarms including low voltage wiring, air compressor, electric motors and starters, receivers, and all necessary parts, accessories, connections and equipment for a complete and operational system
- B. Laboratory compressed air piping system and specialties for 150 psig operating pressure.
- C. The contractor shall provide all elements and accessories required for a complete system according to the current edition of NFPA 99, Gas and Vacuum Systems.
- D. All necessary connections to owner and Contractor furnished equipment shall be made as required.
- E. **Compressed air piping system and specialties for this facility shall be as required for a Level/Category 3 laboratory as defined by NFPA 99 and as it applies to laboratory compressed air systems. NFPA 99 requirements shall take precedence over any specified item and shall be provided as required for NFPA 99 compliance.**
- F. Pressure testing, cross connection testing and final testing per NFPA 99 shall be performed.
- G. The Contractor shall retain a qualified third-party medical air verifier acceptable to the Engineer and the Owner, and attest to final verification of the systems. The contractor shall make all corrections as determined by this third-party verifier, including additional testing as required to attain full certification at no additional time or cost to the Owner. The agency shall provide Verifiers who are both ASSE Series 6030 certified and Medical Gas Professional Healthcare Organization (MGPHO) credentialed. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.
- H. Electrical power and control wiring for the compressor system, alarms wiring from equipment to alarm panels, and modular accessories associated with the system(s) shall be included as required by NFPA 99. All electric power wiring required for installation of equipment under this Section is specified under Electrical Division. This Contractor shall furnish and install all controls and control wiring as specified or required to properly complete the installation. Control conduit is specified under Electrical Division or shown on electrical drawings; all other control conduit shall be provided under this Section of the work. All control conduit, power wiring, relays, contactors, transformers, etc. which are required for this installation, which are not shown on the electrical drawings or specified in the Electrical Division of the specifications, shall be provided under this Section. Coordinate all requirements with the Electrical Sub-Contractor prior to bid. Electrical work performed under this Section shall meet requirements set forth in the Electrical Division and NFPA 99.
- I. Piping, valves, devices, panels, etc. shall be identified use type markers as specified in Section 22 15 10. Colors and background shall be as required by NFPA 99.



## 1.2 APPLICABLE PUBLICATIONS AND SPECIFICATIONS

A. Specifications Section 22 15 10 and 22 15 40 are applicable in full.

B. The publications listed below form a part of this specification to the extent referenced. The publications are referenced by the basic designation only and shall be versions in effect on November 2020.

B. American Society of Mechanical Engineers (ASME):

A13.1 ..... Scheme for the Identification of Piping Systems

B16.15 ..... Cast Copper Alloy Threaded Fittings: Classes 125 and 250

B16.22 ..... Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

B16.50 ..... Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings

ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at or more than 150 psig.

B40.100 ..... Pressure Gauges and Gauge Attachments

ASME Boiler and Pressure Code -

BPVC Section IX ..... Welding, Brazing, and Fusing Qualifications

C. American Society of Sanitary Engineers (ASSE):

6000 Series ..... Professional Qualifications Standard for Medical Gas Systems Personnel

D. American Society for Testing and Materials (ASTM):

B43 ..... Standard Specification for Seamless Red Brass Pipe, Standard Sizes

B687 ..... Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples

B819 ..... Standard Specification for Seamless Copper Tube for Medical Gas Systems

E. American Welding Society (AWS):

A5.8M/A5.8 ..... Specification for Filler Metals for Brazing and Braze Welding

B2.2/B2.2M ..... Specification for Brazing Procedure and Performance Qualification

F. Manufacturing Standardization Society (MSS):

SP-72 ..... Ball Valves with Flanged or Butt-Welding Ends For General Service

SP-110 ..... Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

G. National Electrical Manufacturers Association (NEMA):

ICS 6 ..... Industrial Control and Systems Enclosures

- H. National Fire Protection Association (NFPA):  
70 ..... National Electrical Code  
99 ..... Health Care Facilities Code

### 1.3 SUBMITTALS

- A. Refer to Section 22 15 10 for additional submittal requirements and format.
- B. Station Outlets: A letter from manufacturer shall be submitted stating that outlets are designed and manufactured to comply with NFPA 99. Outlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation. Coordinate requirements with Lab systems specified elsewhere in the construction documents.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
1. Piping.
  2. Valves.
  3. Inlet and outlet cocks
  4. Valve cabinets.
  5. Gages.
  6. Station outlets and rough in assemblies.
  7. Alarm controls and panels.
  8. Pressure Switches.
  9. Manifolds.
  10. Air compressor systems (Provide certified compressor test data at startup.):
    - a. Compressors: Manufacturer and model.
    - b. Characteristic performance curves.
    - c. Compressor operating speed (RPM).
    - d. Capacity: Free air delivered at indicated pressure (SCFM).
    - e. Type of bearings in compressor.
    - f. Type of lubrication.
    - g. Type and adjustment of drive.
    - h. Electric motors: Manufacturer, frame and type.
    - i. Speed of motors (RPM).
    - j. Current characteristics and horsepower of motors.
    - k. Receiver capacity and rating.
    - l. Silencer: Manufacturer, type and model.
    - m. Air filters: Manufacturer, type, model and capacity.
    - n. Pressure regulators: Manufacturer and capacity.

- o. Dew point monitor: Manufacturer, type and model.
- D. Station Outlets: Submit letter from manufacturer stating that outlets are designed and manufactured to comply with NFPA 99. Outlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation.

#### **1.4 QUALITY ASSURANCE**

A. Contractor shall include with submittals an affidavit attesting to compliance with all relevant paragraphs of NFPA 99 most recent edition. Personnel assembling laboratory compressed air system shall meet NFPA 99 "Qualification of Installers" and hold medical gas endorsements as under ASSE Standard Series 6000. The Contractor shall, on company letterhead, furnish documentation attesting that all installed piping materials were purchased cleaned and complied with the requirements of NFPA 99. Electrical Control systems and Laboratory Air System Alarms are to be UL listed as assemblies with label affixed. Laboratory Air System controls are to be wired in accordance with NEC.

B. Equipment Installer: The equipment installer shall provide documentation at the submittal stage proving that the personnel installing the equipment meet the standards set by ASSE Standard Series 6000. Show technical qualifications and previous experience in installing medical gas equipment on three similar projects. Submittals will be automatically rejected without review if NOT provided with this information. Submit names, phone numbers, and addresses of referenced projects. The equipment installer shall perform the following coordination functions:

1. Coordinate with other trades to ensure timely installations and avoid conflicts and interferences.
2. Coordinate and field verify with the metal stud partition installer and/or mason to ensure anchors, sleeves and similar items are provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.
3. Coordinate with the General Contractor to ensure laboratory outlets, whether owner supplied or contractor supplied, in walls, ceiling and all equipment is provided by the same Laboratory Air Equipment Manufacturer.
4. The contractor shall coordinate with the Laboratory Compressed Air System Verifier to deliver a complete, operational, and tested laboratory gas installation ready for owner's use.

C. Equipment Supplier: The Equipment supplier shall demonstrate evidence of installing equivalent product at three installations similar to this project that has been in satisfactory and efficient operation for three years. Names, phone numbers, and addresses where the product is installed shall be submitted for verification.

D. Laboratory Air System Testing Organization: The Laboratory Air System verifier shall show documentation proving that the laboratory gas verifier meets the standards set by ASSE Standard Series 6000. The testing shall be conducted by a party technically competent and experienced in the field of laboratory gas pipeline testing.

E. Names of three projects where testing of vacuum systems has been performed by the testing agency shall be provided. The name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification shall be included in the documentation.

F. The testing agency's detailed procedure shall be followed in the testing of this project and submitted to the Architect 10 working days prior to testing. In the testing agency's procedure documentation, include details of the testing sequence, procedures for

cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, data on test methods, types of equipment to be used, calibration sources and method references shall be submitted.

G. Installation and Startup: The manufacturer shall provide factory authorized representatives to review the installation and perform the initial startup of the system. The factory authorized representatives shall submit a report to the Architect and to the Contractor. The Contractor shall make all corrections identified by the factory authorized representative at no additional cost or time.

H. Certification: The Final inspection documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits allowed by this specification.

I. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections.

J. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

K. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

L. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at or more than 150 psig.

## **1.5 MAINTENANCE SUPPORT**

A. The Laboratory Air System equipment manufacturer shall demonstrate a national factory direct service capability able to perform major overhauls. The Laboratory Air System equipment manufacturer shall provide factory direct preventative maintenance contract to the Owner for a period of 12 months from the date of substantial completion as determined by the Architect. The Laboratory Air System equipment manufacturer shall provide formal maintenance training to the Owner's designated personnel. Training class shall be a minimum of 8 hours and shall take place at the facility using the installed equipment. Servicer shall be no more than 100 miles away, be capable of responding within 4 hours, and provide certified personnel to perform all work.

B. The Contractor shall provide the Owner with two new complete sets of any special tools that are required to maintain the specified system. The Contractor shall provide the Owner with two sets of new Manufacturer recommended spare parts.

## **1.6 AS-BUILT DOCUMENTATION AND CLOSEOUT**

A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions. Refer to Section 22 1510 for additional requirements.

B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc and inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be

included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner shall be required to employ shall be inserted into the As-Built documentation.

C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2018 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

D. **Certification documentation shall be provided to Architect 10 working days prior to submitting the request for final inspection.** The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## 1.7 COORDINATION

A. Coordinate laboratory compressed-air service connections with other service connections. Laboratory Air System service connections are similar to those specified in Division 22 15 45 Section "Laboratory Vacuum Air Systems." **In general, all connections and requirements shall be in accordance with NFPA 99.**

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Laboratory Gas Tube and Fittings, including the air compressor 6" intake line: ASTM B 819, Type L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
- B. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
- C. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

### 2.2 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general- duty brazing unless otherwise indicated.
- C. Threaded-Joint Tape: PTFE.

### 2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service. Manufacturers shall be Allied Health Products, Beaconmeades, Squire-Cogswell/Aeros Instruments, Patton's Medical or **preapproved** equivalent.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
  - 1. Pressure Rating: 300 psig minimum.
  - 2. Ball: Full-port, chrome-plated brass.
  - 3. Seats: PTFE or TFE.
  - 4. Handle: Lever type with locking device.
  - 5. Stem: Blowout proof with PTFE or TFE seal.
  - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze.
  - 1. Pressure Rating: 300 psig minimum.
  - 2. Operation: Spring loaded.
  - 3. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
  - 1. Pressure Rating: 300 psig minimum.
  - 2. Ball: Full-port, chrome-plated brass.
  - 3. Seats: PTFE or TFE.
  - 4. Handle: Lever type with locking device.
  - 5. Stem: Blowout proof with PTFE or TFE seal.
  - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
  - 7. Pressure Gage: Manufacturer installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
  - 1. Interior Finish: Factory-applied white enamel.
  - 2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
  - 3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

## 2.4 LABORATORY COMPRESSED-AIR SERVICE CONNECTIONS

- A. General: Shall be as required by NFPA 99. Manufacturers shall be Allied Health Products, Beaconmeades, Squire-Cogswell/Aeros Instruments, Patton's Medical or **preapproved** equivalent.
- B. Connection Devices: For specific laboratory compressed-air pressure and service

listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed type units made for concealed piping unless otherwise indicated.

- C. Roughing-in Assembly:
  - a. Steel outlet box for recessed mounting and concealed piping.
  - b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
  - c. Double seals that will prevent air leakage.
  - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
- D. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.
- E. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

## 2.5 COMPRESSED LABORATORY AIR PRESSURE CONTROL PANELS

- A. General: Shall be as required by NFPA 99. Manufacturers shall be Allied Health Products, Beaconmeades, Squire-Cogswell/Aeros Instruments, Patton's Medical or **preapproved** equivalent.
- C. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of outlet/inlet supply valve, outlet/inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
  - 1. Minimum Working Pressure: 200 psig.
  - 2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
  - 3. Pressure Gages: 0- to 300-psig range.
  - 4. Before final assembly, provide temporary dust shield and U-tube for testing.
  - 5. Label cover plate "Air Pressure Control."

## 2.6 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Metraflex, Inc.
  - 2. Unaflex.
  - 3. Universal Metal Hose; a Hyspan Co.
- B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
  - 1. Working-Pressure Rating: 200 psig minimum.
  - 2. End Connections: Threaded copper pipe or plain-end copper tube.

## **2.7 SLEEVES**

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

## **2.8 ESCUTCHEONS**

- A. General Requirements for Escutcheons: Manufactured wall escutcheons with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw.
  - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- E. One-Piece, Stamped Stainless Steel Escutcheons: With set screw and chrome-plated finish.

# **PART 3 - EXECUTION**

## **3.1 PREPARATION**

- A. Cleaning of Laboratory Compressed Air Tubing: If manufacturer-cleaned and capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to the Engineer to perform the following procedures:
  - 1. Clean laboratory gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Air Service."
  - 2. Wash laboratory gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
    - a. Scrub to ensure complete cleaning.
    - b. Rinse with clean, hot water to remove cleaning solution.

## **3.2 PIPING INSTALLATION**

- A. Shop Drawing plans, schematics, and diagrams shall indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings. Cut accurately to measurements established at site and work into place without springing or forcing, properly clearing all building features. Arrange and install piping systems sizes as shown, as close as practical, straight, properly supported and run as directly as possible forming right angles or running parallel with building lines, true to line and grade, free of sags and bends. Locate piping as high as practical and in parallel groups as close together as practical. Route through previously built-in sleeves and avoid cutting or other weakening of the structure.



- B. Comply with NFPA 99 and ASSE Standard #6010 for installation of compressed-air piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install air and drain piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating.
- I. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver.
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- Q. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- R. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

### **3.3 VALVE INSTALLATION**

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install safety valves on compressed-air receivers as required by NFPA 99 and where recommended by specialty manufacturers.
- F. Install pressure regulators on compressed-air piping where reduced pressure is required.
- G. Install flexible pipe connectors in discharge piping and in outlet/inlet air piping from remote air-outlet/inlet filter of each air compressor.

### **3.4 JOINT CONSTRUCTION**

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

### **3.5 COMPRESSED-AIR SERVICE COMPONENT INSTALLATION**

- A. Install compressed-air pressure control panel in walls. Attach to substrate.

### **3.6 SLEEVE INSTALLATION**

- A. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel sheet as specified Section 22 15 10.
  - 1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
  - 2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required with clamping ring.
- D. Install sleeves in new walls and slabs as new walls and slabs are constructed. Sleeves not installed as slab is constructed shall be core drilled.
- E. Fire-Barrier Penetrations: All penetrations shall be firestopped regardless of assembly penetrated. Coordinate and provide as required in Section 22 15 10.

### **3.7 ESCUTCHEON INSTALLATION**

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
    - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

### **3.8 HANGER AND SUPPORT INSTALLATION**

- A. Refer to Section 22 15 10. Support spacing required by NFPA 99 takes precedence over Section 22 15 10 and this section.
- B. Individual, Straight, Horizontal Piping Runs:
  - 1. MSS Type 1, adjustable, steel, clevis hangers. (Copper clad)
- D. Multiple, Straight, Horizontal Piping Runs: Unistrut assembly as specified Section 22 15 10.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install supports for vertical copper tubing every 10 feet and as required by NFPA 99.

### **3.9 LABELING AND IDENTIFICATION**

- A. Piping identification labels shall be applied at time of installation in accordance with NFPA 99. Supplementary color identification shall be in accordance with CGA Pamphlet C-9. Identification shall completely surround the circumference of the piping, indicate direction of flow and pressure of the contents of the piping. Install identifying labels and devices for vacuum piping, valves, and specialties.
- B. Install identifying labels and devices for laboratory compressed-air piping systems according to NFPA 99.

### **3.10 FIELD QUALITY CONTROL FOR LABORATORY COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of laboratory compressed-air piping in healthcare facilities and prepare test reports.
- B. Tests and Inspections:
  - 1. Laboratory Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of laboratory compressed-air piping systems concurrently with tests, inspections, and certification of Laboratory Air System piping systems.
  - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
    - a. Initial blowdown.
    - b. Initial pressure test.
    - c. Cross-connection test.
    - d. Piping purge test.
    - e. Standing pressure test for positive-pressure laboratory compressed-air piping.
    - f. Repair leaks and retest until no leaks exist.
  - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of laboratory compressed-air piping systems and perform the following tests and inspections:
    - a. Standing pressure test.
    - b. Individual-pressurization or pressure-differential cross-connection test.

- c. Valve test.
  - d. Master and area alarm tests.
  - e. Piping purge test.
  - f. Piping particulate test.
  - g. Piping purity test.
  - h. Final tie-in test.
  - i. Operational pressure test.
  - j. Laboratory air purity test.
  - k. Verify correct labeling of equipment and components.
- 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
  - a. Inspections performed.
  - b. Procedures, materials, and gases used.
  - c. Test methods used.
  - d. Results of tests.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

### **3.11 DEMONSTRATION**

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain laboratory compressed-air alarm systems. Refer to Sections for "Demonstration and Training."

**END OF SECTION**



## SECTION 23 1570

### HEATING, VENTILATING AND AIR CONDITIONING

#### PART 1. GENERAL

- 1.1. **General Provisions:** Section 22 1510 is applicable in full hereto. **No materials or products that contain asbestos, formaldehyde, lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, shall be utilized.**

Manufacturers not named in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 of the specifications. All prior approvals shall be submitted through the Architect.

- 1.2. **Qualifications of Subcontractor:** Shall be properly licensed and established as a Heating and Air Conditioning Contractor at location of the work and shall maintain locally adequate service facilities. He shall have had previous experience in the satisfactory installation of at least six (6) systems of this type, size and scope.

- 1.3. **Scope:** Include all equipment, material, and labor required for complete and proper operation of HVAC systems, even though not every item involved is indicated. Do not attach any items to other trades' assemblies. Items shall be attached to building structural system. Advisory provisions listed in all Codes referenced in the Contract Documents are mandatory. Where conflicts occur between a Code, Standard, the contract drawings or specifications, the most stringent requirements shall govern and be applied. Refer to other sections of this specification and Section 22 1510 for additional information and requirements.

- 1.4. **Site Visits / Inspections:** It is the contractor's responsibility to have the job ready for inspections when they are scheduled. If the project is not ready for the requested inspection and the Architect, any governmental agency or any other entity requires a re-inspection with the Engineer present, the contractor shall pay Zgouvas, Eiring & Associates a re-inspection fee of \$1,500. The payment shall be made directly to Zgouvas, Eiring & Associates 5 days prior to the scheduled re-inspection.

The Contractor is cautioned to carefully review the extensive requirements of Paragraph "Identification" in Section 22 1510 of the specifications and note that **identification is required to be completed before certain inspections. Failure to comply with this provision will be cause for cancellation of the inspection with all costs of the re-inspection to be borne by the Contractor responsible.**

- 1.5. **Miscellaneous:** The Contractor shall carefully examine the contract documents during the bidding phase. Any missing information in the contract documents that is required for obtaining accurate pricing shall be brought to

the attention of the Architect, **prior to bid date**, so all may be clarified and/or corrected. Failure to identify and resolve the issues prior to bid shall require the Contractor to provide said items, complete, without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods specified by, and as directed by, the Owner's Design Professionals.

- 1.6. **Painting and Colors:** Furnish to the Architect, color cards for standard and premium colors available. **The Architect shall select color where choices exist.** Refer to Architectural Painting Section of the specifications for additional requirements.
- 1.7. **Safety Provisions:** Provide covers or guards on all hot, moving and projecting items that may be deemed by the Engineer, Architect or Owner to be a hazard to occupants of the building or to service personnel.
- 1.8. **Spare Parts:** Manufacturer of any equipment specified shall have a wholesale outlet for readily available replacement parts in the nearest major USA city.
- 1.9. **Submittals:** Refer to Section 22 1510 for **strict** requirements especially as it applies to Project cost constraints, addendums or Value Engineering (VE) items.
- 1.10. **Identification:** Refer to Section 22 1510 for identification requirements. **There are specific requirements prior to the above ceiling and final inspections, respectively, that are mandatory.** The identification section of the specification is extensive. The Contractor shall refer to Section 22 1510, review and provide all identification requirements specified. **Failure to comply with this provision will be cause for cancellation of the inspection with all costs of the re-inspection to be borne by the respective Contractor responsible.**
- 1.11. **Firestopping:** Refer to Section 22 1510 for requirements. **Note that Division 15 firestopping specifications require firestopping of all penetrations regardless of wall/ceiling/floor construction. Refer to Division 1 for additional requirements.** Where there is a conflict between Division 1 specifications and Division 15 specifications, the most stringent requirements shall govern, be applicable and shall be provided.
- 1.12. **Service, Charges, Grease, Filters, etc.:** Furnish complete first charges of refrigerant, grease, oils, etc., and be responsible for such full charges for the guarantee period. Provide service and maintenance for all equipment and systems during the guarantee period. As a minimum, quarterly service calls and reports are required. Make last service call two weeks prior to year-end inspection. All quarterly service shall include lubrication of all motors, bearings, calibration and adjustment of all controls and equipment, full refrigerant charge, new filters, belts, etc. **The Contractor is responsible for quarterly filter changes during the guarantee period and shall inscribe onto the filters' casing the date filters were installed/replaced.** The Contractor shall furnish to the Architect and the Owner individual written

service reports for all work done under this warranty. Failure to provide the Architect with the Owner's written acknowledgement of service calls shall be construed to mean that the service calls have not been accomplished and are still required.

**1.13. Field Instructions:** The Contractor shall operate all systems for a period of six (6) days after completion of the work. During this time, provide competent personnel to thoroughly instruct representatives of the Owner in the proper operation and care of all equipment and control systems. Secure written acknowledgement of such training from the Owner. Failure to provide the Architect with the Owner's written acknowledgement of this training shall be construed to mean that the instructions have not been accomplished and are still required.

**1.14. Bound and Framed Instructions:** **Two weeks before final inspection,** furnish three complete sets of operating and maintenance instructions, bound in hard cover, indexed and tabbed.

- a. The first sheet in the bound instructions shall be a listing of: The Owner/Project Title, Architect, Engineer, General Contractor and Subcontractor.
- b. Second page shall be a Table of Contents listing all products numbers in the order which they appear in the specifications and label the tab accordingly.
- c. All warranty information shall be filled in by the Mechanical Contractor (Serial numbers, Model Numbers and all other information required by the Equipment Manufacturer).
- d. Provide a copy of the Contractor's Warranty
- e. Local source of supply for parts and replacement, including names and telephone numbers of parts suppliers
- f. Provide wiring and control diagrams with explanatory data; control sequences of operation, start-up, operation and shutdown; operating and maintenance instructions for each piece of equipment; manufacturer's bulletins and catalog data; parts list and recommended spare parts. Fold in large sheets of drawings and enclose.
- g. A general maintenance summary section shall be included. Provide a list of each piece of equipment using equipment designations as shown on the plans, and the routine maintenance procedures based on the respective manufacturer's recommended intervals. As a minimum, maintenance shall be grouped and individually tabbed to indicate maintenance operations required:
  1. Once a month
  2. Quarterly
  3. Once every six months
  4. Once a year
- h. Provide drawings of system control and wiring diagrams, condensed operating instructions, and lubricating schedule and include in binder. All components shall be numbered and identified on diagram. Submit for



approval. After approval, place in the binder. Also, frame under glass or plastic and mount in each mechanical room in an optimally viewed location.

- i. Record drawings of the HVAC drawings, including HVAC Controls drawings, in hard copy and PDF format, and in ACAD “.dwg” format, on CD. Refer to Section 22 1510, Part 1, General, Paragraph, Record Drawings for additional requirements.
- j. Copy of Test and Balance Report to include testing of fire dampers, etc. as specified.
- k. Copies of all Site Visit/Inspection Reports including Contractor’s written response that items listed were corrected.
- l. Provide copy of results of all tests specified.
- m. Provide copy of all start-up reports specified.
- n. Provide Owner’s letter certifying training of Owner’s personnel in the operations of the HVAC systems has been accomplished.
- o. Provide copy of valve chart required in Section 22 1510, Identification.
- p. Provide DVDs of HVAC Controls systems training of Owner’s personnel (if applicable)
- q. Final Commissioning report

Additionally, the Contractor shall provide all of the aforementioned information, in digital Adobe Acrobat PDF format, on a CD-R CD. The PDF file shall be provided with an embedded index for each item specified. It shall appear in the left hand window of the opened document so that the Owner or his maintenance personnel can “click” on the indexed item and move immediately to that specific item.

- 1.15. Warranty:** Guarantee work as set forth in Section 22 1510 and Division 1. Guarantee in writing to make good without cost any defects in materials and workmanship for one year following the date of substantial completion of the project, as determined by the Architect, and unless specified otherwise a 5-year warranty on all air conditioning compressors. Provide free maintenance and service during the guarantee period to **include furnishing and replacing of filters**. Refer to other parts for additional requirements and extended warranty requirements.

## **PART 2. ELECTRICAL WORK AND EQUIPMENT**

- 2.1. Power:** All power wiring required for installation of equipment is specified under Electrical Division. Electrical equipment shall be compatible with the current shown on electrical drawings. **Verify voltage and power requirements with Electrical Contractor and Electrical plans prior to ordering equipment.**
- 2.2. Motors:** All motors furnished shall be designed, manufactured, and tested in accordance with the current applicable standards of NEMA, ANSI, IEEE, and ASTM. As a minimum requirement, all motors shall conform to the current applicable sections of NEMA Standard No. MG-1, Part 3. Motors must meet

or exceed The Consortium for Energy Efficiency (CEE) Premium Efficiency™ full load efficiencies. All motors 5 HP and over shall be premium efficiency.

All motors shall be listed under UL recognized component file as applicable. All motors shall be suitable for installation according to the requirements of NEC. Motors shall be wound for the specified voltage and a 1.5 service factor, 1750-RPM open drip proof construction and minimum of Class "F" insulation unless otherwise shown or specified.

The bearings shall have a rated fatigue life of B-10 of 150,000 hours for direct-coupled applications and 50,000 hours for belted applications minimum. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG 1. Load on motors shall not exceed 100% nominal horsepower. Routine factory testing shall be conducted in accordance with Method B of IEEE 112 (current edition), Standard Test Procedure for Polyphase Induction Motors and Generators and shall be as described in Article 12.55 of NEMA MG1, Motors and Generators. **Premium efficient motors shall be warranted for 36 months from date of substantial completion of the project as determined by the Architect.**

Where shown, specified or required, furnish increment wound motors for two-step starting. All motors shall be provided with overload protection and phase protection on all legs. Do not run motors until correct overload elements are installed in starters. Trading overload elements for elements of correct size for motors actually furnished shall be included in this Section.

All motors serving outdoor equipment exposed to weather shall have TEFC motors meeting the requirements set forth previously.

Motors shall be by Allis Chalmers, General Electric Goulds, Louis Allis, Westinghouse or approved equivalent.

- 2.3. Variable Frequency/Speed Drives:** Drives shall be mounted on wall at accessible height standing from floor. Equipment mounted or Uni-strut type frame mounting is not acceptable. All drives shall be provided with integral disconnect switch. Where shown or required to be a part of a new or existing HVAC Controls System (BAS), variable frequency drives shall be equipped with integral disconnect switch and a serial interface to allow bidirectional communication with the existing or new BAS. At a minimum, the following points shall be made available to the controls system: Set Point, Drive Speed (RPM), Frequency (Hz), Current (A), Power (KW), Energy (KWH), Last Fault Number, OK/Faulted Status, Stop/Run Status, and Hand/Off/Auto Status. Drives shall be installed in accordance with NEC requirements for electrical panels.

Drives shall be provided with NEMA 1 enclosures for standard indoor service, NEMA 12 enclosures for dusty/dirty indoor environments and NEMA 3R enclosures for outdoor or wet environments. Air filters shall be provided for air intake openings only on NEMA 3R and 12 enclosures. Drives shall be installed in accordance with NEC requirements for electrical panels. Drives

shall be ABB Model ACH550 or approved equivalent by Danfoss, Allen-Bradley, Eaton, Toshiba or Yaskawa. ABB is the Basis of Design. Refer to Part Automatic Controls at end of 23 1570 or Section 23 1592, Heating, Ventilating and Air Conditioning Building Automation System (BAS), as applicable, for additional requirements.

Refer to other equipment specifications for equipment/drives that are required to have factory installed harmonic filters that are IEEE 519 compliant and reduce TTD to 5%.

- 2.4. Fusing:** Provide factory installed fuses in all equipment requiring fusing for branch circuit protection.
- 2.5. Motor Starters:** To be furnished under this Section; installation thereof is specified under Electrical Division, except for those which are specified to be factory assembled. Starters shall be Cutler-Hammer, Allen-Bradley, Square D or General Electric. Starters shall be U.L. and NEMA approved. Where required for interlocks provide built-in step down transformer. Motors for VFD drives shall be designed for NEMA MG-1, Part 30.

Motor starters shall be mounted on wall at accessible height standing from floor. Equipment mounted or Uni-strut type frame mounting is not acceptable.

Provide for each motor or group of motors requiring a single control (and not controlled from a motor-control center), a suitable controller and devices that will function as specified for the respective motors.

Provide overload protection for each ungrounded conductor to each motor 1/8 HP or larger (manual reset type unless indicated otherwise). The overload-protection device shall be integral with the motor or controller. Unless indicated otherwise, furnish pilot lights with all remote starters. Where auxiliary control devices are connected into control circuit, these devices shall not bypass safety controls (motor-overload protective devices, high-pressure cutouts, low pressure cutouts, etc.). Provide "Hand - Off - Auto" switches, auxiliary contacts, etc. for all starters.

- 2.6. Phase Protection:** All fan motors, indoor units, outdoor units, condensing units, packaged units, etc., shall be provided with surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Protection shall be provided for all 3-phase equipment utilizing ICM Controls Model 450 or equivalent. All single phase equipment with horsepower greater than or equal to 1/8 HP shall be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. The Contractor shall consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities. Phase protection is not required on equipment being controlled via a variable speed frequency drive; if the specified protection is inherent with the variable speed drive furnished.

- 2.7. **Controls:** HAC Contractor shall be responsible for the furnishing and installation of all controls, and control and interlock wiring, as specified or required to properly complete the installation. Control conduit requirements shall be as specified in Electrical Division of the specifications and/or shown on electrical drawings. All control conduit, power wiring, relays, contactors, etc. which are required for controls, which are not shown on the electrical drawings or specified in the Electrical Division of the specifications, shall be provided under this HVAC Section. Coordinate all requirements with the Electrical Sub-Contractor prior to bid.

All adjustable wall mounted sensors, thermostat and humidistat boxes shall be mounted 46" A.F.F. to the center of the box (ADA height). Where wall mounted CO<sub>2</sub> Sensors are indicated, they shall be mounted 58" A.F.F to the center of the box. Electrical work performed under this Section shall conform to requirements set forth in the Electrical Division of the specifications. All wall-mounted devices shall be provided with hinged, locking metal covers with rounded edges. All work shall be done by an approved, independent HVAC Controls Subcontractor whose primary business is the installation and servicing of HVAC controls systems. Refer to Section 23 15 92 for additional requirements.

- 2.8. **Wiring Diagrams:** Furnish to the Electrical Contractor for the specific makes and models of electric-motor operated equipment to be installed. **Verify voltage and power requirements with Electrical Contractor and Electrical plans prior to ordering equipment.**
- 2.9. **Modifications:** The cost of any modifications of the electrical power wiring and/or control wiring conduit required by heating, air conditioning or ventilation equipment or controls having electrical power requirements differing from that shown on the electrical drawings and/or as specified, shall be the responsibility of the Mechanical Contractor. **Verify voltage and power requirements with Electrical Contractor and Electrical plans prior to ordering equipment.**

### PART 3. PLUMBING WORK

- 3.1. **Floor Drains:** By Plumbing Contractor. HAC Contractor shall provide drains from all air conditioning equipment drains, relief valves, air vents, etc. to the floor drains or to outside as indicated on the plans or, in absence of the previous requirements, as directed by the Architect.
- 3.2. **Gas and Water:** Valved supplies to within two (2) feet of equipment are specified under Plumbing Section. Final rigid connections to equipment by HAC Contractor, with work meeting requirements established in Plumbing Section. Provide 6" dirt leg for gas fired equipment. No flexible piping shall be used unless specified otherwise.

## **PART 4. VIBRATION AND NOISE CONTROL**

- 4.1. General:** Eliminate transmission of perceptible vibration, structure-borne noise, or objectionable air-borne noise to occupied area by HVAC equipment. Isolators shall be factory furnished, having static deflection as required to provide 95% isolation efficiency. Isolators for floor-mounted equipment shall be laterally stable, spring type with steel base plates, rib bed neoprene acoustical pads and leveling bolts. Isolators for suspended equipment shall be combination steel spring and rubber-in-shear hangers equal to VMC Series RSH. Provide spring type pipe hangers as required to isolate pipe vibration from the building. The Contractor shall be responsible for all isolation and engage the services of an isolation supplier to furnish all isolation. The Contractor shall provide all required information to the isolation supplier, based on the furnished equipment, as required to properly select the required vibration isolation requirements.

All items of mechanical equipment including all air handling equipment, condensing units, pumps, piping and fans shall be properly isolated from the structure by means of the Engineer's approved vibration absorbing accessories, foundations or supports. Each foundation shall include an adequate number of standard isolation units. Install floor mounted air handling units on minimum of 6" thickness concrete pads as shown on the plans or as specified. Final concrete requirements shall be as directed by the Structural Engineer. Foundations for each piece of equipment shall be submitted for approval

- 4.2. Isolation Supplier Qualifications:** The supplier must be a firm that has a licensed professional engineer on its staff capable of dealing effectively with vibration and noise characteristics, effects and criteria and have facilities and capabilities for measuring and evaluating such disturbances and the preparation of drawings and installation instructions. Submit for approval, manufacturer approved, professional engineer stamped drawings and data showing disturbing frequencies, supported weight, static deflection or natural frequency and efficiency for each isolator and damper proposed for use. Submittals without the licensed professional engineer's stamp will be rejected without review. All isolation components shall be the product of a single manufacturer, Mason Industries, Amber-Booth, Consolidated Kinetics, Korfund Dynamics or Vibro-Acoustics.

Concrete foundations associated with isolators or isolation materials are to be sized by the isolation supplier in consultation with the Structural Engineer. Consideration shall be given to the structural and physical limitations of the space. Shop drawings shall show size and location of anchor bolts for isolators and equipment thereon.

- 4.3. Isolation Supplier Responsibilities:** All isolation material selections are to be based on laboratory, published or factory certified data, proving that such materials and usage comply with these specifications. After installation, should any objectionable noise or vibration be detected, determine the

source, cause and path of such disturbance and correct all deficiencies. The isolation supplier in company with the Contractor and the Architect shall inspect the installation furnished by him, and submit a written report noting any discrepancies found and the resolution to the discrepancies. The supplier shall provide written certification to the Architect that the isolation system installed meets the manufacturer's requirements and will perform as specified and submitted.

- 4.4. Pipe Flexible Connectors:** Flexible connections in water lines shall be corrugated stainless joints designed for 150 psig WP. Bellows shall be laminated 3-ply type 304 stainless steel. Joints shall have van-stone flanges, gaskets, and 5" relaxed face dimension. For each joint furnish a control unit consisting of at least three tie bolts with required nuts, steel springs rated for 1" deflection at actual operating pressures, washers and stop and lock nuts. Provide flexible connectors at each building expansion joint. Flexible connections shall be Keflex or equal.
- 4.5. Roof Mounted Energy Recovery Unit and Exhaust Fans (ERU-1):** **It is IMPERATIVE that the Isolation Supplier coordinate all specified vibration isolation requirements in this part with the unit manufacturer prior to bid.** The ERU Manufacturer has specific requirements that shall be met. The below specification provides intent of what and how it is to be accomplished to provide a quiet installation. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal or structural steel sections containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive to resiliently resist wind forces and withstand the minimum wind loads prescribed in IBC Section 1609 and IMC 301.12. All directional neoprene snubber bushings shall be a minimum of 1/4" thick. Steel springs shall be laterally stable and rest on 1/4" thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous flexible flashing nailed over the lower curbs waterproofing. All spring locations shall have accessibility to adjust springs. Lower curbs shall have provision for 2" of insulation and shall be insulated as recommended by the supports Manufacturer. The roof curbs shall be built to seismically contain the rooftop unit. The unit shall be solidly fastened to the top floating rail, and the lower section anchored to the roof structure. Curb shall be type SRSC or RMSS as manufactured by Mason Industries, Inc. The floating member of the roof curb shall have perimeter angle and cross members to support two layers of 5/8" waterproof sheetrock laid on with staggered joints. Sheetrock shall surround ducts to provide a continuous sound break. This acoustical barrier shall be caulked to minimize sound transmission. Where the mechanical arrangement makes attachment to the floating member unfeasible, the barrier shall be attached at the highest practical elevation of the fixed curb with provision for 1" thick closed cell neoprene flexible seals around the ductwork. A single four-inch layer of 1.5 density fiberglass shall cover the entire solid roof surface under the unit. Ductwork shall be lined with acoustical liner material. Refer to Part "Duct Insulation Work (Internal)", for acoustical liner required. Complete

instructions shall be provided by the spring isolation curb Manufacturer. This Contractor shall coordinate all requirements for installation of sheetrock, insulation, etc., with the General Contractor and provide all as required for a complete installation as recommended by the curb Manufacturer. All curbs shall be factory painted with color selected by the Architect. Curbs shall be Mason Industries, Inc. Type RSC-dB or equivalent by Amber-Booth, Vibro-Acoustics or Kinetics Noise Control. **Mason Industries is the basis of design.**

- 4.6. **Sound Levels:** Sound levels caused by operation of pumps, fans, air handling systems, etc., whether generated within rooms or transmitted to rooms through ducts, walls or floors, pipes, etc., shall not exceed specified NC rating at any point within room not more than 6 feet from an air outlet in accordance with ASHRAE octave band method. Offices, classrooms, conference rooms and similar spaces shall have maximum NC-32; corridors, and lobbies, NC-40; toilets, NC-45.

## **PART 5. TESTING**

- 5.1. **General:** Conduct tests upon completion of the heating, air conditioning and ventilation installations and at times as designated by the Architect. Furnish all necessary personnel and test instruments. Power and fuel is specified under Division 1. Furnish written reports to Architect of all tests and results of testing and include copies in the Bound and Framed Instructions specified hereinbefore.
- 5.2. **Ductwork for Systems 2,000 CFM or Greater:** Test all supply, return and exhaust ducts, plenums and casings and make airtight before covering with external insulation or concealing in masonry. Test supply ductwork under the positive pressure for the respective system. Test return and exhaust ducts, plenum and casing under a positive pressure of 0.75 "WG. Maximum allowable leakage shall be 5%. Vacuum clean ducts, plenums, casings and coils. Demonstrate operation of fire dampers before testing and starting. Check that flexible connections are installed in folds (not pulled tight) and not transmitting vibration.
- 5.3. **Ductwork for Systems Less Than 2,000 CFM:** Test all supply, return and exhaust ducts, plenums and casings and make substantially airtight before covering with external insulation or concealing masonry. Substantially airtight shall be construed to mean that no air leakage is noticeable to the senses of touch or sound at joints.
- 5.4. **Ductwork Associated With the 100% Outside Air Unit and Roof Mounted Energy Recovery Unit and Associated Exhaust Fans:** Ductwork shall be tested in accordance with SMACNA and ASHRAE 90.1. Duct systems shall be tested at 8.0" WG with maximum of 0.5% leakage allowed. Representative sections totaling no less than 25% of the total installed duct area for the designated pressure shall be tested. Should any portion fail to achieve the designated leakage rate, an additional 25% percent of the total installed duct

area shall be tested. Should any portion of this additional duct fail to achieve the designated leakage rate, all duct must be tested. All sections to be tested shall be selected by the Troy University's Commissioning Agent (CxA).

- 5.5. **Water Piping:** Test with hydrostatic pressure at 150% of maximum operation pressure (min. 150 psi). System shall be proved tight and hold for at least 3 hours. Provide for bypassing of pressure sensitive items and avoid placing excessive pressure on mechanical seals, safety devices, etc. Thereafter drain clean and flush circulating systems continuously until water runs clear, and then clean all strainers. Refer to Part 39 Glycol Water Make-Up System and Chilled Water/Hot Water Hydronic Systems Chemical Treatment and System Cleaning for additional cleaning requirements.
- 5.6. **Refrigerant Piping:** Test with CO<sub>2</sub> gas or dry nitrogen and prove tight. Test high and low side of system at 500 psi. Evacuate the system and charging with refrigerant. Test piping with a halide torch and prove tight under actual operating conditions.
- 5.7. **Gas Piping:** After boiler valve train is erected but before connection to main, test valve train for tightness as required by local gas company; or in the absence of such requirements, apply an air pressure test equal to 15 lb. per square inch, which piping shall maintain without pressure drop for at least 8 hours. Stop all leaks shown up by such test, and repeat until specified test results are obtained.
- 5.8. **Domestic Water Circulating System:** Test and adjust domestic water recirculation system to ensure hot water circulation in all mains. Provide flow rate of pump and determined head.
- 5.9. **Notification:** Notify the Architect one week prior to final testing. The Contractor shall provide all testing equipment.

## **PART 6. TESTING AND BALANCING AIR DISTRIBUTION AND HYDRONIC SYSTEMS**

- 6.1. **Procedure:** Test and balance all systems per current edition of the Associated Air Balance Council National Standards for Total System Balance, Section IV, as applicable to air distribution and hydronic balancing. Employ instruments that have been calibrated within six months and checked for accuracy just prior to start of work. Provide for all work as specified in Section IV, Chapters 16, 17, 18, 19, 20, 21, 22, 23, and 24. The entire, current, AABC Standards Manual is applicable, as if written in full herein. Indicate date of testing, space temperature and humidity, outdoor air temperature (DB & WB). Use manufacturer's data for pressure drops through coils, chillers, condensers, etc. and pump performance curves. Include temperature of chilled water and/or hot water and discharge air from each AC unit and coil. The Contractor shall provide additional dampers, valves, drive changes, etc. as required to obtain specified results. Check airflow at each supply, return, exhaust grille, register and diffuser and outside air intakes with



a recently calibrated direct-reading velocity instrument. Adjust systems to deliver quantities within 10 percent of the indicated amounts.

Setting of balancing valves and dampers shall be clearly, neatly and permanently marked so they can be reset at any time.

After building is occupied, make adjustments as requested by the Architect.

- 6.2. Seasonal Adjustments:** At the beginning of the first heating season adjust and balance operating phases and repeat at the beginning of the first cooling season or vice versa.
- 6.3. Control Systems:** In cooperation with the control subcontractor, calibrate, adjust, and test control system, including the refrigerant hot gas reheat coils, to show that the requirements of these specifications have been met. Provide a tabulation of setting on all controls indicating set point and throttling range or differential after controls and systems have been finally adjusted. Include settings on safety controls and cutouts. Verify that all safety settings and limits are appropriate and comply with current safety Codes and Regulations for the respective system.
- 6.4. Sound and Vibration Testing:** Provide in accordance with Section II, Chapter 12 and 13 of AABC Standards Manual.
- 6.5. Phase Protection Verification:** The Test and Balance Contractor, with cooperation from the Mechanical Contractor, shall verify that all phase protection specified has been installed where specified, and installed per the Manufacturer's requirements. The verification of this requirement shall be furnished in tabular form and findings included in the test and balance report. The summary shall list all equipment specified to have the protection, verification that the device is installed per the Manufacturer's recommendation and has been programmed to the Owner's requirements.
- 6.6. Testing of all Fire and Smoke Dampers:** Test all fire and smoke dampers by releasing holding mechanism and activation of smoke dampers and certify in writing that all dampers have been checked and perform correctly.
- 6.7. Domestic Water Circulating System:** Test and adjust domestic water recirculation system to ensure hot water circulation in all mains. Provide flow rate of pump and determined head.
- 6.8. Subcontractor:** All work shall be performed by an independent test and balancing agency specializing in testing and balancing of air conditioning systems. The test and balancing contractor shall be NEBB or AABC certified. **Balancing agencies shall submit experience record and references to Engineer for approval a minimum of seven (7) days before bid date.**
- 6.9. Notification:** Notify the Architect one week prior to final testing. The Contractor shall provide all testing equipment.

- 6.10. Report: Submit report with all performance data 14 days prior to final inspection. No final inspection will be held until the Engineer has reviewed this report.**

**PART 7. SHEET METAL DUCT WORK (LOW VELOCITY 2" S.P.)**

- 7.1. Scope:** Provide as shown and as required for the air conditioning, heating and ventilation systems. Make changes in dimensions, offsets or crossovers as necessary to clear piping, lights and structural members, and to maintain scheduled headroom. Provide all accessories required. Refer to architectural drawings and specifications.

Refer to Architectural section "Painting" for painting of exposed ductwork. In case of the absence of painting requirements in the aforementioned Specification Section(s), the interior and exterior of ductwork visible from any finished space shall be cleaned, primed and painted as directed by the Architect. Ductwork visible through all grilles, registers, diffusers, ceilings, etc. shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

- 7.2. Protection of Interior of Duct from Debris:** ALL open portions of ductwork shall be covered with a self-adhesive film or airtight sheet metal caps to prevent the intrusion of contaminants. All duct taps, duct take-offs, etc., shall be protected immediately after the tap, take-off, etc. has been fabricated in the field. When sections of sheet metal are delivered to the facility for fabrication in the field, which cannot be protected with the specified material, the sheet metal shall be covered with Visqueen. Prior to erecting same, ductwork shall be manually cleaned to remove all dust, dirt and construction debris. All ductwork shall be erected clean. After each section of ductwork is erected, immediately protect all openings as specified herein before. In effect, there shall be no ductwork opening that is exposed to the ambient air. The material shall be a minimum of 3-mil thickness and have a minimum tensile strength of 10 psi. It shall be UV resistant, waterproof and recyclable. Material shall be DuroDyne Dyn-O-Wrap or approved equivalent. **Any ductwork discovered to be unprotected as specified is subject to immediate rejection for use on this project.**

- 7.3. Protection of Interior of Ductwork When Any Air Moving Equipment is Operating During Construction and Prior to Owner's Occupancy:** If air moving equipment must be used during construction, temporary filtration media with a Minimum Efficiency Reporting Value (MERV) of 8, as determined by ASHRAE 52.2 and shall be installed at each return air grille, return air register, exhaust grille, exhaust register, and unit return air inlet. The General Contractor shall provide a written request to the Architect for permission to temporarily operate any HVAC equipment during construction. The request shall be provided a minimum of seven (7) days prior to the desired date of the interruption. Do not operate any equipment without the Architect's written approval.

7.4. **Sizes:** Take measurements at job and fit work into available space. Report to the Architect any unworkable conditions encountered and alter layout or duct sizes as directed without additional cost to the Owner or the Owner's Project Design Professionals. Unless otherwise approved, conform to dimensions indicated. Duct dimensions shown indicate NET FREE AREA after installation of duct liner; increase sizes indicated to allow therefore.

7.5. **Sheet Metal:** ARMCO, or equal, prime quality, G-90 galvanized sheet steel. Unless indicated otherwise on the plans, gauges shall be as recommended in the current edition of current SMACNA "Duct Construction Standards" **but in no case shall be less than listed in the table below for the respective duct largest dimension or diameter.**

Up to 30 inches	24 ga.
31 to 54 inches	22 ga.
55 to 84 inches	20 ga.
85 to 96 inches	18 ga.

Where galvanized metal joins aluminum or copper, separate sheets with lead or chromate impregnated felt gaskets.

7.6. **Factory Fabricated Duct and Fittings:** All exposed round, rectangular or flat oval supply air ducts and fittings shall be factory fabricated and insulated duct and fittings shall be equal to United McGill Acousti-K27 and rated for 2" static pressure. All taps/take-offs to be factory installed. Do not use saddle taps. Insulation shall be Acousti-Line with EPA registered anti-microbial, erosion-resistant acrylic coating. The coating shall resist the growth of fungus and bacteria as determined by ASTM C 1071, ASTM G21 and ASTM G22. The insulation thickness shall be 1" where exposed within the conditioned space and 2" thickness where concealed. Ductwork shall comply with NFPA 90A. Construction and installation shall comply with current SMACNA Standards. Where conflicts occur between current SMACNA and the contract drawings or specifications, the most stringent requirements shall apply and the heaviest gauge metal shall be provided. Duct shall be provided with factory installed heavy-duty Mylar jacket on the airside. All duct-to-duct connections or duct to fitting connections for exposed double wall ductwork, regardless of size, shall be provided with factory-fabricated couplings to provide a neat, smooth appearance. All factory-fabricated ducts shall be shipped from the factory with factory installed heavy duty protective plastic to cover duct and all openings.

Any ductwork installed, which is damaged, shall be replaced at no cost to the Owner, at the discretion of the Architect. Provide as shown and as required for the air conditioning, heating and ventilation systems. Make changes in dimensions, offsets or crossovers as necessary to clear piping, lights and structural members, and to maintain scheduled headroom. Provide all accessories required. Provide additional supports to raise ductwork off any piping or as a minimum, provide Rubatex insulation between ductwork and

piping. The use of Rubatex insulation between piping and the ductwork shall only be allowed when providing supports is not an option.

Refer to architectural drawings and specifications. Refer to Architectural section "Painting" for painting of exposed ductwork. In case of the absence of painting requirements in the aforementioned Specification Section(s), the interior and exterior of ductwork visible from any finished space shall be cleaned, primed and painted as directed by the Architect. Ductwork visible through all grilles, registers, diffusers, ceilings, etc. shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

- 7.7. General Fabrication:** Construct and erect in a skillful manner, meeting requirement of the current SMACNA "Duct Construction Standards" for 2" static pressure unless noted or specified otherwise. **Where conflicts occur between current SMACNA and the contract drawings or specifications, the most stringent requirements shall apply, and the heaviest gauge metal shall be provided.** Form straight and smooth on the inside, with joints neatly finished. Make up in sections of such length that mechanic can reach thru open end to seal insulation at previous joint. Assemble and anchor to be completely free from vibration and drumming under all conditions of operation. Make takeoffs at round ducts with prefabricated round-to-rectangular and rectangular-to-round transitions. Break so that manufacturer's quality stamp is exposed to view.

Where ductwork penetrates non-rated partitions above the ceiling or insulation support/attic air barriers, draft stops and similar partitions, the openings shall be sized as required for duct and insulation, plus 1". Provide duct supports as specified within 12" of each side of the partition penetrated. **DO NOT ALLOW DUCT TO REST ON PARTITION WALLS.** Openings shall be saw cut or properly blocked out and present a neat appearance. Where penetration occurs at rated assemblies, provide appropriate fire damper and install as specified and detailed. Where penetration occurs at non-rated assemblies, fill void between assembly and duct with fire retardant mineral wool insulation and seal with fire stopping material to prevent the passage of smoke and fire. After closing and filling the annular space, provide 4" wide, 16 gauge galvanized steel closure plates around the penetration, completely covering the opening. Closure plates shall fit snugly to duct, shall be secured to assembly and sealed airtight.

Provide additional supports to raise ductwork off any metallic piping. Wherever any bare metallic piping is in contact with externally insulated duct or bare sheet metal duct, there shall be dielectric separation provided. The Contractor shall provide 1" thickness, unslit AP Armaflex insulation of sufficient inside tubular diameter to snugly and completely cover the respective piping. The insulation shall extend the full length of the affected area plus 6" on both sides. Refer to Part "Pipe and Miscellaneous Insulation Work" in this division for AP Armaflex material specification. The use of Rubatex insulation between piping and the ductwork shall only be allowed when providing the proper supports is not an option.

- 7.8. **Exposed Ductwork:** Install tight against the wall and/or ceiling with drive slip joints. Provide 4" wide, 16 gauge galvanized steel closure plates, except at grilles and registers, where exposed ducts pass through walls and partitions. Fill void between wall penetration and duct with fire retardant mineral wool insulation and seal with fire stopping prior to installing closure plate. Closure plates shall fit snugly to duct and shall be secured to wall. All ductwork and closure plates that are exposed to view in finished areas shall be primed and painted as directed by the Architect.

All exposed rectangular ductwork traverse joints shall be made with all metal Ductmate joints system as manufactured by Ductmate Industries, Inc., Quikduc Transverse Duct Connection Systems, Duro Dyne Dyn-O-Mate or approved equivalent. Ductmate system shall be installed in strict accordance with current SMACNA and manufacturer's recommendations and instructions.

Refer to Architectural section "Painting" for painting of exposed ductwork. In the absence of painting requirements in the aforementioned Specification Section(s), the exterior of ductwork visible from any finished space shall be cleaned, primed and painted as directed by the Architect. Ductwork visible through all grilles, registers, diffusers, ceilings, etc. shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

- 7.9. **Branch Ducts to Diffusers:** Round runouts to diffusers, up to and including 14" round, shall be 24 ga., G-60 galvanized, Ductmate Series GreenSeam +Snap Lock pipe with factory sealed longitudinal and transverse gaskets. Gasket for GreenSeam +Snap Lock pipe shall contain antioxidants, fungicides, adhesion promoters, zero VOCs and shall meet or exceed ASTM E-84 test requirements. 16" round to 20" round runouts shall be 24 ga. and equal to Ductmate Series Reeves Lock Pipe, G-60 galvanized pipe.

- 7.10. **Return Air Platforms:** Return air platforms shall be constructed with 1-1/2"x1-1/2"x1/4" steel angle iron frame and 18 ga. G-90 galvanized steel all sides, top and bottom, then sealed by welding or soldering, airtight. Insulate all sheet metal sides, top and bottoms with 2" thickness, 1.5 lb. density, unfaced duct liner, same as internally lined ductwork. Provide angle iron supplemental supports and pedestal type pipe columns to support the units and allow individuals to stand on the platform without platform deformation or failure. Platforms shall be a minimum of 24" tall, or as space permits. **No combustibles are allowed in the return air plenum.**

- 7.11. **Cross-Joints, Seams and Stiffening:** Join and stiffen with combination of joint types and structural angles as recommended in current SMACNA "Duct Construction Standards". **Cross break all flat areas over 30 inches wide.** Install internal ends of slip joints in the direction of flow. Non-galvanized pieces must be painted before assembling with Rust-Oleum metal primer. All transverse joints with long dimension over 24" shall be made with all metal Ductmate joints system as manufactured by Ductmate Industries, Inc., Quikduc Transverse Duct Connection Systems or Dyn-O-Mate. System used

shall be installed in strict accordance with current SMACNA and manufacturer's recommendations and instructions.

Make all cross joints and all branch, grille and diffuser take-offs, except Ductmate joints, air tight by applying fibrated, low VOC, LEED IEQ 4.1 compliant duct sealer. Sealer shall meet and pass ASTM D-2202, ASTM C-731 and EPA regulations. Sealer shall meet the requirements for the pressure classification of the ductwork installed. Sealer shall be Hardcast Duct Seal 321, Foster 32-17 or Childers CP-148.

- 7.12. Turns and Transitions:** Fabricate turns with an inside radius equal to width of duct. At 90-degree turns, Contractor may substitute square elbows, with standard factory-made, multiple, double-blade constructed vanes. Vanes shall be a double wall, true airfoil contour with smoothly rounded entry nose with extended trailing edge. Vanes shall be formed from a single piece of 26 ga., hot dipped galvanized steel and shall be 3" radiused vanes on 2.4" centers. Vanes shall be provided with two (2) tie rods and continuous internal tubes for stiffening and rigidity. Maximum pressure drop shall be .06" W.G. at 1500 FPM. Generated sound power level shall not exceed 54 decibels in band 4 at 2000 FPM (24"x24" duct size). **Single wall turning vanes are not allowed.** Vanes shall be as manufactured by Aero/Dyne Series HEP, Duro Dyne HTV/DHV, Hamlin Sheetmetal or approved equivalent by DuctMate. Avoid abrupt changes in shape, with a slope of 4:1 the minimum allowed.
- 7.13. Branch Duct Take-Off:** Provide at all points where branch ducts take off from trunks, and where ducts divide. Refer to details on the drawings. Damper shall be minimum 22 Ga., G-90 Galvanized steel with 2" build out. Body shall be a minimum of 24 Ga., G-90, galvanized steel with 4"W.G. construction. Fitting shall have 1" flange with corner clips, pre-punched mounting holes and adhesive coated gasket. Take-off shall be Flexmaster LDS, BO3, GSI HETO (high efficiency take-off) HTS2 or approved equivalent.
- 7.14. Fire Dampers:** Provide as shown on drawings and in each duct passing through firewalls, floors, and other fire barriers in accordance with NFPA Code 90A. Install in such manner that fusible links can be replaced. Employ links rated at 165 degrees F (212 degrees where within 10 feet of a heating coil).

Typical dampers shall be UL labeled, minimum 1-1/2 hour rated, (higher where required), equal to Prefco #5500-E6-BC, with Type B low resistance frame and 16 ga. factory sleeves. Equivalent products by Air Balance, Ruskin or Airstream Products will be accepted. Where damper is installed behind wall grilles or registers use No. 5500-E6-LPB.

Install in accordance with all applicable conditions of the UL listing, for which data sheets must be submitted for approval. At typical ducts, provide 16 ga. sleeves secured in opening with 1-1/2" x 1-1/2" x 14 ga. (min.) angles; bolt angles and damper sleeve with galvanized bolts. **Fire dampers indicated for use in storm/tornado/safe areas shall have 10 ga. sleeves and angles. Fire dampers at floor penetrations shall have 12 ga. sleeves and angles.**

Size structural openings so that space between sleeve and masonry is not less than 1/8" per linear foot of duct or more than 1/2". Secure ducts to sleeve per detail and current SMACNA requirements. After installation release holding mechanism and verify proper closure of each damper.

Ductwork in fire-rated floor-ceiling or roof-ceiling assembly system with air ducts that pierce the ceiling of the assembly shall be constructed in conformance with designs in UL Fire Resistance Directory. In general, ducts shall be encased in fire rated material.

At internally insulated ducts, size dampers for gross duct size, so that liner butts into damper frame surround.

- 7.15. **Volume Dampers Used with Automatic Controls:** See Controls at end of Section 23 1592.
- 7.16. **Volume Dampers:** For round ducts less than 12" diameter and rectangular ducts less than 12" in height in either dimension: Single leaf, constructed with 18 gauge galvanized metal with locking type control quadrant, single center u-bolt and pivot rod extending through opposite side of duct with brass bushing at both ends.
- 7.17. **Volume Dampers:** For round ducts greater than or equal to 12" diameter or rectangular ducts greater than or equal to 12" height in either direction, provide opposed blade, airfoil blades of 16 ga.-galvanized steel mounted in steel frames by 3/8" steel trunnions riding in brass bushing with dual U-bolts. Blade width shall not exceed 10 inches and individual blade length shall not exceed 48 inches. Extend one trunnion to permit operation from outside the duct. Provide manually operated dampers with cadmium plated steel locking quadrant. Dampers opening to the outside shall have felted edges.
- 7.18. **Stand-Off Mounting Brackets:** Locking-type quadrant operators for dampers, when installed on ducts to be externally insulated, shall be provided with standoff mounting brackets, bases or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Standoff mounting items shall be integral with the operator or standard accessory of the damper manufacturer.
- 7.19. **Access Panels/Doors:** Provide an access door in the side of the duct for each splitter damper, fire and motorized damper, on each side of duct mounted coils and duct heaters, smoke detectors, in plenums at outside air louvers and elsewhere indicated, specified or required for proper maintenance. Provide access doors/panels in all plenums behind outside air intake louvers and relief air louvers to facilitate cleaning of bird screens. Doors/panels in plenums at outside air intake louvers and relief air louvers shall be minimum 10" wide x full height of plenum. Size and position to provide maximum access to all items. Typical doors shall be double metal faced, 20 ga. Steel, internally insulated same as duct, provided with gasket seal, and with minimum of two-sash locks equivalent to Ruskin Model ADC12 for rectangular ductwork. Access panels/doors may be hinged type in areas

where the door/panel may be completely opened without obstruction. Access doors for round ductwork shall be similar except with two large hand knobs and equivalent to Ruskin Model ADR2 for round ducts 10" round, up to and including, 16" round duct. Doors shall be rated for the anticipated duct pressure, plus 1". **For ducts 10" round and smaller, provide a removable section of duct to provide required access Refer to Section 22 1510 for additional access door/panel requirements including identification.**

- 7.20. Duct Instrument Test Holes:** Provide for each system four test holes (two in supply duct and two in return air plenum) at opposite ends near air handling units with screwed caps. In addition, at duct mounted coils and electric duct heaters provide one on either side of the coil or duct heater.

- 7.21. Flexible Connections:** Install so that the cloth is in folds (not drawn tight). Connect all ducts to air handling units and fans excepting dome type fans with preassembled flexible connection. Fabric width shall be 6" for all air handling equipment. Ceiling mounted exhaust fans and VAV terminal units whose total scheduled CFM is less than or equal to 1,200 CFM may be 4" width.

Connectors for all air handling equipment, including VAV terminals, shall be a factory fabricated and assembled unit with 6" dual fabric, heavy duty, 20 oz/sq. yd polyester/polyester fabric with flame resistant coating and mildew resistant per ASTM G-21. The assembly shall comply with NFPA 701, NFPA 90A, NFPA 90B and ASTM E-84. The unit shall be constructed of minimum 24 ga. galvanized steel meeting ASTM A-653-94-G60. Metal to fabric connectors shall be double locked, airtight and waterproof to 10" W.C. positive pressure and 10" W.C. negative pressure. Assembly shall be DuctMate PROflex or equivalent.

Flexible connections for ceiling exhaust fans and VAV terminal of capacity specified above shall be preassembled flexible connection of 29 ounce fire-resistant, neoprene coated glass fiber cloth equal to Ventfabrics "Ventglas" (4" fabric width), as manufactured by Ventfabrics, Wiremold or Thermaflex.

Provide preassembled flexible connections for all ducts that cross building expansion joints. Flexible connections shall be 6" in width as specified hereinbefore. Coordinate requirement with Architectural plans and provide as required.

Externally insulate all flexible connectors to prevent condensation with 2" thickness external duct insulation as specified later in this section.

Provide copper jumpers across all flexible connectors taking care that jumpers do not bind flexible connections. Provide compression lug and grounding connector screwed into the duct with two (2) screws, on both side of the flexible connector. Bonding wire shall be shielded 12 AWG.

- 7.22. Register and Grille Connections:** Where take-offs are in side of a duct, clinch lock short tee sections onto trunk. Install collars with slip joints and 3/4"



flange at outlet end. At sheetrock and other hard surfaces, set collars exactly flush with surface (mechanic must be on job to make adjustments during installation). Set flange face to receive register gasket, and be concealed by register flange. Collars may be deleted where mounting frames are furnished with registers.

Install boots above lay-in ceilings simultaneously with ceiling work; mechanic must be on job during this phase of construction work.

At return air, relief air and exhaust air grilles 48" or more in either dimension, collars shall be 1" x 2" x 1/8 inch steel angle frames with corners mitered, welded and ground smooth. Frames in ceiling shall be independently suspended from the ceiling structure, or the duct shall have special reinforcing to prevent sagging of the boot.

Interior of ductwork visible through grilles and diffusers shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

**7.23. Hangers and Supports: Duct hangers shall NOT penetrate the external insulation vapor barrier. All duct hanger materials shall be external of the insulation materials, insulation jacket and vapor barriers. All vapor barriers shall be continuous and without penetrations.**

**"Sammy" bolts are prohibited.** Contractor shall provide supplemental steel between structural purlins, bar joists, etc., for duct support as required to meet support spacing specified. Supplemental steel shall be welded in place as directed and specified by the Structural Engineer. Support small (less than 40 united (w+h) inches) horizontal ducts without external insulation with 1-1/4" x 20 ga. band hangers. Provide in pairs close to each transverse joint and in no case more than six feet apart. Bands shall be turned 3" under the lower corner of ductwork and fastened with two (2) self-tapping screws into the bottom of the duct surface. Bands shall be attached up the sides of the ductwork at a maximum of 6" intervals and in the bottom of the duct. Seal all screws with duct sealer as specified for ductwork.

Wherever any duct hanger support exceed 36" length from the top of the supported duct to the structure above, Contractor shall provide a Unistrut support assembly and provide bracing of the assembly with minimum 1"x1"x1/4" angle iron, or as required for the weight of the particular duct. Weld angle iron to the Unistrut and attach to the overhead structure, as specified and directed by the structural engineer, to prevent swaying

All 14" or less concealed round ducts with external insulation shall be provided with band hangers and saddles. Suspend ducts, at six (6) foot intervals with 8" long, 3" wide, 22 gauge galvanized metal saddles hung from structure with 22 gauge, 1" wide straps. Bands shall pass completely under and around round ducts. Loop strap under duct and attach to strap with two (2) galvanized bolts. Thereafter, loop top end of hanger over steel structural members above and fasten with two (2) galvanized bolts. Where concrete

joists occur overhead, secure straps to side of joist with galvanized expansion or ramset bolts. Where flat concrete surface occurs overhead, secure with ramset or expansion bolt fasteners. See other Specification Sections in the Contract Documents for limitations on use of power driven fasteners.

All concealed and externally insulated rigid round metal ducts greater than or equal to 16", all externally insulated rectangular ductwork, all externally insulated square ductwork and all externally insulated flat oval ductwork that is specified to have external insulation with a vapor sealed facing **shall be supported with trapeze hangers consisting of Unistrut, threaded rods and inserts or clamps as required to accommodate overhead construction.** Threaded rods shall be of size required to provide support of three (3) times the anticipated load of the assembly. Trapeze hanger assembly spacing shall not exceed 8 feet.

**Where ducts are specified to have external insulation with a vapor sealed facing, support duct on trapeze hangers consisting of a Unistrut assembly with threaded rods.**

On externally insulated ducts, install 1" thickness, unslit AP Armaflex insulation of sufficient inside tubular diameter to slide over the Unistrut support, completely cover and snugly fit to the bottom horizontal Unistrut duct support. The insulation shall extend the full width of the duct plus a minimum of 6", each side. Where channel shapes are used, orient the open side, down. Refer to Part Pipe and Miscellaneous Insulation Work for AP Armaflex material specification. Space hangers a minimum of 6" (maximum of 12") from the sides of the duct to permit the duct to be placed within the trapeze hangers.

All concealed internally insulated round ducts shall be supported as specified above for externally insulated ductwork except without saddle. Coordinate exposed duct support requirements with plan details.

Support all non-externally insulated horizontal ducts larger than or equal to 50 united (w + h) inches on trapeze type hanger assembly same as specified above for externally insulated duct except without Armaflex surround on the Unistrut. Install inserts or clamps as required to accommodate overhead construction. Spacing shall not exceed 6 feet.

Support small vertical runs with 1/8" steel bands screwed to three sides of duct and expansion bolted to adjacent structural elements; spacing shall not exceed 10 feet. Support vertical runs larger than 40 united (w + h) inches with structural brackets with welded joints.

Where ducts pass through floors, seal as specified hereinbefore, support duct and close opening with minimum 2"x2"x1/8" steel angles on all sides and, secured to both floor and duct. At plenums and risers just above the floor, provide suitable chair assemblies of welded structural shapes.

Where horizontal ducts with standing joints exceed 72 inches in width they shall be provided with additional hangers at the mid-point of their width, consisting of a support bolted to an interior 1/8 x 1-1/2 inch strap that shall, in turn, be bolted to the duct. Internal straps and hangers shall be spaced one for each duct section.

Where trapeze type hangers or Ductmate is used to support exposed ductwork in finished areas, the width of the support shall not exceed the duct width by more than six (6) inches on either side of the duct.

- 7.24. Sound Attenuating Duct Hangers and Supports (Ductwork Below Energy Recovery Unit ERU-1):** All air ducts with a cross section of 1.5 sq. ft. or larger shall be isolated from the building structure by W30 hangers with a minimum deflection of 0.75". Isolators shall continue for a minimum of 50 feet in each direction from the equipment. Springs are seated in a steel washer reinforced LDS Rubber cup molded with a rubber bushing projecting through the bottom hole to prevent rod to hanger contact. Spring diameters and the lower hole sizes, shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing. If ducts are suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps. Submittals on either of the above hangers shall include a scale drawing of the hanger showing the 30° capability. Hangers for rods shall be Type 30 or for straps, W30 as manufactured by Mason Industries, Inc. or equivalent by Amber-Booth, Vibro-Acoustics or Kinetics Noise Control. **Mason Industries is the basis of design.**

All metal ductwork in contact with unistrut hangers shall be provided with AP Armaflex insulation between the unistrut assembly and the metal ductwork. Insulation shall be 1 1/2" thickness, unslit AP Armaflex insulation of sufficient inside tubular diameter to slide over, completely cover and snugly fit to the bottom horizontal unistrut duct support. The insulation shall extend the full width of the duct plus a minimum of 6", each side. Where channel shapes are used, orient the open side, down. Refer to Part Pipe and Miscellaneous Insulation Work for AP Armaflex material specification. Space hangers a minimum of 6" (maximum of 12") from the sides of the duct to permit the duct to be placed within the trapeze hangers.

- 7.25. Roof Intake and Relief Hoods:** Greenheck Model FGI/FGR or approved equivalent by Loren-Cook, aluminum or galvanized steel construction unit with welded joints, complete with 1/2" aluminum bird screen, rain gutter, weather baffle, 10" high (exhaust/relief) or 14" high (intake) height NRCA approved roof curb (outside air) with built-in cant strip, integral fiberglass insulation and wood nailer. Hood sizes smaller than 24"x24" shall be hinged type. All intakes, relief or exhaust vents greater than or equal to 12x12 shall be 125 MPH rated. Maximum intake throat velocity of 250/500 FPM and .05" WC maximum pressure drop. Maximum relief throat velocity of 600 FPM and .05" WC maximum pressure drop. Hood, throat and curb cap shall be minimum 18ga.

Roof curbs shall be painted with two coats of non-reflective paint. Paint type and color as selected by Architect. All roof curbs furnished shall adhere to the roofing manufacturer's requirements so as not to void the roofing warranty. The top of all roof curbs shall be level with pitch built into curb when deck slopes 3/8 of an inch per foot or more. Coordinate with architectural and structural plans for required slope. Coordinate roof curb and interface in the building roofing system and verify minimum net height to be as required by code or as required by Architect. Refer to architectural specification and plans for additional requirements. All roof curbs interfacing shall comply with the Architectural requirements. Coordinate prior to bid and provide as required.

- 7.26. Flexible Air Ducts:** Flexible duct for connections shall be Thermaflex M-KE, Greenguard Level 4 certified, or approved equivalent, air duct rated for a maximum pressure of 16" (4-10 in. ID) or 10" (12-16 in. ID) water column positive and 2" water column maximum negative pressure and 5000 FPM maximum velocity and Listed by Underwriters Laboratories, Inc., under UL Standard 181 as a Class 1 air duct and complying with NFPA Standards 90A and 90B. Duct shall have a maximum flame spread of 25 and a maximum smoke developed rating of 50. Flexible air duct shall be factory made and composed of an inner duct of woven and coated fiberglass providing an air seal and permanently bonded to coated steel wire helix, a fiberglass insulating blanket and low permeability outer vapor barrier of fiberglass reinforced metallized film laminate. R-value shall be a minimum R=8 per ASTM C-518.

Flexible duct length shall not exceed six (6) feet. Supply each duct with **stainless steel worm gear driver and stainless steel band** at take-off fitting and supply fixture connections. Suspend ducts, at three (3) foot intervals with 8" long, 3" wide, 22 gauge galvanized metal saddles hung from structure with 22 gauge 1" wide straps. Loop strap under duct and attach to strap with two (2) galvanized bolts. Thereafter, loop top end of hanger over steel structural members above and fasten with two (2) galvanized bolts. Branch duct connectors for connecting round low velocity branches to rectangular low velocity trunks shall be rectangular to round take-off fittings as detailed on the drawings with damper and standoff mounting bracket.

**Provide a full size radiused, galvanized sheet metal elbow transition piece from flexible duct connection to each diffuser boot.** Elbow gauge shall be as specified hereinbefore in Part, "Sheet Metal Ductwork" for respective duct size.

## **PART 8. HIGH VELOCITY DUCT WORK DESIGNED FOR 4" WG PRESSURE (AHU-2)**

- 8.1. General:** All duct and fittings shall be manufactured by a company who has had its principal business, the manufacture of spiral pipe and welded fittings for at least five years. Provide as shown and as required for the air conditioning, heating and ventilation systems. Make changes in dimensions,

offsets or crossovers as necessary to clear piping, lights and structural members, and to maintain scheduled headroom. Provide all accessories required. Provide additional supports to raise ductwork off any piping or as a minimum, provide Rubatex insulation between ductwork and piping. The use of Rubatex insulation between piping and the ductwork shall only be allowed when providing supports is not an option. Refer to architectural drawings and specifications. Refer to Architectural section "Painting" for painting of exposed ductwork. In case of the absence of painting requirements in the aforementioned Specification Section(s), the interior and exterior of ductwork visible from any finished space shall be cleaned, primed and painted as directed by the Architect. Ductwork visible through all grilles, registers, diffusers, ceilings, etc. shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. **Metal manufacturer's duct material stamp shall be visible on duct exterior surfaces. Any ductwork without the manufacturer's material stamp indicating sheet metal gauge thickness, material, etc., shall be cause for immediate rejection of the effected installation.**

- 8.2. Protection of Interior of Duct from Debris:** ALL open portions of ductwork and equipment shall be covered with a self-adhesive film to prevent the intrusion of contaminates. The material shall be a minimum of three mil thick and have a minimum tensile strength of 10 psi. It shall be UV resistant, waterproof, and recyclable. Open ends of ductwork shall be protected prior to delivery to the project site. Any taps, take-offs, etc., shall be protected immediately after the tap, take-off, etc. has been made in the field. Material shall be DuroDyne Dyn-O-Wrap or approved equivalent. Any ductwork discovered to be unprotected as specified is subject to immediate rejection for use on this project.

All factory-fabricated ducts shall be shipped from the factory with factory installed heavy-duty protective plastic to cover duct and all openings.

All high-pressure ductwork will be manufactured by the same firm to assure tight fit of all ductwork and components.

- 8.3. Construction and Materials:** Round and/or flat oval duct shall be manufactured of G-90, prime galvanized steel meeting ASTM A653 / A653M in the following methods and in the minimum gauges listed. Metal manufacturer's duct material stamp shall be visible on duct exterior surfaces. Any ductwork without the manufacturer's material stamp indicating sheet metal gauge thickness, material, etc., shall be cause for immediate rejection of the effected installation. Minimum general construction and installation shall comply with current SMACNA duct construction standards. Where conflicts occur between current SMACNA and the contract drawings or specifications, the most stringent requirements shall apply and the heaviest gauge shall be provided.

Major Axis or Diameter	Maximum Gauge	Method of Manufacture
3" thru 14 "	26 gauge	Spiral Lockseam
15" thru 26"	26 gauge	Spiral Lockseam
28" thru 36"	24 gauge	Spiral Lockseam
38" thru 50"	22 gauge	Spiral Lockseam
52" thru 60"	20 gauge	Spiral Lockseam
61" and up	18 gauge	Longitudinal Seam

The spiral duct shall have locked seams. Longitudinal seam duct shall have a fusion-weld butt seam and shall be 20 ga. up to 36" and 18 ga. over 36" major axis.

Fitting and couplings shall be of the following minimum gauges:

Diameter	Gauge
3" thru 36"	20 ga.
38" thru 60"	18 ga.
Over 60"	16 ga.

All fittings shall have continuous welds along all seams. All divided flow fittings shall be manufactured as separate fittings, **not as tap collars welded into spiral duct sections or saddle taps.**

All 90° tees and 45° laterals (wyes) up to and including 16" diameter tap size shall have a radiused entrance into the tap, produced by machine or press forming. The entrance shall be free of weld build-up, burrs, or irregularities. Saddle taps are not allowed.

All elbows shall have a perforated inner shell, same as specified below for other double wall duct. Elbows in diameters 3" through 8" shall be two section stamped elbows. All other elbows shall be gored construction with all seams continuous-welded. Elbows shall be fabricated to a centerline radius of 1.5 times the cross-section diameter. All elbows, not die-stamped, shall be fabricated according to the following schedule:

<u>Elbow Angle</u>	<u>Number of Gores</u>
Less than 35°	2
36° thru 71°	3
Over 71°	5

Where it is necessary to use 2-piece mitered elbows, they shall have turning vanes in accordance with the following schedule:

<u>Major Axis or Diameter</u>	<u>Number of Vanes</u>
3" thru 9"	2
10" thru 14"	3
15" thru 19"	4
20" thru 60"	5

Over 60"	12" spacing
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The leading edge of all vanes in ducts over 20" diameter shall be hemmed with 1/2" fold-back. Turning vanes in ducts over 24" shall be reinforced by rods or sectional construction to limit unsupported length to 24". Vanes shall be a minimum of 20 gauge. Galvanized areas that have been damaged by welding shall be coated with corrosion resistant aluminum paint. Turning vanes shall be double wall, airfoil, and sound attenuating type.

- 8.4. Couplings for Round and Flat Oval High Pressure Duct:** Pipe to pipe joints in diameter to 48" diameter, 42" major axis and 24" minor axis are by the use of sleeve couplings, reinforced by rolled beads. All duct-to-duct connections or duct to fitting connections for exposed double wall ductwork, regardless of size, shall be provided with factory-fabricated couplings to provide a neat, smooth appearance.

Pipes to fitting joints in diameters to 48" are by slip-fit of projecting collar of the fitting into the pipe.

Insertion length of sleeve coupling and fitting collar is 2" for diameters through 9" and 4" for diameters 10" and up.

Pipe to pipe and pipe-to-fitting connections in diameters above 48" and 42" major axis and 24" minor axis are made by angle ring flanges. Connections 52" and up are made by the loose ring "Van Stone" flange. A 5/8" flange shall be provided for the body ends of duct sections and fittings to act as a gasketing surface for sealing. The angle ring shall be rolled, welded ring 2" x 2" x 3/16". Bolt hole spacing for angle rings shall not exceed 6".

Longitudinal seam duct greater than 48" diameter or 42" major axis shall be supplied in lengths greater than 4', angle rings must be welded to duct on 4" centers. Welding can be an intermittent weld of 1" in 4".

- 8.5. Internally Insulated Duct and Fittings:** Construction, in general, shall be comprised of an airtight, outer pressure shell, a 2" insulation layer, minimum 2-mil thickness Mylar insulation liner and a perforated metal inner liner that completely covers the insulation through the system. Duct sizes shown are net inside dimensions; add for insulation thickness to specified dimensions. Insulation shall be protected on the air streamside with minimum 2-mil thickness insulation liner. Insulation and Mylar liner shall have a minimum UL flame spread rating of 20 and smoke developed of zero.

The outer pressure shell and the inner liner shall be manufactured from galvanized steel meeting ASTM A-527-71 in the following minimum gauges:

<u>Nominal Duct Size</u>	<u>Outer Shell</u>	<u>Inner Liner</u>
3" thru 12"	26 ga.*	24 ga.
13" thru 24"	24 ga.*	24 ga.
26" thru 34"	22 ga.*	24 ga.

36" thru 48"	20 ga.*	24 ga.
49" thru 58"	18 ga.*	24 ga.
59" and over	16 ga.**	20 ga.

\*Spiral Lockseam

\*\*Longitudinal Seam

Fittings and couplings shall be of the following minimum gauges:

<u>Nominal Duct Size</u>	<u>Outer Shell</u>	<u>Inner Liner</u>
3" thru 34"	20 ga.	22 ga.
36" thru 48"	18 ga.	20 ga.
49" and over	16 ga.	20 ga.

Divided flow fittings shall be made as separate fittings, not tap collars into duct sections, with the following construction requirements:

Sound, airtight, continuous welds at the intersection of the fitting body and tap.

Tap liner securely welded to inner liner with weld spacing not to exceed 3".

Insulation to be packed around the branch tap area for complete cavity filling.

Branch connection is to be carefully fit to cutout openings in inner liner without spaces for air erosion of insulation or sharp projections for noise and airflow disturbances.

All seams in the pressure shell of all fittings shall be continuous-welded. Galvanized areas that have been damaged by welding shall be coated with corrosion resistant aluminum paint.

Perforations are not to exceed 3/32" diameter. The percentage of open area shall be 22%.

Inner liners of both duct and fittings shall be adequately supported by metal spacers welded in position to maintain spacing and concentricity.

- 8.6. Mylar Liner for Internally Insulated Spiral Duct:** Double wall factory fabricated and insulated duct shall be provided with a Mylar insulation liner. This Mylar liner shall be a minimum 2-mil thickness and shall be designed for this application in medium/high pressure commercial HVAC systems. The Mylar liner shall be factory installed between the insulation material and the perforated inner shell of the ductwork. Factory insulated fittings shall have solid inner liners. Fitting shall have appropriate inner collars to match the Mylar pipe sections and safe off insulation edges. The complete system shall ensure no erosion of the insulation material into the duct air stream. The manufacturer shall provide the installing contractor with printed installation instructions to accomplish this system.



**8.7. Coupling for Internally Insulated Duct and Fittings:** An inner coupling shall be provided to align the inner lining to maintain good airflow conditions equivalent to standard round high-pressure duct joints. Butt joints are not suitable for the inner liner. This alignment shall be accomplished by extending the liner of the fitting for slip joint into the pipe or by the use of a double, concentric coupling with the two couplings held by spacers for rigidity and wall spacing. Above 34" I.D. a separate coupling should be provided for inner alignment with the pressure shells joined by angle ring flanged connections.

**8.8. Insulation Ends for Internally Insulated Duct and Fittings:** At the end of an insulated section or run, where internally insulated cut connects to uninsulated spiral duct or fitting, fire damper or flex, a manufactured insulation and fitting shall be its nominal size.

**8.9. Minimum Galvanized Metal Gauges:**

Nominal Duct Width	To 34"	35 to 48"	49" Up
Duct, outer pressure shell	20 ga.	18 ga.	16 ga.
Inner perforated liner	20 ga.	20 ga.	20 ga.

**8.10. Sound Absorbers General:** Provide as required to meet noise criteria specified. See Section Vibration and Noise Control for additional requirements.

**8.11. Joint Sealing:** Round ducts in diameter through 48" or 42" major axis shall be assembled and sealed as follows:

Approved sealer as specified herein supplied to the male end of the couplings and fittings. After the joint is slipped together, sheet metal screws are placed ½" from the joint bead on 8' maximum spacing for mechanical strength. Sealer is applied to the outside of the joint extending 1" on each side of the joint bead and covering the screw heads. Woven fiber tape is immediately applied over the wet sealer.

The duct sealer must be specifically formulated for the job of sealing the field joints for high-pressure systems, United Fire Retardant High Bonding strength or approved equivalent. The sealer shall be compatible with the woven fiber duct tape so the two shall cure and bond together. Samples of sealer and tape and the specification data sheets shall be submitted to the Engineer for approval.

Flanged joints shall be sealed by approved gasketing material.

**8.12. Leakage Testing of Installed System:** The installed high-pressure duct system shall be pressurized to a test pressure of 4 inches water column.

A calibrated orifice type of flow meter shall measure the air leakage at the

test pressure. Total allowable leakage of the system shall not exceed  $\frac{1}{2}$  of 1% of the air handling capacity of the system. If the system is tested in sections, the leakage rates shall be added to give the performance of the whole system.

Leakage concentrated at one point may result in objectionable noise even if the system passes the leakage rate criteria. This noise source must be corrected to the satisfaction of the Engineer.

The orifice flow measurement device must have been individually calibrated against a primary standard, and this calibrated curve permanently attached to the orifice tube assembly.

Testing must be in accordance with a printed procedure submitted to the Engineer for approval.

- 8.13. Smoke Dampers:** Provide as shown on drawing in each duct passing through a smoke partition and elsewhere as required. Each damper shall be complete with damper, sleeve, motor package, removable motor hood, junction box, cable, etc. and shall exceed duct pressure requirements of the duct system as installed. The entire assembly shall be UL Standard UL5555, low leakage, Class I rated dampers for use in smoke controlled systems, equal to Prefco Series 5150, or approved equivalent by Ruskin, Air Balance or Air Stream. Smoke Dampers and related controls that require manual reset or link replacement after actuation are not acceptable. Coordinate power and control interface with electrical/fire alarm system.
- 8.14. Fire Dampers:** Fire dampers shall be Prefco. Equal products by Air Balance, Ruskin or Airstream Products will be accepted. Provide at the locations shown on the plans and as required by Code. All fire dampers shall have an Underwriters' Laboratories, Inc. labeled with a 1-1/2 hour rating.

All dampers shall be of the interlocking blade type. Dampers for horizontal airflow shall be gravity-operated. The damper blades shall be roll formed to provide uniformity of shape for free rotation of the interlocking blades. The springs shall be stainless steel, constant tension design, with the combined tension of the springs being equal to at least 2-1/2 times the force required to close the damper curtain.

The fire dampers shall be fabricated of galvanized steel meeting ASTM A525-65. The damper frame shall be of such a design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve. This damper frame/sleeve shall be 17 gauge for dampers not exceeding 36" W or 24" H, and not less than 14 gauge for dampers exceeding these dimensions.

All fire dampers shall have 100% free opening with no part of the blade stack or damper frame in the air stream. Install in accordance with applicable conditions of the UL listing, for which shop drawings must be submitted for approval.

Immediately downstream of each fire damper, access shall be provided for inspection, testing, and resetting the damper. **For smaller than 8" diameter, a removable section of duct shall be included to provide access.** Identify the duct section on the insulation jacket with plastic label of type specified in Section 22 1510, Identification. The covers of all access openings shall open against the positive pressure inside the duct.

This access section shall be fabricated of 20 gauge-galvanized steel. The housing shall be of welded construction with a pressure seal gasket around the cover. The nominal sizes of the access openings shall be:

<u>Duct Diameter Access Opening</u>	
8" thru 10"	7" dia.
11" thru 13"	10" dia.
14" thru 19"	13" dia.
20" and over	19" dia.

- 8.15. **Hanging and Supporting:** Hanging and supporting for air distribution system shall be in strict accordance with current SMACNA "HVAC Duct Construction Standards" Current Edition, Chapter "Hanging and Supporting Systems".
- 8.16. **Acceptable Manufacturers:** Eastern Sheet Metal Inc., United McGill, SEMCO, Monroe Metal Mfg. or preapproved equivalent.

## **PART 9. HIGH VELOCITY DUCT WORK DESIGNED FOR 10" WG PRESSURE (AHU-1 100% OUTSIDE AIR UNIT)**

- 9.1. **General:** All duct and fittings shall be manufactured by a company who has had its principal business, the manufacture of spiral pipe and welded fittings for at least five years. Provide as shown and as required for the air conditioning, heating and ventilation systems. Make changes in dimensions, offsets or crossovers as necessary to clear piping, lights and structural members, and to maintain scheduled headroom. Provide all accessories required. Provide additional supports to raise ductwork off any piping or as a minimum, provide Rubatex insulation between ductwork and piping. The use of Rubatex insulation between piping and the ductwork shall only be allowed when providing supports is not an option. Refer to architectural drawings and specifications. Refer to Architectural section "Painting" for painting of exposed ductwork. In case of the absence of painting requirements in the aforementioned Specification Section(s), the interior and exterior of ductwork visible from any finished space shall be cleaned, primed and painted as directed by the Architect. Ductwork visible through all grilles, registers, diffusers, ceilings, etc. shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Ductwork and fittings shall be as specified for AHU-2 except ductwork, fittings, attachments, supports, etc shall be as required for 10" WG working pressure and SMACNA. Duct insulation shall be 2" thickness.

**PART 10. HIGH VELOCITY DUCT WORK DESIGNED FOR 10" WG NEGATIVE PRESSURE (ERU-1 ENERGY RECOVERY AIR UNIT)**

**General:** All main duct and fittings shall be manufactured by a company who has had its principal business, the manufacture of spiral pipe and welded fittings for at least five years. Provide as shown and as required for the air conditioning, heating and ventilation systems. Make changes in dimensions, offsets or crossovers as necessary to clear piping, lights and structural members, and to maintain scheduled headroom. Provide all accessories required. Provide additional supports to raise ductwork off any piping or as a minimum, provide Rubatex insulation between ductwork and piping. The use of Rubatex insulation between piping and the ductwork shall only be allowed when providing supports is not an option. Refer to architectural drawings and specifications. Refer to Architectural section "Painting" for painting of exposed ductwork. In case of the absence of painting requirements in the aforementioned Specification Section(s), the interior and exterior of ductwork visible from any finished space shall be cleaned, primed and painted as directed by the Architect. Ductwork visible through all grilles, registers, diffusers, ceilings, etc. shall be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Ductwork and fittings shall be as specified for AHU-2 except ductwork, fittings, attachments, supports, etc shall be as required for 10" WG negative working pressure and SMACNA. Ductwork shall be provided with internal plastisol acid resistant coating. No perforations allowed in the internal solid metal liner. Liner shall be solid.

**PART 11. DUCT INSULATION WORK (EXTERNAL)**

- 11.1. General:** All work by Insulating Sub-Contractor whose primary business is the installation of insulation materials with experienced applicators in accordance with manufacturer's recommendations. Duct must be clean, dry and pressure tested before covering is applied. Cover flexible connections with insulation material as hereinafter specified to same thickness as adjacent duct. All insulation materials (coatings and mastics) shall be fire resistive per NFPA Pamphlet No. 90, ASTM C 411, shall be UL listed and shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84, NFPA No. 255 or UL 723. Finished insulation system shall provide complete thermal barrier throughout the equipment and air distribution system, including effective and durable vapor barriers and vapor stops for any system or condition potentially subject to condensation. Insulation system shall be provided to prevent condensation or potential thereof, to prevent transmission of water vapor into the insulation system (vapor barriers), and to prevent transmission of water vapor within the insulation system should vapor barrier compromises occur during operation and/or maintenance of the building (vapor stops).

Refer to Section Sheet Metal Ductwork, Paragraph Hangers and Supports, for miscellaneous insulating requirements.

- 11.2. Material:** Provide Greenguard certified glass fiber duct insulation with reinforced foil kraft laminate jacket, formaldehyde-free.

All **supply air and return air ducts** located in the attic, mechanical mezzanine or outside the building insulation envelope shall be provided with a total of 3.5" thickness external insulation, in addition to the specified acoustical liner. The first layer shall be **1.5" thickness, 0.75 lb. density, without reinforced foil kraft laminate jacket** and with characteristics specified above. The second layer shall be **2" thickness, 1.5 lb. density, with reinforced foil kraft laminate jacket** and with characteristics specified below.

**OPTION:** In lieu of providing two layers of insulation for supply and return air ducts as specified above, the Contractor may substitute one layer of 4.25" thickness, 0.75 lb density **with reinforced foil kraft laminate jacket** with characteristics specified below.

All **supply air and return air** ductwork located above the ceiling within the building insulation envelope, in chases and other similar areas, but not in the attic or a mechanical mezzanine, shall be provided with **2" thickness, 1.5lb. density, duct wrap with reinforced foil kraft laminate jacket** as specified below. Note that this requirement does not apply to ductwork that is exposed to view in finished areas. Refer to internal duct insulation requirements for duct exposed to view in finished areas.

All **outside air** ductwork shall be provided with **1.0" thickness, .75lb. density, with reinforced foil kraft laminate jacket** as specified below. Note that this requirement does not apply to ductwork that is exposed to view in finished areas. Refer to internal duct insulation requirements for duct exposed to view in finished areas.

Thermal conductivity for **1.0" thickness** per ASTM C-518, **0.75 lb. density** shall be not less than  $k=0.27 \text{ BTU} \cdot \text{in}/(\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F})$  and minimum installed  $R=3.0$  at 75°F mean temperature with test based on material thickness compressed 25%.

Thermal conductivity for **1.5" thickness** per ASTM C-518, **0.75 lb. density** shall be not less than  $k=0.27 \text{ BTU} \cdot \text{in}/(\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F})$  and minimum installed  $R=4.2$  at 75°F mean temperature with test based on material thickness compressed 25%.

Thermal conductivity for **2" thickness** per ASTM C-518, at its rated thickness, and **1.5 lb. density** shall be not less than  $k=0.24 \text{ BTU} \cdot \text{in}/(\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F})$  and minimum installed  $R=6.3$  at 75°F mean temperature with test based on material thickness compressed 25%.

Thermal conductivity for **4.25" thickness** per ASTM C-518, **0.75 lb. density** shall be not less than  $k=0.27 \text{ BTU} \cdot \text{in}/(\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F})$  and minimum installed  $R=12.0$  at  $75^\circ\text{F}$  mean temperature with test based on material thickness compressed 25%.

See "Duct Insulation (Internal)" for internal acoustical insulation required in addition to the external insulation specified hereinbefore.

Supply air, return air and outside air ducts within enclosed mechanical rooms do not require flexible, external, duct insulation. Instead, supply, return air and outside air ducts in all mechanical rooms shall be insulated with 1" thickness, 3.0 lb. density, rigid glass fiber duct insulation to a point above the ceiling of the adjacent conditioned space. Facing shall be aluminum foil reinforced with fiberglass yarn and laminated with fire resistant adhesive to Kraft paper. Thermal conductivity value shall be per ASTM C-612, Type 1B, at its specified thickness, shall be not less than  $k=0.24 \text{ BTU} \cdot \text{in}/(\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F})$  at  $75^\circ\text{F}$  mean temperature. Insulation shall meet or exceed the requirements of ASTM E 84, UL 723, ASTM C 1136-Type II, NFPA 90A, NFPA 90B, FHC 25/50 and ASTM C 795. Moisture sorption shall be less than 5% by weight and maximum moisture vapor transmission of 0.02 perms. Insulation shall be Owens-Corning Series 1400 FR Spin-Glas Board or equal material by Knauf, Schuller, Owens-Corning or CertainTeed. Note that rigid board insulation is not required in the attic or mechanical mezzanine.

- 11.3. Thickness:** Minimum 2.0" thickness and density specified above with reinforced foil kraft laminate jacket. Coordinate with variations specified above for additional layers or 4.25" thickness and provide as required.

Where 2" internal acoustical insulation is specified for ductwork located above the ceiling within the building insulation envelope, in chases and other similar areas, but not in the attic or a mechanical mezzanine, the respective external insulation may be reduced by 1" total thickness with respective density previously specified. **No reduction in insulation thickness shall be taken for any ductwork located in the attic, mechanical mezzanine or outside of the building insulation envelope.** See limits of acoustical insulation in Part Duct Insulation Work (Internal) below. Where duct board is specified within the mechanical rooms, external duct wrap insulation is not required.

- 11.4. Manufacturer:** Johns-Manville Micro-Lite EQ, Type 150 or Type 75 with thickness and density as specified above. Equivalent material by Knauf, Schuller, Owens Corning or CertainTeed will be accepted.
- 11.5. Ducts to be Insulated Externally:** Supply air and return air ducts including ducts with acoustical liner, outside air ducts, make-up air ducts, toilet/shower/housekeeping/janitor closet areas exhaust ducts, short branch duct collar connections to grilles, registers and diffusers, 24" upstream and downstream of each electric duct heater, all flexible canvas connectors and exterior rim/cone of all ceiling diffusers. See Part "Duct Insulation Work (Internal)" for sound attenuating insulation requirements of externally insulated ductwork.

- 11.6. Application:** Sheet metal duct shall be clean, dry and tightly sealed at all joints and seams before applying duct wrap. Adhere insulation to metal with 4" strips of Foster 85-60, ITW Miracle-Kingco M595 Ultratack or Childers CP-127, low VOC insulation bonding adhesive meeting ASTM C916 at 8" on center on circumferential joints. Wrap insulation tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2". The 2" flange of the facing shall be secured using 9/16" flare-door staples applied 6" on center and taped as specified hereinafter. On longitudinal joints, the overlap shall be secured using 9/16" flare-door staples applied 6" on center and taped as specified hereinafter. For rectangular ducts wider than 23", additionally support insulation with weld pins and speed clips 18" on center. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping. Insulate standing seams and stiffeners that protrude through the insulation with 2" thick, faced, flexible blanket insulation. Cover with reinforcing mesh and coat with vapor barrier finish coating. Vapor seal all seams, joints, pin penetrations, other breaks, circumferential and longitudinal joints with reinforcing mesh and coat with vapor barrier facing. Mesh shall be **4" wide pre-sized glass cloth** adhered and finished with two (2) coats of a white vapor barrier coating, Foster 30-33, Vimasco 749 or Childers CP-33. **No FSK tape will be allowed.** Fiberglass cloth shall be Great Lakes Textiles Style GL1658, 20x10 thread count per square inch, 0.004-inch thickness and 1.60 oz. /sq. yd., Childers Chil Glas #10 glass mesh, Foster Mast-A-Fab polyester mesh or equivalent product by 3M.

Any externally insulated duct with metallic vapor barrier that is in contact with sprinkler piping shall be provided with a section of Rubatex insulation between ductwork and piping. Rubatex shall be 3/4" thickness, AP Armaflex insulation of sufficient inside tubular diameter to slide over, completely cover and snugly fit the contacted pipe. The insulation shall extend the full width of the duct plus a minimum of 6", each side of the duct. Refer to Part Pipe and Miscellaneous Insulation Work for AP Armaflex material specification. Slit Armaflex may be used in lieu of unslit. If slit Armaflex is used, glue the longitudinal joint and butt joint with Armaflex glue and follow with 3" wide, 1/8" thickness Armaflex across all glued joints. The use of Rubatex insulation between piping and the ductwork shall only be allowed when raising the effected duct is not an option.

- 11.7. Insulation Pins and Washers:** **The use of adhesives for attaching pins and washers to the ductwork is prohibited.** Pins shall be cupped-head, capacitor-discharge-weld pins, zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135 inch diameter shank, length to suit depth of insulation specified with integral 1-1/2 inch galvanized carbon-steel washer. Insulation retaining washers shall be self-locking type formed from 0.016-inch thick galvanized steel with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

## **PART 12. DUCT INSULATION WORK (INTERNAL)**

- 12.1. General:** All work by experienced applicators in accordance with manufacturer's recommendations. Duct liner, mastics and materials shall comply with all requirements and other building code requirements. All insulation materials (coatings and mastics) shall be fire resistive per NFPA Pamphlet No. 90A and 90B and shall be UL listed and shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Liner materials shall conform to the performance based ASTM C1071, which includes ASTM C518 Thermal Conductivity, ASTM C411 Temperature Resistance, ASTM C665 Corrosiveness, ASTM E84 Surface Burning Characteristics, ASTM C1338 Fungi Resistance, ASTM C1304 Odor Emissions and ASTM C1104 Moisture Vapor Sorption.
- 12.2. Material:** Liner shall be a Greenguard certified, low VOC, Type I liner as defined by ASTM C1071 and characteristics complying with ASTM E 84, UL 723, NFPA 255, NFPA 259 and ASHRAE 62. It shall have an acrylic coating formulated with an immobilized, EPA registered, protective agent to protect against growth of fungi and bacteria as required by ASTM C1071 and tests conducted in accordance with ASTM C 1338, ASTM G21 and ASTM G 22. It shall not support microbial growth and have glass fibers bonded with a thermosetting resin. The airstream surface shall be protected with a reinforced coating with flexible glass cloth reinforcement. The liner shall have a reinforced factory applied edge coating and operate in an environment of a maximum of 250°F and maximum of 6,000 fpm air velocity. Thermal conductivity per ASTM C-518, at its rated thickness, shall be not less than  $k=0.16 \text{ BTU} \cdot \text{in} / (\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F})$  and  $R=6.3$  at 75 F mean temperature in accordance with ASTM C18. Sound absorption coefficients for the liner shall be per ASTM C 423 and ASTM E 795 test methods and the table below. **Furnish sound characteristics for approval with the material submittal.**

**Sound Absorption Coefficient at Frequency**

Thickness (In)	(Cycles per Second)						NRC
	125	250	500	1000	2000	4000	
1.5	0.10	0.47	0.85	1.01	1.02	0.99	0.85
2.0	0.25	0.66	1.00	1.05	1.02	1.01	0.95

- 12.3. Manufacturer:** Shall be Johns Manville Linacoustic RC or equivalent material by Schuller, Knauf, Pittsburgh, CSG, Owens Corning or CertainTeed.
- 12.4. Thickness:** 1.5 inches thickness. Return air platforms/plenums 2.0" thickness.
- 12.5. Ducts and Equipment to be Insulated Internally:** Exposed supply air, exposed return air and exposed outside air ducts in areas without ceilings, return air plenums/platforms, transfer air (jumper and ATD) ducts, all ducts downstream of VAV terminal units and relief air ducts.



- 12.6. **Acoustical Duct Lining:** Line all ducts downstream of VAV terminal units, and transfer air (jumper and ATD) ducts with insulation equal to Johns Manville Linacoustic RC and **2.0" thickness**. Sound absorption characteristics shall be as specified above.
- 12.7. **Application:** Adhere insulation to the entire surface of the sheet metal with fire resistive, low VOC, UL labeled, fire resistive, water based, ASTM C 916, Type II compliant adhesive before the metal is broken. Adhesive shall be Foster 85-60 or Childers CP-127. Secure all sheets wider than 24 inches with sheet metal screws and washers or stud pins and clips 16 inches on center, each way. Joints shall be straight and smooth and shall be buttered with adhesive to prevent erosion and improve airflow. Product shall have factory applied edge coating to assure sealing of transverse edges per current SMACNA and NAIMA installation standards.

Damage to the liner shall be repaired using Johns Manville SuperSeal products as required or equivalent materials by other manufacturers with their specific equivalent products.

- 12.8. **Metal Nosings:** All exposed leading and trailing edges shall be secured with sheet metal nosings to protect insulation edges. Metal nosings shall be securely installed over all transversely oriented liner edges facing the airstream at forward and rear discharge towards coils, dampers, ducts, plenums, changes of insulation thicknesses of adjoining insulation, any exposed insulation ends and at any point where lined duct is preceded by unlined duct. See detail on the plans. All remaining miscellaneous exposed edges shall be sealed/coated. There shall be no exposed fiberglass ends in the airstream.

### **PART 13. ZERO CLEARANCE GREASE DUCT FIRE PROTECTION INSULATION**

- 13.1. **General:** Provide two hour rated duct enclosure classified by UL for all Lab exhaust ductwork from the point of penetration of the rated enclosure to its termination point within each space. Example: Where an exhaust duct penetrates the rated shaft, it shall be fire wrapped from the connection point to the main within the rated shaft back to the respective fume hood, snorkel, etc. Exhaust duct work located within the rated shaft does NOT require fire wrap. Note that the energy recovery plenum for the Energy Recovery Unit ERU-1 requires fire wrap. System shall be 3M "Fire Master" Duct Wrap or approved equivalent. Install per UL Label.
- 13.2. **Description:** Provide a refractory ceramic, non-asbestos fiber blanket encapsulated with scrim-reinforced foil as an enclosure and rated exhaust air ductwork. Enclosure shall protect both internal and external conditions.
- 13.3. **Test Data:** Enclosure shall be UL listed for two-hour grease duct enclosures. Enclosure shall be tested to ASTM E119 time/temperature curve, tested to UL 1978 internal grease fire at zero clearance to combustible materials,

tested to ASTM E84/UL723 flammability test of flame spread of 5 and smoke spread of 5 and tested to ASTM E814/UL1479 duct penetration protection.

- 13.4. Installation:** Do not install any insulation until a test has been performed and the installation has been accepted by the Code Authority having jurisdiction. Refer to Section "Testing" hereinbefore.

All installation shall be per current UL listing and the requirements of the insulation Manufacturer. Use carbon steel or stainless steel bonding.

## **PART 14. REGISTERS, GRILLES AND DIFFUSERS**

- 14.1. General:** All grilles, registers and diffusers shall be product of a single manufacturer; shall baked enamel finish with color as selected by the Architect. Architect may require painting of the diffusers, grilles, registers, etc., in the field. Where field painting is required, diffusers, grilles and registers shall be factory primed for painting in the field. Refer to Architectural Section "Painting", coordinate requirements and provide finish as required. Where lay-in type panels and frames are specified, check ceiling suspension system and coordinate interfacing. All grilles, registers and diffusers not in integral lay-in metal panels shall be mounted with aluminum-countersunk screws with finish to match respective items. All grilles, registers and diffusers shall be ADC or approved equivalent Agency certified. **All ceiling diffusers, ceiling grilles and ceiling registers located within a designated storm shelter or safe area shall be provided with earthquake/hurricane tabs/clip** and required accessories for securely supporting from the structure above with minimum 12 ga. galvanized ceiling suspension system wire.
- 14.2. Square Ceiling Diffusers with Round Neck:** Titus Model TMSA-AA, Price ASCDA, removable core type, aluminum construction, with baked enamel finish color selected by the Architect, designed for four-way diffusion complete with Titus AG-85, Price VCR8E steel butterfly blade damper. Diffuser face shall be 24" x 24" with type frame to interface with ceiling system. Use lay-in type frame where lay-in ceilings occur. Do not furnish with 1" thickness insulated blanket for back of diffuser. Specifications require 2" thickness insulation.
- 14.3. Ceiling Mounted Exhaust Air and Return Air Registers:** Titus Model 50-F-0-5-D-25, Price Model 80DAL-F-SW-A all aluminum fabricated egg-crate type with baked enamel finish color to be selected by the Architect, Allen key operated aluminum opposed blade damper and lay-in type frame. Where lay-in ceilings occur, each register shall have integral 2' x 2' or 2' x 4' aluminum modular lay-in ceiling panel with finish to match diffuser.
- 14.4. Ceiling Mounted Return Air or Relief Air Grilles and Air Transfer (Jumper Duct) Grilles:** Same as return air registers except without dampers.
- 14.5. Linear Ceiling and Sidewall Supply Air Diffusers:** Titus Series ML-39, Price Series SDS-100 with 1" slots, extruded aluminum construction, complete

with all accessories including MP-SP pattern controller, flanged border and concealed mounting (no visible screws) , Type X end border, end caps, type MC mitered corner as required. Refer to Architectural ceiling plans and ceiling specifications and coordinate frame types, etc. and provide as required for proper installation for the respective ceiling type.

Diffusers shall be provided with Titus Series Type MPI, Price Series UP factory fabricated and insulated supply air plenum. Insulation shall be minimum 1" thickness and be factory coated to prevent erosion. Diffuser plenum shall be provided with G-90 galvanized sheet metal, factory fabricated oval to round or oval to rectangular duct fitting for proper connection to the plenum.

Return air diffuser/register shall be Titus Series MLR-39, Price Series SDR with 1" slots and with same accessories specified for the supply air linear slot diffusers. Provide concealed mounting for all diffusers/registers located in hard ceilings. Exterior finish shall be painted. Color to be selected by the Architect (including frame and screws). Interior finish shall be flat black and shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

- 14.6. Expanded Metal Grilles:** Provide metal grille equal to McNichols Co., flattened expanded metal, galvanized, hot dipped, 3/4, #16 flattened, minimum 70% open (free) area with U-Edging to protect occupants from injury. Provide over all open ends of ductwork, louvers, etc. Grille shall be factory primed for painting in the field as directed by the Architect.
- 14.7. Laboratoy Diffusers (Indicated on the plans with Triangle):** Shall be shall be TITUS model RadiaTec-AL. Diffusers shall be constructed using a maximum 4 inches tall back pan designed for optimum performance of the diffuser. The back pan shall be divided into two chambers connected via a baffle aperture designed to evenly distribute air across the diffuser's perforated face. The back pan shall have integral hanger tabs for securing the unit to the overhead structure. The baffles forming the aperture will be located within the lower air chamber. The face of the diffuser shall be constructed of 13 percent free area perforated aluminum or 1/4" inch stagger centers.
- The interior of the diffuser shall be accessible for sanitization from below (room-side) by loosening the quarter-turn fasteners to allow the face to swing open, and can be disengaged by releasing the retainer cables attaching the face to the diffuser frame. The diffuser shall be 24x24 or 24x48 as shown in the schedule on the plans. the diffuser shall be full radial air diffusion (two-way) or one-half radial air diffusion (one-way). See plans for deflection pattern. The face and back pan shall be constructed of aluminum. Performance tests shall have been conducted in ASHRAE Standards 70-91 and 113-90.
- 14.8. Equal Products:** By Titus, Price, Krueger and Metalaire will be accepted.

## **PART 15. LOUVERS FOR OUTSIDE AIR INTAKE, RELIEF OR EXHAUST**

- 15.1. General:** Shall be tested in accordance with AMCA Standard 500, 500-L, 510, 511, 540 and 550 as applicable to the project site and shall bear the AMCA Certified Ratings Seal. Louver Effectiveness shall be in accordance with AMCA 500-L99, Section 8.3.2 - Wind Driven Rain Water Penetration Test. Louver welding shall comply with AWS D1.2, Structural Welding Code – Aluminum and AWS D1.3, Structural Welding Code - Sheet Steel. AMCA 540 and AMCA 550 louvers shall be provided as indicated in IBC Section 1609 Hurricane Prone Regions map. Refer to Section 08 9100 for additional requirements. Where this specification conflicts with Section 08 9100, the requirements of Section 08 9100 shall be applied.

Louver submittals shall require two reviews. The Engineer and the Architect will both review the submittal. Furnish to the Architect two complete color charts showing the full range of colors available for units with factory-applied color finishes. Architect shall select all colors.

- 15.2. Stationary/Fixed Blade Louvers:** Generally, provide as specified in the Architect's specifications. In absence of those requirements, stationary drainable louver with drain gutters in head frame with downspouts in the jambs and mullions with all welded construction. Hidden vertical supports to allow unlimited continuous line appearance. Frame shall have steeply angled integral sill. 4 inches frame depth, .125 frame thickness, .081-inch wall thickness with extruded aluminum, Alloy 6063-T6. Blades shall be drainable 37.5 degrees at 5-3/32 inches, 0.081-inch nominal wall thickness and constructed of extruded aluminum, Alloy 6063 T6. Single sections shall not exceed 120 inches wide by 90 inches high or 90 inches wide by 120 inches high. Louvers larger than the maximum single size shall require field assembly of smaller sections. Louvers shall have minimum 54% free area. Water penetration shall be maximum of 0.01 ounces per square foot of free area at an air flow of 700 feet per minute free area velocity when tested for 15 minutes. Maximum pressure drop across louvers shall be 0.15" w.g. bird screens on exhaust louvers. Bird screens shall be aluminum, 5/8 inches by 0.040 inch expanded and flattened. Bird screen frame shall be removable, re-wireable and with minimum design loads in accordance with ASCE – 7, or local requirements of Authority Having Jurisdiction (AHJ). Do not install insect screens on HVAC louvers. Mullions shall be as specified in the Architect's louver section of the specifications. Louver finish shall be 70 percent PVDF. Finish shall be applied at 1.2 mil total dry film thickness. Coating shall conform to AAMA 2605. Apply coating following cleaning and pretreatment. Finish shall have 20-year warranty. Fastening, anchors, inserts and bituminous paint shall be as specified in the Architects louvers specifications.
- 15.3. Miscellaneous:** Where louvers are shown on the plans to have integral motorized dampers, motors and linkage shall be concealed within the louver frame. All actuators shall be 24-volts. Provide full size expanded metal grille over interior side of louver opening to protect occupants from injury due to motorized damper blades and motors.

- 15.4. Warranty:** Manufacturer shall provide standard warranty for louver systems for a period of five years from date of acceptance of the project as determined by the Architect. Manufacturer shall provide 20-year warranty for fluoropolymer-based finish on extruded aluminum substrates. Finish coating shall not peel, blister, chip, crack or check. Finish coating shall not chalk more than 8 numerical ratings when measured in accordance with ASTM D4214. Finish coating shall not change color or fade more than 5 NBS units as determined by ASTM D2244 and ASTM D822. Finish coating shall not erode at a rate more than 10%/ 5 year as determined by Florida test sample. Manufacturer shall provide a 5 year for Class I and a 3-year warranty for Class II anodized finish on extruded aluminum substrates. Finish shall not crack, craze, flake or blister. Louvers shall not change or fade more than (5) Delta-E Hunter units as determined by ASTM method D-2244. Louvers shall not chalk in excess of ASTM D-4214-07 number (8) rating per ASTM D-4214-07.
- 15.5. Manufacturers:** Louvers shall be Reliable Model 4375Z125 or equivalent by Ruskin, Carnes or Airlite. Reliable is basis of design.

## **PART 16. WATER, CONDENSATE & DRAINAGE PIPING**

- 16.1. General Workmanship:** Cut accurately to measurements established at site and work into place without springing or forcing, properly clearing all building features. Route through previously built-in sleeves and avoid cutting or other weakening of the structure. Ream all pipes to remove burrs. Make changes in direction and size with fittings (no bushings will be allowed). Vent the high points of all forced water mains and branches with automatic vents discharged properly to waste. Cap or plug open pipe ends during installation to keep out foreign material.

Take off branches from supply and return mains as shown. Make connections carefully to insure unrestricted circulation, eliminate air pockets, and to permit complete drainage of the systems. At control valves make changes in sizes of steam mains with eccentric reducer fittings. Grade all piping not less than 1" in 40 feet. Unless otherwise specified herein, all pipefittings shall be designed for 150 psig working pressure.

Make all connections to equipment using screwed unions in sizes 2" and smaller and flanged unions in sizes 2-1/2" and larger. Install unions in all piping connections to each piece of equipment, including traps, pumps, coils, etc. Unless otherwise specified, pipe and fittings installation shall conform to the requirements of ANSI B31.1.

All piping shall be concealed within walls, chases, above ceilings, etc., unless specifically noted otherwise.

- 16.2. Hot Water and Chilled Water Piping:** Schedule 40 black steel ASTM A53, Grade B pipe within the building; use black malleable iron screwed fittings in

sizes 2 inches and smaller, and long radius welding fittings in sizes 2-1/2" and larger. Provide companion flanges on welded piping at all valves, strainers, etc., and at connections to equipment. Fittings shall be designed for 150 psig. working pressure. Underground condenser water piping shall be plastic coated, equal to Republic X-Tru-Coat as specified for gas piping

**OPTION:** Contractor may use Type L hard drawn copper water tube and wrought copper fittings for piping below 2" in size in lieu of Schedule 40 specified above. ProPress or similar type fittings are not allowed. **All 90° and 45° elbows and fittings shall be full radius, long sweep, with radius 1.5 times the pipe diameter.** Copper shall be manufactured to meet the requirements of ANSI/ASME B16.

- 16.3. Condensate Drain Piping and Drain Pipe from Drip Pans to Floor Drains:** Type M hard copper tubing with wrought copper solder joint fittings. ProPress or similar type fittings/joints are not allowed.

Condensate piping from condensing type boilers combustion chamber to the neutralizing tank shall be PVDF acid resistant piping. Piping from discharge of neutralizing tank to drain shall be Type M hard copper tubing with wrought copper solder joint fittings unless Manufacturer recommends otherwise.

All PVDF pipe and fittings shall be joined by no-hub mechanical joint method with plain end fittings and No-Hub couplings. Each No-Hub coupling shall have an outer band of 300 series stainless steel with 5/16" bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. The No-Hub joint shall conform to the requirements of ASTM F1673. PVDF piping shall be marked with its UL Classification to indicate compliance with UL723 (ASTM E84). All fittings shall meet or exceed Schedule 40 dimensions.

All PVDF piping and fittings installation shall be in strict accordance with the Manufacturer's recommendations. Piping and fittings shall be Orion Super Blue PVDF (Polyvinylidene Fluoride). Equivalent products as manufactured by Enfield, GEO, Zurn and Fisher will be accepted.

Provide a trap in each drain line with capped or plugged cleanout tees. Trap depth shall be as required by the equipment Manufacturer. In absence of the equipment Manufacturer's trap requirements, traps shall be equal to the total system pressure plus one inch. Provide an electric switch, conforming to UL 508, to shut down the unit <and alarm to the building energy management system operator console> should the line become obstructed.

- 16.4. Screw Joints:** Properly cut tapered threads and make perfectly tight with a stiff mixture of graphite and oil, brush applied to male threads only.
- 16.5. Flanged Joints:** Faced true, packed, and made up perfectly square and tight. Gaskets shall be asbestos free sheet packing 1/16" thick or U. S. Rubber No. 4899 in cut shapes (No. 899 in sheets). Material to be same as pipe. Flanges at valves and equipment connections shall have same rating as valve and equipment.

- 16.6. Welded Joints:** Fusion weld in accordance with the recommendations of American Welding Society (AWS) and in accordance with the welding procedure of the Heating, Piping and Air Conditioning Contractors' National Association and conforming to the requirements of the ASME Power Boiler Code, ASA Piping Code and ANSI B31.1 for shop and job site welding of piping work. Make welded joints on the piping system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no weld metal shall project inside the pipe.

Make changes in direction and intersections of lines with welding fittings. Mitering of pipe to form elbows, notching straight runs to form tees, or any similar methods are forbidden. **Welders shall be AWS certified. Welders shall submit current AWS certificate** and shall affix AWS Certificate number and identification adjacent to each weld made.

- 16.7. Copper Joints:** Make assemblies with tin-antimony (95-5) solder and non-corrosive flux (this does not apply to refrigerant piping). Clean and polish the tube and the inside of the fittings, using No. 60 steel wool. Apply flux and place fitting on the tube. Heat joint evenly, but take care not to overheat fitting. Apply solder until a solder line shows completely around the joint. Remove surplus solder and allow joint to cool. ProPress or similar type fittings/joints are not allowed.
- 16.8. Escutcheons:** Provide all pipes passing through the floors, walls or ceilings of finished rooms with chrome plated brass escutcheon plates securely fastened in place with round head set screws.
- 16.9. Unions:** Provide adjacent to all valves (one side) and mechanical equipment. Provide companion flanges on all flanged valves, pumps, and other mechanical equipment. Unions shall be of the following types:

**Black Steel Lines:** 2" and under - 150-pound ground joint malleable. 2 1/2" and over - 150 pound flange and gasket type, malleable.

**Copper Lines:** Ground joint, copper to copper.

**Dielectric Unions:** Provide where copper pipe joins to steel pipe, EPCO or approved equivalent. Contractor shall provide a globe valve on each side of each dielectric union to allow for replacement of the union.

**Gaskets for flanged joints:** Best grade compressed material approved for the temperature and pressure of the system.

- 16.10. Expansion:** Provide for expansion and contraction of all piping and make proper provisions so that there will be no undue strain on any pipe or equipment.

- 16.11. Sleeves:** Refer to Section 22 1510, Para. B. 4. Pipe Sleeves.

**PART 17. UNDERGROUND PRE-FABRICATED CHILLED WATER PIPING SYSTEM**

- 17.1. General:** Underground piping system shall be equal to Rovanco Steel System or equivalent by Xtru-Therm or Therma-Core and shall consist of integral sealed, 20-foot long units of Schedule 80 black steel pipe, A-53 Grade B, ERW insulated with rigid polyurethane foam that is sealed with a PVC outer jacket. System shall be designed for working temperature of up to 210 degrees F. and 150-psig pressure.
- 17.2. Piping:** Piping shall be ASTM A53, Grade B, black steel pipe; Schedule 80 with welded joints and required anchor plates. All piping shall be hydrostatically tested in the field under a pressure of 250 psi and all welded piping joints shall be hammer tested. **All 90° and 45° elbows and fittings shall be full radius, long sweep, with radius 1.5 times the pipe diameter. All offsets of water piping shall be made with 45° fittings in lieu of 90° fittings wherever possible.** Pressure test shall be a minimum of six (6) hours.
- 17.3. Insulation:** Polyurethane foam with the following minimum characteristics: K Factor = .14, Density 2 pcf, Closed Cell Content - 90-95% in conformance with MIL-I-24172 and ASTM C-591 completely filling the annular space between carrier pipe and jacketing. Minimum insulation thickness shall be per Table 1 of Rovanco Steel System Specification Sheet.
- 17.4. Jacket:** High impact, seamless Polyvinylchloride (PVC) Class 12454-B compound conforming to ASTM 1784, Type 1, Grade 1. No FRP over wrap or sprayed jacketing will be allowed. Minimum jacket thickness shall be 60 Mills thickness up to 1 1/2" pipe, 70 Mills thickness for 2" to 3" pipe, 80 Mills thickness for 4" pipe and 100 Mills for 8" pipe. Provide end seals.
- 17.5. Field Service, Installation and Testing:** All pipes, pads, expansion loops, fittings, anchor plates and joints shall be installed in accordance with the manufacturer's recommendations. All required thrust blocks shall be formed and poured in place. No prefabricated thrust blocks are allowed. Field service shall be provided by a certified manufacturer's company field service technician. The technician will be at the project site to check unloading, storing, and handling of pipe, pads, expansion loops, joint installation, pressure testing, and backfilling techniques. This service will be added into the cost as part of the project technical services required by the pre-insulated pipe manufacturer. Immediately after installation in the trench, a partial backfill shall be made in the middle of each unit leaving the joints exposed for inspection.

After the hydrostatic test, a final backfill of sand shall be hand-placed and hand-tamped in 4" layers of 12 inches minimum over the top of the jacket. The remainder of the backfill shall be selected earth. Topography of pipe to grade



of compacted fill shall meet H-20 Highway Loading. Do not use tracked or wheeled vehicles for tamping. Provide reinforced concrete armor over piping crossing traffic areas.

- 17.6. **Expansion Ells:** As a minimum, provide as indicated on the plans. Provide as required by piping system manufacturer including anchors and piping anchor plates. External expansion compensation utilizing flexible expansion pads minimum one inch thick extending on either side, both inside and outside the radius of the fittings, shall be used with all fittings having expansion in excess of 1/2". Minimum pad size shall be as shown on the plans.
- 17.7. **Identification:** All underground piping shall be identified with detectable direct burial marking tape. The marking tape shall bear the printed identification of piping below it. Tape shall be minimum 6" wide and minimum 5.0 mil overall thickness. Construction shall be 0.80-mil clear virgin polypropylene film, reverse printed and laminated to a 0.35 solid aluminum foil core and then laminated to a 3.75 mil clear virgin polyethylene film. Tape shall be printed per APWA color coding, diagonally striped and large, bold, black lettering. Tape shall be buried 6" to 8" below finished grade and continuous over all underground chilled water piping. For trenches over 8'-0" wide, provide an additional continuous length of detectable printed tape. Tape shall be Pro-Line Safety Products or equivalent by Seton or Stranco.
- 17.8. **Shop Drawings:** The piping supplier shall furnish for approval manufacturer approved and designed engineered shop drawings and sealed by a registered Professional Engineer who is registered in the State where the Manufacture of the product is accomplished or in the State where the project is being constructed. The registered Professional Engineer shall be a full time employee of the piping system Manufacturer. Shop drawings shall indicate the underground distribution system, complete, with recommended expansion ells, anchors, fittings, pads, etc. Piping system design and thermal expansion shall be in accordance with ASME B31 Standards of Pressure Piping, Current Edition. Minimum requirements shall be as indicated on the plans. Additional requirements above those indicated on the plans shall be provided as required by the respective Manufacturer.

## **PART 18. PIPING SPECIALTIES**

- 18.1. **General:** All valves, temperature wells, pressure wells and similar items in insulated piping shall be provided with extended stems, operators, etc. as required to provide a minimum of 1" of clearance between the outside of the insulation jacket and the valve handle, well nipples, etc. Seal the opening where the stem penetrates the insulation as required to maintain the insulation.
- 18.2. **Expansion Tank:** Ex-Trol pressurized, diaphragm, black steel, closed type, ASME Code constructed and labeled, designed for 150 psi working pressure, of size shown and suitable for the system propylene glycol solution specified

and equal to product of Amtrol. The tank shall be equipped with drain valve, and air charging valve and other trim required for a complete installation. Provide suitable welded saddles and floor supports.

- 18.3. Air Eliminator and Dirt Separator:** Furnish and install as shown on the drawings a Spirotherm or approved equivalent air and dirt separation fitting on the hot water heating system, chilled water system and condenser water system. All fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and entering velocity not to exceed 4 feet per second at specified GPM. Spirovent "VHT" units or approved equivalent specifically designed larger for high velocity systems may have an entering velocity of up to 10 feet per second and a pressure drop not to exceed 3.1 feet. Performance curves from the unit manufacturer shall be furnished as part of the submittal for each unit. Units to include internal copper coalescing medium to facilitate maximum air and dirt separation and suppress turbulence. Alternate units shall be furnished with galvanized steel strainer and stainless steel collector tube for a similar purpose. Provide integral high capacity float actuated air vent at top fitting of tank. Alternates must include cast iron float actuated air vent rated at 150 psig, which shall be threaded to the top of the fitting. Unit shall have the bottom of the vessel extended for dirt separation with the system connection nozzles equidistant from the top and bottom of the vessel and include a blowdown connection and valve.
- 18.4. Air Vent Valves:** Provide as shown and at high points whether indicated or not, to assure adequate air elimination and prevention of air pockets. To be Armstrong #1-AV, each complete with two test cocks (one for optional vent and one for automatic outlet). Connect both outlets to copper tubing and extend to floor drain or exterior. Equal products by Bell & Gossett or Dole will be accepted.
- 18.5. Safety Relief Valves:** ASME approved, Bell & Gossett, Foster or Spence. Size for full system capacity. Provide full size discharge line to outside or floor drain as required by applicable codes.
- 18.6. Strainers:** Basket or wye type strainers designed for 150 psig WP shall be of the same size as the pipeline in which they are installed. Strainer bodies shall be heavy and durable of best quality gray cast iron. Bottoms to be drilled and plugged, except that pipe nipples and drain valves shall be furnished and installed on all strainers over 3/4" in size. Each strainer shall be equipped with an easy to remove cover and sediment basket. Basket shall be of 22-gauge sheet brass, having perforations to provide a net free area through the basket of at least 4 times that of the entering pipe. The flow shall be into the basket and out through the perforations. Furnish and install strainers of approved type on the suction of each pump as shown on the drawings. These strainers shall have baskets of not smaller than 40 mesh, selected for 100% of pump capacity.
- 18.7. Pressure Reducing Valves:** Bell & Gossett, Foster, Watts or Spence, 150 psig WP with pressure range to suitable for system.

- 18.8. Air Separator-Air Scoop:** Air separators shall be full size of pipe. Provide for each separator and Amtrol No. 706 air vent and pipe to floor drain. Air separators shall be equal to B&G Rolairtrol. Approved equivalents by Taco or Thrush. Provide for each closed loop pump.
- 18.9. Indoor Thermometers:** Shall be high impact ABS case with 1/2" LCD digits and wide ambient formula, 1% accuracy, internal potentiometer for recalibration, with glass passivated thermistor, brass socket and in full conformance with ASME B40.3-1990 and Fed. Spec GG-T-321D and solar (self) powered. Thermometer shall be Weiss DVD6 or approved equivalent by Trerice, Weksler, March or Maxwell Moore will be accepted. Stem height shall be as required to clear insulation thickness. Weiss is the basis of design.
- 18.10. Outdoor Thermometers:** Industrial glass thermometer, variable angle, 9" scale, aluminum case with blue liquid filled tube, separable socket and stem as required to completely clear insulation thickness, and accuracy within 1% of scale range. Thermometer shall be Weiss A9VU6 or approved equivalent by Trerice, Weksler, March or Maxwell Moore will be accepted. Stem height shall be as required to clear insulation thickness. Weiss is the basis of design.
- 18.11. Pressure Gauges:** Bourdon tube type, as manufactured by Trerice No. 600, each complete with cast aluminum case, #870 vibration or pulsation snubber No. 735 needle valve and #885 pigtail. Gauge dials shall be not less than 4-1/2" and cases shall be of aluminum alloy. Furnish with suitable pressure ranges for each application. When installed in pipe smaller than 1-1/2" enlarge to 2". Equal products by Weskler, Marsh or Trerice will be accepted.
- 18.12. Circuit Sensor Flow Meters and Setters:** Provide where indicated on plans manual Venturi flow balancing meters and combination flow measuring and balancing type instruments as manufactured by Flow Design, Inc., or approved equivalent.

All devices shall have a Venturi section and a throttling valve with a memory stop on the downstream side of the Venturi.

The ball valve (sizes 1/2" – 2") shall have a brass or bronze body, blowout-proof stem, virgin Teflon seats, brass stem, stem seals and a steel handle.

All butterfly valves 2" to 14" shall be cast iron full-lug type, with EPDM seat, 41655 stem, bronze sleeve bearing and an aluminum/bronze disk.

All valves 1/2" to 2" shall be factory leak tested at 100-psi air under water.

Devices with sweat or NPT connections 1/2" – 2": 400 PSIG at 250°F.

Devices with flanged connections 2" –14": 240 PSIG at 250°F.

Provide one portable Meter Set with a dial pointer indicator. Meter Set shall be supplied complete with a master chart for direct conversion of meter readings to GPM, rust proof carrying case, two ten foot rubber test hoses with brass valves for quick connections to setters. Meter shall become property of the Owner.

- 18.13. Pressure and Temperature Test Stations (Pete's Plug):** Where indicated on the drawings, provide 3" long, 1/4" NPT "Pete's Plug" fitting to receive temperature and pressure probes. Station shall be solid brass with two self-closing valve cores of Nordel with maximum 275°F temperature rating and 500 PSI pressure rating. Plug shall be fitted with a color-coded cap strap with gasket, cap retaining strap and shall be rated at 1,000 PSI at 140°F. Provide 1500 XL Pete's plug temperature and pressure test kit. Kit shall be turned over to the Owner with closeout documents. The Contractor to receive written acknowledgement from the Contractor that the kit was received. Plugs shall be 110XL Pete's Plug II as manufactured by IMAC Systems or equivalent by Honeywell or B&G.
- 18.14. Valves:** Provide where shown and/or specified. All valves shall be the product of one American Manufacturer and shall meet the Buy American Act 41, USC 10a-10d. Arrange and install valves to be readily accessible for servicing. Where piping is insulated, provide thermal insulating T-handles with preformed holes for identification tags. All handles shall comply with UL 2043 and shall be UL listed for installation in air-handling spaces (return air plenums). Handles shall be NIBCO Nib Seal, Jomar Long Neck T-Handle, Apollo Thermal seal, Hammond/Milwaukee Valve Insulator MS. Coordinate handle height requirement with specified insulation thickness. Provide height as required to clear insulation and operate without damage to piping insulation. Install with stems or spindles above the horizontal. All valve parts shall have physical properties of ASTM Specification B-62, B-61 and A-126 Grade B as applicable to the pressure specified. Design, workmanship, materials and testing shall conform to MSS SP-80.
- 18.15. Butterfly Valves:** Provide for chilled water, hot water and condenser water piping over 3". Valves shall be double offset, 250-psig WP lug type designed for installation between the faces of 150# ASA150 flanges. Valves shall have ductile iron bodies, aluminum bronze or stainless-steel discs, and 416 stainless steel stems, EPDM seats and stem seals designed for 225° F. working temperature. Provide with extension necks extending at least 2" beyond OD of flanges, lever handles with infinite throttling and memory stops for valves 8" and smaller, worm and pinion operators with lever crank for valves 10" and larger.
- 18.16. Globe Valves 2" and Smaller:** Shall be NIBCO T-275-Y or Jomar Terminator G, bronze, Class 200 WSP, with replaceable glass-filled Teflon disc, threaded ends.

- 18.17. Globe valves 2-1/2" and Larger:** Shall be NIBCO F-738-31 or Jomar Terminator G Flanged, Class 150 lb. WSP, Ductile, OS&Y, flanged.
- 18.18. Square Head Cocks:** 2" and smaller shall be Rockwell Series 42 semi-steel 175 lb. WOG, screwed. Cocks 2-1/2" and larger shall be Rockwell Series 143 semi-steel 175 lb. WOG, flanged. For sizes over 4" provide enclosed worm gear operator with extensions to outside insulation and position indicator.
- 18.19. Combination Balancing and Shut-off Valves:** Shall be equal to Armstrong CBV or Jomar Terminator G with "Memory" balance point.
- 18.20. Check Valves 2" and Smaller:** NIBCO T-473-B 200 lb. WSP, bronze swing check valve. Use silent type in vertical locations. Check valves at pumps shall be of the non-slam spring loaded type.
- 18.21. Check Valves 2-1/2" and Larger:** NIBCO F-938-31U, Class 150 lb. WSP, Ductile Iron, flanged. Check valves at pumps shall be of the non-slam spring loaded type.
- 18.22. Ball Valves for Water Piping in Sizes 1/2" through 3":** NIBCO T- or S-585, Jomar T-or-S 100, Apollo series 82-100/200 or Jomar S/T-600-4B with 2-1/4" extended stems, bronze or heat treated CW511L brass body, ASTM B-21 Alloy C hard brass ball, PTFE seals and lever type operating handle. Ball valves shall be full-bore type.
- 18.23. Control Valves:** Specified under Controls.
- 18.24. Acceptable Manufacturers:** Stockham-Crane, Jenkins, Kitz, NIBCO. Model numbers are NIBCO.

## **PART 19. SPLIT COUPLED VERTICAL IN-LINE PUMPS**

- 19.1. Type:** Single stage, dual-arm, single suction, cast iron with 125 psig ANSI/PN16 flanges, rigid spacer type coupling and premium efficiency drip proof motors shall incorporate radially split, single stage centrifugal pumps. The suction and discharge connections shall be flanged and the same size and shall have separate drilled and tapped for seal flush and gauge connections for each pump. Pump working pressure shall be 175 psig at 150°F. The inlet and outlet ports on the casing shall be at least one size larger than the single pump size, so that both units may operate in parallel with no loss of single pump efficiency. Pumps are indicated to be supported from the piping. The pump manufacturer shall select hangers required for a distance of twenty five (25) feet from suction and discharge pump connections.
- 19.2. Impeller:** Each pump shall have a cast bronze dynamically balanced impeller.
- 19.3. Shaft:** Solid 416 Stainless steel.

- 19.4. **Bearings:** Regreaseable ball bearings equivalent to motor bearing standards for quiet operations.
- 19.5. **Seal:** Pumps shall be provided with a lower seal flush throttle bushing outside balanced mechanical seal with stainless steel parts and Viton secondary seal bronze gland plate with stainless steel studs and nuts. Provide factory installed flush line with manual vent. Provide for the flush line, two (2) 50-micron cartridge type filters and a sight flow indicator. The first shall be installed at start-up. The Contractor shall **install the second filter after the system has been thoroughly flushed of all contaminants.**
- 19.6. **Suction Guide Strainer:** Provide full size pump inlet cast iron, Model SG. Remove strainer prior to testing pump.
- 19.7. **Coupling:** Rigid spacer type of high tensile aluminum alloy. Coupling shall be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor. Provide OSHA compliant coupling guard.
- 19.8. **Motor:** Shall be open and drip proof, with regreaseable ball bearings. The current characteristics shall be as shown on the drawings. Pump motor(s) shall be non-overloading across the entire pump curve. Increase horsepower as required and coordinate with Electrical Contractor prior to bid. Where parallel pumping is indicated on the plans, the Pump Manufacturer's pump curve shall cross the system curve for both single pump and combined operation. For variable speed applications, the term "control curve" shall replace the "system curve" in this specification. All motors shall be provided with surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Refer to Para. Motors. Pumps shall be provided with manufacturer furnished and mounted variable speed drives in NEMA 4x enclosure.
- 19.9. **Harmonic Filters:** Pumps/Drives shall be provided factory installed harmonic filters that are IEEE 519 compliant and reduce TTD to 5%.
- 19.10. **Factory Start-up Service:** The Contractor shall provide for a factory-trained technician, employed by the unit manufacturer and not a sales representative, to check out all equipment and furnish written report indicating equipment is installed in strict accordance with manufacturer's recommendations.
- 19.11. **Acceptable Manufacturers:** Armstrong Series 4302 or approved equivalent by TACO, Armstrong or Aurora.

## **PART 20. REFRIGERANT PIPING AND ACCESSORIES**

- 20.1. General:** Arrange and install piping systems sizes as shown approximately as indicated, straight, properly supported and run as directly as possible forming right angles or running parallel with building lines, true to line and grade. Locate piping as high as practical and in parallel groups as close together as practical. Work shall present a neat and professional appearance.

Refrigerant piping, including mini-split piping, shall be Type L hard drawn, ACR copper refrigerant tubing with wrought copper solder joint fittings. All offsets and changes in direction shall be made with 90° or 45° elbows as required. System shall be complete and sized to conform to current ACRMA standards, except that refrigerant suction risers shall be sized for a gas velocity not less than 2000 fpm.

Where refrigerant piping is shown rising in the wall cavity and requires modifications to the block wall due to the size of the piping and insulated assembly, the block shall be neatly saw cut. Provide reinforcing to the affected portions of the wall as indicated on the structural drawings and details, the same as required at window and door openings. See the structural drawings for specifics. Extreme coordination is required prior to the erection of the structural slab and wall. Coordinate with the General Contractor.

Refer to Section 22 1510 and provide wall sleeves and escutcheons as specified for typical piping. Sleeves for pipe passing through exterior walls that contain refrigerant piping shall be Schedule 80 PVC pipe, 1/2" larger in diameter than piping and piping covering. Refer to Section 22 1510, Sleeves and Firestopping for additional requirements. Taping or nylon pull tying of liquid lines to suction lines is not allowed. Refer to Section 22 1510 and below for requirements. Coordinate wall sleeve sizes required for refrigerant piping with insulation and aluminum jacket requirements. Piping within wall cavities shall be seamless type with no joints.

- 20.2. VRF Systems Piping:** VRF systems refrigerant piping shall be Type L hard drawn, as specified above, from outdoor units to the respective VRF indoor unit. All piping shall be provided with manual isolation valves at the respective indoor unit to isolate each individual unit for maintenance reasons. Coordinate with VRF Manufacturer and provide as required. Refrigerant piping supports and anchoring shall be as specified below.

- 20.3. Joints:** Brazed or soldered joints only. Flare joints are not allowed. Make up with high temperature silver solder suitable for twice (2x) the working pressure, at maximum capacity, of the system. Pass dry nitrogen gas through pipe while joints are soldered. No joints shall be allowed within any masonry walls or any other inaccessible area. Solder shall be Sil-Fos 15 or approved equivalent. All soldering or brazing, materials and methods used shall be as recommended by the unit manufacturer. Piping within wall cavities and other inaccessible areas shall be seamless type with no joints.

- 20.4. Piping Diagram:** Various manufacturers of VRF systems have different reasons for the use of loops, traps, accumulators, receivers, etc., in piping arrangements, therefore, submit for approval, the air conditioning equipment Manufacturer's recommended, dimensioned plan view and isometric piping diagram proposed for use for each system, showing all valves, loops, pipe sizes and all appurtenances, required for the proper operation of the respective system. Piping diagrams shall be as required to obtain the maximum available warranty period for the system and components. **Failure to provide a manufacturer approved diagram will make the contractor responsible for all required changes to the piping system without additional cost to the Owner or his Design Professionals.** Submit catalog data and manufacturer's ratings for all valves, catch-alls, etc. with diagram for each system. Identify all items for respective system and list capacities, pressure drops, etc.
- 20.5. Solenoid Valves (Where Required):** Install in liquid refrigerant connection to the evaporators. Valves shall be designed for the operating pressure and capacity as listed in manufacturer's catalog with a pressure drop not exceeding 2 psi, and shall be sufficient for the requirements of the installation. Install in horizontal runs with body vertical.
- 20.6. Expansion Valves (Where Required):** Properly sized diaphragm or bellows type, with external superheat adjustment set for 10 degrees F. superheat. Install in the liquid refrigerant supply lines to the evaporators. Expansion valves up to and including 7-1/2 tons capacity shall be Sporlan Type "S" or approved equivalent. Expansion valves over 7-1/2 ton capacity shall be Sporlan Type "O" or approved equivalent. Install Sporlan full size catch-all filter-drier ahead of valve.
- 20.7. Refrigerant Service Valves:** Provide for the proper servicing of the equipment. All refrigerant circuit access ports located outdoors shall be fitted with color coated, all brass, and locking type tamper resistant caps. The locking caps shall be color coded for the refrigerant used. Caps shall be Novent Series 8668 for R-410 refrigerant with 86698 NV Multikey unlocking mechanism for R-410 refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide owner with minimum of six (6) spare keys.
- 20.8. Refrigerant Filter Drier (Catch-all):** Install in refrigerant line on the inlet side of each thermostatic expansion valve a Sporlan, three desiccants type filter drier. Filter driers up to and including 10-ton capacity shall be sealed type. Filter driers over 10-ton capacity shall be replaceable core type. Units shall have minimum surface filtering area and capacity not less than that shown in Sporlan Valve Company Bulletin 40 10 under sizes for "field replacement or field built up sizes". Careful attention must be given to providing the correct type of filter drier as it pertains to type of refrigerant used in the respective system.



**20.9. Refrigerant Service Valves:** All outdoor units containing refrigerant shall be provided with color coated, all brass, and locking type tamper resistant caps. The locking caps shall be color coded for the refrigerant used. Caps shall be Novent Series 8668 for R-410 refrigerant with 86698 NV Multikey unlocking mechanism for R-410 refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide owner with minimum of six (6) spare keys.

**20.10. Pipe Sleeves:** See Section 22 1510 for requirements.

## **PART 21. PIPE HANGERS AND SUPPORTS**

**21.1. General:** Refer to Section 22 1510.

**21.2. Painting of Hangers and Supports:** All exposed ferrous metal parts of hangers, Unistrut and other assemblies used for supporting of ducts, piping and plumbing related items in mechanical rooms, crawl space, above ceilings, etc., including black steel pipe, uncoated cast iron pipe, hangers, brackets, etc. shall be painted with two coats of black latex paint. Paint shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84, In lieu of painting, the contractor may substitute factory painted or coated items. All paints and coatings shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

## **PART 22. PIPE AND MISCELLANEOUS INSULATION WORK**

**22.1. General Provisions:** All work by experienced applicators in accordance with manufacturer's recommendations. Installation shall be as recommended by the Manufacturer. Where specified installation conflicts with the Manufacturers recommendations, the strictest application shall be provided. Piping must be clean, dry and pressure tested before covering is applied. Size pipe hangers to fit over insulated pipe size. **Hangers shall not be in contact with bare pipe and shall not penetrate the vapor barrier.** See hangers and supports for requirements. Cover fittings, valves and flanges with insulation material as hereinafter specified to same thickness as adjacent pipe covering except screwed unions in hot and chilled piping and other specifically named items. Neatly bevel covering edges adjacent to unions and other points of termination. All insulation materials including coatings and mastics shall have a composite rating for insulation, jacket or facing, including adhesives, not to exceed 25 flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E-84, NFPA 255 and UL 723.

**22.2. All Chilled Water Piping:** Prior to insulating, provide electric pipeline heating cable for all piping, fittings, valves, flanges, etc., which are exposed to the elements, including piping located at roof level for the ERU-1 **and its related**

**condensate drain lines.** Provide aluminum jacket, after installing electric pipeline cable and insulation as specified below.

Insulate all flanges, valves, and fittings, etc. with factory fabricated Foamglas fitting-covers of a thickness equal to that of insulation on adjoining pipe and securely fasten in place. Apply mastic on pipe. Butt the adjoining sections firmly together with mastic at ends and seal the longitudinal flap of the jacket with white vapor barrier cement, Foster 81-99 adhesive. Seal end joints with factory furnished 3-inch wide vapor barrier strips of same material as jacket, applied with lap cement. Apply aluminum bands and vapor barrier strips over edges of joint sealer strips and at center of each section of insulation. Seal insulation on flanges, valves and fittings with Foster 30-35, then finish the entire surface by application of vinyl acrylic jacket applied and sized with Foster 30-35 mastic.

Insulation shall be Pittsburgh Corning Foamglas One rigid insulation with factory applied vapor barrier ASJ facing. The entire assembly shall comply with ASTM C552, ASTM C 1639 and UL 1709.

Insulation thickness shall be as follows:

Chilled Water Pipe sizes 1-1/2" to 3", 2" thickness

Chilled Water Pipe sizes over 3", 3" thickness

**22.3. Chilled Water Piping Valves and Fittings Less Than 1 1/2" In Size :**

Insulate with 2" thickness, UL fire and smoke rated, black, flexible foamed, elastomeric, closed cell pipe insulation by AP Armaflex or equivalent by K-Flex or Aerocel AC EPDM. It shall be Greenguard certified tubular insulation with Microban antimicrobial protection. Insulation shall have a 'k' factor of not more than 0.25 at 75°F mean temperature and a water vapor transmission rate of 0.05 perm-inches or less.

Slip insulation onto pipe prior to erecting. **Longitudinal cutting of the insulation is prohibited. Do not stretch or bend insulation, nor slide insulation over sweat fittings.** Insulate sweat fittings with miter-cut pieces of insulation as recommended in Armaflex installation instructions, the same size as on adjacent piping. On piping with screwed fittings, make up fitting covers from Armaflex with an inside diameter large enough to overlap the insulation on the pipe next to the fitting. Fitting cover shall be long enough to overlap the pipe insulation by a minimum of one inch on each side. Glue the 1" overlap and seal to the adjacent pipe insulation with same adhesive and tape specified hereinbefore. Seal all butt joints with Armaflex BLV, Black, low VOC, air-drying contact adhesive. After gluing joints, wrap joint with 3" wide, 1/8" thick AP/Armaflex self-adhering tape.

**22.4. All Heating Hot Water Piping, Valves and Fittings:** Insulate with Owens-Corning SSL II with ASJ Max Fiberglass pipe insulation, thickness as shown below, thermal conductivity of  $k = 0.23 \text{ Btu-in/hr-ft}^2\text{-}^\circ\text{F}$  at 75°F mean temperature. Insulation shall comply with ASTM C547, ASTM C585, ASTM

C1136, ASTM C795, NFPA 90A and 90B and be UL Labeled for Flame Spread Index of 25 or less and Smoke Developed Index of 50.

Adhere SSL by removing release paper after the insulation is installed on pipe and sealing the lap starting in the center of each section, working towards ends. Lap shall be pressurized by rubbing with a plastic sealing tool. Install 3" butt strips in the same manner at the joint between sections and at 3'-0" on center. Staple jacket flaps with nominal 3/4" wide stainless steel or Monel outward-clinching insulation staples on 8" centers. Insulation staples shall have a vapor retarder coating or covered with greater than 3 ply laminate jacket (less than 0.0001 perms) adhesive tape or vapor barrier mastic that conceals the entire staple.

Insulate all fittings and elbows with premolded fiberglass fittings containing **rigid** insulation of equal thickness and density of the adjacent piping and are UL Labeled for Flame Spread Index of 25 or less and Smoke Developed Index of 50.

In lieu of premolded PVC covers at elbows and fittings, which contain rigid insulation as specified hereinbefore, Contractor may at his option miter the insulation. Thereafter, seal staples and cover ends on both sides of fitting with butt strip, staple and seal staples with insulating sealant. Where applicable, finish open ends of sectional covering by rounding off with insulating cement, glass cloth and lagging adhesive.

Insulation thickness shall be as follows:

for pipe sizes 1-1/4" and less, 1" thickness  
for pipe sizes 1-1/2" to 2 1/2", 2" thickness  
for pipe sizes over 2", 3" thickness

**22.5. Chilled Water Piping Aluminum Jacket:** All piping insulation exposed to the elements shall be covered with a preformed, 20 mil (.02") thick, smooth finish, 3003 and 3105 series aluminum conforming to ASTM B-209 standards. Fittings shall be 20-mil (.02") thick, die shaped, and smooth finish, Type 1100 aluminum jacket meeting ASTM C585. Provide 1/2" wide, 20-mil (.02") thick, Type 3003 aluminum bands on maximum 24" centers but not less than two bands per jacket section. Locate longitudinal lap of aluminum jacket on bottom for all horizontal piping. Seal jacket lap on bottom and make watertight with silicone caulk. The aluminum jacket shall extend and terminate a minimum of 24" inside the respective indoor space. Seal the penetration weather tight. **Venture Clad or similar product is prohibited.**

**22.6. Refrigerant Suction Lines and VRF System Liquid Lines:** Insulate with UL fire and smoke rated unslit, black, flexible foamed, elastomeric, closed cell pipe insulation by AP Armaflex or equivalent by K-Flex or Aerocel AC EPDM. It shall be Greenguard certified tubular insulation with Microban antimicrobial protection. Insulation shall have a 'k' factor of not more than 0.256 at 90°F mean temperature, water absorption percent by volume of 0.2 and a water vapor transmission rate of 0.05 perm-inches or less.

Note that Various Manufacturers of VRF systems require the insulating of refrigerant liquid lines. When required by the Manufacturer, they shall be insulated using materials specified above and in thickness required by the respective Manufacturer. Where the VRF or mini-split system Manufacturer requires less than 1" insulation, install thickness recommended with materials specified above using methods specified below. **Preinsulated piping from the Manufacturer is not allowed unless it meets the requirements specified above.**

Slip insulation onto pipe prior to erecting. **Longitudinal cutting of the insulation is prohibited. Do not stretch or bend insulation at any turn, nor slide insulation over sweat fittings.** Insulate sweat fittings and elbows with miter-cut pieces of insulation as recommended in Armaflex installation instructions, the same size as on adjacent piping. Fitting cover shall be long enough to overlap the pipe insulation by a minimum of one inch on each side. Glue the 1" overlap and seal to the adjacent pipe insulation with same adhesive and tape specified hereinbefore. Seal all butt joints with Armaflex BLV, Black, low VOC, air-drying contact adhesive. After gluing joints, wrap joint with 3" wide, 1/8" thick AP/Armaflex self-adhering tape.

**All insulated piping shall be continuous without cutting at clamp/support assemblies. All refrigerant liquid lines which are NOT required to be insulated by the equipment Manufacturer shall not be insulated except, they shall be provided with insulated insert at clamps to Unistrut assemble as specified below.**

- 22.7. Refrigerant Pipe Supports:** Do not use clevis hangers for refrigerant piping. All refrigerant piping, regardless of size, shall be supported with Unistrut assemblies. Provide Unistrut assembly, supporting horizontal refrigerant piping on intervals not exceeding 10 feet. Provide dielectric separation between dissimilar metals. Support piping so that no vibration will be transmitted to the building structure.

Provide an insulated piping clamp assembly at each Unistrut hanger, including the liquid line and any bare copper line attached to the assembly. The insulated clamp shall provide a crush resistant airtight seal and shall consist of a rigid, closed cell, foam insulation to support tubing and absorb vibration. The outer cover shall consist of a rubber coating that seals the cushion completely after installation to prevent condensation. **Plastic inserts/connectors between insulation joints are prohibited.** Clamps shall be steel with electrochromate finish. Rated assembly temperature range shall be -50°F to +250°F. It shall be self-extinguishing as tested under ASTM D 635. after installing device, tape each joint with 3" width insulating Armaflex tape as specified hereinbefore. Insulated lines shall use ZSi Series Cush-A-Therm, ArmaFix Eco Light or approved equivalent.

For units on concrete pad, support piping on concrete pad with rustproof-coated 1-1/2" x 1-1/2" x 1/8" galvanized steel angle supports anchored to pad

with steel base plate and bolts. See Part "Hangers and Supports" for coating requirements of Unistrut assembly.

**22.8. Refrigerant Piping and Condensate Drainage Piping Aluminum Jacket:**

All insulated exterior refrigerant piping, insulated exterior hot gas reheat coils hot gas piping and all insulated condensate drainage piping terminating in janitor sink, floor sink and hub drains in finished areas, all mechanical rooms and any location that would subject the piping insulation to damage shall be covered with an aluminum jacket.

Where refrigerant piping rises within the wall cavity to above the ceiling, attic or similar space, the aluminum jacket shall terminate within the exterior wall cavity and sealed weather tight to the sleeve in the wall. Where the refrigerant piping extends from the outside, directly into the mechanical room, the aluminum jacket shall terminate a minimum of 8" into the space and sealed weather tight on both sides of the wall and sleeve.

The aluminum jacket shall be 20 mil (.02") thick, smooth finish, 3003 and 3105 series aluminum conforming to ASTM B-209 standards. Fittings shall be 20-mil (.02") thick, die shaped, and smooth finish, Type 1100 aluminum jacket meeting ASTM C585. Provide 1/2" wide, 20-mil (.02") thick, Type 3003 aluminum bands on maximum 24" centers but not less than two bands per jacket section. **Venture Clad or similar product is prohibited.**

**22.9. Condensate Drain Lines:** To include discharge lines on all equipment specified with or provided with air conditioning condensate drainage pumps. Insulate using same methods and materials as specified for refrigerant piping except 1/2" thickness.

**22.10. Chilled Water System Expansion Tanks, Air Eliminators, Pumps and Casings, Water Chiller Evaporator and Related Auxiliaries:** Insulate with nominal 2" thick Armstrong Armaflex sheet insulation with joints sealed with adhesive as recommended by the insulation manufacturer. **Do not cover ASME Stamps or Equipment Nameplates.**

**22.11. Painting and Identifying:** Paint and identify after installation is completed as specified in Section 22 1510. Where piping is specified with an aluminum jacket, painting is not required. Provide identification of type specified hereinbefore on the insulation covering indicating unions, strainers and check valves.

**22.12. Submittal Data:** Submit for approval complete data on materials and application methods proposed.

**22.13. Manufacturers:** Approved equivalents by Pittsburgh Corning, CertainTeed, Baldwin-Ehret-Hill, Manville, Owens Corning, Armstrong Childers and 3M Company will be accepted.

## **PART 23. ELECTRIC PIPELINE HEATING CABLE**

- 23.1. General:** Provide for outdoor above ground chilled water piping, starting inside the conditioned space and/or 18" underground and extend to equipment jacket. Include glycol water piping from a point 18" below the roof structure to the point of connection of the glycol water piping to the ERU-1 on the roof. Also, provide for ERU-1 condensate drain lines.

Install heating cable prior to insulating pipes. Heating cable shall be equal to Chromalox "CRP-Self Regulating Heating Cable" designed for current shown on the electrical drawings. Cable shall be equipped with conduit connectors and outdoor thermostat set on 38 degrees F. Provide wattage as required to prevent freezing at 0° F ambient. Apply in accordance with manufacturer's recommendations. As a minimum, provide two turns of heat cable per linear foot of pipe.

## **PART 24. HEAVY DUTY MODULAR 100% OUTSIDE AIR UNIT (AHU-1)**

- 24.1. General:** Unit serves a Laboratory facility that is classified as a Level 3 by NFPA 99 and Level 4 as defined by ASHRAE. Furnish and install where shown on the plans, mechanical frame style air handling units 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. 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. Each unit shall bear an ETL or UL label under UL Standard 1995 indicating the complete unit is listed as an assembly. ETL or UL listing of individual components, or control panels only, is not acceptable.

- 24.2. Referenced Standards and Publications:** AMCA Standard 99: Standards Handbook, AMCA /ANSI Standard 204: Balance Quality and Vibration Levels for Fans, AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings, AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans, AMCA Standard 500: Test Methods for Louvers, Dampers and Shutters, AHRI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil, ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter, ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems, UL Standard 1995: Heating and Cooling Equipment and ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

- 24.3. Unit Construction:** 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.

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

The construction of the air handling unit shall consist of a (1" x 2") steel frame with formed 16-gauge galvanized steel 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. 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.

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.

The unit shall have double wall construction with 20 gauge solid galvanized liner in the entire unit. The double wall interior panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.

The entire unit to be insulated with a full (R23.6) 3.5" thick closed cell foam insulation. Foam shall be ecomate (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.

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. Access doors shall be provided with a 10 x 10 dual thermal pane safety glass window, UV rated.

- 24.4. Fan Section:** The multiple fan array systems shall include multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified Class III as required. Class I fans are not acceptable. Fans shall be rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor cube or cell shall include a minimum 10-gauge, G 90 Galvanized steel intake wall, .100 aluminum spun fan inlet funnel, and a 10-gauge G90 Galvanized steel motor support plate rail and structure. All motors shall be standard foot mounted type TEAO selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor or Toshiba for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Steel cased motors and/or ODP motors are not acceptable. All motors shall include permanently sealed (L10-500,000 hr) bearings and shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft currents. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, **exceeding category BV-5**, to meet or exceed an equivalent Grade G.55, producing a maximum rotational imbalance of .022" per second peak, filter in ( .55mm per second peak, filter in). Fan and motor assemblies submitted for approval incorporating larger than 22" wheel size and 215 T frames size motors shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement with a maximum rotational imbalance of .022" per second peak filter in (.55 mm per second peak, filter in). Copies of the certified balancing reports shall be provided with the unit O&M manuals at the time of shipment. Submittals that do not include



a statement of compliance with this requirement will be returned to the contractor without review.

The multiple fan array AHU unit shall provide the specified acoustical performance as scheduled for the unit supply discharge opening(s) and OSA opening. Listed or alternate manufacturers, other than the basis of design, providing multiple fan arrays that incorporate fans which are not manufactured by the AHU manufacturer, must provide modeled acoustical performance of the AHU unit for pre-bid approval by the engineer 10 working days before the project bid date. Submitted sound and performance data for preapproval showing only single fan performance for multiple fan arrays will be returned without review. Approved alternate or listed 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 on. The letter from the OEM fan manufacturer must clearly state that the submitted air handling unit perimeter boundary performance in the submitted AHU configuration is guaranteed, and that any deficiencies in performance from that as scheduled will be corrected at no cost to the owner. Submittals for listed and alternate manufacturers that do not contain the letter of guarantee as described above will be returned to the contractor disapproved and must be resubmitted for approval. 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.

The fan array shall consist of multiple fan and motor "cubes" or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. In order to assure uniform velocity profile in the AHU cross section, the fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing that must be such that the submitted array dimensions fill a minimum of 90% of the cross-sectional area of the AHU air way tunnel. There shall be no blank off plates or "spacers" between adjacent fan columns or rows to position the fans across the air way tunnel. The array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit to equal the specified cooling coil and/or filter bank face velocity by  $\pm 10\%$  when measured at a point 36" from the intake side of the fan array intake plenum wall, and at a distance of 72" from the discharge side of the fan array intake plenum wall. 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 pre-bid 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.

Each individual cube or cell in the multiple fan arrays shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled. The system effects for the back flow prevention device(s) shall be included in the criteria for TSP determination for fan selection purposes and shall be indicated as a separate line-item SP loss in the submittals. Submitted AHU performance that does not indicate allowance for system effects for the back flow prevention device(s) and the system effect for 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 of the requested information included for approval. Back Draft Damper performance data that is per AMCA ducted inlet and discharge arrangements will not be accepted. Damper data must be for the specific purpose of preventing back flow in any disabled fan cube and that is mounted directly at the inlet of each fan. Motorized dampers for this purpose are not acceptable. Submitted fan performance data which only reflect published performance for individual fans in AMCA arrangement "A" free inlet and discharge will not be accepted. AHU Manufacturers that do not manufacture the fans being submitted on must provide certified performance data for fans as installed in the AHU unit with Back Draft damper effects included. At the sole discretion of the engineer, such performance testing may be witnessed by the engineer and/or the owner's representative.

Each fan motor shall be individually wired to a control panel containing a single VFD as the primary VFD and a backup VFD wired in bypass. Each VFD shall be sized for the total connected HP for all fan motors contained in the fan array. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards and local code requirements. When specified and scheduled, the multiple fan array electrical panel shall include system optimization controls to actively control fan speed and to enable and disable fans in the multiple fan array. The number of active fans in the array shall be automatically determined, and the speed of the enabled fans shall be adjusted to produce the required coincidental flow and pressure at the perimeter boundary of the unit at substantially peak efficiency. The system optimization controls shall continuously monitor required flow and pressure and shall automatically optimize the operating array configuration and speed for peak efficiency. When specified, system, optimization controls shall be provided that will interface with, and be compatible with the BAS as specified elsewhere. It is the responsibility of the contractor to assure that the fan system optimization controls are compatible with the BAS system. System optimization controls shall be provided by the AHU unit manufacturer to assure single source responsibility for fan volume controls, and shall require only an input control signal from the controls contractor for SP or flow for proper operation of the system optimization controls. When specified, the AHU unit manufacturer shall provide a single communication interface with the BAS and shall coordinate with the controls contractor to make sure that all necessary data points are communicated.

AHU manufacturers that are approved for bidding purposes only, other than the basis of design manufacturer, and that are submitting multiple fan arrays, shall test one or more of the submitted AHU's for flow, pressure, leakage,

BHP and acoustics as submitted and approved, prior to shipment. The testing shall be witnessed by an owner's representative and approved by the engineer prior to shipment of any of the submitted AHU equipment. A test report shall be provided for each tested AHU unit and the report shall be included in the O&M manuals for the units.

Each fan & 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. All fan/motor access doors shall open against pressure.

- 24.5. Fanwall Technology™ (FWT) With Redundant Variable Frequency Drive Control (N+1):** Provide one Yaskawa Variable Frequency Drive for normal operation and a second Yaskawa Variable Frequency Drive for Redundant Backup operation. Provide control wiring and control circuitry to transfer from main VFD to Redundant VFD when main drive has faulted. The Variable Frequency Drives shall be sized accordingly to start and hold all motors in the FANWALL Array. Provide service disconnect with fuses or circuit breaker. Coordinate VFD requirements with Section 23 15 92 and provide as required.
- 24.6. Harmonic Filters:** Air handling unit fans/drives shall be provided factory installed harmonic filters that are IEEE 519 compliant and reduce TTD to 5%.
- 24.7. Water Coils:** All coil assemblies shall be leak tested under water at 315 PSIG. Performance shall be certified under AHRI Standard 410. Coils exceeding the range of AHRI standard rating conditions shall be noted. 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. Headers are to be seamless copper with die formed tube holes. 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. Water coils shall be 5/8" o.d. x .035" wall copper tube with .049" return bends, .010" aluminum fins with 16-gauge 304 stainless steel casing.
- 24.8. Condensate / Drain Pans:** IAQ style drain pans shall be provided under all cooling coils. 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 drain connections shall be piped and trapped separately for proper drainage.

- 24.9. Filters:** 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. The filters shall be as manufactured by Camfil, Purolator, AAF or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.
- 24.10. Filter Gauge:** Each Filter bank shall be furnished with: Magnehelic filter gauge with a 4-3/4" OD white static pressure dial with black figures and zero pointer adjustment.
- 24.11. Dampers:** Temtrol TD-6 or approved equal. Provide Class 1 rated, ultra low leak dampers (less than 3 cfm/sq ft. at 1" w.g.). Low leakage dampers shall have extruded aluminum airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santoprene rubber edge seals and zinc plated or stainless-steel tubular steel shaft for a non-slip operation. Shaft bearings shall be spherical, non-corrosive nylon to eliminate friction and any metal-to-metal contact. Damper jamb seals shall be UV rated, nylon glass reinforced or stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16-gauge galvanized steel frame.
- 24.12. Unit Convenience Features:** Each section shall be equipped with a vapor-proof LED service light with guard. Lights shall be controlled by one light switch mounted adjacent to the supply air fan access door. Furnish a powered, 120 volt GFI duplex convenience outlet on the exterior of the unit. 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.
- 24.13. Ultraviolet (UV-C) Lights:** Comply with UL / C-UL or ETL for Ultraviolet Fixturing. Store UV-C Fixturing in a clean, dry place and protect from weather and construction traffic. Acceptable Manufacturers: UV Resources – RLM Xtreme, Substitutions: Prior approval required. Qualifications: UV-C products supplier shall provide proof of 100% inbound and outbound testing of equipment. Fixturing: The UV-C Power supply shall have been tested, listed and labeled as compliant with UL, CSA and CE. Plenum Wiring Loom: The Loom shall meet UL Subject 13 and UL 1581, Article 725 of the NEC and meet UL VW-1 material ratings. The optional metallic Loom cladding shall be UL recognized DXUZ2 and constructed of flexible galvanized steel and cover the entire Loom. Lamps: Each lamp shall contain no more than 5 milligrams of mercury consistent with current environmental practices. Lamp Watts shall be printed on all lamps, no exceptions. Lamps shall not produce ozone and shall be hermetically sealed within a layer of UV-C transmissible FEP to protect against lamp breakage and to contain lamp contents should breakage occur.

Power supply and fixturing shall be warranted to be free from defects for a period of five (5) years. Lamps shall be warranted to be free from defects for a period of one (1) year.

Lamps shall be installed in sufficient quantity and in such a manner so as to provide an equal distribution of UV-C energy. When installed, the UV-C energy produced shall be of the lowest possible reflected and shadowed-losses and shall produce 360 degree UV-C irradiance from the lamps within the UV cavity.

Fixture modeling shall be included in the submittal and must contain the necessary calculations to demonstrate that a minimum of 6 lamp watts, as recommended by ASHRAE, are distributed equally to each square foot of coil surface area to achieve a minimum of 100 microwatts per square centimeter equally distributed to the surfaces at the plenum sides, top and bottom. All calculations are to be at 55 degrees F and 500 fpm air velocity, no exceptions.

The power supply housing shall be capable of installation within or outside of the air stream, secondary compartment or NEMA enclosure. Lamps shall be mounted to irradiate the intended surfaces as well as all of the available line of sight airstream through proper placement, 360° irradiation and incident angle reflection.

To protect personnel, all access panels and doors to the UV-C assembly and/or within view of the UV-C assembly shall include mechanical interlock switches to insure that the UV-C assembly will be de-energized when any of these accesses are opened. A redundant disconnect service switch is to be installed on the AHU's exterior, next to the plenum access door, in plain sight to provide a method to more specifically de-energize the UV-C lamp circuits prior to entering the lamp plenum.

Lamp Watts shall be printed on all lamps, no exceptions. Each lamp shall contain less than 5 milligrams of mercury, consistent with current environmental practices. Lamp useful life shall be a minimum of 9,000 hours with no more than a 15% output loss at the end of the lamps life (12 months of continuous use). Lamps shall be constructed with UV-C resistant bases and shall not produce ozone. Lamps shall produce the specified output in moving air of up to 1000 fpm and temperatures of 0-90° C. Lamps shall be hermetically sealed within a layer of UV-C transmissible FEP to provide protection against lamp breakage and to ensure Lamp contents from a broken Lamp, are contained.

**24.14. Factory Start-Up Service:** The Contractor shall provide for a factory-trained mechanic, employed by the unit manufacturer and not a sales representative, to check out all equipment and furnish written report indicating equipment is installed in strict accordance with manufacturer's recommendations.

- 24.15. Manufacturers:** Provide custom air handling units as manufactured by Temtrol, Huntair, Mammoth, Ventrol or Governair. All others require prior approval. Temtrol is the basis-of-design.

## **PART 25. HEAVY DUTY MODULAR AIR HANDLING UNITS (AHU-2)**

- 25.1. General:** Central station, double wall construction air handling units of the type, of size and capacity as schedule. Unit fan and coil performance shall be certified in accordance with ARI Standard 430 (current edition) for fans and 410 (current edition) for coils. Installation shall be in strict accordance with manufacturer's recommendations. Air handling units shall be AMCA certified for total static indicated on the drawing plus 1.5".

- 25.2. Unit Casing and Fan Sections:** Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft<sup>2</sup> of casing surface area) = CL X P<sup>0.65</sup>. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class. Under 55F supply air temperature and design conditions on the exterior of the unit of 81F dry bulb and 73F wet bulb, condensation shall not form on the casing exterior. The AHU Manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.

Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).

Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 per inch of panel span

Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of  $13 \text{ Hr} \cdot \text{Ft}^2 \cdot ^\circ\text{F} / \text{BTU}$ . Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

Traction enhancements shall be applied to the unit floor to improve the walking surface in those unit sections where the floor is fully accessible, and not impeded by internal structural or functional features

Provide access doors for access to all sections. Access doors shall provide access to both entering and leaving side of all coils. Doors shall provide access to enter and clean each coil, and access to fan and drive. These doors are to be a minimum of 20 inches wide by full casing height, galvanized, double wall, hinged, removable access doors. Access door shall have a full perimeter automotive type gasket to prevent air leakage, and vent lock style, exterior handle that can be opened from unit interior.

Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels. All doors downstream of the cooling coil shall be provided with a thermal break construction of door panel and door frame. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance. Handle hardware shall be designed to prevent unintended closure. Access doors shall be hinged and removable without the use of specialized tools. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height. A single door handle shall be provided for each door linking multiple latching points necessary to maintain the specified air leakage integrity of the unit. A shatterproof window shall be provided in access door at the UV-C lights section of the unit. Window shall be thermal dual pane, capable of withstanding unit operating pressures, and shall be safe for viewing

UV-C lamps. Test ports shall be supplied in access doors as required to facilitate the field commissioning by the test and balance contractor. Test ports shall not compromise the ASHRAE leakage class of the unit.

The condensate drain pan shall have double wall construction with 16 gauge 304 stainless steel interior pan, threaded drain connections, and shall extend under the complete fan and coil section. It shall be insulated with 0.6-inch thick plastic foam faced with an additional aluminum foil vapor barrier and cemented between the steel outer pans and the heavy gauge steel inner pan. Insulation, adhesive and inner coating to comply with NFPA-90A flame spread and smoke generation requirements. Drain pan to be IAQ, indoor air quality, type sloped such that no condensate will stand in the pan.

**25.3. Drain Pans:** All cooling coil sections shall be provided with an insulated, double-wall, 16 ga. stainless steel drain pan. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil, sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions and trapped per manufacturer's requirements. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor are unacceptable. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps. The installing contractor shall ensure the unit is installed level and trapped in accordance with the manufacturer's requirements.

**25.4. Coil Sections and Coils:** Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is unacceptable. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated.

When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the



coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the sections primary drain pan.

The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil. The intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition. Coil shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation and a uniform dry film thickness from 0.8 to 1.2 mil on all surface areas including fin edges. Corrosion durability shall be confirmed through testing to no less than 5,000 hours salt spray per ASTM B117.

Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water. Headers shall be constructed of round copper pipe or cast iron. Tubes shall be 1/2-inch .016 copper, with aluminum fins. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.

- 25.5. Fan Sections:** Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.

Provide fans of type and class as required based on characteristics shown in the equipment schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and meticulously designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications.

Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive to bypass resonant frequencies shall not be acceptable. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans selected with inverter balancing shall have a maintenance free, circumferential conductive microfiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.

Fans shall be direct driven plenum fans. Direct drive plenum fans with integral frame motors, shall be mounted on isolation bases. Fan shall be dynamically

balanced throughout the operating range to a BV-3 (0.20 in/s) per AMCA 204 test standard. Fan and motor shall be internally isolated with spring isolators.

A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements and shall be as specified hereinbefore. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply air, outside air and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor to avoid transmission of noise and vibration through the ductwork and building structure.

Direct drive plenum fans shall be provided with ECM motors and shall be a nine-blade, single width, single inlet fan with high efficiency welded aluminum impeller that is dynamically balanced as an assembly. Fan shall be maintenance free throughout its operating life. Fans shall be balanced to a G6.3 per AMCA 204. Access to motor and fan assembly through hinged access door shall be provided. Access door shall be sized for removal of entire motor and fan assembly. Motor shall contain integrated PID controller and accept a 0-10VDC input signal for variable speed control. Operation of the fan at the specified conditions shall not exceed the capacity of the drive at 60hz and shall operate within its stable operation to 90Hz.

Fan airflow measurement systems shall be provided to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no less than +/- 5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.

- 25.6. Motors and Drives:** Direct driven fans utilizing integral frame motors shall use 2-pole (3600 rpm), 4-pole (1800 rpm) or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation capable to operate continuously at 104 deg F (40 deg C) without tripping overloads. Motors shall be premium efficiency open drop proof built to NEMA Standards for continuous use. Refer to 23 1570, Paragraph 2.2. Motors for efficiency and additional requirements.
- 25.7. Harmonic Filters:** Chiller/Drives shall be provided factory installed harmonic filters that are IEEE 519 compliant and reduce TTD to 5%.
- 25.8. Phase Protection:** All equipment shall also be provided with surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Protection shall be provided for all 3-phase equipment utilizing ICM Controls Model 450 or equivalent. All single phase equipment with horsepower greater than or equal to 1/8 HP shall be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure

appropriate for the installation. The Contractor shall consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities. Phase protection is not required on equipment being controlled via a variable speed frequency drive.

- 25.9. Filters:** Filter shall be 6-inch throwaway type equal to Farr Series Riga-Flo-XL. Filter media shall be of the non-woven synthetic fabric type and shall be reinforced by a woven scrim backing. All filters shall be common industry standard size filters that are readily available and do not have to be fabricated. Cutting and taping of filter segments to make a proper filter is prohibited.

The filter media shall have an average efficiency of 40-45% on ASHRAE Test Standard 52. It shall have an average arrestance of not less than 96% in accordance with that test standard. The filter shall be listed by Underwriters Laboratories as Class 2.

Maximum Filter Face Velocity – 500 FPM

The Unit manufacturer shall furnish a filter box as shown on the drawings. **The Contractor is responsible for quarterly filter changes during the guarantee period and shall inscribe onto the filters' casing the date filters were installed/replaced.** Each filter section shall be provided with a factory-installed, flush-mounted Dwyer dial-type differential pressure gauge piped to both sides of the filter to indicate status. Gauge shall maintain a +/- 5 percent accuracy within operating temperature limits of -20°F to 120°F.

- 25.10. Air Flow Measuring Stations:** Airflow measuring stations shall be provided and located in the outside and/or return air paths as required to measure airflow. Airflow measuring stations shall be tested per AMCA Standard 611 and licensed to bear the AMCA Ratings Seal for airflow measurement performance. Integral control damper blades shall be provided as galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage. The airflow measurement station shall measure up to 100 percent of the total outside air and or return air. The airflow measurement station shall be capable of measuring down to 300 fpm. The airflow measuring device shall adjust for temperature variations. Output shall be provided from the station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/- 5 percent. Airflow measuring stations shall be mounted on the AHU interior. The installing contractor shall provide duct-mounted pleated media MERV 8 filtration upstream of airflow monitoring stations requiring air straightening vanes to prevent blockage of vanes. A filter access door shall be provided for filter replacement that does not degrade the specified duct leakage class. Duct-mounted filtration section with access door for filter removal shall be tested for compliance to specified duct leakage class on the schedule and plans.

- 25.11. Ultraviolet (UV-C) Lights:** Design of the UV-C light array shall assure that the UV-C energy striking the intended coil and drain pan surfaces shall not be less

than 550 microwatts per square centimeter and provide not less than 99 percent surface disinfection efficiency. The minimum intensity at any point on the surface plane of the coil must exceed 100 microwatts per square centimeter. Energy consumption at the design intensity shall be no more than 10 watts for each square foot of treated, cross sectional plane.

UV-C lamps and fixtures shall be positioned to provide an equal distribution of UV-C energy and to minimize shadowed areas. The fixture assembly shall be designed and installed such that the sum of the lamp arc lengths in a row is a minimum of 90% of the irradiated surfaces total width. The lamps shall not produce ozone.

Each lamp shall be high-output, hot cathode, T8 diameter, medium bi-pin type that produces UVGI of 254 nanometers. Lamps shall contain no more than 5.5 milligrams of mercury while producing the specified UV-C output when installed in an environment with 500 fpm air velocity and subjected to temperatures of 55-135 degrees F. Lamp life shall be 9,000 hours minimum with no more than a 20 percent loss of output after two years of continuous use.

Fixtures shall meet the UL drip-proof design criteria and be constructed of stainless steel to resist corrosion. Racks for fixtures shall be constructed of galvanized steel as AHU interior. Fixtures shall have been independently tested and recognized by UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards 153, 1598 and 1995.

All polymeric materials that come into direct or indirect (reflected) contact with UV-C light shall be tested and certified as UV-C tolerant. Any polymeric material in direct or indirect contact with UV-C light not certified as UV-C tolerant shall be completely shielded from the UV-C light using a certified UV-C tolerant material such as metal. UV-C tolerance is defined as being capable of performing its intended duty for a minimum of 20 years.

Access doors shall be provided at the location of each UV-C light as indicated on the plans and schedule. All sections of the air handler with access doors where the UV-C lights may pose a risk for direct exposure shall have a mechanical interlock switch that disconnects power to the lights when the door is opened. In addition to the mechanical interlock switch, each unit shall be equipped with an externally mounted on-off/disconnect/shut off switch that disconnects power to the UV-C lights. The switch shall be equipped with a lock-out/tag-out to prevent unwanted operation of the UV-C lights. A view port with cover shall be provided in each UV section to allow viewing of the UV-C light array confirming operation. The view port and other AHU windows shall be treated to assure the UV-C energy emitted through it is below the threshold limits specified by NIOSH and ACGIH. Units shall have a safety warning label applied to the exterior of each section containing UV-C lights.

Complete safety, maintenance and servicing instructions for the UV-C lights and fixtures shall be incorporated into the air handler manufacturers standard installation, operating and maintenance manuals.

**25.12. Variable Frequency Drive (VFD):** Variable frequency drives shall be provided, mounted and wired by the AHU manufacturer as indicated on the schedule and drawings. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFDs shall be UL listed. The listing shall allow mounting in plenum or other air handling compartments. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL 508 certified for the building and assembly of option panels. Assembly of separate panels with options by a third-party is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel. The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor. The VFDs full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting. The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating. An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test. Galvanic and/or optical isolation shall be provided between the VFDs power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules. The VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier

frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.

Protection shall be provided against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, undervoltage, VFD overtemperature and motor overtemperature. The VFD shall display all faults as words. Codes are not acceptable. The VFD shall be protected from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD shall continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230 volt units, 313 V AC for 460 volt units, and 394 volts for 600 volts units. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator. The VFD package shall include semi-conductor rated input fuses to protect power components.

To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise the AHU manufacturer shall ensure that inverter rated motors are supplied. The VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance. The VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad. The VFD shall catch a rotating motor operating forward or reverse up to full speed. The VFD shall be rated for 100,000 amp interrupting capacity (AIC). The VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD shall identify which of the output phases is low or lost. The VFD shall continue to operate without faulting until input voltage reaches 539 V AC on 460 volt units.

VFD shall be provided with Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference. On units with bypass, a VFD/Off/Bypass selector switch shall be provided. The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode. The VFD shall provide digital manual speed control. Potentiometers are not acceptable. A lockable, alphanumeric backlit display keypad shall be provided. The keypad shall be remotely mountable up to 10 feet away using standard 9-pin cable. The keypads for all sizes of VFDs shall be identical and interchangeable.

A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.

At a minimum, the following points shall be controlled and/or accessible: VFD Start/Stop, Speed reference, Fault diagnostics, Meter points,

**25.13. Factory Engineered Automatic Temperature Controls:** One programmable DDC controller shall be provided by the AHU manufacturer for the AHU. Each programmable DDC controller shall use the LonTalk protocol and shall be LonMark certified to ensure open communication with other open BASs. Complete communications and diagnostics including all AI, BI, AO, BO, set points and alarms shall only require a twisted pair of wires between the unit controller and the BAS. Each unit controller shall be factory wired to the unit end devices. Each controller shall have a user display touch screen for user interface. The display on indoor units shall be unit mounted in the factory. Displays shall give user access to AHU status, set points and alarms.

The programmable DDC controller and the control components shall be selected, mounted, wired and tested by the AHU manufacturer to ensure delivery of specified performance and to minimize jobsite startup time. Testing shall be performed to ensure wiring continuity between the controller and all devices, and to ensure proper operation of the end devices. DDC controllers shall be located on unit as indicated on the drawings.

Factory mounted controller shall be preprogrammed at the factory to minimize startup delay of the unit(s) at the job site. Controller shall be programmed with manufactures preferred standard basic programming based on unit configuration and options. Any additional programming or custom programming shall be provided at the job site by the unit manufacturer or controls contractor.

**25.14. Factory Start-Up Service:** The Contractor shall provide for a factory-trained mechanic, employed by the unit manufacturer and not a sales representative, to check out all equipment and furnish written report indicating equipment is installed in strict accordance with manufacturer's recommendations. Also, provide temperature, pressure and amp readings taken during testing to substantiate unit performance including the range of the refrigerant hot gas reheat coil as applicable.

**25.15. Acceptable Manufacturers:** Trane Performance Climate Changers or approved equivalent by Carrier or Temtrol.

## **PART 26. ENERGY RECOVERY UNIT/PLENUM (ERU-1)**

**26.1. General:** Laboratory is classified as a Level 3 by NFPA 99 and Level 4 as defined by ASHRAE. The unit cabinet shall be constructed with a true no-thru-metal design. All interior and exterior metal components must be isolated from contact with each other by a minimum of one inch of non-metallic material, including the distance between interior or exterior metal sheets and any fasteners penetrating these sheets. If an alternate thermal break method of construction is provided the alternate design must be clearly identified, and, at a minimum, include thermal break material that is at least 1" deep in the direction of heat flow. Simple thermal break gaskets will not be acceptable.

The minimum thermal resistance value of the wall, floor or roof panels as measured at the panel joints is to be R-1.46. Panel thermal performance to be tested according to ASTM C 518 by an independent testing agency, with report included in submittal package. Base coil performance shall be at standard conditions (density 0.075 lbs. / ft<sup>3</sup>).

- 26.2. Quality Assurance:** Air coil performance shall be certified by AHRI according to AHRI standard 410. Unit casing shall be certified by an independent laboratory registered with A2LA to meet the requirements of NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals. Flame Spread index shall be tested and certified by an independent laboratory registered with A2LA according to standard UL 723 Test for Surface Burning Characteristics of Materials. Report numbers shall be indicated on product submittal data. Plenum air leakage performance shall have been tested to meet or exceed the Sheet Metal and Air Conditioning Manufacturers Association (SMACNA) class 2 performance levels at 10" of differential pressure. The cabinet surface shall be tested according to ASTM B-117 in a salt-spray apparatus for a minimum of 8,000 hours. Before the test, the test sample shall be scribed with a deep X. If the sample is painted, this X shall traverse the thickness of the paint and primer. At the end of 8,000 hours, the sample must be evaluated as a 10 on 10, with zero evidence of blistering, creep, or delamination.
- 26.3. Module Assembly:** Each mating section to have a flush surface around its entire mating perimeter. Provide 3/4" closed cell neoprene gasket for field installation on one mating surface. Unit modules to be drawn together using a field supplied come-along chain and integral lifting lugs mounted on unit base rail. Provide F.R.P. or stainless-steel assembly brackets, bolts and rods at roof level to assist in compression of module gasket.
- 26.4. Unit Base Rail:** Base rail to be manufactured of FRP profiles or structural FRP, or fully welded and epoxy coated structural steel members adequately braced and reinforced to withstand all loads during shipment, rigging, installation, and operation. If a structural steel base rail is provided, the base rail must be protected from the ambient environment by epoxy paint or fiberglass-reinforced-plastic (FRP) laminate jacket that can withstand 8,000 hours of salt spray testing per ASTM B 117 with no corrosion or lifting present at the scribe. Unit base rail must be of suitable strength for the service required, and provided with cross-members as required to meet shipping and rigging loads. Base rails manufactured from steel or structural FRP must be designed for a maximum of L/360 deflection. For outdoor units mounted on roof curbs, the outside perimeter of the base rail must overhang the curb by 2". The overhang shall create a positive positioning system that ensures that the equipment is properly located on the curb, and that the unit is prevented from slipping off the curb by the geometric shape of the base rail, not through the use of fasteners or brackets.
- 26.5. Fasteners:** All fasteners, including bolts and self-tapping or self-drilling screws, are to be fabricated of solid 316 stainless steel. Series 304 or any



400 series stainless steel is not acceptable. Documentation showing conformance to this specification is required in the submittal package.

- 26.6. Casing:** The wall, roof and floor panels shall be minimum of 1.25" thick double-wall panels providing an R-value of 1.46 or better at the panel joints and corners. True no thru-metal construction is required.

The outside liner shall be minimum 4mm thickness F.R.P. or 16 gauge 316 stainless steel sheet steel exterior. Finish color shall be Industrial Grey for unit exterior. Provide finish coat or pigment that provides a minimum of 8,000 hours of salt spray resistance without corrosion or lifting along the scribe when tested according to ASTM B- 117. Fasteners may be uncoated if they are fabricated from 316 stainless steel. All exterior roof and wall panels shall have no exposed bolts or screws. Self-drilling or self-tapping screws which penetrate the exterior liner are not permitted. Outdoor units shall pitched 1/4" per foot towards roof edge(s) to ensure water runoff.

The inside liner shall be minimum 4mm thickness F.R.P. or 22-gauge, 316 stainless steel sheet steel exterior. Floor liner/floor panels shall be of the same construction as the roof and wall panels. The floor panels shall be installed on top of the unit structural baserail so that the baserail forms a complete sub-base underneath the floor panels. Floor systems that require insulated base rails or insulated base rail cavities are not acceptable. Minimum 4mm thickness F.R.P. or 16-gauge 316 stainless steel sheet steel walk-on surface. Minimum 4mm thickness F.R.P. or 22-gauge 316 stainless steel sheet steel under-liner

- 26.7. Access Doors:** Access doors shall be of the same construction as the unit wall panels. Door construction shall be one piece construction with mechanical-grip (automotive style) gaskets required. Adhesive-backed, or stick-on gaskets, are not acceptable. Doors shall have rounded corners so that the door gasket only has one joint. Door gasket shall be easily removable and replaceable. Surface mount stainless steel latches with no thru-metal parts. Lift-off construction for ease of maintenance and replacement. Doors shall have stainless steel or Nylon hinge construction. All fasteners or bolts used in the door construction shall be 316 stainless steel.

- 26.8. Outdoor Air Bypass:** The unit shall be complete with an outdoor air bypass section which will allow the fan(s) to maintain the required outlet velocity and system pressure when the exhaust airflow is turned down. Bypass air damper(s) shall be opposed-blade, airfoil design, extruded aluminum with a clear anodized finish, with linkage hardware installed in the side frame. All aluminum linkage hardware parts shall be clear anodized and all non-aluminum linkage hardware parts shall be type 316 stainless steel. Dampers shall be suitable for applications up to 12 inches wg., in extruded aluminum. Each bypass damper shall be housed inside a fiberglass reinforced plastic (FRP) weather cowl and bird screen to prevent the possibility of rainwater entrainment. All dampers shall have an extended control shaft for electronic, pneumatic or manual control actuation.

**26.9. Fans:** Fans shall be M.K. Plastics model, accessories, and performance as shown on the plans and as specified. Equivalent manufacturers shall meet the specified BHP, RPM, Outlet velocity, Plume height and sound performance. Only substitutions bearing the AMCA seal for both sound and air movement will be considered. For ease of maintenance and accessibility, fans shall be mounted on rails at the same level as the plenum base rail. The plenum shall include framed openings for connection of the fan damper(s) and canvas. Refer to the next Part for additional fan requirements.

**26.10. Coils:** Coil casing (tube sheets) shall be minimum 16-gauge 304 stainless steel. Coil headers shall be copper tube with threaded red brass connections. Coil tubes shall be minimum 5/8" O.D. copper tube, minimum 0.035" tube wall thickness and minimum 0.049" return-bend tube wall thickness and minimum 4 rows deep. Coil fins shall be minimum 0.010" aluminum, corrugated profile and maximum 8 FPI. Coil coating shall be baked phenolic coating over entire coil, including headers, connections, tube sheets, fins, and return bends. all coil connections shall pass through the side-wall of the unit through factory penetrations, sealed airtight with grommets and caulking. Coils shall be individually removable. Stacked coils shall have independent stainless steel or FRP structural rails permitting the removal of any individual coil without disturbing the other coils or coil piping.

A triple sloped stainless steel drain pan shall be provided under each coil with it pitched in three directions to drain located at lowest point. It shall be insulated, fully drainable, 2" depth and with 304 stainless steel construction. Drain pan must be constructed to be independent of the unit floor structure and be easily removable and replaceable. The drain pan is to be installed on top of the floor panels, so that the insulation value of the floor panels is uncompromised.

Provide double-wall blank-off panels to eliminate air bypass around the coil. Blank-off panels must be constructed of the same materials and design as the walls of the unit and provide a minimum of R-1.46 at any point on the panel or joint surface. Single-wall blank-off panels are not acceptable.

**26.11. Filters:** Provide a face-loading filter section which shall be 18-gauge 304 stainless steel filter frame construction, Type 8 universal filter frames, fully welded at all corners, and gasketed with stainless steel filter clips. Provide one (1) set of filters, factory installed in the filter rack. Filters shall have MERV 8 efficiency rating, 2" deep and in sizes 24"x24" or 12"x24" sizes with 0.23" initial pressure drop at 500 fpm and 1.0" final resistance. Provide a filter indicator gauge with a 0-1" w.g. readout scale. Install pressure probes upstream and downstream of the filter bank to indicate the air pressure drop across the filter bank. Install stainless steel with stainless steel metal pressure tips to properly detect static pressure. Filters shall be American Air Filter type Perfect Pleat HC or approved equal. Frames shall be American Air

Filter Universal Holding Frame, 18 gauge 304 stainless steel, Dwyer Magnehelic and Dwyer tips.

- 26.12. Electrical:** Provide a lighting system including two (2) vapor-proof, low-power-draw LED bulbs marine light fixtures per accessible section with 1/2" replaceable EMT and 12 gauge wires. Lighting system shall have an auto-off system so that personnel cannot accidentally leave the lights illuminated. This system may be a timer or a motion detection system. The entire lighting circuit shall be constructed with no-thru-metal construction, including any fasteners or conduit required to complete the installation. Provide a powered convenience outlet system; 15-amp GFCI service outlet, located beside the filter access door, weatherproof housing for GFCI receptacle. Installing contractor to provide 120V power wiring to GFCI receptacle.
- 26.13. Testing:** The unit shall undergo a thorough quality control inspection, with the inspections results and corrective actions recorded and kept available for review. The unit shall undergo a factory pressure and leakage test. The test shall be performed and certified by an independent testing company not affiliated with the unit manufacturer. The leak test shall be performed in accordance with the latest SMACNA air duct leakage test manual and shall be performed at 10" w.g. negative pressure. Demonstrate a maximum of SMACNA class 2 performance at the specified test pressure and provide results to the Engineer.
- 26.14. Installation:** Install FPVC flexible connections with stainless steel straps, provided by the fan manufacturer, between fan inlet and bypass plenum. Ensure that the flexible connection is at least 6 inches wide. Pipe housing drain(s) to the nearest roof drain. Contractor shall provide heat-trace system to keep drains frost free, including p-traps. Provide P-traps as per manufacturer's recommendations. Fans shall be mounted on seismically restrained spring vibration isolators, provided by the fan manufacturer, selected based on fan size, loading conditions and deflection requirements per the fan schedule and specification. Coordinate requirement with Part 4, Vibration and Noise Control in this Section 23 15 92. Install unit in strict accordance with manufacturer's instructions.
- 26.15. Vibration Isolation:** Prior to bid, the ERU Manufacturer shall review Part 4, Vibration and Noise Control as it pertains to this unit assembly. Coordinate with the Part 4 Isolation Supplier to provide an assembly for a quiet, vibration free installation. Coordination shall be accomplished prior to bid.
- 26.16. Warranty:** The unit manufacturer shall include a 5-year parts-only limited warranty against corrosion of the unit panels and base rail. If alternate steel construction is provided, the unit manufacturer shall include a 5-year parts and labor warranty against corrosion, peeling and flaking of the paint system. This warranty shall include all painted surfaces including the walls, roof, and base rail.

- 26.17. Acceptable Manufacturers:** M. K. Plastics Corporation, K-Kore Energy Recovery Plenum or equivalent by South Hampton Industrial, Annexair and Governair. M.K. Plastics is the basis of design.

## **PART 27. ERU-1 HIGH PLENUM, DILUTION EXHAUST FANS**

- 27.1. General:** Provide N+1 arrangement for the exhaust fan system. Laboratory is classified as a Level 3 by NFPA 99 and Level 4 as defined by ASHRAE. Fans shall be belt driven, high plume, AMCA arrangement as shown on the plans. Performance ratings shall conform to AMCA standard 205, 211, 260 and 311. All fans shall be licensed to bear the AMCA ratings seal for FEG ratings (AMCA 205), Air Performance (AMCA 210), Sound Performance (AMCA 300), and Induced Flow for high plume dilution fans (AMCA 260). Acceptable manufacturers whose equipment are not licensed to bear the AMCA seal for Sound, Air Performance and Induced Flow must submit performance tests conducted by an independent third party at a registered AMCA test facility, certified for accuracy and stamped by a registered professional engineer (PE). Classification for Spark Resistant Construction shall conform to AMCA 99. All fans prior to shipment shall be completely assembled and test run as a unit at the specified operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings.

Submit for approval dimensional drawings and product data on each high-plume dilution laboratory exhaust fan assembly. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted. Provide nozzle velocity of exhaust fan, total exhaust flow, and discharge plume height at specified wind velocity.

**Strictly adhere to quality assurance requirements of AMCA certification.** Provide AMCA Certified FEG minimum acceptable rating values of FEG 67, FEG 80, FEG 85 or FEG 90 as applicable for the specified fans.

- 27.2. Coatings:** Fan stand and impellers shall be corrosion resistant coated with a two part electrostatically applied, baked, corrosion resistant, Plastifer™ Polyester powder coating system. Standard finish color to be M.K. Plastics light gray. All steel surfaces shall be cleaned and prepared using a multi-stage process that includes phosphate washing to increase corrosion resistance, surface area and improve paint adhesion. Coatings shall consist of a 70% zinc rich polyester primer and a polyester powder resin top coat that shall be electrostatically applied and cured. Final coating thickness shall be a minimum 4-6 mil for superior corrosion resistance, and shall include UV inhibitors to prevent chalking from sunlight. Fan housings that have 8-10 mil thick liquid coating are not allowed.
- 27.3. Fan Housing and Outlet:** Fan housing shall be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.

Casings shall have smooth exterior and resin rich interior. Fan housing shall be manufactured in specifically formulated resins, for maximum corrosion resistance, and reinforced with fiberglass for structural strength. Fastening bolts holding the casing to the support plate are to be encapsulated in FRP. **No uncoated metal fan parts in the corrosive air stream will be allowed.**

A bifurcated fiberglass reinforced plastic (FRP) discharge nozzle shall be supplied by the fan manufacturer and designed to efficiently handle an outlet velocity of up to 7,000 FPM. The discharge shall include a venturi and fiberglass wind band to induce ambient air. All fiberglass parts shall include UV inhibitors in the resins. Flame retardancy shall be 25 or less. A graphite liner and grounding strap shall be included to remove any possible buildup of static electricity. An integral fan housing drain shall be used to drain rainwater when the fan is de-energized. A bolted housing access door shall be supplied for impeller inspection. Finish shall be Manufacturer's standard color. The hub seal shall be Teflon. Manufacturer shall provide a vacuum hub seal to avoid any contaminated air from escaping.

- 27.4. Fan Impeller:** Impellers shall have die-formed airfoil, backward curved steel blades. All hollow blade wheels shall be continuously welded around all edges. All wheels shall be statically and dynamically balanced on precision electronic balancers to a Balance Quality Grade G6.3 per ANSI/AMCA 204 or better. Fan impeller shall be coated with a minimum of 4-6 mil electrostatically applied baked polyester corrosion resistant powder coating.
- 27.5. Fan Inlet Elbow/Plenum:** Provide an inlet elbow/plenum as required for the arrangement shown on the plans. The elbow/plenum shall be equipped with bypass air damper(s) and fiberglass reinforced plastic (FRP) weather cowl and birdscreen, for introducing outside air at roof level upstream of the fan. As standard the plenum shall be constructed of corrosion resistant fiberglass, double wall, with 1" thick K-Kore™ (or preapproved equivalent) thermal and acoustical insulated fiberglass panels, bonded, reinforced and sealed together to prevent noise and air leakage. All plenums shall be mounted on an insulated curb. Provide a factory fabricated combination integral fan platform plenum curb as shown on the plans. Inlet elbow/plenum to be attached to the fan inlet by a flexible FPVC connector, provided by the fan manufacturer. Bypass air damper(s) shall be opposed-blade, airfoil design, extruded aluminum with a clear anodized finish, with linkage hardware installed in the side frame. All aluminum linkage hardware parts shall be clear anodized and all non-aluminum linkage hardware parts shall be type 316 stainless steel. Dampers shall be suitable for applications up to 10 inches wg. in extruded aluminum. Each bypass damper shall be housed inside a fiberglass reinforced plastic (FRP) weather cowl and birdscreen, to prevent the possibility of rainwater entrainment. Fan isolation damper(s) shall be parallel-blade, airfoil design, extruded aluminum with a clear anodized finish, with linkage hardware installed in the side frame. All aluminum linkage hardware parts shall be clear anodized and all non-aluminum linkage hardware parts shall be type 316 stainless steel. Dampers shall be suitable for applications up to 10 inches wg. in extruded aluminum. Each isolation damper shall be housed inside a fiberglass reinforced plastic (FRP) damper

enclosure, bolted to the bypass air plenum with a round slip connection at one end for fan inlet attachment. All dampers shall have an extended control shaft for electronic or manual control actuation.

- 27.6. Fan Motor and Drives:** Motors to be premium efficiency, standard NEMA frame, 1800 RPM, TEFC with a 1.15 service factor. A factory mounted NEMA 4X disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.

Fans submitted that use 900 RPM, 1200 RPM, or C-Face motors, shall include one spare motor per fan system, in accordance with ANSI Z9.5, section 4.14.7.4, CRITICAL SERVICE SPARES. **Contractor shall be responsible for all changes and coordination with the electrical contractor and the electrical engineer if this option is provided.**

Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service. Motor sheaves shall be cast iron, fixed pitch. Shaft shall be ANSI C-1045 steel, and shall be coated with TECTYL protectant.

Bearings shall be heavy duty, grease lubricated, spherical roller or adapter mounted anti-friction ball, self-aligning, pillow block type and selected for a minimum average bearing life (AFBMA L-10) in excess of 200,000 hours at the maximum fan RPM. All shaft bearings and non-permanently lubricated motors shall have extended lube lines with zerk fittings.

- 27.7. Harmonic Filters:** Fans/drives shall be provided factory installed harmonic filters that are IEEE 519 compliant and reduce TTD to 5%.
- 27.8. Manufacturers:** M. K. Plastics Corporation, model Axijet-FSW Belt-Drive High Plume Dilution Fan or equivalent by Loren Cook, Strobic or Greenheck. M.K. Plastics is the basis of design.

## **PART 28. SUPPLY AIR TERMINAL UNITS (SATU)(AHU-1)**

- 28.1. General:** Furnish and install TITUS Model DESV, or preapproved equivalent, single duct, variable air volume terminals of the sizes and capacities shown in the plans. Terminals shall be certified under the ARI Standard 880 Certification Program and carry the ARI Seal. Noncertified terminals may be submitted after testing at an independent testing laboratory under conditions selected by the engineering consultant in full compliance with ARI Standard 880.
- 28.2. Construction:** The terminal casing shall be minimum 22-gauge galvanized steel, internally lined. The discharge connection shall be slip and drive construction for attachment to metal ductwork. The casing shall be constructed to hold leakage to the maximum values shown in the Casing Leakage table.

The damper shall be heavy gauge steel with shaft rotating in Delrin® self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage to the maximum values shown in the Damper Leakage table.

Electric actuator shall directly mount to the actuator shaft. The actuator shall rotate 0 to 90° in less than 1.5 seconds with a maximum torque of 40 in-lb. The actuator shall operate on 24VAC power, over a temperature range of 40 to 120°F. The actuator shall be enclosed in an UL94V-0 rated plastic case. Direct or reverse action shall be field-selectable by applying an external jumper.

Casing with access panel shall be constructed to hold leakage to the maximum values shown in the Casing Leakage table.

At an inlet velocity of 2000 fpm, the minimum static pressure required to operate any terminal size shall not exceed 0.13-inch wg for the basic terminal.

- 28.3. Electric Heating Coil:** SCR controlled, proportional, modulating electric coils shall be supplied and installed on the terminal by the terminal manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5 inches to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3.5 inches apart, staggered for maximum thermal transfer and element life, and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety devices.

Electric coils shall contain a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, proportional electronic airflow sensor for proof of flow, and line terminal block.

The proportional electronic airflow sensor shall be totally independent of the duct static pressure and shall adjust the heater capacity according to the available airflow. The heaters shall deliver maximum heating when needed with normal minimum airflow, reduce heating with lower than minimum airflow and stop heating with no airflow. Unit shall include an integral door interlock type disconnect switch which will not allow the access door to be opened while power is on. Non-interlocking type disconnects are not acceptable. All individual components shall be UL listed or recognized.

- 28.4.** Heaters shall be equipped with a proportional SCR controller to modulate the heater load according to the temperature control signal. The electronic controller shall be compatible with the following input signals:

- Variable voltage signal 0-10 VDC
- Pulse width modulation AC or DC

- 28.5. Terminal Fiber-Free Liner:** The terminal casing shall be minimum 22-gauge galvanized steel, internally lined with engineered polymer foam insulation which complies to UL181 and NFPA 90A. Insulation shall be 1½ pound density, closed cell foam. Exposed fiberglass is not acceptable. The insulation shall be mechanically fastened to the unit casing. The casing shall be constructed to hold leakage to the maximum values shown in the Casing Leakage table.

## **PART 29. FUME HOOD AIR FLOW ALARM**

- 30.1. General:** Provide for each hood an alarm system complete with velocity monitor, velocity sensor, visual and audible alarms, LED signals and other auxiliaries required to provide safe hood operation. Note the hood fan is constant volume. The system shall be equal to TSI Fume Hood Monitor, Model FHC-50 with BAS contacts.

The fume hood face velocity monitor system shall be furnished and installed to monitor the measured face velocity of a fume hood independent of sash position and duct static pressure. The system shall continuously monitor and display face velocity to comply with the recommendation set forth in Appendix A of OSHA regulation 29 CFR 1910.1450. The system shall also indicate the presence of airflow to comply with the NFPA 45 Standard. Coordinate all power requirements with Electrical Contractor prior to bid and provide all as required for installation.

## **PART 30. GENERAL EXHAUST VALVES (GEV, FHEV, HEV ASSOCIATED WITH ERU-1)**

- 30.1. General:** Furnish and install TITUS Model DECV or preapproved equivalent, single duct, variable air volume terminals of the sizes and capacities shown in the plans.
- 30.2. Construction:** The exterior terminal casing and internal surfaces shall be shall be constructed of 304 stainless steel with a minimum of three concentric rolled beads to ensure units are round. The damper shall be 304 stainless steel with shaft rotating in Delrin® self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage to the maximum values shown in the Damper Leakage table.

Actuators shall be capable of supplying at least 40-inch lbs. of torque to the damper shaft and shall be mounted externally for service access. Electric actuator shall directly mount to the actuator shaft. The actuator shall rotate 0 to 90° in less than 1.5 seconds with a maximum torque of 40 in-lb. The actuator shall operate on 24VAC power, over a temperature range of 40 to 120°F. The actuator shall be enclosed in an UL94V-0 rated plastic case.



Direct or reverse action shall be field-selectable by applying an external jumper.

### **PART 31. LABORATORY SNORKELS**

- 31.1. General:** Troy University is purchasing the snorkels, fume arms, attachments, etc., under a separate contract. The University will furnish to the Mechanical Contractor to install (Owner furnished, Contractor installed).

### **PART 32. LABORATORY ISLAND CANOPY HOODS**

- 32.1. General:** Furnish and install single wall, solid, factory fabricated, laboratory island canopy hoods as shown on the plans. Hoods shall be suspended from the structure above. They shall be constructed of 304 Stainless steel with LED light(s) within the hood with hood mounted light switch. Exhaust inlet shall be as shown on the plans but in general, same size as the duct connecting to it. Provide all required rods, clips, etc for installation. Hanging assemblies shall be cross braced as required to prevent swaying of the hood. Hood mounting height shall be approximately 80" from bottom of hood to finish floor. Coordinate mounting height with Architect and Engineer prior to installing the hood.

### **PART 33. VARIABLE AIR VOLUME TERMINAL UNITS (AHU-2)**

- 33.1. General:** Units shall be factory-packaged pressure independent with capacity and performance as scheduled on the drawings. Unit performance data must SP rated in accordance with ARI Standard 880, and must display the ARI symbol on all units.
- 33.2. Construction:** Air volume damper, fans and controls shall be factory assembled into a single cabinet (field assembly will not be allowed). Cabinets shall be constructed of not lighter than 22 gauge, zinc-coated steel.

Plenum air inlets shall be rectangular or square. Primary air inlets shall have round/oval flanged connection. Discharge shall have 611 collar round or rectangular depending on unit size for duct attachment. Provide factory fabricated sound attenuators as required to obtain the specified noise criteria.

Internal surfaces shall be acoustically and thermally insulated 0.50" thick fiberglass free material having UL approval meeting NFPA 90A.

Units shall be provided with full bottom access panel equipped with ¼" turn fasteners for complete access to internal components.

The air volume damper assembly shall be located inside the unit casing and shall be constructed from exactly dimensioned extruded anodized aluminum or galvanized steel components. Damper blades shall have galvanized steel

or extruded ribs which key into a grooved shaft to insure permanent attachment of damper. All internal damper pivot points shall be nylon fitted for noiseless operation and shall require no lubrication.

Air volume dampers shall be constructed to prevent air leakage in excess of 2% of air rated quantity at 2" inlet static pressure.

- 33.3. Performance Rating:** Performance of units shall be based on test conducted using ASHRAE Standards and ADC Standards as guidelines where applicable with no ductwork between the unit discharge and the sound room.

- 33.4. Electric Heating Coil:** Shall be factory mounted, UL listed resistance open type heater with disc type automatic reset thermal cutout primary safety device, load carrying manual reset thermal cutout, secondary safety in load circuit. Heater elements shall be open construction, 80 percent nickel and 20 percent chromium. Terminal connections shall be stainless steel with ceramic insulators. Integral terminal panel designed to house contactors and be factory installed. Each heater shall be provided SCR control.

Disconnect switch with interlocking door handle on terminal box door to disconnect all power to the entire unit. The units shall be factory circuited/wired as required by Local and National Electrical Codes. The power/control terminal box shall be gasket for tight seal. Each unit shall have fused disconnect switch with fuses sized per nameplate of the unit.

All heaters shall also be provided with phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling.

- 33.5. Controls:** Controls shall be electronic DDC pressure independent, with adjustable minimum-maximum limits with velocity reset. Factory mounted controls shall be provided to accomplish the specified sequence of operation including damper actuator, pressure switch, electronic thermostat, transducer, damper position switch transformer, etc. Refer to Section 23 1592. Automatic Temperature Controls and Building Automation System BAS and coordinate all work with control subcontractor.

Terminal unit manufacturer shall include the cost for factory mounting, continuity check, calibrating and testing of direct digital controls. Field mounted DDC controls are not acceptable.

- 33.6. Wiring:** Factory mounted control power transformer and internal power wiring, regardless of control type shall be provided so that only a single point power connection is required. Provide manual disconnect.
- 33.7. Factory Tests:** Fan/motor combinations, volume dampers and controls shall be run tested, sequence of operation checked and cfm limit preset at the factory prior to shipment.

**33.8. Filter:** Provide 1" thick, MERV 8, disposable type filter with frame. **The Contractor is responsible for quarterly filter changes during the guarantee period and shall inscribe onto the filters' casing the date filters were installed/replaced.**

**33.9. Acceptable Manufacturers:** Price, Trane, Carrier, Titus or Enviro-Tec.

#### **PART 34. PACKAGED OUTDOOR AIR-COOLED WATER CHILLERS (C-1 AND C-2)**

**34.1. General:** The contractor shall furnish and install air-cooled water chiller with screw compressors as shown and scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled. Chillers shall be in compliance/rated, as applicable with AHRI 550/590 - Standard for Water Chilling Packages using the Vapor Compression Cycle, AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment, ASHRAE 15 - Safety Code for Mechanical Refrigeration, ASHRAE 90.1 - Energy Efficient Design of New Buildings, ASME - Boiler and Pressure Vessel Code SEC VIII, Division 1, UL 1995 - Central Cooling Air Conditioners, ASTM B117 - Standard Method of Salt Spray (Fog) Testing, ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products, ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments, ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings, ISO 9001 and California Administrative Code - Title 24. All proposals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI. Units shall be factory leak and pressure tested at 385 psig high side, 220 psig low side, then evacuated and charged. Standard power connections include main three phase power to the compressors, condenser fans and control power transformer. Provide a powered convenience outlet. A separate field supplied low voltage power source shall be provided to power the evaporator freeze protection. Coordinate power requirement with Electrical Contractor prior to bid and provide as required. Unit panels, structural elements and control boxes shall be constructed of galvanized steel and mounted on a bolted galvanized steel base. Unit panels, control boxes and the structural base shall be finished with a baked on powder paint. Anytime water only is present in the evaporator, the Trane Symbio(TM) 800 controller shall have flow control of the chilled water system. Flow control shall be accomplished either directly or through an input to a building automation system to conduct an action resulting in minimum flow through the chiller evaporator barrel to avoid potentially catastrophic damage to the evaporator due to freezing. If the system is specified to be provided with 20% by weight propylene glycol to protect down to the lowest expected ambient. Ethylene glycol is not allowed. Chiller shall comply with ASME Pressure Vessel Code Section VIII. ASME nameplates shall be attached to applicable pressure vessels including oil separators. Chillers shall be Trane Series ACR or approved equivalent by Carrier or Multi-Stack.

- 34.2. Compressors:** Construct chiller using semi-hermetic, variable speed drive, helical rotary screw compressor per circuit. Provide compressor motor that is suction gas cooled with robust construction and system design protection. Provide oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating. Provide compressor with automatic capacity reduction equipment consisting of capacity control via variable speed drive and/or slide valve. Compressor must start unloaded for soft start on motors. Chiller shall be capable of operation down to 25% load without hot gas bypass.
- 34.3. Evaporator:** The evaporator shall be designed, tested, and stamped in accordance with ASME code for a refrigerant side working pressure of 200 psig. Waterside working pressure shall be 150 psig. Insulate the evaporator with a minimum of 2 inch UV rated insulation. Insulation shall be field installed as specified elsewhere in this specification. Evaporator heaters shall be factory installed and shall protect chiller down to -20°F. Contractor shall wire separate power to energize heat tape and protect evaporator while chiller is disconnected from the main power. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned copper tubes, roller expanded into tube sheets. Provide ability to remove evaporator tubes from the heat exchanger. Evaporator shall have cleanable tubes. Provide water drain connection, vent and fittings and factory installed leaving water temperature control and low temperature cutout sensors. Water connections shall be grooved pipe. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.
- 34.4. Condenser Fans:** Low sound fans shall be balanced and direct driven. All condenser fan TEAO motors have permanently lubricated ball bearings and external overload protection. Each condenser fan shall have an integrated drive to provide variable speed for optimized efficiency and lower part load sound.
- 34.5. Condenser:** Air-cooled condenser coils shall have aluminum fins mechanically bonded to internally finned aluminum tubing. The tubing shall be a long life alloy designed to deliver corrosion performance that meets or exceeds microchannel coils. The condenser coil shall have an integral subcooling circuit. Condensers shall be factory proof tested at 525 psig and leak tested with helium in a mass spectrometer chamber at 150 psig. All tube connections are mechanical except the brazed copper to aluminum inlet and outlet connections.
- 34.6. Chiller Mounted Adaptive Frequency Drive (AFD):** The water chiller shall be furnished with a fluid cooled Adaptive Frequency Drive (AFD). The AFD efficiency shall be 97% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.96 at all loads for AFD.

All other starters shall have a minimum displacement power factor of 0.85. Power semi-conductor and capacitor cooling shall be from a liquid or air cooled heatsink. Unit shall have a single point power connection. A molded case standard interrupting capacity circuit breaker shall be factory pre-wired with terminal block power connections and equipped with a lockable external operator handle, making it available to disconnect the chiller from main power. A control power transformer shall be factory-installed and factory-wired to provide unit control power. Unit wiring shall run in liquid-tight conduit. High short circuit current rating (SCCR) of 10kA. Under Over voltage protection provided at the unit level. Customer wired 15 amp; 115-volt GFCI convenience outlet shall be factory mounted on the exterior of the control panel.

- 34.7. Harmonic Filters:** Chiller/Drives shall be provided factory installed harmonic filters that are IEEE 519 compliant and reduce TTD to 5%.
- 34.8. Compressor and Lube Oil System:** The rotary screw compressor shall be semi-hermetic, direct drive with capacity control via an adaptive frequency drive, rolling element bearings, differential refrigerant pressure oil pump and oil heater. The motor shall be suction gas cooled, hermetically sealed, permanent magnet motor. An oil separator shall be separate from the compressor. Oil filtration shall be provided internal to the compressor. Check valves in the compressor discharge and lube oil system shall also be provided.
- 34.9. Refrigerant Circuit:** Each unit shall two refrigerant circuits, with one or two rotary screw compressor per circuit. Each refrigerant circuit shall include liquid line shutoff valve, suction service valve, discharge service valve, filter (replaceable core type), liquid line sight glass, electronic expansion valve sized for maximum operating pressure, charging valve, discharge and oil line check valves, high side pressure relief valve, integrated oil loss sensor, fully modulating compressors and electronic expansion valves shall provide variable capacity modulation over the entire operating range.
- 34.10. Refrigerant Service Valves:** All outdoor units containing refrigerant shall be provided with color coated, all brass, and locking type tamper resistant caps. The locking caps shall be color coded for the refrigerant used. Caps shall be Novent Series 8668 for R-410 refrigerant with 86698 NV Multikey unlocking mechanism for R-410 refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide owner with minimum of six (6) spare keys.
- 34.11. Unit Controls:** A color, touch sensitive liquid crystal display (LCD) shall be unit mounted and a minimum of 7" diagonal. Graphical Icons provide links to sub menus on the subsystems operations. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor, evaporator, and motor information as well as associated diagnostics. The chiller control panel shall provide password protection of all setpoints. The controller shall have the ability to display all

primary sub-system operational parameters on dedicated trending graphs. The operator shall be able to create up to 6 additional custom trend graphs, choosing up to 10 unique parameters for each graph to trend log data parameters simultaneously over an adjustable period and frequency polling. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges: Run time, Number of starts, current chiller operating mode, chilled water set point and set point source, electrical current limit set point and set point source, entering and leaving evaporator water temperatures, saturated evaporator and condenser refrigerant temperatures, evaporator and condenser refrigerant pressure, oil tank pressure, intermediate oil pressure in the compressor, compressor motor current per phase, compressor motor percent RLA, compressor motor voltage per phase, phase reversal/unbalance/single phasing and over/under voltage protection, low chilled water temperature protection, high and low refrigerant pressure protection, load limit functions (both current based or pulldown rate based) to limit compressor loading on high return water temperature, condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize chiller efficiency, display diagnostics, oil pressure control based off of maintaining system differential pressure, compressors status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag and oil loss indication.

Weatherproof control panel shall be mounted on chiller, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer. The chiller controller shall utilize a microprocessor that will automatically take action to prevent chiller shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.

Provide the following safety controls with indicating lights or diagnostic readouts.

1. Low chilled water temperature protection.
2. High refrigerant pressure.
3. Low oil flow protection.
4. Loss of Oil diagnostic
5. Loss of chilled water flow.
6. Contact for remote emergency shutdown.
7. Motor current overload.
8. Phase reversal/unbalance/single phasing.
9. Over/under voltage.
10. Failure of water temperature sensor used by controller.
11. Compressor status (on or off).

Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:

1. Leaving chilled water setpoint adjustment from touch panel input
2. Entering and leaving chilled water temperature output
3. Percent RLA output for each compressor
4. Pressure output of condenser
5. Pressure output of evaporator
6. Ambient temperature output
7. Voltage output
8. Current limit setpoint adjustment from LCD input.

The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

- 34.12. Flow Switch:** Factory installed evaporator water flow switch shall be provided with the control logic to turn the chilled water flow on and off as the chiller requires for operation and protection.
- 34.38. Architectural Louvered Panels:** Louvered panels cover the complete condensing coil and service area beneath the condenser.
- 34.39. Low Noise Fan and Chiller Operation:** Manufacturer must provide both sound power and sound pressure data in decibels, per AHRI 370. A-weighted sound pressure at 30 feet should be provided at 100%, 75%, 50% and 25% load points to identify the full operational noise envelope. If manufacturer cannot meet the noise levels, sound attenuation devices and/or barrier walls must be installed to meet this performance level. Chiller shall ship with a muffler on each rotary screw compressor and very low noise condenser fans to meet the scheduled sound levels. If chiller does not meet sound levels, chiller manufacturer shall provide additional attenuation features.
- 34.40. Start-Up Service:** This subcontractor shall arrange for and bear all expenses for the services of a factory trained technician (not a sales representative) provided by the manufacturer to check charge of the systems and to start and test run the equipment for three (3) days when the installation work has been completed. Furnish complete test report indicating temperature, pressure drop, pressures, amp readings and other data required to substantiate unit performance.
- 34.41. Phase Protection:** All equipment shall also be provided with surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling.
- 34.42. System Additives:** The subcontractor shall add water treatment chemicals as recommended by a water treatment specialist. Refer to Part 39 Glycol Water Make-Up System and Chilled Water/Hot Water Hydronic Systems Chemical Treatment and System Cleaning for additional cleaning requirements.

**34.43. Warranty:** General warranties are specified in Section "General Mechanical Provisions". The Contractor and equipment Manufacturer shall provide a non-prorated, total of five years, warranty on the air-cooled chiller compressor(s). The manufacturer's warranty shall provide for the repair and/or replacement of the chiller compressor(s) that become inoperative because of defects in material or workmanship. The Contractor is responsible for any parts and labor not provided by the equipment Manufacturer. The warranty shall include refrigerant and all other costs associated with the compressor(s) shipment to the Contractor or Facility, compressor(s) replacement, installation and returning the chiller to its proper operating condition.

The Contractor shall respond within 24 hours upon notification that a chiller compressor has failed under the terms of the warranty. "Respond" shall mean having a Manufacturer certified technician onsite to evaluate the extent of the needed repairs and ordering of all items required for repair. Shipping of the replacement compressor shall be via maximum of 2-day delivery of the compressor(s) if the unit is inoperable or cannot maintain a minimum chilled water supply temperature of 50°F to the affected facility.

The warranty period shall begin on the same date as substantial completion of the installation, as determined by the Architect, and shall continue for the full product warranty period specified above.

## **PART 35. FIRE-TUBE CONDENSING BOILERS (B-1 AND B-2)**

**35.1. General:** Boiler shall be natural gas fired, fully condensing, and fire tube design. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code. Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

**35.2. Heat Exchanger:** The heater exchanger shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel interior with a carbon steel shell and of fire tube design. Fire Tube shall have an OD = 1.654" and a wall thickness = 0.039". The top and bottom tube sheets shall have a minimum thickness = 3/8". The heat exchanger shall be designed for a single-pass water flow. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger design. Cast iron, aluminum, or copper tube or water tube boilers will not be accepted. The boiler shall have a fully welded 316L stainless steel condensate collection basin.



- 35.3. Intake Filter and Dirty Filter Switch:** Boiler shall include an intake air filter with a factory installed air pressure switch. The pressure switch shall alert via the BAS and at the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.
- 35.4. Pressure Vessel:** The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow. Pressure drop shall be no greater than 6.5 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 157 gallons.
- 35.5. Burner:** Natural gas, forced draft single burner premix design. Operation of the burner shall not exceed that of 5.7% oxygen level or 40% excess air. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall be removable from the boiler without removing the gas/air manifold.
- 35.6. Acid Dilution Kit:** Manufacturer shall provide an acid dilution kit with the furnace to dilute combustion gases acidic condensate prior to piping condensate to the drain. Condensate piping from the combustion chamber to the neutralizing tank shall be PVDF acid resistant piping. Piping from discharge of neutralizing tank to drain shall be Type M hard copper tubing with wrought copper solder joint fittings unless Manufacturer recommends otherwise.
- All PVDF pipe and fittings shall be joined by no-hub mechanical joint method with plain end fittings and No-Hub couplings. Each No-Hub coupling shall have an outer band of 300 series stainless steel with 5/16" bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. The No-Hub joint shall conform to the requirements of ASTM F1673. PVDF piping shall be marked with its UL Classification to indicate compliance with UL723 (ASTM E84). All fittings shall meet or exceed Schedule 40 dimensions.
- All PVDF piping and fittings installation shall be in strict accordance with the Manufacturer's recommendations. Piping and fittings shall be Orion Super Blue PVDF (Polyvinylidene Fluoride). Equivalent products as manufactured by Enfield, GEO, Zurn and Fisher will be accepted.
- 35.7. Blower:** Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.
- 35.8. Gas Train:** The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of a minimum of 20:1 turndown.

- 35.9. Ignition:** Spark ignition with 100 percent main-valve shutoff with electronic flame supervision. Boilers using a pilot for ignition and/or UV scanners for flame supervision shall be unacceptable.
- 35.10. Jacket:** Heavy gauge primed and painted steel jacket with snap-in closures. Jacket panels shall be fully removable; the front door and side panels shall not require tools for removal. The jacket shall be mounted on a steel base with a minimum thickness = 1/4". The control compartment enclosure shall be NEMA 250, Type 1A compliant. Jacket shall have minimum 1/2" inch thick, mineral fiber insulation surrounding the heat exchanger.
- 35.11. Oxygen Sensor:** An O<sub>2</sub> sensor shall be provided with the boiler. The O<sub>2</sub> sensor shall be provided by the boiler manufacturer. The O<sub>2</sub> sensor shall be in the combustion chamber. Boilers with O<sub>2</sub> sensors placed elsewhere on the unit shall not be permitted.
- 35.12. Boiler Trim:** Boiler shall be provided with safety relief valve, pressure gauge, drain valves, condensate trap and condensate acid dilution device.
- 35.13. Acid Dilution Kit:** Manufacturer shall provide an acid dilution kit with the furnace to dilute combustion gases acidic condensate prior to piping condensate to the drain. Condensate piping from the combustion chamber to the neutralizing tank shall be PVDF acid resistant piping. Piping from discharge of neutralizing tank to drain shall be Type M hard copper tubing with wrought copper solder joint fittings unless Manufacturer recommends otherwise.

All PVDF pipe and fittings shall be joined by no-hub mechanical joint method with plain end fittings and No-Hub couplings. Each No-Hub coupling shall have an outer band of 300 series stainless steel with 5/16" bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. The No-Hub joint shall conform to the requirements of ASTM F1673. PVDF piping shall be marked with its UL Classification to indicate compliance with UL723 (ASTM E84). All fittings shall meet or exceed Schedule 40 dimensions.

All PVDF piping and fittings installation shall be in strict accordance with the Manufacturer's recommendations. Piping and fittings shall be Orion Super Blue PVDF (Polyvinylidene Fluoride). Equivalent products as manufactured by Enfield, GEO, Zurn and Fisher will be accepted.

- 35.14. Controls:** Boilers shall be provided with 8" LCD screen display displaying status, modulation percentage, setpoints, and sensor data at a minimum on the home screen. Additional information such as history and parameters can be accessed via the touchscreen display without the need for navigation buttons. Boiler shall have a password security code for the User and the Installer to access adjustable parameters. Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve. Boiler shall have a PC port allowing the connection of PC boiler software. Boiler shall display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. Boiler shall have the ability to set a time delay after a heating demand

is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours. The boilers shall be provided with factory installed Modbus and BACnet MSTP gateway interface to enable building automation system to monitor, control, and display boiler status and alarms via BACnet IP and LonWorks gateways. Coordinate requirement with the BAS Contractor and provide as required.

**35.15. Vent / Combustion Air System:** Vent shall be ICC (Industrial Chimney Company) or approved equivalent, Category IV vent system constructed of 444 stainless steel shall approved and meet the requirements of UL1738. Vent/Combustion Air assembly shall be furnished with all required hangers, spacers, etc., required for installation. Vent/Combustion Air sizes shall be as recommended by the boiler Manufacturer.

**35.16. Performance Tests:** Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply. Perform field performance tests to determine capacity and efficiency of boilers. Repeat tests until results comply with requirements indicated. Provide analysis equipment required to determine performance. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate. Notify Architect in advance of test dates. Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report. Document test results in a report and submit to Architect.

**35.17. Manufacturer:** Lochinvar Crest or equivalent Aerco "Benchmark" or Cleaver Brooks "Clearfire". Lochinvar is the basis of design.

## **PART 36. VARIABLE CAPACITY HEAT PUMP AIR CONDITIONING SYSTEM (VRF OUTDOOR UNIT)**

**36.1. General:** The variable capacity, heat pump air-conditioning system shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system. Approved equivalents by LG, Daikin and Carrier will be accepted. The system shall consist of the TUHYP outdoor unit, multiple CITY MULTI indoor units, and M-NET DDC (Direct Digital Controls) to integrate as required into the specified BAS. Each CITY MULTI indoor unit or group of CITY MULTI indoor units shall be independently controlled. The units shall be listed by Electrical Testing Laboratories (ETL) or Underwriters Laboratories and bear the ETL or UL label. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance

with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit. The units shall be covered by the manufacturer's limited warranty for a period of ten (10) year parts and ten (10) year compressor and two (2) years labor to the Owner from date of substantial completion as determined by the Architect. Contractor to provide Diamond Builder Drawings, training, etc., as required to obtain the maximum warranty coverage from the Manufacturer. **Verify voltage and power requirements with Electrical Contractor and Electrical plans prior to ordering equipment.**

- 36.2. Condensing Unit:** The TUHYP outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory prior to shipping to the project site. The sum of connected capacity of all CITY MULTI indoor units shall range from 50% to 130% of outdoor rated capacity. Outdoor unit shall have a sound rating no higher than 59 dB(A). Both refrigerant lines from the outdoor unit to indoor units shall be individually insulated. **Refer to other portions of this 23 1570 specification for refrigerant piping insulation requirements.** The outdoor unit shall have an accumulator with refrigerant level sensors and controls. The outdoor unit shall have a high-pressure safety switch, low pressure safety switch and over-current protection and DC bus protection. The outdoor unit shall have the ability to operate with a maximum height difference of 98 feet and total refrigerant tubing length of 393 feet. The greatest length is not to exceed 200 feet between the outdoor unit and the CITY MULTI indoor units and shall not require line size changes or traps. The outdoor unit shall have rated performance for heat operation at 0°F for the ambient temperature without additional low ambient controls. The outdoor unit shall be capable of cooling operation down to 23°F outdoor ambient without additional low ambient controls. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel finish and a factory applied salt/coastal environment corrosion resistant protective coating. The coil shall be protected with an integral metal hail guard.
- 36.3. Condenser Fan and Motor:** The unit shall be furnished with direct drive, variable speed motors. The fans will be forward curved type blades for quiet operation. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed. The fan motor shall be mounted for quiet operation. The fan shall be provided with a raised guard to prevent contact with moving parts.
- 36.4. Compressor:** The compressor shall be a single high performance, inverter driven, modulating capacity scroll compressor. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable down to 25%. The compressor shall be equipped with an internal thermal overload protection.

All refrigerant circuit access ports located outdoors shall be fitted with color-coded, all brass, locking type tamper resistant caps. The locking caps shall be color coded for the refrigerant used. Caps shall be Novent Series 8668 for R-410 refrigerant with 86698 NV Multikey unlocking mechanism for R-410 refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide owner with minimum of six (6) spare keys.

- 36.5. Condenser Coil:** The outdoor coil shall be of nonferrous construction with lanced or corrugated fins on copper tubing. The coil fins will have a factory applied salt/coastal environment corrosion resistant protective coating.
- 36.6. Controls:** The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair, non-polar shielded cable to provide total integration of the system. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control. System shall be capable of email generation for remote alarm annunciation to the specified BAS. Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in Mitsubishi Electric controls system configuration and operation. The representative shall provide proof of certification for Mitsubishi Electric Controls Applications Training indicating successful completion of no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one (1) eight (8) hour period to be completed during normal working hours at a time and location specified by the Architect. Prior to bid, coordinate all controls requirement with the specified BAS Contractor and provide all as required for to accomplish the specified sequences of operation, and VRF system control and monitoring.
- 36.7. Special Considerations:** The equipment manufacturer shall size the refrigerant piping for all the units and shall furnish all accessories and auxiliaries required for a complete and proper installation for the specific application shown on the drawings and the specified sequence of operation. Refer to Section Refrigerant Piping and Accessories for additional requirements

- 36.8. Phase Protection:** All indoor and outdoor equipment shall also be provided with surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Protection shall be provided for all 3-phase equipment utilizing ICM Controls Model 450 or equivalent. All single-phase equipment with horsepower greater than or equal to 1/8 HP shall be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure appropriate for the installation. The Contractor shall consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities.
- 36.9. Refrigerant Service Valves:** All outdoor units containing refrigerant shall be provided with color coated, all brass, and locking type tamper resistant caps. The locking caps shall be color coded for the refrigerant used. Caps shall be Novent Series 8668 for R-410 refrigerant with 86698 NV Multikey unlocking mechanism for R-410 refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide owner with minimum of six (6) spare keys.
- 36.10. Factory Start-up Service:** For all systems with specified, the Contractor shall provide for a factory-trained technician, employed by the unit manufacturer and not a sales representative, to check out all equipment and furnish written report indicating equipment is installed in strict accordance with manufacturer's recommendations. Also, provide temperature, pressure and amp readings taken during testing to substantiate unit performance.
- 36.11. Additional Warranty Requirements:** General warranties are specified above. The manufacturer's warranty shall provide for the repair and/or replacement of the compressor(s) that become inoperative because of defects in material or workmanship. The warranty period shall begin on the same date as substantial completion of the installation as determined by the Architect and shall continue for the full product warranty period specified above. The warranty shall include refrigerant and all other costs associated with the compressor(s) shipment to the Contractor or Facility, compressor(s) replacement, installation and returning the unit to its proper operating condition. The Contractor shall respond within 24 hours upon notification that a compressor has failed under the terms of the warranty. "Respond" shall mean having a Manufacturer certified technician on site to evaluate the extent of the needed repairs and ordering of all items required for repair.

## **PART 37. VARIABLE CAPACITY HEAT PUMP AIR CONDITIONING SYSTEM (VRF INDOOR UNITS)**

- 37.1. General:** The variable capacity, heat pump air-conditioning system indoor units shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant

Flow) zoning system. Approved equivalents by LG, Carrier and Daikin will be accepted.

- 37.2. Indoor Unit:** The TPKFY wall mounted style indoor unit. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. Return air shall be filtered by means of an easily removable, washable filter. **Verify voltage and power requirements with Electrical Contractor and Electrical plans prior to ordering equipment.**
- 37.3. Unit Cabinet:** All casings, regardless of model size, shall have the same white finish Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required. There shall be a separate back plate which secures the unit firmly to the wall.
- 37.4. Fan and Motor:** The indoor fan shall be an assembly with a turbo fan direct driven by a single motor. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set point and space temperature. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space. The grille shall have an i-see sensor that will measure room temperature variations and adjust the airflow accordingly to evenly condition the space.
- 37.5. Evaporator Coil:** The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phosphor-copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan. Condensate pumps for all indoor units shall be Blue Diamond, Series MaxiBlue or approved equivalent. Pump shall be thermally protected, up to 3.7 GPH flow rate, 23 ft. head, 15 ft. suction, self-priming, powered by the indoor unit and maximum 21-db sound level. Pump shall be provided with mounting feet, extension cables and multi-tank configuration as required. Mechanical Contractor shall coordinate power

requirements for pump, prior to bid, and provide as required to complete the installation. Both refrigerant lines to the TPKFY indoor units **shall be insulated in accordance with Refrigerant Piping Insulation, hereinbefore of this Section 23 1570.**

- 37.6. Unit Controls:** This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies. Prior to bid, coordinate all controls requirement with the specified BAS Contractor and provide all as required for to accomplish the specified sequences of operation, and VRF system control and monitoring.
- 37.7. HVAC Controls:** The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® interface required by the BAS specified in Section 23 1592. All controls shall be hardwired. Wireless controls are not allowed. The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit. Control wiring for the Simple MA remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Simple MA remote controller shall be assigned an M-NET address. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded, plenum rated wire as defined by the Diamond System Builder output. Network wiring shall be plenum rated CAT-5 with RJ-45 connection.
- 37.8. HVAC Controls Network:** The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, online maintenance support, and integration with Building Management Systems (BMS) using BACnet® interfaces. All available points from the control panel and smart controllers shall be available and shown at the operator console specified BAS in Section 15920.



- 37.9. Controllers/Thermostats:** Shall be a hardwired Simple MA Controller and shall be mounted on the wall at ADA height. The Simple MA Remote Controller shall support a selection for English for display information. The Simple MA temperature display shall be Fahrenheit. The Simple MA Remote Controller shall control the following grouped operations: On/Off, Operation Mode (cool, heat, auto\*, dry, fan and setback temperature set point,) fan speed setting, and airflow direction setting. The Simple MA Controller shall support timer settings of on/off/temperature up to 8 times in a day in 5-minute increments. The Simple MA Remote Controller shall support an Auto Off timer. The Simple MA Remote Controller shall be able to limit the set temperature range from the Simple MA Remote Controller, or via a PC through a licensed EB-50GU. Also, the temperature range can be set from a touch screen panel on the TC-24. The room temperature shall be sensed at either the Simple MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Simple MA Remote Controller shall display a four-digit error code in the event of system abnormality or error. The ME Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB5 connection terminal on the indoor unit.
- 37.10. Centralized Controller (Web-Enabled):** Provide an AE-200 Centralized Controller. The AE-200A Centralized Controller shall be powered with an integrated 100-240 VAC power supply. The AE-200A Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. This basic set of operation controls for the AE-200 Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the AE-200A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the AE-200A Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers. The AE-200A Centralized Controller shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication. All available points from the control panel and smart controllers shall be available and shown at the operator console specified BAS in Section 15920.
- 37.11. System Integration:** Provide the Mitsubishi Electric Cooling & Heating BACnet® interface, BAC-HD150, shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2004) and be Certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support BACnet Broadcast Management (BBMD). The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address. Coordinate requirement with BAS Section 15920 prior to bid and provide all as required for proper integration.

- 37.12. Refrigerant Service Valves:** Provide for the proper servicing of the equipment. All refrigerant circuit access ports located outdoors shall be fitted with color coated, all brass, and locking type tamper resistant caps. The locking caps shall be color coded for the refrigerant used. Caps shall be Novent Series 8668 for R-410 refrigerant with 86698 NV Multikey unlocking mechanism for R-410 refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide owner with minimum of six (6) spare keys.
- 37.13. Phase Protection:** All indoor and outdoor equipment shall also be provided with surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Protection shall be provided for all 3 phase equipment utilizing ICM Controls Model 450 or equivalent. All single phase equipment with horsepower greater than or equal to 1/8 HP shall be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure appropriate for the installation. The Contractor shall consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities.
- 37.14. Factory Start-up Service:** For all systems with specified, the Contractor shall provide for a factory-trained technician, employed by the unit manufacturer and not a sales representative, to check out all equipment and furnish written report indicating equipment is installed in strict accordance with manufacturer's recommendations. Also, provide temperature, pressure and amp readings taken during testing to substantiate unit performance.
- 37.15. Warranty:** Contractor shall provide Diamond System Builder drawings, completed training in the design and installation of the system, etc., as required to obtain the Manufacturer's maximum available warranty.

## **PART 38. ELECTRIC DUCT HEATERS**

- 38.1. General:** Shall be open grid, flanged type. The coil with all components shall be built in at the factory and carry a UL label. Each coil will have double thermal protection, consisting of a thermal overload Klixon device and heat limiters in the power legs. If back up contactors are used as secondary thermal overload protection in lieu of the fused elements, these contactors shall be built-in and prewired at the factory. Each heater shall be factory wired for single power connection.

The heater coil shall be provided with SCR control for maximum efficiency. All coils shall be factory fused and pre-wired as required to meet the latest National Electric Code. Each coil terminal box will be factory insulated to prevent condensation.

Resistance wire used in each coil shall be 80% nickel and 20% chromium with no iron content. Wire shall be supported by ceramic bushings, mounted in a galvanized steel frame on not more than 4" centers.

- 38.2. Accessories:** Control box with factory built-in transformers; un-fused safety disconnect; factory mounted, pre-wired, pressure-type air flow switch field adjustable from 0.07" to 5.0" WG pressure-type air flow switch. Under no circumstances will a sail switch be allowed.
- 38.3. Installation:** Complete installation shall comply with the manufacturers' installation instructions, UL listing requirements, NEC and local codes. Locate and arrange for easy access and service.
- 38.4. Acceptable Manufacturers:** Brasch, Indeeco, Tutco or Chromalox. Brasch is basis of design.

**PART 39. GLYCOL-WATER MAKE-UP SYSTEM AND CHILLED WATER/HOT WATER HYDRONIC SYSTEMS CHEMICAL TREATMENT AND SYSTEM CLEANING**

- 39.1. General:** Provide a water treatment system capable of automatically feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations. System shall include wall mounted panel, tanks, pumps, chemicals, etc. as required for a complete and functional system. Provide submittal of the proposed water treatment plan including a layout; control scheme; a list of existing make-up water chemistry. Provide a description of health, safety and environmental concerns for handling the chemicals. The system shall be initially set manually based on the water analysis of the make-up water. All chemicals and additives shall be as recommended by the water treatment specialist and as required by Troy University Facilities Division. Submit operating and maintenance manuals for the step-by-step water treatment procedures. The manuals shall include testing procedures used in determining water quality.
- 39.2. Glycol Solution:** Provide for the closed loop chilled water system a 20 percent concentration by weight of industrial grade propylene glycol, and corrosion inhibitors. Provide for the closed loop heating hot water system a 30 percent concentration by weight of industrial grade propylene glycol, and corrosion inhibitors. The glycol shall contain corrosion inhibitors. Silicate based inhibitors are not acceptable. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.
- 39.3. Pumps and Tanks:** Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. The chemical feed pumps shall be positive displacement diaphragm type. The pump's cylinders, plungers, ball check valves, and check valve bodies shall be of corrosion resistant materials suitable for the chemicals being pumped.

The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. Volumetric accuracy of the pumps shall be within one percent over the range indicated. Pump capacities shall be adjustable by positioning crank pin with micrometer setscrews. Stroke length scale shall be divided in percentage graduations engraved on scale. The discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge. The pumps shall be controlled by an external controller/timer.

Drive motors shall be 110-volt, single phase and shall have drip-proof enclosures. Provide three chemical tanks: one for each system. The tanks shall be constructed of materials compatible with the chemicals to be stored in the tank, high density polyethylene, with a hinged cover and mounted on legs. Tanks shall have filling and drain connections and gauge glass. Each tank shall be furnished with one pump, mounted and piped with black iron pipe and fittings, with suction strainer and stainless-steel screen, and with 1/2 inch relief valve with steel body and stainless steel trim. Tank bottom shall be dished concave to a radius equal to the diameter of the tank. Motor-driven agitator shall be provided. The tanks shall have sufficient capacity to require recharging as required for the systems served.

**39.4. Glycol Water Make Up Pump:** Bronze fitted, self priming, high head type suitable for pumping a 20 percent to 50 percent glycol water solution in intermittent service. The pump shall be provided with a mechanical shaft seal and be flange connected to a 1750 rpm NEMA type C motor. The pump capacity shall be minimum 3 gpm, 50 psig discharge pressure with a suction lift capability of 5 inches of mercury, with a 1/3 horsepower, drip proof motor. The pump shall be a regenerative turbine type providing self-priming with built in or external relief valve set for design head of the pump. Provide a back pressure regulating valve, spring loaded, diaphragm actuated type with bronze or steel body, stainless steel trim with capacity to relieve 100 percent of pump flow with an allowable rise in the regulated pressure of 10 psig above the set point. Set point shall be 15 psig above system PRV setting. Provide low water control, stainless steel or plastic float, positive snap acting SPST switch mechanism, rated 10 amps 120 volt AC, in General Purpose (NEMA 1) enclosure. The control shall be rated for pressures to 150 psig and make alarm circuit on low water level. The alarm circuit shall be wired to an alarm light on the nearest local Temperature Control panel (LTCP).// Provide remote output relay to indicate alarm condition at the BAS operator console.

**39.5. Chemical Injection Assembly:** Provide an injection assembly at each chemical feed point. Locate the injection assembly downstream of recirculating pumps. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the piping. Each assembly shall include a shutoff valve and check valve at the point of entrance.

**39.6. Controls and Control Panel:** Each system shall be provided with Hand – Off – Auto control, low level and operational pilot lights, and dry contact for low-level alarm connected to DDC control system. The control panel shall be a NEMA 12 enclosure suitable for surface mounting. The panel shall be constructed of coated steel with a hinged door and lock. The panel shall contain a laminated plastic nameplate identifying each of the following functions:

- (1) Main power switch and indicating light
- (2) MAN-OFF-AUTO selector switch
- (3) Indicating lamp for bleed-off valve
- (4) Indicating lamp for each chemical feed pump
- (5) Set point reading for each timer

**39.7. One Shot Feeder:** Provide a five (5) gallon shot feeder for each system. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

**39.8. Flushing and Cleaning:** The system shall be pressure tested and accepted as leak free prior to flushing and cleaning. Control systems that operate automatic isolation valves, temperature control valves, or other automated hydronic devices must be in place and operational prior to cleaning. Manual operation of automated valves is not acceptable. The contractor shall use temporary strainers to flush and clean the piping systems. Do not use Owner's permanent strainers to trap debris during pipe flushing operations. Fit the temporary construction strainers with a line size blowoff valve.

The Mechanical Contractor shall fill the system with fresh water. Meter the fill level to ascertain the system volume. Open/close automatic valves as required to achieve flow in all areas. The Water Treatment Contractor, with cooperation from the Mechanical Contractor and the BAS Contractor, shall develop a circulation plan that will ensure flow throughout the facility. A coordinated isolation plan is required to circulate the system in sections. The system should be operated as close to 10 ft/sec as possible during the cleaning and flushing operations. Install all piping main bypasses as required to facilitate cleaning.

Enable the pumps, and circulate the system for a length of time to be determined by the Water Treatment Contractor.

Flush the system with fresh water for time period as directed by the Water Treatment Contractor. Disable the pumps. The Water Treatment Contractor shall test and verify flush water quality before proceeding. Drain the system. Remove all startup strainers from the system, and clean. This shall include strainers at pumps, coils, fill points, etc. Purge the dirt separator. Fill the system and chemically clean the system as directed by the Water Treatment Contractor. Perform additional strainer cleanings in the defined systems as requested by the Water Treatment Contractor. Repeat the cleaning process until the Water Treatment Contractor deems the system acceptable. Perform final flush as directed by Water Treatment Contractor. The Water Treatment Contractor shall test and verify the final flush water condition before

proceeding. Remove all startup strainers from the system, and replace with the specified operational strainer. This includes strainers at pumps, terminal coils, fill points, etc. Refill system to operating pressure. The Water Treatment Contractor shall treat the system for normal operation. The Water Treatment Contractor shall provide test reports of system water quality to the Architect, Engineer and enclose in O&M manuals.

**39.9. Field Instructions and Training:** Conduct a training course for the operating staff at a time and place as designated by the Owner. The training period shall consist of a total 4 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. Provide field instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and posted in the Mechanical Room adjacent to the system. The field instructions shall cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

**39.10. Test Kits:** Furnish to the Owner three (3) test kits for each system.

**39.11. Warranty:** The Water Treatment Contractor shall warrant the installation and maintain the installation for a period of 12 months from the date of substantial completion, as determined by the Architect. During the warranty period, the Water Treatment Contractor is responsible for maintaining the system, chemicals, testing to verify proper levels are maintained, etc. The Water Treatment Contractor shall visit the site quarterly and provide a report of his findings to the Owner.

**39.12. Manufacturer:** Culligan, Chemtreat, Ecolab or approved equivalent.

**END OF SECTION**



## **SECTION 23 1571**

### **STAINLESS STEEL ROUND, RECTANGULAR AND FLAT OVAL EXHAUST DUCTS AND FITTINGS**

#### **1) GENERAL**

##### **1.1) RELATED DOCUMENTS**

- A) General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B) Sections 22 and 23 of the specifications are applicable in full.
- C) Ductwork and related appurtenances shall be rated for 10" WG negative pressure.
- D) All exhaust ductwork from all laboratory devices (snorkels, hoods, return/exhaust grilles and registers, etc.) to the main exhaust ducts shall be stainless steel as specified here.

##### **1.2) SUMMARY**

- A) SECTION INCLUDES: Refer to Section 4.0 for Specific System Requirements.
  - 1) Round spiral ducts and fittings
  - 2) Flat-oval spiral ducts and fittings
  - 3) Factory insulated round spiral ducts and fittings
  - 4) Factory insulated flat-oval spiral ducts and fittings
  - 5) Spiral ducts and fittings fabricated of materials other than G90 galvanized steel
  - 6) Exposed spiral ducts and fittings
  - 7) Spiral ducts and fittings that will be painted
  - 8) PVC coated spiral duct and fittings for underground burial
  - 9) PVC coated spiral duct and fittings for fume exhaust applications
  - 10) Aluminum spiral duct and fittings for swimming pools
  - 11) Seismic restraint of spiral ducts and fittings
  - 12) Leakage testing of spiral ducts and fittings

##### **1.3) REFERENCES**

- A) Eastern Sheet Metal (ESM) – Product Guide Rev # 3 04/09
- B) SPIDA – Round HVAC Duct and Fittings Guide
- C) SPIDA – Flat Oval HVAC Duct and Fittings Guide
- D) AMCA Publication 511-10 – Certified Ratings Program – Product Rating Manual for Air Control Devices
- E) ASHRAE Handbook -- HVAC Systems and Equipment (2008)
- F) ASHRAE Duct Fitting Database Version 5.00.00 (2008)
- G) NAIMA Standard AH124 (2002) -- Fibrous Glass Duct Liner Standard



- H) NFPA 90A (2009) – Standard for the Installation of Air Conditioning and Ventilating Systems.
- I) NFPA 90B (2009) – Standard for the Installation of Warm Air Heating and Air Conditioning Systems
- J) SMACNA -- HVAC Duct Construction Standards (DCS) - Metal and Flexible (2006)
- K) SMACNA Duct Performance Test Standard No. DPTS-2005
- L) SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition (2008)
- M) SMACNA -- Duct Cleanliness for New Construction Guidelines – 2000
- N) SMACNA – HVAC Air Duct Leakage Test Manual 2011
- O) UL 181 -- Factory Made Air Ducts and Air Connectors
- P) UL 723 -- Test for Surface Burning Characteristics of Building Materials
- Q) USGBC --- LEED 2009 for New Construction

#### 1.4) DEFINITIONS

- A) Rated Pressure --- material gauges/thicknesses and construction methods are defined by specified system pressure classes, as shown in Paragraph 4.0 Duct Schedules, of this section, and applying appropriate construction standards.
- B) Dual Wall Duct – Duct with an inner metal skin to retain an interstitial insulation and an outer skin to serve as the pressure shell.

#### 1.5) SUBMITTALS

- A) Product Data – including manufacturer’s installation instructions, application, materials of construction, gauges, reinforcement tables, joint type, joint spacing, acoustical lining, inner metal lining, fittings construction details, descriptive literature and maintenance data for:
  - 1) Round and Flat-Oval Spiral Duct and Fittings

#### 1.6) QUALITY ASSURANCE

- A) Manufacturers shall be members of the Spiral Duct Manufacturers Association (SPIDA) who are committed to producing quality uniform products in accordance with the above standards.
- B) Manufacturer shall have 10 years of documented experience in fabricating spiral duct and fittings for installation by non-related contractors. Contractor fabricated spiral duct and fittings are not acceptable.
- C) Manufacturer shall be a member of AMCA.
- D) Manufacturer shall participate in AMCA Certified Ratings Program for Round Spiral Duct and publish the ratings per AMCA Publication 511-10 section 20.

## 2) PRODUCTS

### 2.1) CONSTRUCTION

- A) Gauge Selection shall be as required for 10" negative pressure with minimum being 18 ga. Stainless steel.
- B) Sealing
  - 1) All exhaust duct duct shall be welded.
- C) Sizing
  - 1) Duct sizes shown are inside clear dimensions. For dual wall duct and for lined single wall ducts, maintain sizes inside lining.
  - 2) Factory-fabricated longitudinal seam welded duct is acceptable for ducts larger than standard factory spiral sizes.
- D) Fitting Construction
  - 1) Branch fittings may be provided as full body fittings or as saddles factory mounted on spiral pipe. Branch types shall be as shown on the drawings. Field mounted branches are not acceptable except as noted below.
  - 2) Field mounted saddles are not allowed.
- E) Dual wall duct fittings shall have spacers to maintain concentricity.
- F) All oval fittings with a major axis greater than or equal to 40" shall have continuously welded longitudinal and radial seams.
- G) The outer pressure shell of dual wall round duct fittings greater than or equal to 40" diameter and all dual wall oval duct fittings with a major axis greater than or equal to 40" shall have continuously welded longitudinal seams.
- H) Duct Cleanliness – Refer to Section 22 15 70.
- I) Duct Reinforcement
  - 1) As required for 10" Negative pressure
- J) Acceptable Manufacturer's - Subject to compliance with project specific requirements, provide products manufactured by one of the following:
  - 1) Eastern Sheet Metal
  - 2) United McGill
  - 3) Lindab
  - 4) Hamlin
  - 5) Others require prior approval

## 2.2) MATERIALS

- A) Sheet Metal
  - a) First fifty linear feet from the energy recovery unit shall be double wall, no perforations, Factory fabricated and insulated 304 stainless steel, Comply with ASTM A167; Type 304 with Finish No. 2B.
  - b) Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections, including pitting, dents and other imperfections including those which

would impair post painting. Exposed to view ductwork shall be as outlined in part a above.

- B) Metal inner liners for dual wall duct construction
  - 1) Unless noted otherwise, the inner wall for dual wall duct fittings shall be 18 gauge solid stainless steel.
- C) Reinforcement, unless otherwise specified, structural reinforcement will match the duct material and be in compliance with SMACNA and as required for 10" negative pressure.
- D) Connectors, unless otherwise specified, connectors will match the duct material.
- E) Fasteners – unless otherwise specified, structural reinforcement will match the duct material, i.e. 304 stainless steel.

### 3) EXECUTION

#### 3.1) DUCT INSTALLATION

- A) Install ducts according to MANUFACTURERS INSTALLATION INSTRUCTIONS.
- B) Install round and flat-oval ducts in maximum practical lengths per the SMACNA 2005 DCS, Chapter 5 "Hanging and supporting system." Contractor shall have experience in hanging stainless steel ductwork and shall determine the best method of hanging the ductwork to avoid dissimilar metal contact or other corrosion that could be caused in a laboratory environment.
- C) Install ducts with fewest possible joints.
- D) All duct penetrations shall be sealed.
- E) Install factory fabricated and insulated fittings for changes in direction, size and shape and for branch connections for the first fifty linear feet.
- F) Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G) Install ducts close to walls overhead construction columns and other structural and permanent enclosure elements of building.
- H) Route ducts to avoid passing through electrical equipment rooms and enclosures.
- I) Where ducts pass through non-fire rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges (escutcheon plates) of same material thickness as duct. Overlap openings on all sides by at least 1.5 inches.
- J) Where ducts pass through fire rated interior partitions or shafts, ductwork shall be wrapped with " thickness fire wrap as specified in section 23 15 70.
- K) Protect duct interiors from moisture, construction debris and dust, and other foreign materials as specified in Section 23 15 70.

### 3.2) TRANSVERSE CONNECTIONS

- A) All transverse connections shall be welded.

### 3.3) INSTALLATION OF EXPOSED DUCTWORK

- A) Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B) Welds shall be smooth and provide an aesthetically appealing view as determined by the Architect.
- C) Maintain consistency, symmetry and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories and air outlets.

### 3.4) PAINTING DUCT -Not required for stainless steel duct.

### 3.5) HANGER AND SUPPORT INSTALLATION

- A) The upper attachment of suspension systems shall be based upon three times (3x) the anticipated weight load.
- B) Deflection of trapeze or horizontal supports shall not exceed 3/8".
- C) Maximum hanger or support spacing shall be 10 feet.
- D) Proprietary hanger and support systems shall be used in accordance with manufacturer's installation instructions.
- E) Contractor fabricated hanger and support systems shall be in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.

### 3.6) FIELD QUALITY CONTROL

- A) Duct Cleanliness – Installation of ductwork under this section shall comply with the “Intermediate” requirements defined within the SMACNA “Duct Cleanliness for New Construction Guidelines”. It is the responsibility of the installing contractor to wipe down the interior of the duct prior to installation and to cap all open duct ends once installed. Refer to Section 23 15 70 for additional requirements.
- B) Leakage Tests
  - 1) Refer to Section 23 15 70.
  - 2) Testing methods shall be in accordance with the SMACNA HVAC Duct Leakage Test Manual. The scope of testing shall exceed the recommendations of the Manual.
  - 3) Representative sections totaling no less than 25% of the total installed duct area for the designated pressure class shall be tested. Should any portion fail to achieve the designated leakage rate, an additional 25% percent of the total installed duct area shall be

tested. Should any portion of this additional duct fail to achieve the designated leakage rate all duct must be tested.

- 4) All sections shall be selected by the building owner or the designated representative of the building owner.
- 5) Positive pressure leakage testing is acceptable for negative pressure ductwork.
- 6) Any duct failing the pressure test will be resealed and retested, at no extra expense to the owner, until the appropriate leakage rate is achieved.

#### 4) DUCT SCHEDULES

##### 4.1) FUME EXHAUST

- A) Systems: ERU-1
- B) Material: Stainless Steel Type 304
- C) Pressure Class: -10" WG
- D) Double and Single Wall as specified above

## **BUILDING MANAGEMENT SYSTEM (BMS) AND AUTOMATIC TEMPERATURE CONTROL (ATC) SYSTEMS**

### **SECTION 23 1592**

#### **1.1 GENERAL**

A. The BMS/ATC (Building Management System/Automatic Temperature Control) systems as specified herein shall be provided in their entirety by **Trane** as the BMS/ATC Contractor. The BMS/ATC Contractor shall base his Bid on the system as specified, the sequence of operations, the points list and contract documents. Regardless of the points listed in these documents, the Contractor shall provide the number of points, the types of points, and other controls as required for the proper monitoring and control of the specified sequences of operation. Where conflicts occur between this specification section and other referenced specifications, the strictest requirement shall apply. Sections 22, 23 and Section 16 specifications are applicable in full.

#### **1.2 SUMMARY**

- A. This Facility is considered a Level 3 Laboratory as defined by NFPA 99 and Level 4 as defined by ASHRAE. All requirements apply.
- B. The BMS/ATC shall be hardwired. Wireless controls are not allowed.
- C. Furnish and install a Facility Management and Lab Control system as specified hereafter and indicated on the drawings. Systems shall consist of all direct digital control equipment, thermostats, humidistats, valves, dampers, operators, switches, sensors, controllers, conduit, and wiring. The BMS shall be utilized for monitoring/control of all HVAC systems specified. The system provided shall be fully integrated into the existing Trane campus wide network. The DDC system shall not require the addition of any central workstation hardware or software to enable centralized control as specified.
- D. The Building Management System (BMS) and Automatic Temperature Control (ATC) Systems shall be complete in all respects, tested, and ready for operation. Campus Wide Communication shall utilize existing TCP/IP Ethernet, switches, etc., provided by Owner. Coordinate all TCP/IP Ethernet, switches, etc., requirements prior to bid with Troy University I.T. Department else be responsible for providing requirements at no additional charge to Troy University.
- D. The system shall be completely digital with electric actuation for system components.
- E. The control system shall interface completely with laboratory fume hood controls and room/building pressure controls. The basis of design for the fume hood/pressure controls is TSI inc. Other Manufacturer's require 10-day prior approval. Follow prior approval procedures as specified in the Division One specifications.

- F. This contractor shall be responsible for provision, installation, and setup up of all fume hood/room pressure controls including Supply Air Terminal Units and Exhaust Air Valves. Coordinate all requirements with the Mechanical Contractor and Test and Balancing Contractor as required and provide as specified. All material shall comply with specifications as follow.

### **1.3 SUBMITTAL DATA**

- A. General: All submittals shall comply with the requirements of Division 1- GENERAL REQUIREMENTS and Section 22 1510 and 23 1570.
- B. Product Data: Data shall be submitted for the following items:
  - 1. Control devices including those factory mounted as an integrated part of the mechanical equipment.
  - 2. Valves
  - 3. Dampers
  - 4. Control System Diagrams
  - 5. Points Lists by Systems
  - 6. Microprocessors
  - 7. Flowmeters
  - 8. Remaining items as shown on the plans
  - 9. Lab fume hood controllers
  - 10. Room pressure monitors
  - 11. Lab controllers
  - 12. Fume Hood Alarm
- C. Operation and maintenance instructions: Data shall be provided for the following items:
  - 1. All items shown on the plans

### **1.4 QUALITY ASSURANCE**

- A. Qualifications of BMS/ATC Installers
  - 1. Installers shall have a minimum experience of fifteen years in the engineering, installation, calibration, and software programming of DDC controls on commercial laboratory systems of same size and scope of this project.
  - 2. The installer shall be a directly owned factory office of the control manufacturer with factory trained service personnel permanently located within a 100 mile radius of the job site.

### **1.5 RELATED WORK**

- A. All automatic valves and separable wells provided under this section shall be installed by the mechanical contractor in accordance with Division 23.

- B. Piping connections, taps, and wells required for flow, pressure, or temperature devices shall be installed by the mechanical contractor in accordance with Division 23.
- C. All automatic dampers and air flow measuring stations provided under this section shall be installed by the mechanical contractor in accordance with Division 23.
- D. Power wiring to Control Panels and interconnection of smoke detectors to building fire alarm system shall be provided under Electrical Division of the specifications. Remaining requirements shall be by the Mechanical Contractor. Coordinate as required for a seamless installation and integration.
- E. Control conduit requirements shall be as specified in Electrical Division of the specifications and/or shown on electrical drawings. All control conduit, power wiring, relays, transformers, contactors, etc. which are required for controls, which are not shown on the electrical drawings or specified in the Electrical Division of the specifications, shall be provided under this HVAC Section. Coordinate all requirements with the Electrical Sub-Contractor prior to bid.
- F. All adjustable wall mounted sensors, thermostat and humidistat boxes shall be mounted 46" A.F.F. to the center of the box (ADA height). Electrical work performed under this Section shall conform to requirements set forth in the Electrical Division of the specifications. All wall-mounted devices shall be provided with hinged, locking metal covers with rounded edges, as desired by the Owner.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL DESCRIPTION**

A. The Facility Management System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.

B. The facility management system shall consist of the following:

- Standalone DDC panels
- Standalone application specific controllers (ASCs)
- Standalone make up air controller and fume hood controls

The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, standalone DDC panels, and operator devices.

C. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate



independently by performing its own specified control, alarm management, operator I/O and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

D. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

E. It shall be the responsibility of the BAS/ATC Contractor to fully coordinate with all equipment suppliers, and with the fire alarm system designer/installer to provide a complete functional control system.

F. All Direct Digital Controllers shall be factory mounted, programmed and commissioned. Where factory mounting, programming or commissioning is not possible, it shall be the responsibility of BAS/ATC Contractor to provide, at time of submittal, a detailed plan as required. It shall be the responsibility of the Mechanical Equipment Supplier and the ATC Contractor to ensure that the entire system (Mechanical Equipment and Automatic Temperature Controls) be free of defect and function as specified. Any control devices required by the "Mechanical Equipment" specification or the "Automatic Temperature Control" specification shall be furnished without any additional cost to owner.

## **2.2 NETWORKING / COMMUNICATIONS**

The design of the FMS shall network the existing operator workstations and Standalone DDC panels. Inherent in the system's design shall be the ability to expand or modify the network either via the local area network.

### **A. Local Area Network**

#### **1. Workstation/DDC Panel Support**

Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.

#### **2. Dynamic Data Access**

All operator devices shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

Access to system data shall not be restricted by the hardware configuration of the facility management system. The hardware configuration of the FMS network

shall be totally transparent to the user when accessing data or developing control programs.

### 3. General Network Design

Network design shall include the following provisions:

- a. High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices.
- b. Support of any combination of controllers and operator workstations directly connected to the local area network. All devices shall be supported on a single local area network.
- c. Message and alarm buffering to prevent information from being lost.
- d. Error detection, correction, and retransmission to guarantee data integrity.
- e. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
- f. Software synchronization of the real-time clocks in all DDC panels shall be provided.

## 2.3 STANDALONE DDC PANELS

### A. General

Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and plans.

### B. Memory

Each DDC panel shall have sufficient memory to support its own operating system and databases including:

- Control Processes
- Energy Management Applications
- Alarm Management
- Historical/Trend Data for all points
- Maintenance Support Applications
- Custom Processes
- Operator I/O
- Dial-Up Communications

- Manual Override Monitoring

#### C. Point Types

Each DDC panel shall support the following types of point inputs and outputs:

- Digital inputs for status/alarm contacts
- Digital outputs for on/off equipment control
- Analog inputs for temperature, pressure, humidity, flow, and position measurements
- Analog outputs for valve and damper position control, and capacity control of primary equipment
- Pulse inputs for pulsed contact monitoring

#### D. Expandability

The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.

The system architecture shall support 10% expansion capacity of all types of DDC panels, and all point types included in the initial installation.

## 2.4 SYSTEM SOFTWARE

#### A. General

All necessary software and programming necessary to form a complete operating system as described in this specification shall be provided.

#### B. Control Software Description

##### 1. Pre-Tested Control Algorithms

The DDC panels shall have the ability to perform the following pre-tested control algorithms:

- Two Position Control
- Three position control
- Proportional Control
- Proportional plus Integral Control
- Proportional, Integral, plus
- Derivative Control
- Automatic Control Loop Tuning

##### 2. Equipment Cycling Protection

Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

### 3. Heavy Equipment Delays

The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

### 4. Power Fail Motor Restart

Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

## C. Energy Management Applications

DDC panels shall have the ability to perform any or all of the following energy management routines:

- Time of Day Scheduling
- Calendar Based Scheduling
- Holiday Scheduling
- Temporary Schedule Overrides
- Optimal Start
- Optimal Stop
- Night Setback Control
- Enthalpy Switchover (Economizer)
- Peak Demand Limiting
- Temperature Compensated Load Rolling
- Fan Speed/CFM Control
- Heating/Cooling Interlock
- Supply Air Reset
- Supply Water Reset
- Chilled Water Reset
- Boiler Hot Water Reset
- Chiller Sequencing
- All items show on the plans and as specified.

All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

## D. Alarm Management

Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either

operator activity at a PC workstation or local I/O device, or communications with other panels on the network.

#### 1. Point Change Report Description

All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

#### 2. Prioritization

The user shall be able to define the specific system reaction (i.e. OWS alarm display etc.) for each point. Alarms shall be prioritized to enhance operator response to critical alarms. A minimum of three priority levels shall be provided.

#### 3. Report Routing

Alarm reports, messages, and files will be directed to user-defined operator devices, or PC(s) used for archiving alarm information. Alarms shall also be automatically directed to a default device when the primary device is off-line.

#### 4. Alarm Messages

In addition to the point's descriptor and the time and date, the user shall be able to print, display or store the alarm message to more fully describe the alarm condition or direct operator response.

#### F. Historical Data and Trend Analysis

A variety of Historical Data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.

##### 1. Continuous Point Histories

Standalone DDC panels shall store continuous Point History Files for those analog inputs and binary inputs and outputs listed on the point schedule.

The Point History routine shall continuously and automatically sample the value of selected analog inputs at half hour intervals. Samples shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points shall include a continuous record of the last ten status changes or commands for each point.

##### 2. Extended Sample Period Trends

Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting data over extended periods of time. Minimum sample intervals of 1 minute to 2 hours shall be provided. Each standalone DDC panel shall have a dedicated buffer for trend data, and shall be capable of storing a minimum of 5000 data samples.

### 3. Data Storage and Archiving

Trend data shall be stored at the standalone DDC panels, and up-loaded to hard disk storage when archival is desired. Uploads shall occur based upon either user defined interval, manual command, or when the trend buffers become full. All trend data shall be available for use in third party computer applications.

#### G. Runtime Totalization

Standalone DDC panels shall automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.

The Totalization routine shall have a sampling resolution of one minute or less.

The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

#### H. Analog/Pulse Totalization

Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, Gallons, KBTU, Tons, etc.).

The Totalization routine shall have a sampling resolution of one minute or less.

The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

#### I. Event Totalization

Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event Totalization shall be performed on a daily, weekly, monthly or yearly basis.

The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

## **2.5 APPLICATION SPECIFIC CONTROLLERS- HVAC APPLICATIONS**

### **A. General**

Each Standalone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).

Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

Each ASC shall have sufficient memory to support its own operating system and data bases including:

- Control Processes
- Energy Management Applications
- Operator I/O (Portable Service Terminal)

The operator interface to any ASC point data or programs shall be through any network-resident PC workstation, Cell phone or any PC or portable operator's terminal connected to any DDC panel in the network or local I/O devices (LED's Switches etc.) where described and provided.

All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

## **Part 2.6 Laboratory Specification**

### **2.6.1 Description**

This facility is classified as a Level/Category 3 per NFPA 99. A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. The exhaust flow rate of a laboratory fume hood shall be controlled precisely to maintain a constant average face velocity into the fume hood. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates and maintain laboratory pressurization in relation to adjacent spaces (positive or negative). The laboratory airflow control system shall be capable of operating as a standalone system or as a system integrated with the Building Management System (BMS).

### **2.6.2 Acceptable Manufacturers**

- A. The plans and specifications for the laboratory airflow control system are based on systems and equipment manufactured by TSI Corporation. Equivalent by Phoenix will be acceptable.

- B. The laboratory airflow system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical spaces using a Quality Management System registered to ISO 9001:Current Date.
- C. In strict accordance with this specification, alternative laboratory airflow control systems and equipment shall only be considered for approval provided that the equipment be equal in every respect to the operational characteristics, capacities and intent of control sequences specified herein. Approval to bid does not relieve the laboratory airflow control system supplier from complying with the minimum requirements or intent of this specification.
- D. The Engineer and Owner shall be the sole judges of quality and equivalence of equipment, materials, methods and life cycle cost.

### **2.6.3 Warranty Period**

Warranty shall commence upon the date of substantial completion of the facility as determined by the Architect and extend for a period of 12 months, whereupon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the owner.

## **3.0 Laboratory Fume Hood Controller**

- A. Description  
A Fume Hood Controller shall be furnished and installed to monitor and control the measured face velocity of a fume hood independent of sash position and duct static pressure. The system shall continuously monitor face velocity to comply with the recommendation set forth in Appendix A of OSHA regulation 29 CFR 1910.1450. The system shall also indicate the presence of airflow to comply with the NFPA 45 Standard.
- B. Acceptable Manufacturers  
Specifications and drawings are based on TSI Inc. Model FHC50-01 Fume Hood Controller.
- C. Alternate Manufacturers
  - i) Systems and equipment by manufacturers other than TSI shall be part of a completely designed, tested, cataloged, and factory coordinated package from a single manufacturer. Manufacturer shall have successful customer installations of Fume Hood Controllers in operation for a period of over five years.
  - ii) Equipment other than that manufactured by TSI will only be considered for acceptance if the substituted equipment is equal to every aspect of the operation capabilities, capacities, and control sequence intent. The Owner and Engineer shall be the sole judge of equivalence.



- iii) The alternate manufacturer shall provide a separate concordance schedule indicating the section, paragraph, and subparagraph of these specifications with a direct statement designating the compliance with these specifications. For all areas of non-compliance, the alternate manufacturer shall detail the specific approach taken. The alternate manufacturer shall detail the impact of any substitutions on user safety, energy costs, and the sizing of the ducts, fans, boilers, chillers, air handlers and any other equipment. Alternate manufacturers approved to bid must comply with the intent and requirements of the specification.
- iv) Fume Hood Controllers measuring volumetric exhaust flow and sash position to calculate average face velocity are unacceptable.

**D. Warranty**

The Fume Hood Controller shall have a limited two-year warranty for all parts. The warranty shall commence on the date of substantial completion as determined by the Architect.

**3.1 - System Performance Requirements**

- A) The Fume Hood Controller shall use a sidewall sensor to measure the average fume hood face velocity. The sidewall sensor shall have the sensitivity to measure the effects of obstructions and duct static pressure fluctuations on the average fume hood face velocity. The fume hood sensor shall have a resolution of 1 foot per minute velocity and shall detect any change in the face velocity within 0.05 second. Volumetric airflow measurements used to imply fume hood face velocity shall not be acceptable.
- B) The Fume Hood Controller shall be completely independent for each individual fume hood. The fume hood control system shall control the face velocity independent of other fume hood and laboratory control systems. The Fume Hood Controller shall be able to respond to face velocity disturbances caused by events including but not limited to sash movement.
- C) Room air shall be drawn across the sensing element. If hood design or installation prohibits room air from being drawn across the sensor, a fume hood sensor venting kit shall vent room air through an orifice in the front of the hood to the sensing element. Fume hoods needing vent kits include but are not limited to those hoods where the chase is connected to the plenum or extends up to the ceiling.
- D) To ensure fast, accurate control, the Fume Hood Controller shall have a PID control algorithm with two sets of tuning constants. The two sets of tuning constants enable fast response to large disturbances while maintaining stability at setpoint. The control sensitivity defining the breakpoint between input and steady state response shall be adjustable. The fume hood face velocity control system shall update the control output 20 times per second.
- E) Local audible and visual alarms and relay contacts shall be enabled whenever the measured face velocity falls below a user configurable low alarm set point or rises

above a user configurable high alarm set point. A mute key shall silence the audible alarm.

- F) Calibration shall be done electronically through the use of the integral keypad. Calibration shall consist of adjusting the sensor zero point and sensor span to match a reference measurement. Password protection of the calibration items shall limit unauthorized access. Neither remote calibration nor calibrating through the use of potentiometers is acceptable. Factory calibration alone is not permitted.
- G) The Fume Hood Controller shall have an emergency key and an emergency input contact, either of which shall completely open that fume hood's damper (or variable speed drive) for maximum exhaust in the event of a spill.
- H) For energy-efficiency, the Fume Hood Controller shall have a setback input contact and a setback key, either of which shall initiate control for that fume hood at a reduced face velocity setpoint. The Fume Hood Controller shall automatically adjust high and low alarm set points to avoid nuisance alarms when setback mode is enabled.

### 3.2 Materials

- A) The Fume Hood Controller shall use a sidewall sensor to measure the average fume hood face velocity. The sidewall sensor shall use a precision platinum RTD, ceramic coated for corrosion resistance and ease of maintenance. The sidewall sensor shall be temperature compensated over a range of 55°F to 95°F. Systems employing a thermistor-based face velocity sensor or measuring the exhaust flow volume and open sash area to calculate face velocity are not allowed.
- B) The Fume Hood Controller shall have a graphic display of the measured average face velocity and all configuration parameters. Configuration shall be done through a keypad integral to the controller. Password protection shall limit unauthorized access to configuration parameters. The controller shall have indicator lights for alarm, mute, or normal operating conditions. High, low or no flow alarm contacts shall close in the appropriate alarm condition. An analog output of face velocity shall be user-configurable to either 0 to 10V or 4 to 20 mA. The Fume Hood Controller shall have an RS-485 communications port, supporting the MODBUS and Johnson Controls N2 protocols for seamless integration to the building automation system.

Alternate: The Fume Hood Monitor (Model FHC50-01-BAC) shall have an RS-485 communications port, supporting BACnet® MS/TP protocol for seamless integration to building automation systems.

Alternate: The Fume Hood Monitor (Model FHC50-01-LON) shall have an RS-485 communications port, supporting LonWorks® protocol for seamless integration to building automation systems.

- C) The Fume Hood Controller shall be provided with a damper/actuator assembly. Damper assemblies shall be round butterfly, to fit the ductwork. Damper material shall be 16-gauge galvanized steel, 304 stainless steel, 316 stainless steel, or Ameron-coated galvanized steel to match the ductwork. Pressure drop through a fully open damper shall be less than 0.1 in H<sub>2</sub>O at 2000 fpm velocity. Round

dampers shall have two factory-formed ridges to prevent binding. Dampers shall be sleeve-mounted.

Alternate: Damper assemblies shall be flange-mounted.

Alternate: Damper assemblies shall be flange-mounted with companion rings.

Alternate: The Fume Hood Controller shall be provided with a venturi valve/actuator assembly.

- D. The damper shall have a factory-mounted electric actuator. The electric actuator shall have a stroke time of less than 1.5 seconds for a 90 degree rotation. A thermally-resettable fuse shall protect the motor from overload. Direct or reverse action shall be field-selectable.

#### **Part 4.0 – Room Controller**

A) Description

A room controller system shall be furnished and installed to maintain the measured laboratory pressurization independent of supply and exhaust flow volumes. The system shall ensure that the air flows into the laboratory space from areas of low hazard to comply with the requirement for air flow monitors in ANSI Z9.5.

B) Acceptable Manufacturers

Specifications and drawings are based on TSI Inc. SUREFLOW™ Model 8681 Room Controller or equivalent by Phoenix.

C) Alternate Manufacturers

- i) Systems and equipment by manufacturers other than TSI shall be part of a completely designed, tested, cataloged, and factory coordinated package from a single manufacturer. Manufacturer shall have successful customer installations of room control systems in operation for a period of over five years.
- ii) Equipment other than that manufactured by TSI will only be considered for acceptance if the substituted equipment is equal to every aspect of the operation capabilities, capacities, and control sequence intent. The Owner and the Engineer shall be the sole judge of equivalence.
- iii) The alternate manufacturer shall provide a separate concordance schedule indicating the section, paragraph, and subparagraph of these specifications with a direct statement designating the compliance with these specifications. For all areas of non-compliance, the alternate manufacturer shall detail the specific approach taken. The alternate manufacturer shall detail the impact of any substitutions on user safety, energy costs, and the sizing of the ducts, fans, boilers, chillers, air handlers and any other equipment. Alternate manufacturers approved to bid must comply with the intent and requirements of the specification.

- iv) Room control systems designed to solely maintain either a pressure differential or volume offset are unacceptable.

#### **4.1 Warranty**

- A) The room control system shall have a limited two-year warranty for all parts. The warranty shall commence on the date of substantial completion as determined by the Architect.

#### **4.2 System Performance Requirements**

- A) The room control system shall be completely independent for each individual laboratory. The room control system shall not depend on measurements from other laboratory control systems.
- B) The room control system shall independently control the supply and the general exhaust with 0 to 10 VDC signals to maintain a difference between the supply and exhaust flow volumes (offset). If the offset is greater than setpoint, then the room controller shall decrease the general exhaust flow rate and then increase the supply flow rate to its maximum set point until the desired offset is achieved. If the offset is less than setpoint, the room controller shall decrease the supply flow rate to its ventilation minimum setpoint and then increase the general exhaust flow rate until the desired offset is achieved. The room controller shall receive voltage signals related to the supply, general exhaust, and fume hood or total exhaust air flow volumes.
- C) The room control system shall measure the pressure differential between the laboratory and reference space. The room control system shall reset the offset within user-configured limits to maintain room pressure set point. The room pressure sensor shall have a resolution of 5% of the measured value and shall detect any change in the room pressure within 0.1 second, with a minimum reading of 0.0001 inches H<sub>2</sub>O.
- D) The room controller shall control the space temperature by modulating the reheat valve with a 0 to 10 VDC control signal and the supply air volume. When the space is too warm, the room controller shall close the reheat valve and then increase the supply air volume. When the space is too cool, the room controller shall reduce the supply air volume to its ventilation minimum set point and then open the reheat valve. The exhaust air volume will follow the supply air volume to maintain room balance. The room controller shall accept a 1000  $\Omega$  platinum RTD temperature sensor. The room controller shall always provide additional supply air as needed for to maintain room balance.
- E) To ensure fast, accurate control, the room control system shall have a PID control algorithm with two sets of tuning constants. The two sets of tuning constants enable fast response to large disturbances while maintaining stability at setpoint. The control sensitivity defining the breakpoint between input and steady state response shall be adjustable. The room control system shall update the control output 10 times per second.

- F) Local audible and visual alarms and relay contacts shall be enabled whenever the measured room pressure differential falls below a user configurable low alarm set point or rises above a user configurable high alarm set point, after a configurable delay. A mute key shall temporarily silence the audible alarm. Manual or automatic reset of the alarms shall be configurable.
- G) Local audible and visual alarms shall be enabled whenever the supply or exhaust air volume falls below the configurable low alarm set point, after a configurable delay. A mute key shall temporarily silence the audible alarm. Manual or automatic reset of the alarms shall be configurable.
- H) The room control system shall have an emergency key to enable emergency mode. The room control system will drive the supply and general exhaust dampers to achieve maximum pressurization in emergency mode.
- I) The room controller shall have an unoccupied mode, enabled through RS-485 communications. In unoccupied conditions, the room controller shall utilize a second minimum supply flow set point and will not increase the supply flow rate for cooling.
- J) Calibration of room pressure differential and air flows shall be done electronically through the use of the integral keypad. Calibration shall consist of adjusting the sensor zero point and sensor span to match a reference measurement. Password protection of the calibration items shall limit unauthorized access. Neither remote calibration nor calibrating through the use of potentiometers is acceptable.

#### **Part 4.4 - Materials**

- A) The room control system shall measure the supply flow volume, exhaust flow volume, and room pressure differential. Systems that exclusively measure the room pressure or supply and exhaust flow volumes are not allowed.
- B) The room control system shall accept up to 1 supply, 1 general exhaust, and 2 other exhaust flow measurements. The flow measurements shall be 0 to 10V signals, linear with respect to either velocity pressure or velocity.
- C) The room controller shall have a digital display of all configuration parameters. Configuration shall be done through a keypad integral to the controller. Password protection shall limit unauthorized access to configuration parameters. The controller shall also have indicator lights for low and high alarm and normal operating conditions. The room controller shall have an RS-485 communications port, supporting the Modbus® or Johnson Controls N2 protocols for seamless integration to the building automation system.
- D) The room pressure sensor shall be bi-directional. The sensor shall be capable of being mounted in the corridor (reference space) or the laboratory (controlled space). The room pressure sensor shall use two in-line ceramic coated RTDs to measure the pressure differential. The room pressure sensor shall be temperature compensated over a range of 55°F to 95°F. Sensors employing a thermistor-based sensor or that cannot differentiate between positive and negative pressures

are not allowed. Field-calibration of the sensor shall be performed through the keypad on the room controller.

## **Part 5.0 – Room Pressure Monitor**

### **5.1 Description**

A room pressure monitor system shall be furnished and installed to maintain the measured laboratory pressurization independent of supply and exhaust flow volumes. The system shall ensure that the air flows into the laboratory space from areas of low hazard to comply with the requirement for air flow monitors in ANSI Z9.5.

### **5.2 Acceptable Manufacturers**

- A. Specifications and drawings are based on TSI Inc. Model 8635-M SUREFLOW™ Room Pressure Monitor. Equivalent by Phoenix will be acceptable
- B. Alternate Manufacturers
  - i.) Systems and equipment by manufacturers other than TSI shall be part of a completely designed, tested, cataloged, and factory coordinated package from a single manufacturer. Manufacturer shall have successful customer installations of room pressure monitor systems in operation for a period of over five years.
  - ii) Equipment other than that manufactured by TSI will only be considered for acceptance if the substituted equipment is equal to every aspect of the operation capabilities, capacities, and control sequence intent. The engineer shall be the sole judge of equivalence.
  - iii) The alternate manufacturer shall provide a separate concordance schedule indicating the section, paragraph, and subparagraph of these specifications with a direct statement designating the compliance with these specifications. For all areas of non-compliance, the alternate manufacturer shall detail the specific approach taken. The alternate manufacturer shall detail the impact of any substitutions on user safety, energy costs, and the sizing of the ducts, fans, boilers, chillers, air handlers and any other equipment. Alternate manufacturers approved to bid must comply with the intent and requirements of the specification.
  - iv) Room pressure monitor systems measuring the volumetric supply and exhaust flows to the room to infer the room balance are unacceptable.

### **5.3 Warranty**

- A The room pressure monitor system shall have a limited two-year warranty for all parts. The warranty shall commence on the date of substantial completion as determined by the Architect.

#### 5.4 System Performance Requirements

- A) The room pressure monitor system shall be completely independent for each individual laboratory. The room pressure monitor system shall not depend on measurements from other laboratory control systems.
- B) The room pressure monitor system shall measure the pressure differential between the laboratory and reference space. The room pressure sensor shall have a resolution of 5% of the measured value and shall detect any change in the room pressure within 0.1 second, with a minimum reading of 0.0001 inches H<sub>2</sub>O.
- C) Local audible and visual alarms and relay contacts shall be enabled whenever the measured room pressure differential falls below a user configurable low alarm set point or rises above a user configurable high alarm set point, after a configurable delay. A mute key shall temporarily silence the audible alarm for a user configured delay. Manual or automatic reset of the alarms shall be configurable.
- D) Local audible and visual alarms shall be enabled whenever the measured air volume falls below the configurable low alarm set point, after a configurable delay. The audible alarm shall have a mute key to temporarily silence the alarm for a user-configured delay. Manual or automatic reset of the alarms shall be configurable.
- E) The room pressure monitor shall have a door switch input. The room pressure monitor shall utilize a second set of alarm set points to avoid nuisance alarms at the reduced pressure differential.
- F) Calibration of room pressure differential and air flow shall be done electronically through the use of the integral keypad. Calibration shall consist of adjusting the sensor zero point and sensor span to match a reference measurement. Password protection of the calibration items shall limit unauthorized access. Neither remote calibration nor calibrating through the use of potentiometers is acceptable.

#### 5.5 Materials

- A) The room pressure monitor system shall measure the room pressure differential. Systems that exclusively measure the supply and exhaust flow volumes are not allowed.
- B) The room pressure monitor system shall accept 1 flow measurement. The flow measurement shall be a 0 to 10V signal, linear with respect to either velocity pressure or velocity.
- C) The room pressure monitor shall have a digital display of all configuration parameters. Configuration shall be done through a keypad integral to the monitor. Password protection shall limit unauthorized access to configuration parameters. The monitor shall also have indicator lights for low and high alarm and normal operating conditions. An analog output of room pressure differential shall be user-configurable

to either 0 to 10V or 4 to 20 mA. The room pressure monitor shall have an RS-485 communications port, supporting the Modbus® or Johnson Controls N2 protocols for seamless integration to the building automation system.

- D) The room pressure sensor shall be bi-directional. The sensor shall be capable of being mounted in the corridor (reference space) or the laboratory (controlled space). The room pressure sensor shall use two in-line ceramic coated RTDs to measure the pressure differential. The room pressure sensor shall be temperature compensated over a range of 55°F to 95°F. Sensors employing a thermistor-based sensor or that cannot differentiate between positive and negative pressures are not allowed. Field-calibration of the sensor shall be performed through the keypad on the room pressure monitor.

## **6.0 General Execution**

### **6.1 Installation**

- A) The Automatic Temperature Controls (ATC) contractor shall install all controls in each space, as recommended by the manufacturer's installation instructions.
- B) The ATC contractor shall connect all control wiring as required.

### **6.2 Equipment Start-Up, Calibration, and Training**

- A) The manufacturer or a factory-authorized representative shall perform system start-up. Start-up shall include calibration of controls. Calibration shall be performed only after substantial completion of the building. Ceilings and doors shall be installed and the HVAC systems (exhaust and supply fans) shall be properly air-balanced. The balancing contractor shall be responsible for final verification and reporting of all air flows.
- B) The manufacturer or a factory-authorized representative shall provide 8 hours of training for building personnel.

## **7.0 Interface to Building Management Systems**

- A. The laboratory airflow control system network shall digitally interface with the BMS. The required software interface drivers shall be developed and housed in a dedicated interface device furnished by the laboratory airflow control system supplier.
- B. All room-level points shall be available to the BMS for monitoring or trending. The gateway shall maintain a cache of all points to be monitored by the BMS. The room-level airflow control devices shall update this cache continually.
- C. The building-level network shall be high-speed minimum 1.25 Mbps communications protocol. The building-level network shall support up to 100 subnets or pressurization zones, or 6000 data points.
- D. A commercially available interface card shall be provided in order to connect to the building-level network.



- E. A commercially available network interface card shall be provided with the gateway to interface with the BMS.

## **7.1 Installation**

- A. The automatic temperature controls (ATC) contractor shall install all components under initial supervision.
- B. The ATC shall install an appropriately sized and fused 24 Vac transformer suitable for NEC Class II wiring.
- D. All cable shall be furnished and installed by the ATC contractor. The ATC contractor shall terminate and connect all cables as required. The ATC shall utilize cables specifically recommended by the laboratory airflow controls supplier.
- E. The mechanical contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.
- F. The mechanical contractor shall provide and install all reheat coils and transitions.
- G. The mechanical contractor shall provide and install insulation as required.
- H. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

## **7.2 System Start-up and Training**

- A. System start-up shall be provided by a factory-authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment, as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust or return), system programming and integration to BMS (when applicable).
- B. The balancing contractor shall be responsible for final verification and reporting of all airflows.
- C. The laboratory airflow control system supplier shall furnish a minimum of sixteen hours of owner training by factory trained and certified personnel. Training sessions shall be recorded and provided to the Owner for his future use. Furnish Owner four copies on standard DVD media. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves and general troubleshooting procedures.
- D. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall

## **8.0 OPERATOR INTERFACE**

- A. Basic Interface Description

### 1. Command Entry/Menu Selection

Operator workstation interface software shall minimize operator training needs through the use of Windowing, English language prompting, and point identification, all supported by standard PC application software such as Microsoft Windows or equivalent.

### 2. Graphical and Text-Based Displays

Operator workstation shall provide consistent graphical displays of all system point and application data. Control submittal piping, air flow and misc drawings shall be converted to graphics for depicting all systems in a graphical manner on the operator workstation. Point identification, engineering units, status indication, and application naming conventions shall be consistent at all workstations.

### 3. Password Protection

Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as is appropriate for various users.

Passwords shall be consistent for all operator devices. Changes made to password definition shall automatically update passwords at all DDC panels on the network.

A minimum of five levels of access shall be supported:

- Level 1 = Data Access and Display
- Level 2 = Level 1 + Operator Overrides
- Level 3 = Level 2 + Database Modification
- Level 4 = Level 3 + Database Generation
- Level 5 = Level 4 + Password Add/Modification

Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, shall be limited to only those items defined for the access level of the password used to log-on.

### 4. Operator Commands

The operator interface shall allow the operator to perform the following commands.

- Startup or shutdown selected equipment
- Adjust setpoints
- Add/Modify/Delete time programming
- Enable/Disable process execution
- Lock/Unlock alarm reporting for each point
- Enable/Disable Totalization for each point
- Enable/Disable Trending for each point

- Override PID Loop setpoints
- Enter temporary override schedules
- Define Holiday Schedules
- Change time/date
- Enter/Modify analog alarm limits
- Enter/Modify analog warning limits
- View limits
- Enable/Disable Demand Limiting for each meter
- Enable/Disable Duty Cycle for each load

#### 5. Logs and Summaries

Reports shall be generated automatically or manually and directed to: workstation displays, printers, or disk files. As a minimum, the system shall provide the following reports:

- All points in the network
- All points currently in alarm
- All off-line points
- All points currently in override status
- All disabled points
- All points currently locked out
- All items defined in a "Follow- Up" file
- All Weekly Schedules
- All Holiday Programming
- Analog point Limits and Deadbands

Summary reports shall also be provided for specific points, logical point group, a user-selected group or groups in the entire facility without restriction due to the hardware configuration.

#### B. System Configuration and Definition

All temperature and other automatic control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following Add/Delete/Modify functions:

- Standalone DDC panels
- Operator Workstations or Application Specific Controllers
- Points of any type, associated point parameters, tuning constants and alarm reporting definition for each point
- Control loops
- Energy management applications, time and calendar-based programming
- Totalization for every point
- Historical Data Trending for every point

- Custom control processes
- Any and all graphic displays, symbols, and cross-references to point data
- Dial-up telecommunication definition
- All operator passwords
- Alarm Messages

### 1. Programming Description

Graphical programming shall allow the user to define the software configuration of DDC control logic for HVAC system control sequences, fan interlocks, pump interlocks, PID control loops, and other control relationships through the creation of graphical logic flow diagrams.

Control sequences are created by using a mouse input device to draw interconnecting lines between symbols depicting inputs, operators (comparisons and mathematical calculations), and outputs of a control sequence. As a minimum, graphic symbols shall be used to represent:

- Process inputs, such as temperature, humidity, or pressure values, status, time, date, or any other measured or calculated system data.
- Mathematical process operators, such as addition, subtraction, multiplication, or greater than, equal to, less than, etc.
- Logical process operators such as AND, OR, Exclusive OR, NOT, etc. Time delays
- Process control outputs such start/stop control points, analog adjust points, etc.
- Process calculation outputs
- Text file outputs and advisories

Inputs and outputs for any process shall not be restricted to a single DDC panel but shall be able to include data from any and all other DDC panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).

### 2. Program Sequence Testing and Simulation

A programming tool shall be provided to simulate control sequence execution strategies before they are applied to respective systems. Users shall be able to enter hypothetical input data, and verify desired control response and calculation results via displays and/or printouts.

### 3. Database Save/Restore/Backup

Backup copies of all standalone DDC panel databases shall be stored in at least one personal computer operator workstation.

Continuous supervision of the integrity of all DDC panel data bases shall be provided. In the event that any DDC panel on the network experiences a loss of its data base for any reason, the system shall automatically download a back-up

copy of the respective data base to restore proper operation. Users shall also have the ability to manually execute selective downloads of any or all portions of a DDC panels data base

## **9.0 OPERATOR DEVICES**

### **A. Local or Portable Operator Terminals**

Each DDC panel shall be capable of supporting a permanent or portable operator terminal as described earlier.

The minimal operator functions provided by the Local or Portable operator terminal shall include the following:

- Start and Stop Points
- Modify Setpoints
- Modify PID Loop Setpoints
- Override PID Control
- Change Time/Date
- Add/Modify Start/Stop Weekly Scheduling
- Add/Modify Setpoint Weekly Scheduling
- Enter Temporary Override Schedules
- Define Holiday Schedules
- View Analog Limits
- Enter/Modify Analog Warning Limits
- Enter/Modify Analog Alarm Limits
- Enter/Modify Analog Differentials
- View Point History Files

The DDC panel operator terminal shall provide access to all real or calculated points in the controller to which it is connected or any other controller in the network.

Operator access procedures at Local or Portable operator terminals shall be identical to each other, as well as identical to that at the PC, Laptop or cell phone operator workstations.

Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error.

## **10.1 VAV AIR SYSTEMS APPLICATION (AHU-2)**

The BAS shall provide an Air Systems application program that coordinates air handlers (AHU-2) and Variable Air Volume Terminal equipment.

A. The Air Systems application shall perform the following functions:

- B. Startup and shutdown the air handler safely. Ensure the VAV boxes are open sufficiently when the air handler is running, to prevent damage to the ductwork and VAV boxes due to high air pressure.
- C. Calibrate VAV boxes.
- D. Fan Pressure Optimization (ASHRAE 90.1) - Minimize energy usage by controlling system static pressure to the lowest level while maintaining zone airflow requirements. System static pressure controlled to keep the "most open" zone damper between 65% and 75% open.
- E. The Fan Pressure Optimization application shall have the ability to identify and display the discharge air setpoint of the air-handler and the VAV box that serves the critical zone (e.g., the zone with the most open VAV box damper). This information shall dynamically update with changes in the location of the critical zone.
- F. During commissioning, the Architect and the controls contractor shall confirm the performance of Fan Pressure Optimization by conducting a field functional test that demonstrates critical zone reset.
- G. Demand Controlled Ventilation – the active ventilation setpoint shall modulate between the occupied ventilation and occupied standby ventilation setpoint; Resetting the setpoint based on CO2 levels in the space.
- H. The Air Systems application shall provide a user interface that includes status of current system operation with real time data of key operating parameters. Key operating parameters include:
  - I. Duct Static Pressure
  - J. Duct Static Optimization Setpoint
  - K. Outdoor Airflow
  - L. Duct Static Optimization Maximum VAV Damper/Source VAV Box

## **10.2 Chiller Plant Control Application (Boilers Plant Control Similar)**

The BAS shall provide a chiller plant application program that coordinates chiller equipment operation for minimal energy usage.

- A. The Chiller Plant application shall perform the following functions:
  - 1. The chiller plant control application shall have the ability to control up to 2 chillers as detailed in the sequence of operations.
  - 2. This application shall be able to control both constant and variable flow systems including variable primary flow as well as parallel, series and decoupled piping configurations.
- B. The chiller plant control application shall be able to control multiple chiller plants per site.
- C. Diagnostics/Protection The chiller plant application program shall be able to integrate individual chiller diagnostics into control action decisions.
- D. Event Processing - All chiller plant control and status events shall be recorded, at the operator's selection, in the building management system event log to facilitate troubleshooting.
- E. Alarm Indications - The chiller plant control status screens shall display chiller plant and individual chiller alarm messages.
- F. Rotation of Chillers based on either runtime or schedule.

- G. The chiller plant control application shall provide a user interface that includes textual descriptions of current plant operation with real time status and data. The textual description shall explain when a chiller will be added, or subtracted and under what conditions and timing.
- H. The chiller plant control application shall provide a user interface that includes operator overrides for force add, force subtract, and rotation.
- I. The chiller plant control application shall provide a user interface that enables configuration changes made by radio button, swipe and type fields, selection list, and check box entry for feature definition:
  - 1. Plant type
  - 2. Rotation method
  - 3. Add method, and settings
  - 4. Subtract method, and settings
  - 5. Soft Start option, and settings
  - 6. Rapid Power Fail Recovery option
  - 7. Ambient Lockout option, and settings
- J. The chiller plant application shall provide a user interface that enables setup modifications made by entry field, check box, and selection fields for chiller plant members:
  - 1. Chiller members
  - 2. Lockout interlock per chiller
  - 3. Pump assignment per chiller
  - 4. Unload at start option, and settings per chiller
  - 5. Design capacity per chiller
  - 6. Run hours per chiller
  - 7. Auto restart option, per chiller
  - 8. Sequence type, per chiller
- K. The chiller plant control application vendor shall provide a published applications guide that details the chiller plant application operation, configuration, setup, and troubleshooting. The applications guide documentation shall be maintained under version control and updated by the manufacture to reflect most recent feature updates as made available. Contents of the guide shall Include:
  - 1. Description of chiller types
  - 2. Description of Plant types
  - 3. Necessary hardware, equipment, sensors, outputs, and controls
  - 4. Commissioning and programming
  - 5. Sequences of operation
  - 6. Soft Start
  - 7. Rapid Power Fail Recovery
  - 8. Ambient Lockout
  - 9. Add Logic
  - 10. Subtract Logic
  - 11. Setpoint calculations
  - 12. Unload at start
  - 13. Rotation strategies
  - 14. Sequencing options
  - 15. Special Applications
  - 16. Troubleshooting

- L. The chiller plant application shall include the following plant system alarms to notify the BAS and operators of failure conditions:
  - 1. Failed to command system pump on
  - 2. Failed to confirm system flow on
  - 3. Failed to command system pump off
  - 4. Failed to confirm system flow off
  - 5. System water flow lost
  - 6. System supply water sensor failed
  - 7. System return water sensor failed
  - 8. All chillers have failed
  - 9. All chillers are unavailable
  - 10. Refer to points lists for additional requirements

### **10.3 INSTALLATION OF SENSORS**

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequate for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Install duct static pressure tap with tube and facing directly down-stream of airflow.
- F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.
- H. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms. Refer to Section 23 1570 for specific conduit and support requirements.
- I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

### **11.0 Power Monitoring Devices**

#### **A. Current Measurement (Amps)**

- 1. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
  - a. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
    - Operating frequency – 50 - 400 Hz.
    - Insulation – 0.6 Kv class 10Kv BIL.



- UL recognized.
  - Five amp secondary.
  - Select current ration as appropriate for application.
  - Acceptable manufacturers: Veris Industries
- b. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
- 6X input over amp rating for AC inrushes of up to 120 amps.
  - Manufactured to UL 1244.
  - Accuracy: +.5%, Ripple +1%.
  - Minimum load resistance 30kOhm.
  - Input 0-20 Amps.
  - Output 4-20 mA.
  - Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
  - Acceptable manufacturers: Veris Industries

## **B. Status and Safety Switches**

### **1. General Requirements**

- a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

### **2. Current Sensing Switches**

- a. The current sensing switch shall be self-powered with solid state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
- d. Acceptable manufacturers: Veris Industries

3. Air Filter Status Switches

- a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
- b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
- c. Provide appropriate scale range and differential adjustment for intended service.

4. Air Flow Switches

- a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

5. Air Pressure Safety Switches

- a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
- b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

6. Low Temperature Limit Switches

- a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
- b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
- c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

7. BTU Meter for Chilled Water and Hot Water Systems

- a. The BTU Meter shall have a communications card to provide complete energy, flow and temperature data to the control system through a single network connection.
- b. All process data and programming functions shall be accessible via front panel display and keypad of the BTU Meter.
- c. The BTU Meter shall be N.I.S.T. Traceable Calibration with Certification. The BTU measurement system shall be individually calibrated using application specific flow and temperature data and which shall be provided with calibration certifications.
- d. The Temperature Sensors shall be custom calibrated and matched to an accuracy better than  $\pm 0.15^{\circ}$  F over calibrated range.
- e. The Flow Meters shall be accurate to within  $\pm 0.5\%$  of rate at the calibrated typical flow rate and within  $\pm 2\%$  of rate over an extended 50:1 turndown range (0.4 - 20 ft/s).
- f. Provide all mechanical installation hardware, color coded interconnecting cabling and installation instructions to ensure error-free installation and accurate system performance.

## **12.0 SEQUENCES OF OPERATION**

### **A. General Sequences of Operation:**

The room controller simultaneously controls room pressure, room balance, ventilation and temperature in each space.

#### **Room Balance and Room Pressure Control Sequence of Operation:**

The room controller continuously maintains a constant flow offset between supply and exhaust volumes. If the offset becomes too large, indicating that the room balance is too negative, the room controller closes the general exhaust and then opens the supply to its maximum setpoint. If the offset becomes too small, indicating that the room balance is not negative enough or positive, the room controller closes the supply to its minimum ventilation or cooling flow and then opens the general exhaust.

The room controller simultaneously measures the room pressure differential and resets the flow offset to maintain pressure at setpoint. If the room pressure differential is too negative, the room controller decreases the control offset to its

minimum setpoint until room pressure setpoint is reached. If the room pressure differential is not negative enough, the room controller increases the control offset to its maximum setpoint until room pressure setpoint is reached.

**Ventilation Control Sequence of Operation:**

The room controller maintains the supply air volume at or above its minimum setpoint.

**Temperature Control Sequence of Operation:**

The room controller continuously measures the room temperature. If the room temperature rises above setpoint, the room controller closes the reheat valve and then opens the supply air valve until either the room temperature reaches setpoint or the supply air volume reaches its cooling maximum setpoint. If the room temperature falls below setpoint, the room controller reduces the supply air volume to its minimum ventilation or room balance flow and then opens the reheat valve until room temperature achieves setpoint.

All Lab Temperature, Pressurization, and Fume Hood Controls shall work integrally to maintain a safe and comfortable lab.

Facility Management System shall monitor and control the following points:

- All points associated with temperature and pressurization control

**B. AHU-1 & ERU-1 ( General Lab Areas )**

AHU-1 and Roof mounted ERU and related exhaust fans are specified as an "N+1" arrangement whereby upon failure of a fan or VFD, the backup shall engage. The supply fan shall be controlled by DDC system subject to safeties wired through VFD safety circuit. Safeties shall include static hi limit, temperature low limit, fire alarm contacts for smoke detectors and overloads.

When a safety trips, the unit will continue to run at its required capacity through its back-up. If back-up fails, the unit shall continue to run at a reduced capacity of 50% air flow volume. The associated exhaust / recovery fans shall also ramp down to 50% of normal capacity. The system will continue to operate to preserve a minimum lab fume operation unless manually shut down.

ERU-1 recovery exhaust fans shall be interlocked to run when the supply fan runs. If the supply fan shuts down due to failure, safeties or associated smoke detector, the backup exhaust fan VFDs shall engage and continue normal operation. If the back-up fails, the exhaust fan VFDs shall be automatically positioned to 50% capacity.

When the air handling unit is commanded to start, the supply and exhaust fans shall run, system shall open the outside air damper and control shall be energized.

The supply fan variable frequency drive shall modulate in response to the static pressure setpoint as sensed by static pressure sensors located at 2/3 down longest run of duct.

ERU-1 heat recovery system shall consist of a variable frequency drives and heat recovery glycol loop. The VFDs shall modulate in unison as required to maintain heat recovery unit exhaust duct intake static pressure setpoint. The DDC controller shall monitor the exhaust fan stack velocity. If the stack velocity drops to 4000 fpm the DDC controller shall override the static pressure control loop and modulate the VFDs to maintain a minimum stack velocity of 4000 fpm. When this occurs the recovery unit exhaust duct intake static pressure shall be maintained by modulating an outside air intake damper. In case of failure of one fan or VFD the backup fan shall engage and operate as required. upon failure of the backup, the remaining fan will modulate individually to maintain exhaust static pressure and alarm plant operations through the campus network.

The digital controller will modulate the preheat and chilled water valves in sequence to maintain the unit discharge air temperature setpoint. Each chilled water valve shall be sized for ½ capacity shown in the schedule. The chilled water valves shall be sequenced so that one valve is 100% open before the second valve is modulated. Should the preheat air temperature drop below setpoint (45degF), preheat valve shall modulate open to maintain minimum temperature.

When the ERU fan runs, the energy recovery pump will be started subject to pump starter safeties. When pump status is proven, the digital controller will modulate the energy recovery 3 way control valve to temper the incoming outside to a minimum of 45 deg F ( adjustable ).

Facility Management System shall monitor and / or control the following points:

- Supply air and exhaust air flow in CFM
- Supply air and exhaust air duct static
- Exhaust stack velocity ( each stack )
- Supply fan and exhaust fan VFD available integrated points
- Damper and valve commanded position
- Filter status
- Static high limit and mixed air low limit
- Heat recovery pump status
- Temperature sensors in supply air, heat recovery discharge air, preheat discharge air, and heat recovery loop
- Refer to points list on plans for additional requirements.

### **C. Mechanical Room Unit Heaters – Hot Water**

Unit heaters shall be controlled from local space thermostat. Upon a rise above space setpoint (65 deg F adjustable) hot water valve shall open and Unit Heater fan shall start. When space temperature drops below setpoint the unit heater fan shall cycle off and the hot water valve shall close.

**D. Generator Monitoring**

The FMS system shall monitor the emergency generator to provide status, fuel level and alarm monitoring.

**E. Vacuum Pump and Air Compressor**

The FMS system shall monitor the air compressor and vacuum pump. Provide as required to receive all available data possible via the respective manufacturer's interface.

**F. Pipeline Heating Cable:**

Monitor pipeline heating cable for chillers and ERU to verify availability and operation.

**G. Carbon Monoxide Monitors and Natural Gas Detection Sensors in Labs**

Carbon monoxide detectors in basement mechanical room (shown on mechanical plans adjacent to the boilers) and natural gas detection monitors in labs/classrooms (shown on the plumbing plans) shall annunciate a warning alarm to the BAS operator console.

**H. Refer to the Plans for Remaining Miscellaneous Sequences of Operation**

**13.0 Utility Monitoring**

The FMS System shall monitor and / or calculate the following building utilities:

- Central Plant hot water supply temperature, return temperature, flow and calculate BTU usage. BTU usage shall be available and integrated into the campus automated energy reporting system.
- Central Plant chilled water supply temperature, return temperature, flow, and calculate BTU usage. BTU usage shall be available and integrated into the campus automated energy reporting system.
- kWh usage (output provided with building meter )
- Central Plant chilled water flow totalized and available for monthly reporting
- Central Plant hot water flow totalized and available for monthly reporting
- Refer to points list on plans for additional requirements

**14.0 Miscellaneous University Requirements**

**Where the below requirements conflict with items specified hereinbefore, the below requirements shall be adhered to.**

**Controls:**

A global set point feature for the individual building shall be programmed, displayed graphically, and adjustable by the end user.

BAS Graphics shall allow end-user the ability to adjust the unoccupied status setpoints. This applies to temperature and humidity values.

Programming will be consistent with existing programming methods and graphics currently in use with consideration to the end user and the ability to change graphical and program values from local control.

Calendar/holiday scheduler feature will be programmed so it will ONLY affect the building selected from the menu bar. Calendar scheduling feature WILL NOT be programmed so it affects the entire campus as this does not allow for any flexibility of scheduling building shutdowns during holidays.

**Thermostats:** Shall include a simple occupancy override pushbutton for local control during unoccupied status. This will allow the condition space system to operate temporarily and shall be programmed for 2 hours of operation. Thermostats shall include humidity sensing capability. If thermostat with humidity sensing capability is not available alternative must be discussed and approved by the Troy Physical Plant. If applicable: Humidity values must be considered as priority to override the Unoccupied Status

**Temperature Set Points.**

**Thermostats and DDC controls shall be password protected**

**Thermostat Verification Criteria:**

Controls contractor, in conjunction with the Mechanical Contractor and the CxA shall verify the following with Troy University:

- (A) Thermostat installed and secured properly.
- (B) Operation of the button(s) raises and lower set points.
- (C) Thermostat shows room temperature during normal mode.
- (D) While HVAC system is in Unoccupied Status, press override button and verify system operates for 2 hours and returns to Unoccupied Status.
- (E) Verify that thermostat displays accurate room temperature by comparison with a calibrated secondary instrument.
- (F) During Unoccupied status, if applicable, thermostat(s) with humidity sensor capability shall be exposed to a method of high humidity and verify that the HVAC system(s) will change to Occupied status and operate until humidity set point reached.
- (G) Current room numbering and desired floor plan for graphics usage

**Operating Status:**

**Occupied Status**

Set points will be programmed by contractor in a manner that they can be displayed and adjusted graphically. The initial values shall be 70 – 74 degree operating range.

**Occupied Status Verification Criteria:**

Controls contractor in conjunction with the Mechanical Contractor and the CxA shall verify the following with Troy University:

- (A) Visually represent that the specified set points have been applied.
- (B) Demonstrate that the set point values can be modified graphically.
- (C) Demonstrate that cooling operation shall maintain cooling set point lowering cooling set point to 62 degrees and field verify and/or graphically verify that cooling equipment to include, but not limited to (chillers or other cooling methods) function, circulating pumps on, fans on, cooling valves modulate, VAV's damper modulation, AHU VFD's establish engineered duct pressures, heating or reheat sources are off, OA dampers functioning to maintain 1000PPM CO2.
- (D) Demonstrate that heating operation shall maintain heating set point raising heating set point to 80 degrees and field verify and/or graphically verify that heating equipment to include, but not limited to electric heating methods function, circulating pumps on, fans on, heating SCR controls modulate, VAV's damper modulation, AHU VFD's establish engineered duct pressures, heating, OA dampers functioning to maintain 1000PPM CO2.

**Unoccupied Status**

Set points will be programmed by contractor in a manner that they can be displayed and adjusted graphically. The values shall be 60 degrees for heating and 78 degrees for cooling.

**Unoccupied Status Verification Criteria:**

Controls contractor in conjunction with the Mechanical Contractor and the CxA shall verify the following with Troy University:

- (A) Visually represent that the specified set points have been applied.
- (B) Demonstrate that the set point values can be modified graphically.
- (C) A value of 55 degrees will be over written to the program and verify that the heating methods will switch to Occupy status and operate until Unoccupied set point is satisfied, then return to Unoccupied status. Likewise a value of 80 degrees will be over written to the program and verify that the cooling system or



cooling methods will switch to Occupy status and operate until set point satisfied and then return to Unoccupied status.

**CO2 Sensors:**

**AHU-2:**

Conditioned space control incorporates a Carbon Monoxide (CO2) sensor in the return duct. Outdoor Air (OA) supply shall be calculated by the BAS to maintain 1000PPM CO2 set point during occupied status for the zone in which the AHU serves. OA dampers shall be set to achieve 100% closure during unoccupied settings.

**Air Handler Units and VAV's:**

Conditioned space control shall incorporate Carbon Dioxide (CO2) sensors accordingly. Outdoor Air (OA) supply shall be calculated by the BAS to maintain 1000PPM CO2 set point during occupied status for the zone in which the VAV's are serving. OA dampers for AHU's shall be set to achieve 100% closure during unoccupied settings.

**CO2 Verification Criteria:**

Controls contractor in conjunction with the Mechanical Contractor and the CxA shall verify the following with Troy University:

(A) When HVAC system is in Unoccupied mode, open air handler unit access door to access the OA dampers and verify if dampers are 100 percent closed. Minimum OA dampers will be 100 percent closed during Unoccupied status.

(B) CO2 operation shall be tested by manipulation of system to indicate 2000 PPM and monitor operation of the OA dampers to open for reduction of CO2 and/or exhaust methods are operation, if applicable for balance.

(C) CO2 operation shall be tested by manipulation of system to indicate 400 PPM and monitor operation of the OA dampers for closure and RA damper is 100 percent open. Minimum OA damper should be 10 percent open or as specified for air control quality standards and balance.

(D) Return air dampers, minimum OA dampers, exhaust dampers/fans shall be visually verified to operate accordingly in respect to OA damper position and building balance requirements.

**15.0 WARRANTY**

- B. All BAS/ATC devices and installation shall be warranted to be free from defects in workmanship and material for a period of one year from the date of job acceptance of the project by the Owner. Any equipment, software, or labor found to be defective during this period shall be repaired or replaced without expense to the Owner. Factory authorized warranty service shall be available within 60

miles of jobsite. Provide two 10-hour sessions during the warranty period for program modifications desired by owner or additional training.

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VICINITY MAP



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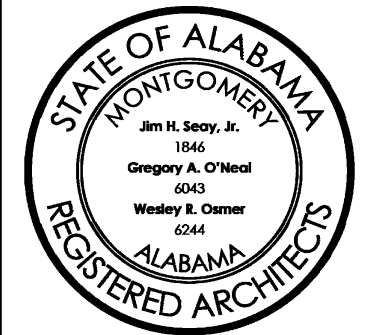
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CENTER FOR MATERIALS AND  
MANUFACTURING SCIENCES  
TROY UNIVERSITY | TROY, ALABAMA

FACULTY RESEARCH FACILITY

SS&L Job No: 18144

DCM Project No: 2020416

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E024	PANELBOARD SCHEDULES

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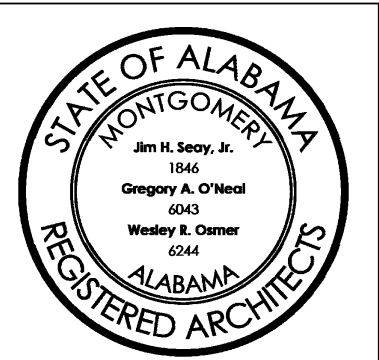
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Checked By	JS, FL

CENTER FOR MATERIALS AND  
MANUFACTURING SCIENCES

TROY UNIVERSITY | TROY, AL

Sheet Title
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General Project Notes:

GENERAL NOTES APPLY TO THE ENTIRE PROJECT. SPECIFIC NOTES APPLY TO ISOLATED WORK AREAS AND ARE FOR THE CONVENIENCE OF THE CONTRACTOR. HOWEVER, ALL ISOLATED WORK AREAS ARE NOT NOTED. SHOULD A CONDITION OCCUR THAT IS NOT SPECIFICALLY NOTED, THE CONTRACTOR SHALL PROCEED WITH WORK PER GENERAL DEMOLITION NOTES OR A SPECIFIC WORK NOTE(S) USED IN OTHER SIMILAR CONDITIONS, WHICHEVER IS MORE STRINGENT, PER APPROVAL OF ARCHITECT.

CONTRACTOR'S RESPONSIBILITY TO FIELD VERIFY CONDITIONS

- CONTRACTOR TO VISIT SITE AND TO BECOME TOTALLY FAMILIAR WITH EXTENT OF WORK REQUIRED PRIOR TO BID.
- CONTRACTOR TO VERIFY DIMENSIONS OF INTERIOR PARTITION WALLS. IF DISCREPANCY OCCURS, NOTIFY ARCHITECT PRIOR TO FRAMING.
- CONTRACTOR TO VERIFY ALL FINISHED DIMENSIONS BEFORE INSTALLATION OF CABINET WORK AND TRIMWORK.
- DIMENSIONS OF EXISTING STRUCTURES ARE ONLY FOR THE CONVENIENCE OF THE CONTRACTOR, VERIFY ALL EXISTING CONDITIONS. LOCATION OF WALLS SHALL BE AS SHOWN ON PLAN RELATIVE TO EXISTING CONDITIONS.
- CONTRACTOR TO VERIFY ALL DIMENSIONS AND FIELD CONDITIONS WITH THE DRAWINGS, IN PARTICULAR: WALL DIMENSIONS, INCOMING UTILITIES, ETC. REPORT IMMEDIATELY TO THE ARCHITECT ANY VARIANCES OR FIELD CONDITIONS THAT MAY CAUSE CONSTRUCTION PROBLEMS PRIOR TO COMMENCING WORK.

CONTRACTOR'S RESPONSIBILITY TO COORDINATE THE WORK

- CONTRACTOR TO VERIFY LOCATIONS OF ALL UTILITIES PRIOR TO COMMENCING. FURNISH INFORMATION NECESSARY TO ADJUST, MOVE OR RELOCATE EXISTING STRUCTURES, UTILITY POLES, LINES, SERVICES OF OTHER SYSTEMS LOCATED IN, OR AFFECTED BY CONSTRUCTION. COORDINATE WITH LOCAL AUTHORITIES HAVING JURISDICTION WITH CONSTRUCTION.
- CONTRACTOR TO VERIFY APPLICABLE OPENINGS, DOOR SIZES, AND DIMENSIONS OF MECHANICAL ROOMS WITH EQUIPMENT. IF DISCREPANCY OCCURS, NOTIFY ARCHITECT PRIOR TO FRAMING.
- OMIT
- CONTRACTOR TO VERIFY WITH STRUCTURAL, PLUMBING, MECHANICAL, AND ELECTRICAL THE QUANTITY AND SIZES OF ALL SLEEVES REQUIRED. ALL SLEEVES TO BE ONE HOUR RATED, PROVIDE GREATER RATING IF PENETRATING INTO HIGHER RATED SPACE.
- COORDINATE CONDUIT, PIPING, AND DUCTWORK SO THAT THE HEAD HEIGHT IS NOT ENCUMBERED AND SERVICES ARE AS TIGHT UP TO STRUCTURE AS POSSIBLE.
- CONTRACTOR TO COORDINATE PLUMBING, MECHANICAL, FIRE SPRINKLER, ELECTRICAL, AND LIGHTING WITH STRUCTURAL ELEMENTS. CONDUIT LINES, ECT. SHALL RUN AT RIGHT ANGLES OR SEGMENTED BETWEEN COLUMN LINES AND BE CLEAN AND NEAT IN APPEARANCE.
- COORDINATE LOCATION OF SWITCHES, OUTLETS, THERMOSTATS, LIGHTS, ETC. W/ SHELVEING, TRIM, MARKER BOARDS, CABINETRY, AND TOILET ACCESSORIES. MOVE AS REQUIRED TO MISS SHELVEING, STORAGE, CASEWORK, VISUAL DISPLAY BOARDS.
- COORDINATE CONDUIT, PIPING, AND DUCTWORK SO THAT HEAD HEIGHT IS NOT ENCUMBERED AND SERVICES ARE AS TIGHT UP TO STRUCTURE AS POSSIBLE, THIS WILL INCLUDE JOGGING DUCTS, SPRINKLER LINES, PLUMBING LINES, CONDUIT, ECT. UP AND DOWN OR AROUND AS REQUIRED TO ACHIEVE CEILING HEIGHTS AS INDICATED. COORDINATE INSTALLATION AND SEQUENCING OF DISCIPLINES TO ACHIEVE.
- THE GENERAL CONTRACTOR SHALL STAKE OUT ALL MAJOR FEATURES SHOWN ON THE SITE PLAN TO VERIFY THE SITE LAYOUT RELATIVE TO THE PROPERTY LINES AND SITE CONDITIONS PRIOR TO ANY UTILITIES OR FOOTINGS BEING INSTALLED.
- COORDINATE FINAL CEILING HEIGHT WITH ALL WINDOWS. ALL TRADES SHOULD BE ABLE TO FIT WITHIN THE ALLOTTED SPACE IF COORDINATED BY THE GENERAL CONTRACTOR AND EACH TRADE. IF FURR DOWNS ARE REQUIRED TO ACCOMMODATE ABOVE CEILING ITEMS, THE CONTRACTOR IS RESPONSIBLE TO PROVIDE FURR DOWNS AND COORDINATE LOCATIONS WITH THE ARCHITECT.
- PLUMBING, FIRE-PROTECTION, MECHANICAL, AND ELECTRICAL WORK REQUIRED BY THIS CONTRACT IS NOTED ON CONTRACT DOCUMENTS. THE TRADE CONTRACTORS SHALL BE RESPONSIBLE FOR COORDINATION OF THEIR WORK WITH ALL TRADES. CHANGE ORDERS SHALL NOT BE APPROVED FOR EXTRA WORK ARISING FROM TRADE CONTRACTORS NOT COORDINATING WORK.
- CONTRACTOR WILL BE RESPONSIBLE FOR ALL LAYOUT FOR INTERIOR/EXTERIOR WALLS AND FOUNDATION AND WILL BE RESPONSIBLE FOR MAINTAINING A BENCHMARK AND CONTROL LINES AT EACH FLOOR LEVEL.
- CONTRACTOR WILL BE RESPONSIBLE FOR FURNISHING AND INSTALLING CEILING OR WALL-MOUNTED ACCESS DOORS AS REQUIRED TO ACCESS COMPONENTS OF ITS SYSTEM AND TO COORDINATE WITH OTHER TRADES SO ACCESS IS MAINTAINED. COMPLY WITH LIFE SAFETY PLAN.
- OMIT
- CONTRACTOR SHALL COORDINATE TO ASSURE ALL EQUIPMENT CAN BE BROUGHT INTO THE BUILDING. THIS INCLUDES MANUFACTURE COMPONENT SIZE/ASSEMBLY, CRITICAL PATH SCHEDULING, AND COORDINATION OF OTHER TRADES.

General Project Notes (Continued):

CONTRACTOR'S RESPONSILTY TO COMPLY WITH APPLICABLE GOVERNING CODES/AUTHORITIES:

- ALL WORK SHALL BE IN ACCORDANCE WITH ALL APPLICABLE CODES, LAWS, AND ORDINANCES. EACH TRADE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL PERMITS, INSPECTIONS, AND CERTIFICATES REQUIRED BY GOVERNING ENTITIES.
- CONTRACTOR TO CONFIRM ALL OSHA AND APPLICABLE STANDARDS TO ASSURE SAFETY OF ALL PERSONS ON SITE DURING ENTIRE COURSE OF CONSTRUCTION.
- NEITHER THE ARCHITECT, NOR THE OWNER SHALL BE RESPONSIBLE FOR JOB SAFETY. EACH TRADE CONTRACTOR SHALL BE RESPONSIBLE FOR JOB SITE SAFETY AND SAFETY OF THE PUBLIC DURING CONSTRUCTION AND SHALL PROVIDE APPROPRIATE WARNINGS, BARRICADES, ETC. AS REQUIRED PER CODES.
- PROMPTLY NOTIFY THE ARCHITECT IN WRITING IF ANY CONTRACT DOCUMENTS ARE FOUND TO BE IN VARIANCE WITH THE APPLICABLE LAWS AND ORDINANCES. NECESSARY CHANGES WILL BE MADE BY APPROPRIATE MODIFICATIONS.
- IF ANY WORK IS PERFORMED KNOWING IT TO BE CONTRARY TO SUCH CODES, LAWS, ORDINANCES, RULES AND REGULATIONS, AND WITHOUT NOTICE TO THE ARCHITECT, THAT TRADE CONTRACTOR ASSUMES FULL RESPONSIBILITY AND BEARS COSTS ATTRIBUTED TO BRING WORK TO COMPLIANCE OF SUCH CODES, LAWS, ORDINANCES, AND RULES AND REGULATIONS.

GENERAL PROVISIONS FOR FIRE RATED CONSTRUCTION

- ALL RECESSED ACCESSORIES LOCATED IN FIRE RATED WALLS SHALL BE EITHER OF FIRE RATED CONSTRUCTION OR COORDINATED WITH THE ADJACENT TRADES TO ALLOW CODE COMPLIANT GYPSUM BOARD TO BE CONTINUOUS BEHIND THE ACCESSORIES.
- EACH RESPONSIBLE CONTRACTOR SHALL SEAL ALL PENETRATIONS MADE AS PART OF THEIR WORK IN FIRE-RATED CONSTRUCTION AS REQUIRED BY ALL APPLICABLE CODES. EACH CONTRACTOR TO VERIFY WITH LOCAL FIRE MARSHAL OR BUILDING OFFICIAL HAVING JURISDICTION. EACH RESPONSIBLE CONTRACTOR WILL SEAL ALL PENETRATIONS MADE AS PART OF THEIR WORK THROUGH NON-RATED PARTITIONS. ALL FIRE CAULK TO BE THE SAME BRAND AS DETERMINED BY CONTRACTOR.
- ALL NEW AND EXISTING FIRE WALLS IN WORK AREAS ARE TO BE CARRIED TO THE UNDERSIDE OF THE ROOF DECK AND SEALED AS REQUIRED FOR NECESSARY FIRE RATINGS, AND LABELED PER THE AUTHORITY HAVING JURISDICTION.
- MATERIALS WITHIN PLENUMS, EXCEPT AS REQUIRED BY THE 2009 INTERNATIONAL MECHANICAL CODE SECTION 602.2.1.1 THROUGH 602.2.1.6, MATERIALS WITHIN PLENUMS SHALL BE NONCOMBUSTIBLE OR SHALL HAVE A FLAME SPEAD INDEX OF NOT MORE THAN 25 AND A SMOKE-DEVELOPED INDEX OF NOT MORE THAN 50 WHEN TESTED IN ACCORDANCE WITH ASTM E84 OR UL 723.

MISCELLANEOUS GENERAL PROVISIONS:

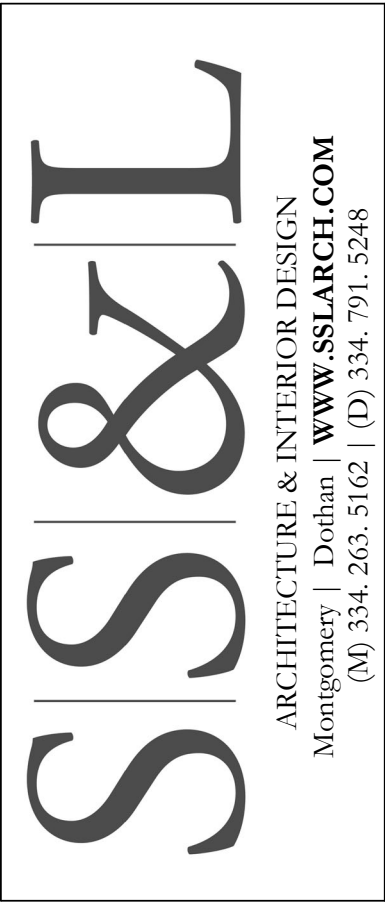
- CONTRACTOR TO NOTIFY ARCHITECT IMMEDIATELY IF THERE ARE ANY DISCREPANCIES WITH TAGGED DETAILS, ENLARGED PLANS, ELEVATIONS, ETC.
- IN ROOMS WITH FLOOR DRAINS, SLOPE TO DRAIN AT 1 PERCENT SLOPE UNLESS SPECIFICALLY NOTED OTHERWISE.
- AIR AND VACUUMM PIPING THAT IS EXPOSED TO VIEW SHALL NOT BE PAINTED.

Typical Abbreviation Legend:

ACT	Acoustical Ceiling Tile	JT	Joint
A/C	Air Conditioning	LAM	Laminate
AB	Anchor Bolt	LAV	Lavatory
ADA	American Disabilities Act	LVR	Louver
AFF	Above Finish Floor	MIN	Minimum
BM	Beam	MAX	Maximum
BRG	Bearing	MECH	Mechanical
BRK	Brck	MET	Metal
CFCI	Contractor Furnished	MFR	Manufacturer
	Contractor Installed	MH	Man Hole
CIP	Cast In Place	MIN	Minimum
CJ	Control Joint	MISC	Miscellaneous
CL	Column Line	MLDG	Moulding
CLG	Ceiling	MO	Masonry Opening
CLR	Clear	MTD	Mounted
CMU	Concrete Masonry Unit	MW	Microwave
COL	Column	NIC	Not In Contract
CONC	Concrete	NO	Number
CONT	Continuous	NOM	Nominal
CONTR	Contractor	NTS	Not to Scale
COORDF	Coordination	OC	On Center
CORR	Corridor	OFCI	Owner Furnished
CT	Ceramic Tile		Contractor Installed
CTR	Center	OFOI	Owner Furnished
DBL	Double		Owner Installed
DET	Detail	OPP	Opposite
DIA	Diameter	P	Paint
DR	Drain	PL	Plate / Property Line
DN	Down	PL LAM	Plastic Laminate
DS	Downspout	PLYWD	Flywood
DW	Dishwasher	PNL	Panel
DWG	Drawing	PT	Pressure Treated
DWR	Drawer	R	Radius / Riser
EA	Each	RB	Rubber Base
EF	Exhaust Fan	REFR	Refrigerator
EJ	Expansion Joint	REINF	Reinforce (D)
EL	Elevation	REQD	REQUIRED
ELEC	Electrical	REV	Revised
EQ	Equal	RM	Room
EX	Existing	SCHED	Schedule
EXP	Exposed	SECT	Section
EXT	Exterior	SHT	Sheet
FF	Finish Floor	SHW	Single Hung Window
FIN	Finish	SIM	Similar
FL	Floor Line	SPECS	Specifications
FLNG	Flashing	SQ	Square
FTG	Footing	SS	Sanitary Sewer
GA	Gauge	STD	Standard
GFRC	Glass Fiber Reinforced Concrete	SVT	Solid Vinyl Tile
		STL	Steel
GWB	GWB	T	Tile
HT	Height	T#G	Tongue & Groove
HM	Hollow Metal	TYP	Typical
HOR	Horizontal	UNO	Unless Noted
HR	Handrail		Otherwise
HTR	Heater	VERT	Vertical
HVAC	Heating, Ventilation & Air Conditioning	VTR	Vent Thru Roof
		VWC	Vinyl Wall Covering
HxWxL	Height, width, length	WD	Wood
IN	Inches	WWM	Welded Wire Mesh
INSUL	Insulation	WWF	Welded Wire Fabric
INT	Interior	YP	Yellow Pine
JST	Joist		

General Symbol Legend

	BUILDING ELEVATION TAG
	INTERIOR ELEVATION TAG
	BUILDING SECTION TAG
	WALL SECTION TAG
	DETAIL TAG
	ROOM TAG
	ADA APPROVED TURNING SPACE
	SPOT ELEVATION
	DOOR TAG (SEE DOOR SCHEDULE)
	WINDOW TAG (SEE WINDOW SCHEDULE)
	WALL/STOREFRONT TAG (SEE WALL/STOREFRONT SCHEDULE)
	REVISION TAG (SEE REVISION SCHEDULE)
	SPECIFIC NOTE TAG
	ELECTRIC WATER COOLER (SEE PLUMBING)
	FIRE EXTINGUISHER CABINET



Rev.	Description	Date
5	Add. 5	01/15/2021

Job Number	18144
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Date	11/17/2020
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Drawn By	CS,JB,DB,LG
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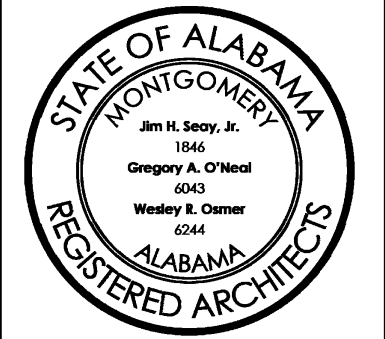
Checked By	JS, FL
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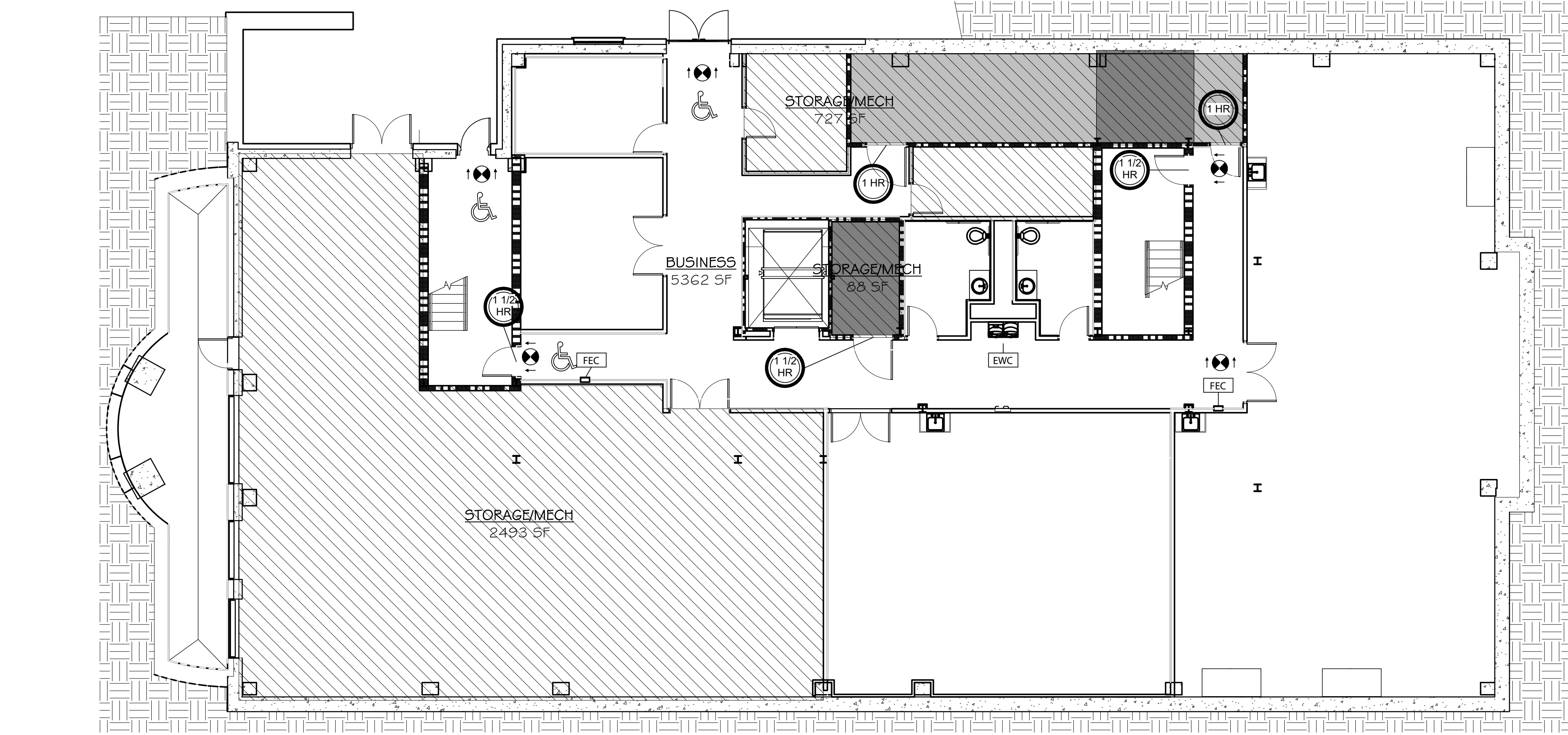
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Sheet Number	
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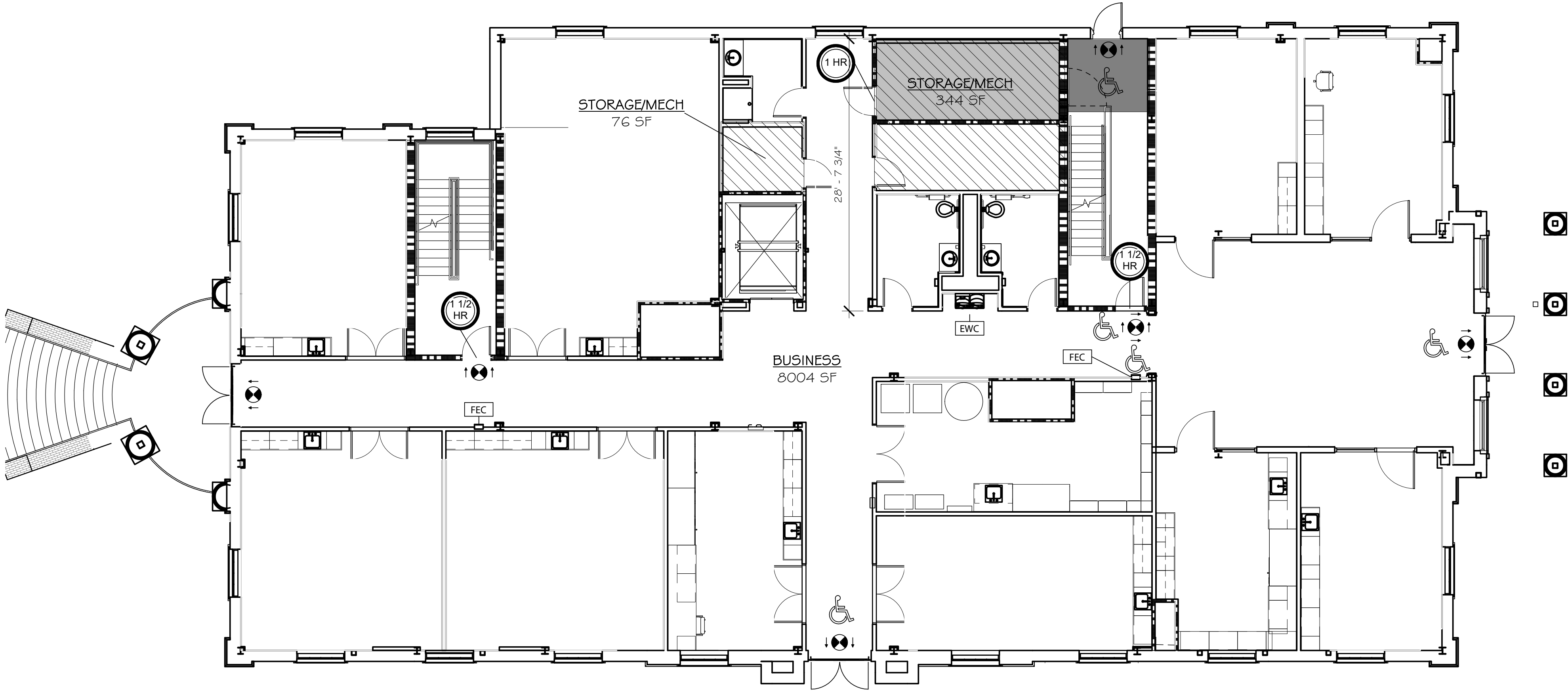
AN1.0







1 LEVEL 0  
1/8" = 1'-0"



2 LEVEL 1  
1/8" = 1'-0"

LIFE SAFETY LEGEND

- EWC ELECTRIC WATER COOLER - SEE PLUMBING
- FEC FIRE EXTINGUISHER CABINET
- FEB FIRE EXTINGUISHER BRACKET
- AED AUTOMATED EXTERNAL DEFIBRILLATOR
- 1 HOUR FIRE RATING (UL#)
- 2 HOUR FIRE RATING (UL#)
- 3 HOUR FIRE RATING (UL#)
- EMERGENCY EXIT SIGNAGE
- HANDICAP ACCESSIBLE EXIT LOCATION
- EXIT TRAVEL PATH
- AREAS INDICATED TO RECIEVE 1-HR RATED CEILING
- AREAS INDICATED TO RECIEVE 2-HR RATED CEILING
- HATCH FOR LIFE SAFETY CALCULATIONS FOR MECHANICAL STORAGE OCCUPANCY

Rev.	Description	Date
5	Add. 5	01/15/2021

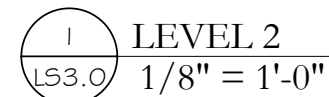
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Date	11/17/2020
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Checked By	JS, FL









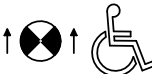



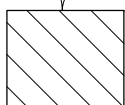
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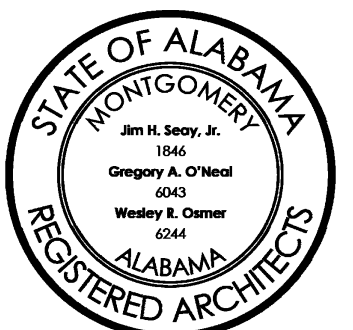
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LIFE SAFETY PLANS

Sheet Number  
LS2.0

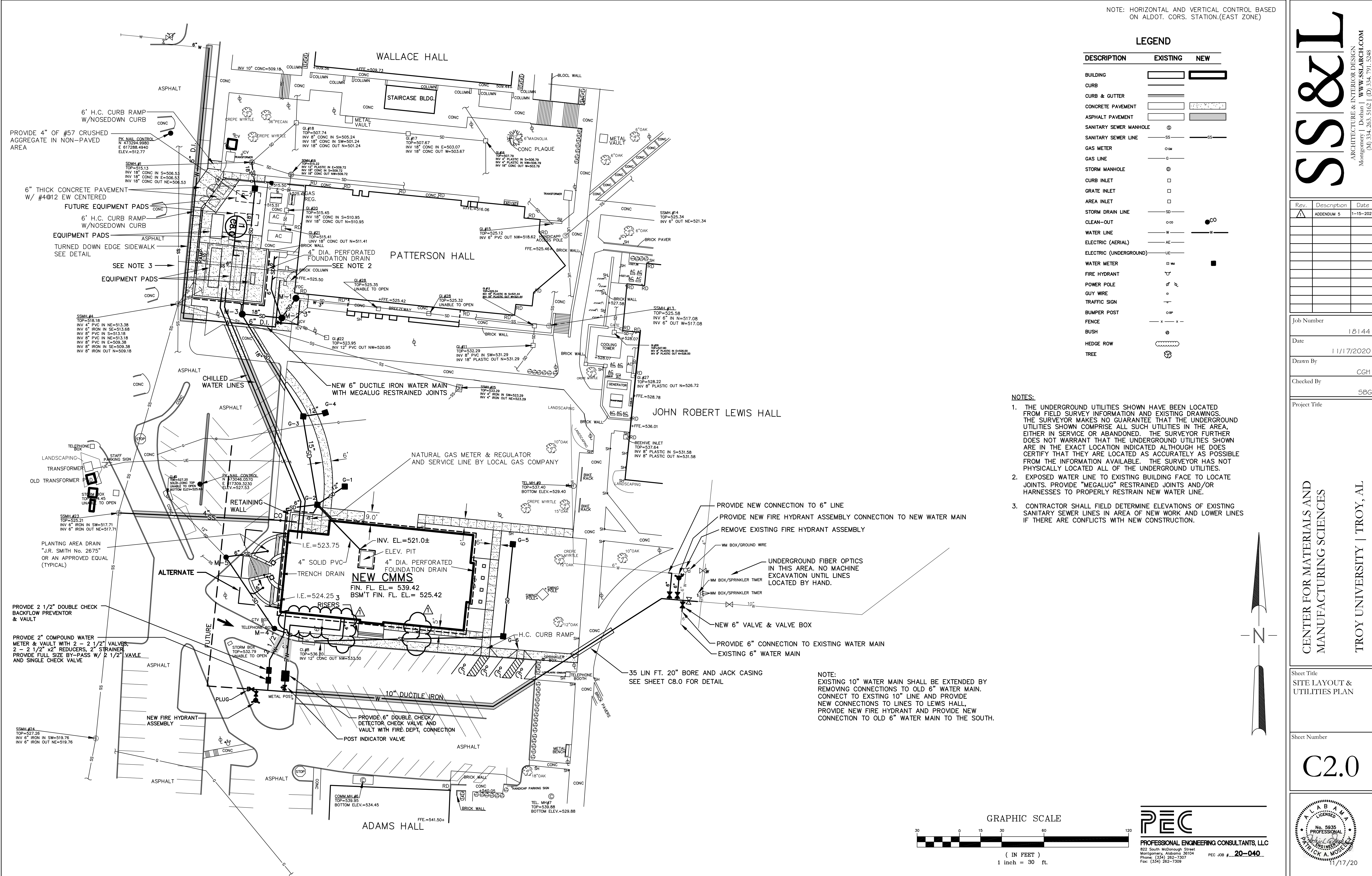




- |   |   |
|---|---|
|  | ELECTRIC WATER COOLER - SEE PLUMBING                                |
|  | FIRE EXTINGUISHER CABINET   |
|  | FIRE EXTINGUISHER BRACKET   |
|  | AUTOMATED EXTERNAL DEFIBRILLATOR                                    |
|  | 1 HOUR FIRE RATING (UL#   |
|  | 2 HOUR FIRE RATING (UL#   |
|  | 3 HOUR FIRE RATING (UL#   |
|  | EMERGENCY EXIT SIGNAGE  |
|  | HANDICAP ACCESSIBLE EXIT LOCATION                                   |
|  | EXIT TRAVEL PATH  |
|  | AREAS INDICATED TO RECIEVE 1-HR RATED CEILING                       |
|  | AREAS INDICATED TO RECIEVE 2-HR RATED CEILING                       |
|  | HATCH FOR LIFE SAFETY CALCULATIONS FOR MECHANICAL STORAGE OCCUPANCY |







NOTE: HORIZONTAL AND VERTICAL CONTROL BASED ON ALDOT. CORRS. STATION.(EAST ZONE)

LEGEND

DESCRIPTION	EXISTING	NEW
BUILDING		
CURB		
CURB & GUTTER		
CONCRETE PAVEMENT		
ASPHALT PAVEMENT		
SANITARY SEWER MANHOLE		
SANITARY SEWER LINE		
GAS METER		
GAS LINE		
STORM MANHOLE		
CURB INLET		
GRATE INLET		
AREA INLET		
STORM DRAIN LINE		
CLEAN-OUT		
WATER LINE		
ELECTRIC (AERIAL)		
ELECTRIC (UNDERGROUND)		
WATER METER		
FIRE HYDRANT		
POWER POLE		
GUY WIRE		
TRAFFIC SIGN		
BUMPER POST		
FENCE		
BUSH		
HEDGE ROW		
TREE		

NOTES:

1. THE UNDERGROUND UTILITIES SHOWN HAVE BEEN LOCATED FROM FIELD SURVEY INFORMATION AND EXISTING DRAWINGS. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED ALTHOUGH HE DOES CERTIFY THAT THEY ARE LOCATED AS ACCURATELY AS POSSIBLE FROM THE INFORMATION AVAILABLE. THE SURVEYOR HAS NOT PHYSICALLY LOCATED ALL OF THE UNDERGROUND UTILITIES.
2. EXPOSED WATER LINE TO EXISTING BUILDING FACE TO LOCATE JOINTS. PROVIDE "MEGALUG" RESTRAINED JOINTS AND/OR HARNESSSES TO PROPERLY RESTRAIN NEW WATER LINE.
3. CONTRACTOR SHALL FIELD DETERMINE ELEVATIONS OF EXISTING SANITARY SEWER LINES IN AREA OF NEW WORK AND LOWER LINES IF THERE ARE CONFLICTS WITH NEW CONSTRUCTION.

NOTE:  
EXISTING 10" WATER MAIN SHALL BE EXTENDED BY REMOVING CONNECTIONS TO OLD 6" WATER MAIN. CONNECT TO EXSTING 10" LINE AND PROVIDE NEW CONNECTIONS TO LINES TO LEWIS HALL, PROVIDE NEW FIRE HYDRANT AND PROVIDE NEW CONNECTION TO OLD 6" WATER MAIN TO THE SOUTH.

GRAPHIC SCALE



( IN FEET )  
1 inch = 30 ft.



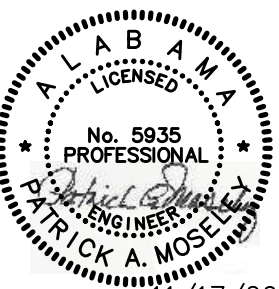
PROFESSIONAL ENGINEERING CONSULTANTS, LLC  
822 South McDonough Street  
Montgomery, Alabama 36104  
Phone: (334) 262-7307  
Fax: (334) 262-7309  
PEC JOB # 20-040

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Sheet Title  
SITE LAYOUT &  
UTILITIES PLAN

Sheet Number

C2.0



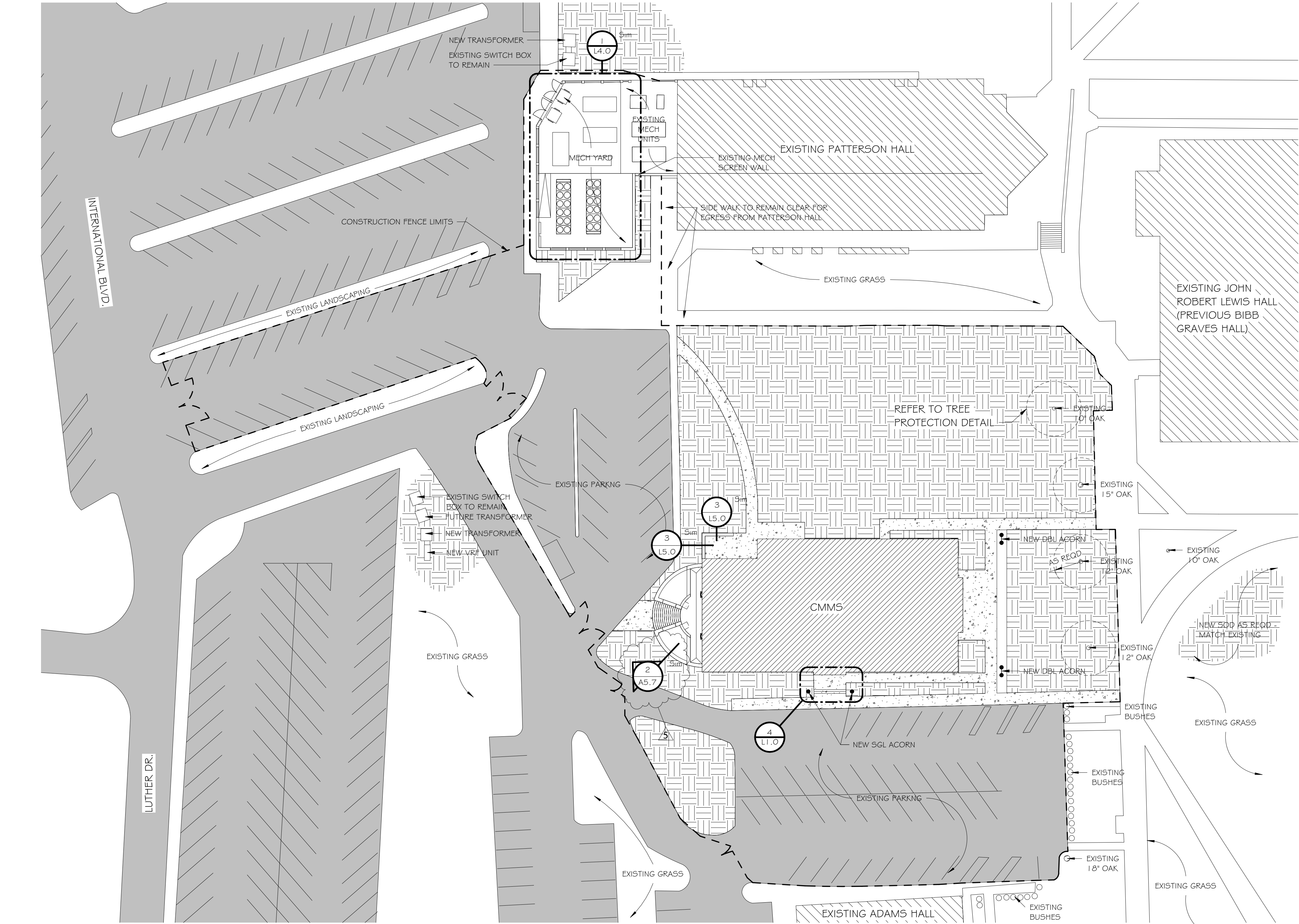
11/17/20

Rev.	Description	Date
ADDENDUM 5		1-15-2021

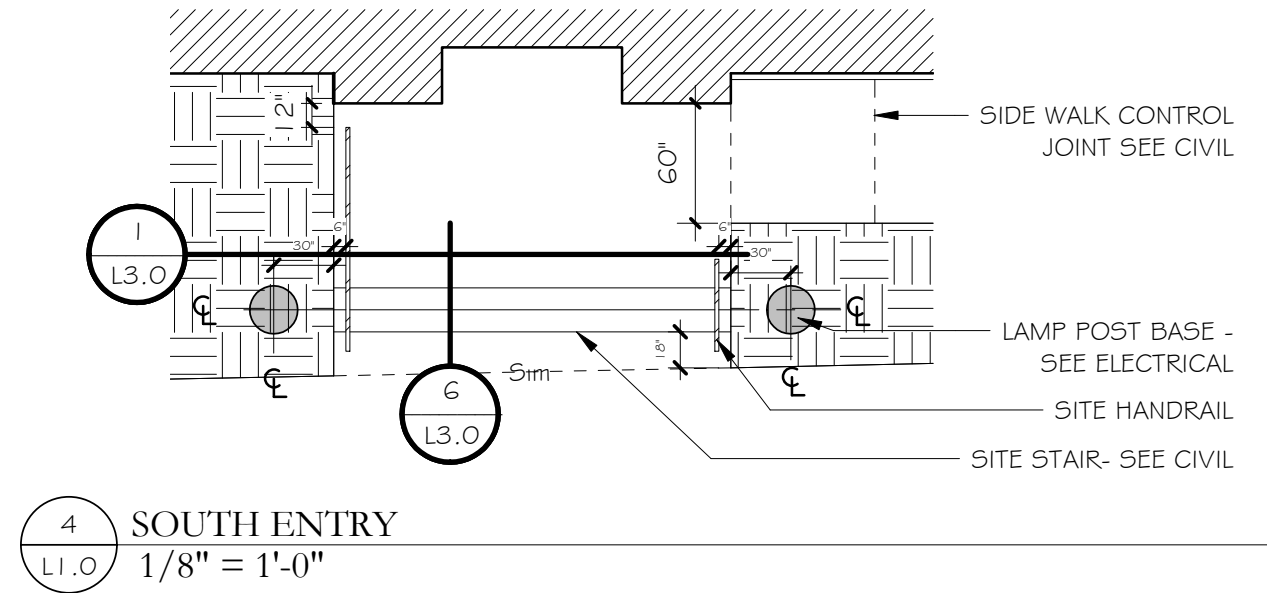
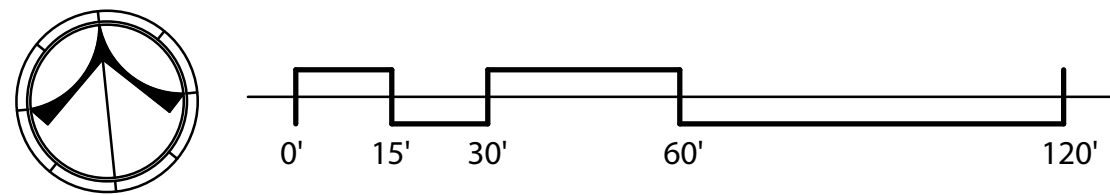
Job Number	18144
Date	11/17/2020
Drawn By	CGH
Checked By	SBG

Project Title





1 SITE PLAN  
L1.0  
1" = 30'-0"



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5	Add. 5	01/15/2021

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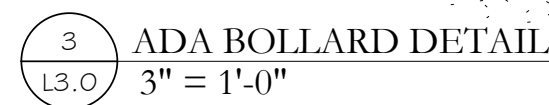
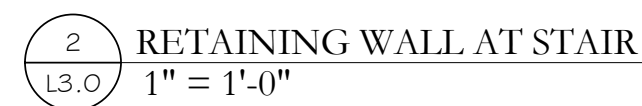
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SITE PLAN

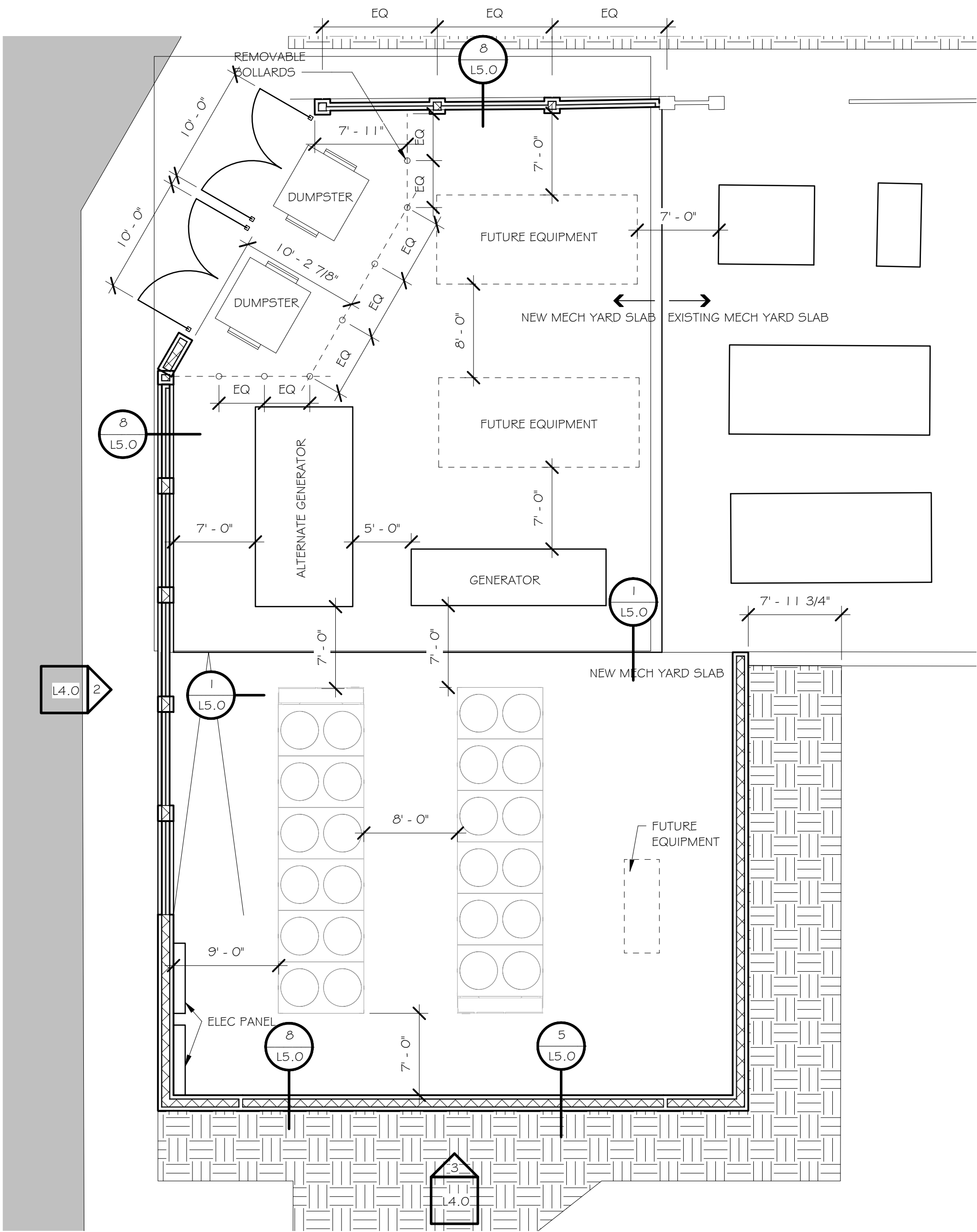
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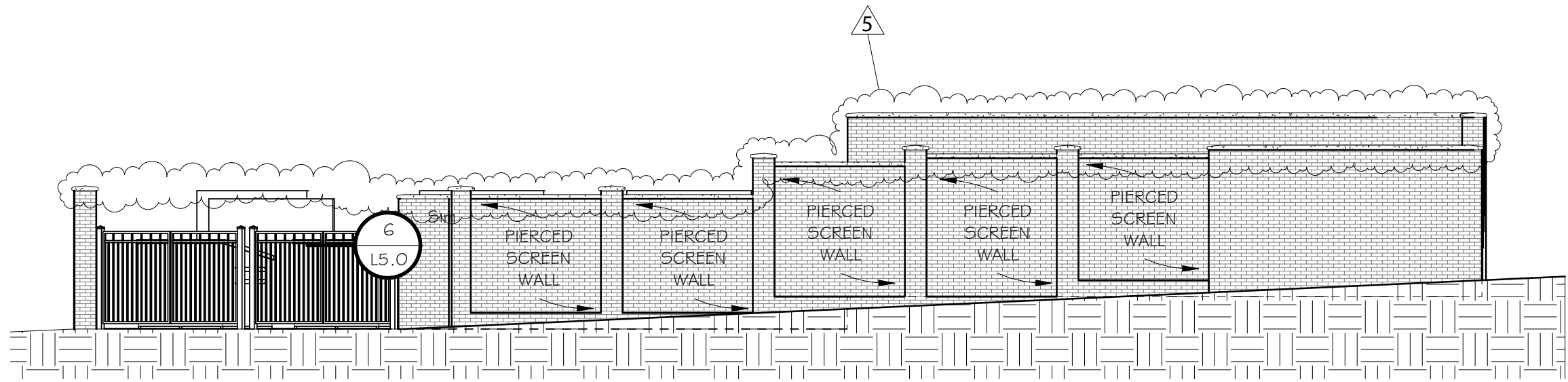




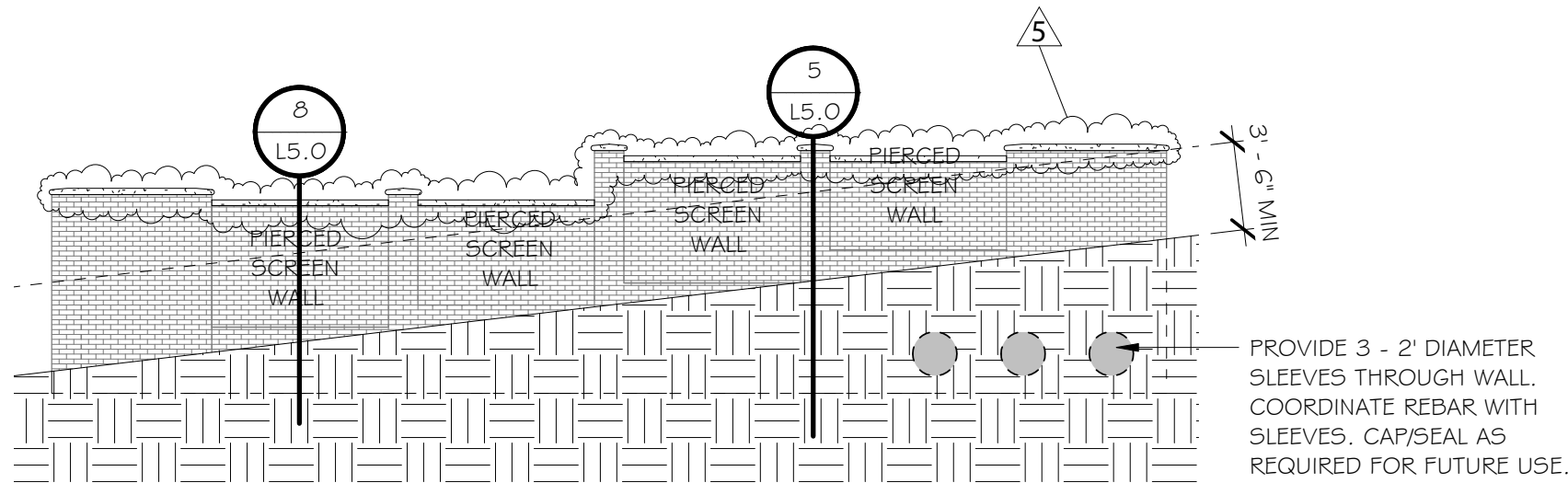




1  
L4.0  
MECHANICAL YARD  
1/8" = 1'-0"



2  
L4.0  
MECHANICAL YARD WEST ELEVATION  
1/8" = 1'-0"



3  
L4.0  
MECHANICAL YARD SOUTH ELEVATION  
1/8" = 1'-0"

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5	Add. 5	01/15/2021

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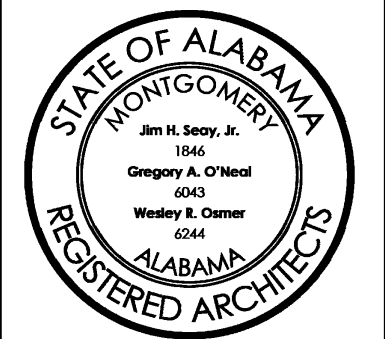
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Sheet Title  
MECHANICAL  
YARD

Sheet Number

L4.0



NOTE: EXTEND CONTINUOUS MASONRY REINFORCING IN WALL INTO PILASTER, TYP.

CAST STONE CAP - MATCH EXISTING ADJACENT MECHANICAL WALL CAP  
STAINLESS STEEL PINS  
CMU WITH CONCRETE FILLED CELLS  
BRICK  
MASONRY TIES @ 16" O.C.  
WALL TO PILASTER, TYP.

GRADE VARIES - SEE CIVIL

CONCRETE - SEE STRUCTURAL  
FOUNDATION DRAIN (SEE CIVIL)  
PEJ  
CONCRETE (SEE CIVIL)

PREFABRICATED DRAINAGE COMPOSITE  
PARASEAL DUAL WATERPROOFING MEMBRANE OR EQUAL  
VULKEM 201/60 OR EQUAL WATERPROOFING  
PERFORATED PVC FOUNDATION DRAIN IN FILTER FABRIC SOCK - SEE CIVIL  
WRAP DRAINAGE BOARD FABRIC 360 DEGREES AROUND PVC FOUNDATION DRAIN

\*FOOTING - SEE STRUCTURAL

SEE STRUCTURAL

NOTE: EXTEND CONTINUOUS MASONRY REINFORCING IN WALL INTO PILASTER, TYP.

CAST STONE CAP BEYOND

CAST STONE CAP - MATCH EXISTING ADJACENT MECHANICAL WALL CAP  
STAINLESS STEEL PINS  
CONTINUOUS HORIZONTAL MASONRY REINFORCING AT 8" ON CENTER WHERE SOLID COURSES OCCUR

WALL SHALL BE TWO WYTHES (8 INCHES)

MASONRY TIES @ 16" O.C.  
WALL TO PILASTER, TYP.

COLUMN BEYOND

GRADE VARIES - SEE CIVIL

CONCRETE - SEE STRUCTURAL

PEJ  
CONCRETE (SEE CIVIL)

PREFABRICATED DRAINAGE COMPOSITE  
PARASEAL DUAL WATERPROOFING MEMBRANE OR EQUAL  
VULKEM 201/60 OR EQUAL WATERPROOFING  
PERFORATED PVC FOUNDATION DRAIN IN FILTER FABRIC SOCK - SEE CIVIL  
WRAP DRAINAGE BOARD FABRIC 360 DEGREES AROUND PVC FOUNDATION DRAIN

FOOTING - SEE STRUCTURAL

SEE STRUCTURAL

BRICK ROWLOCK CAP  
PROVIDE BRICK AT ALL EXPOSED SURFACES (TYP.)  
FINISH GRADE (VARIES, SEE CIVIL)  
VARIES - SEE CIVIL  
3'-6" MIN. - U.N.O.  
1' - 3 5/8"  
1" @ 3/8" 1"  
SLOPE  
CONCRETE RETAINING WALL, SEE STRUCTURAL  
MORTAR NET  
TERMINATION BAR & SEALANT  
THROUGH WALL FLASHING  
WEEP  
METAL DRIP EDGE

PREFABRICATED DRAINAGE COMPOSITE  
PARASEAL DUAL WATERPROOFING MEMBRANE OR EQUAL  
VULKEM 201/60 OR EQUAL WATERPROOFING  
GROUT FILL  
PERFORATED PVC FOUNDATION DRAIN IN FILTER FABRIC SOCK - SEE CIVIL  
WRAP DRAINAGE BOARD FABRIC 360 DEG AROUND PVC FOUNDATION DRAIN  
AGGREGATE FILL MATERIAL - WRAP WITH FILTER CLOTH  
CONCRETE FOOTING, SEE STRUCTURAL

3  
L5.0  
RETAINING WALL  
1" = 1'-0"

5  
L5.0  
MECH YARD SCREEN WALL/COLUMN SECTION  
1 1/2" = 1'-0"

1"X1"X1/8" TUBE STEEL @ 9" O.C. (PAINT)  
1/4" SHEET METAL (PAINT)  
3"X1-1/2"X1/4" STEEL ANGLE FRAME (PAINT)  
3"X3"X1/4" STEEL ANGLE FRAME (PAINT)  
BARREL HINGE - SEE SPECS  
3"X3"X1/4" STEEL TUBE (PAINT) FILLED WITH CONCRETE  
BRICK VENEER

6  
L5.0  
DUMPSTER GATE DETAIL  
3" = 1'-0"

8  
L5.0  
MECH YARD PIERCED SCREEN WALL SECTION  
1 1/2" = 1'-0"

SEE CIVIL  
SEE STRUCTURAL  
SEE CIVIL  
SEE CIVIL  
SEE STRUCTURAL  
SEE STRUCTURAL

4  
L5.0  
MECH YARD STEP  
1 1/2" = 1'-0"

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Sheet Title  
MECHANICAL  
YARD DETAILS

Sheet Number

L5.0

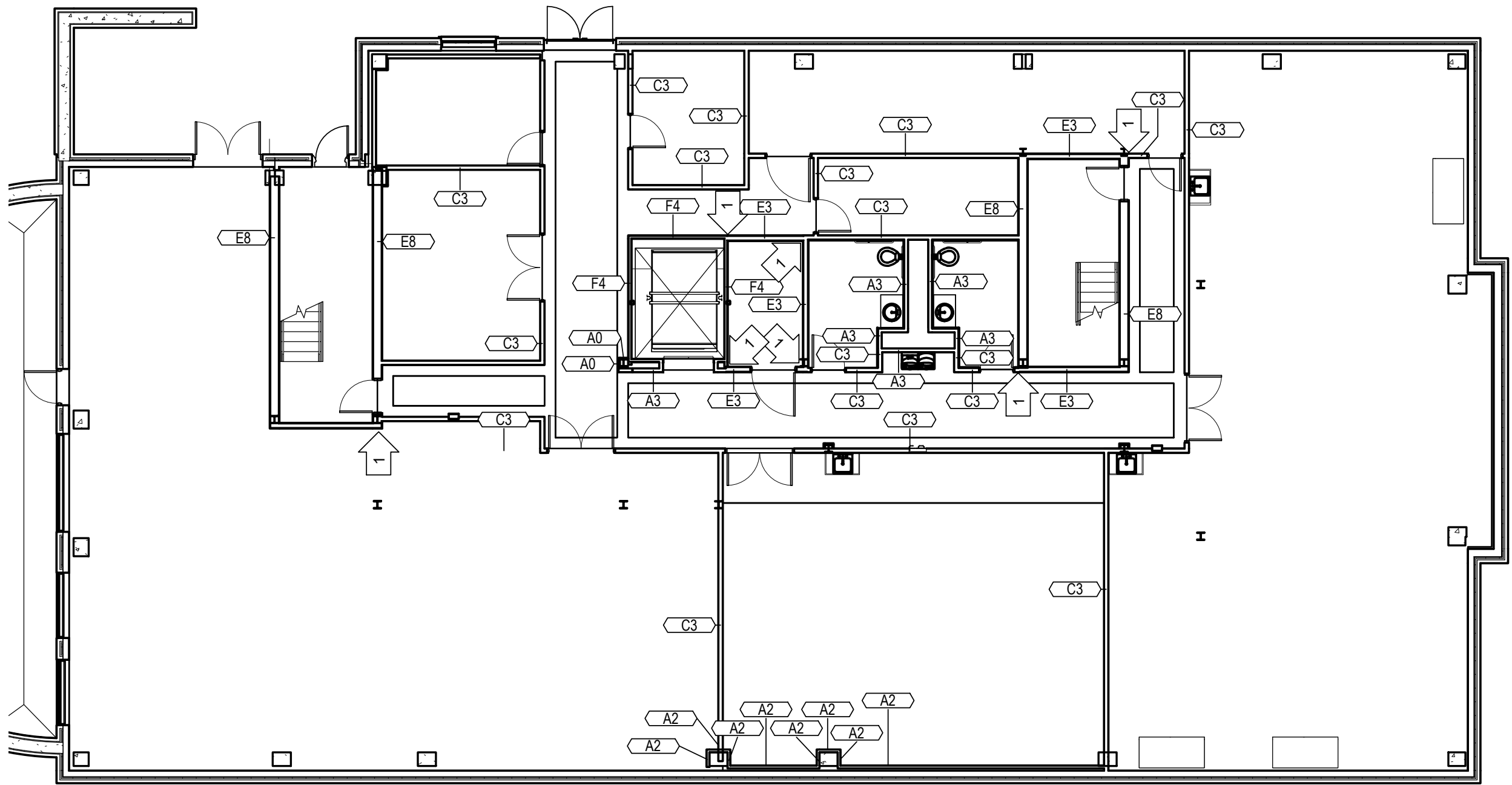


GENERAL NOTES:

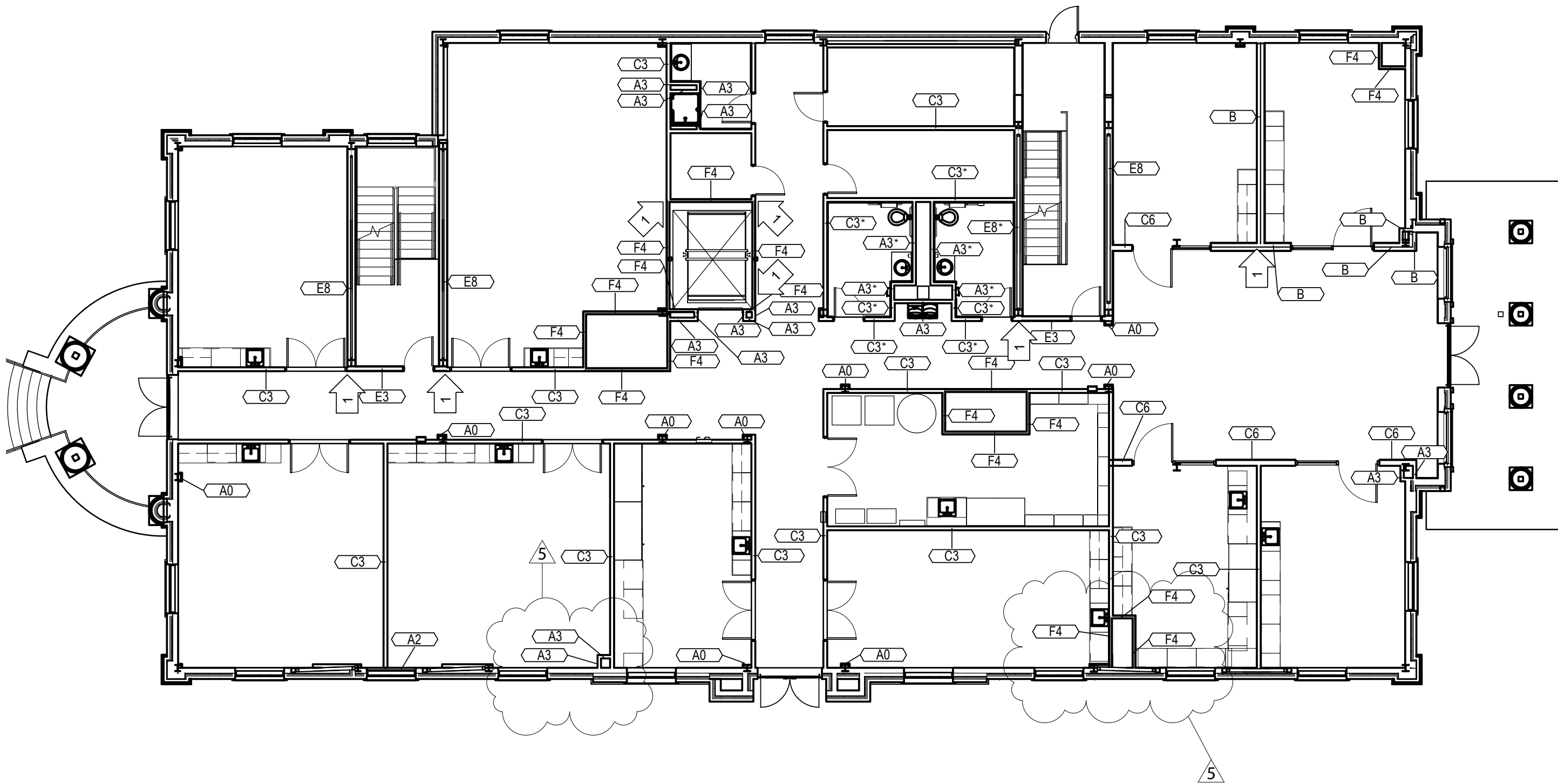
- 1. TYPICAL AT COLUMNS AND STRUCTURAL ELEMENTS PROTRUDING FROM WALLS: PROVIDE METAL STUD AND GYPSUM WALL BOARD FURR OUT AS REQUIRED TO FULLY CONCEAL.
- 2. REFER TO LIFE SAFETY PLAN FOR PARTITION RATINGS.
- 3. ALL PARTITIONS TO EXTEND # SEAL TO DECK ABOVE, U.N.O.
- 4. WALL TYPE PLANS ARE SHOWN WITH ALTERNATES. IF ALTERNATE IS NOT ACCEPTED REFER TO FLOOR PLANS FOR BASE BID WALLS.

SPECIFIC NOTES:

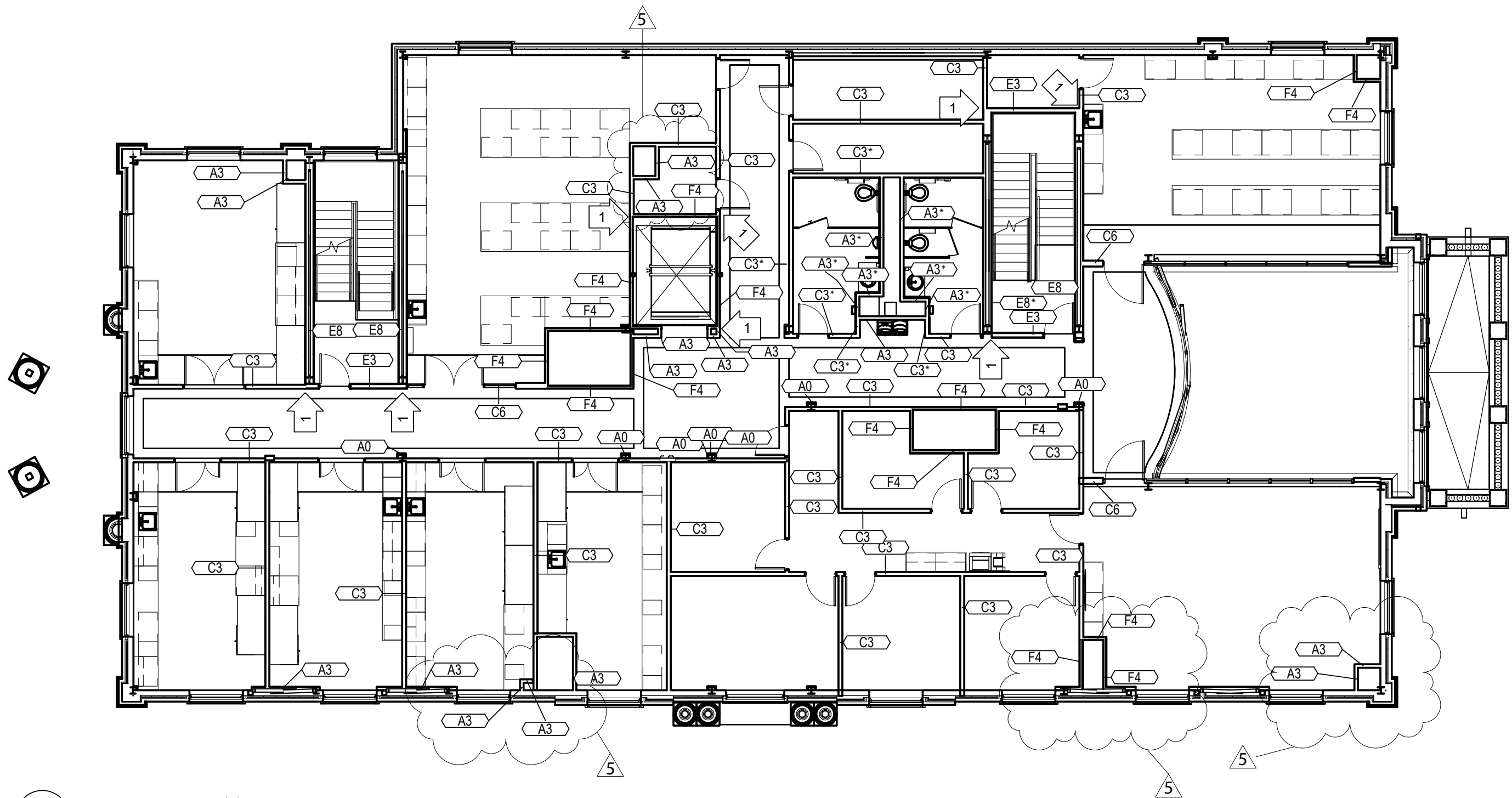
- 1 INTERSECTION OF TWO DIFFERENT WALL TYPES. STUD FACES MIGHT NOT ALIGN. STUDS TO BE OFFSET AS REQUIRED FOR GYPSUM BOARD/ FINISH FACE TO ALIGN.



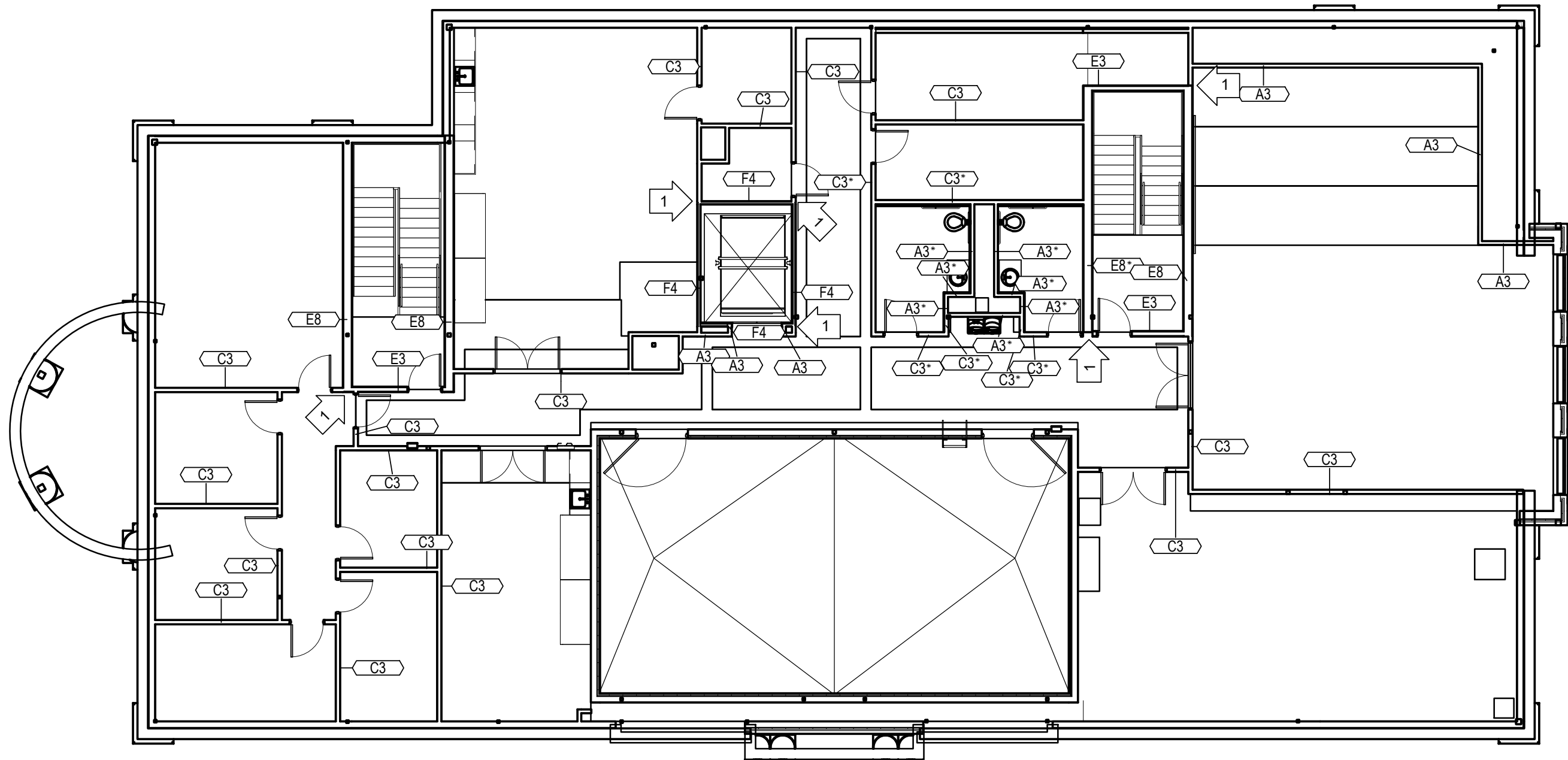
1 LEVEL 0 WALL TYPE PLAN  
3/32" = 1'-0"



2 LEVEL 1 WALL TYPE PLAN  
3/32" = 1'-0"



3 LEVEL 2 WALL TYPE PLAN  
3/32" = 1'-0"



4 LEVEL 3 WALL TYPE PLAN  
3/32" = 1'-0"

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Add. 5		01/15/2021

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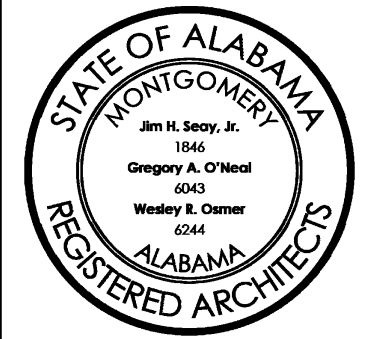
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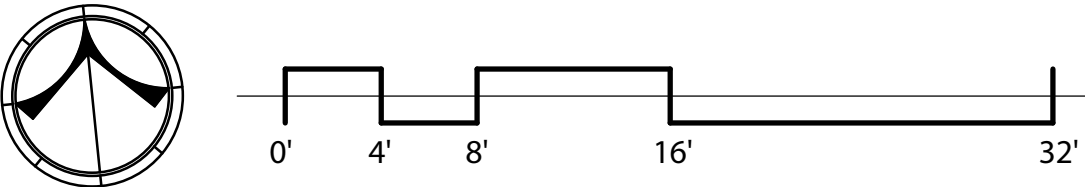
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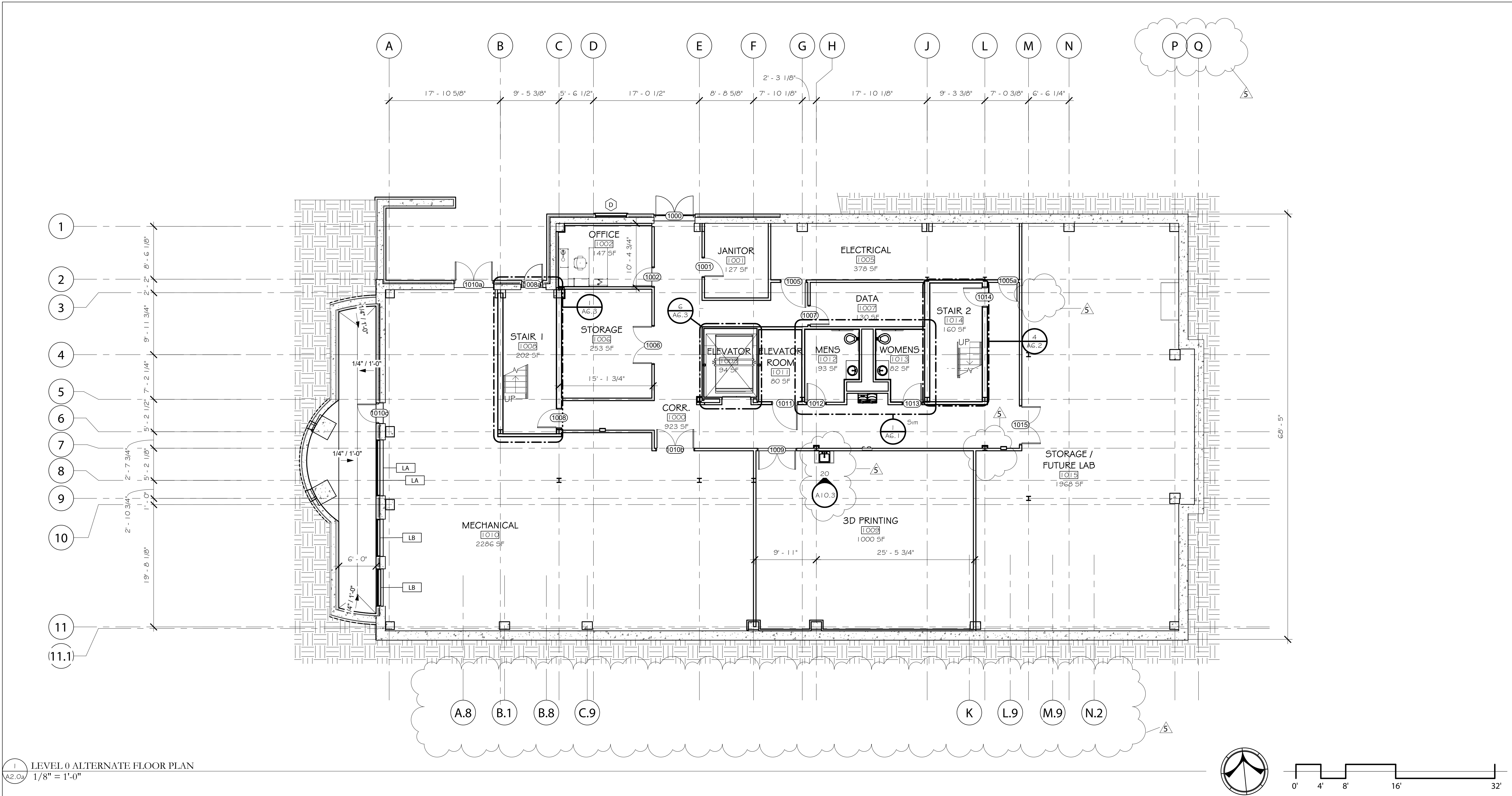
Sheet Title  
WALL TYPE PLAN

Sheet Number

A1.1







GENERAL NOTES:

1. TYPICAL AT COLUMNS AND STRUCTURAL ELEMENTS PROTRUDING FROM WALLS: PROVIDE METAL STUD AND GYPSUM WALL BOARD FURR OUT AS REQUIRED TO FULLY CONCEAL.
2. REFER TO LIFE SAFETY PLAN FOR LOCATIONS OF FIRE EXTINGUISHERS WITH RECESSED CABINETS.

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5	Add. 5	01/15/2021

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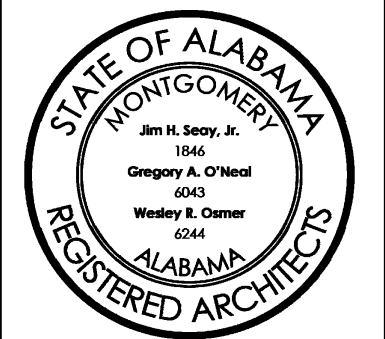
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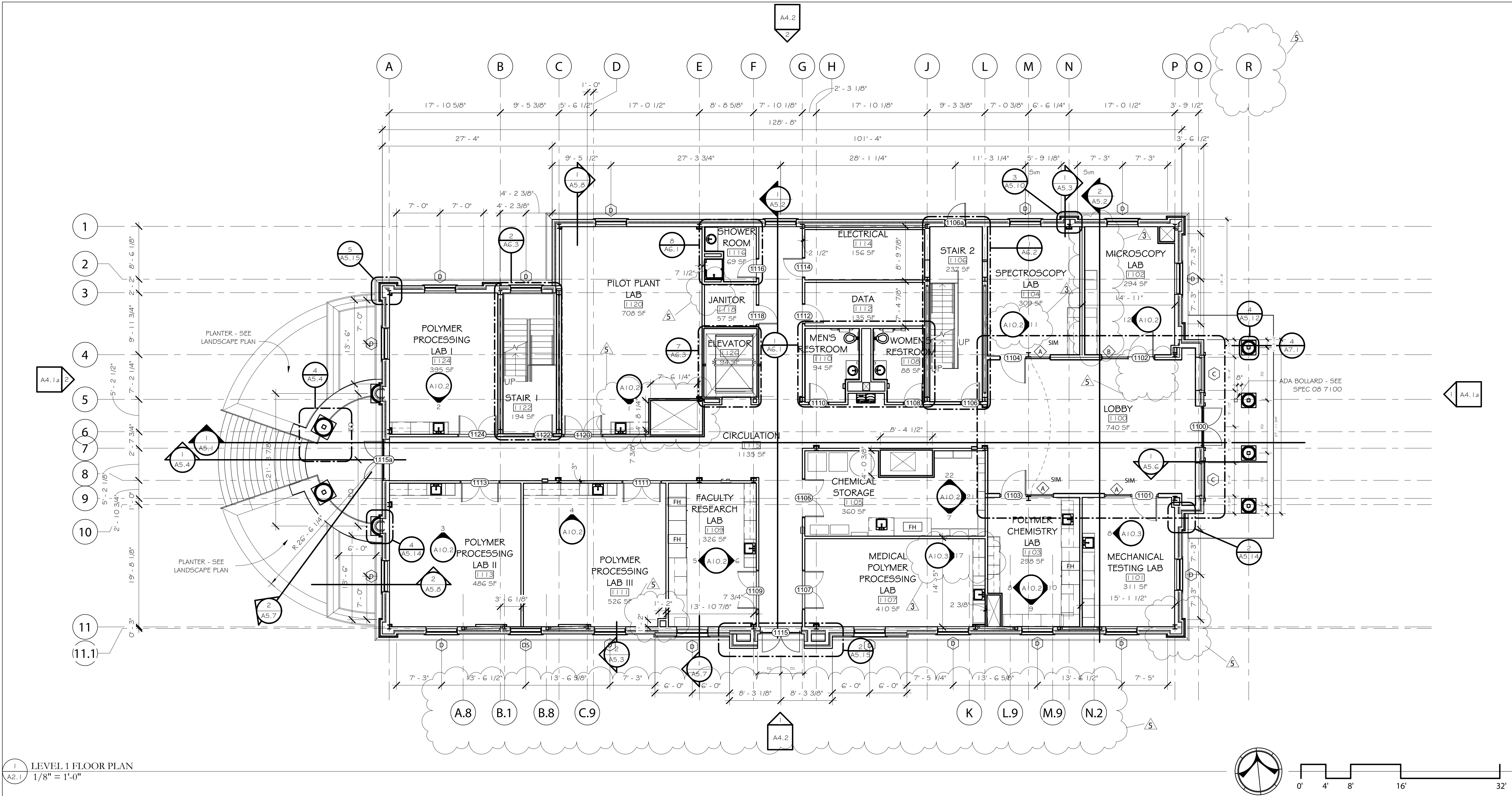
LEVEL 0  
ALTERNATE  
FLOOR PLAN

Sheet Number

A2.0a







Rev.	Description	Date
3	Add. 3	12/16/2020
5	Add. 5	01/15/2021

Job Number	18144
Date	11/17/2020
Drawn By	CS,JB,DB,LG
Checked By	JS,FL

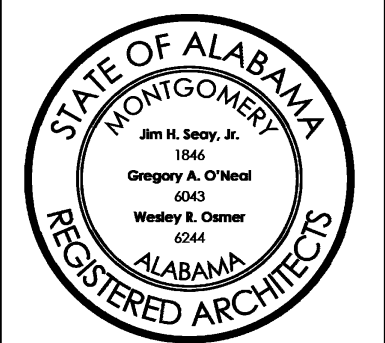
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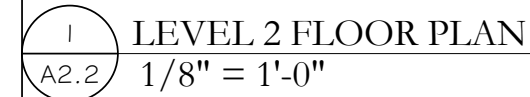
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Sheet Title  
LEVEL 1 FLOOR  
PLAN

Sheet Number

A2.1





1. TYPICAL AT COLUMNS AND STRUCTURAL ELEMENTS PROTRUDING FROM WALLS: PROVIDE METAL STUD AND GYPSUM WALL BOARD FURR OUT AS REQUIRED TO FULLY CONCEAL.
2. REFER TO LIFE SAFETY PLAN FOR LOCATIONS OF FIRE EXTINGUISHERS WITH RECESSED CABINETS.

Lab Number	18144
Date	11/17/2020
Drawn By	CS,JB,DB,LG
Checked By	JS, FL

Project Title

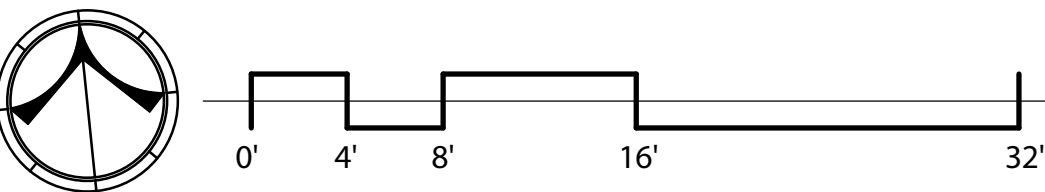
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Sheet Title  
LEVEL 2 FLOOR  
PLAN

Sheet Number

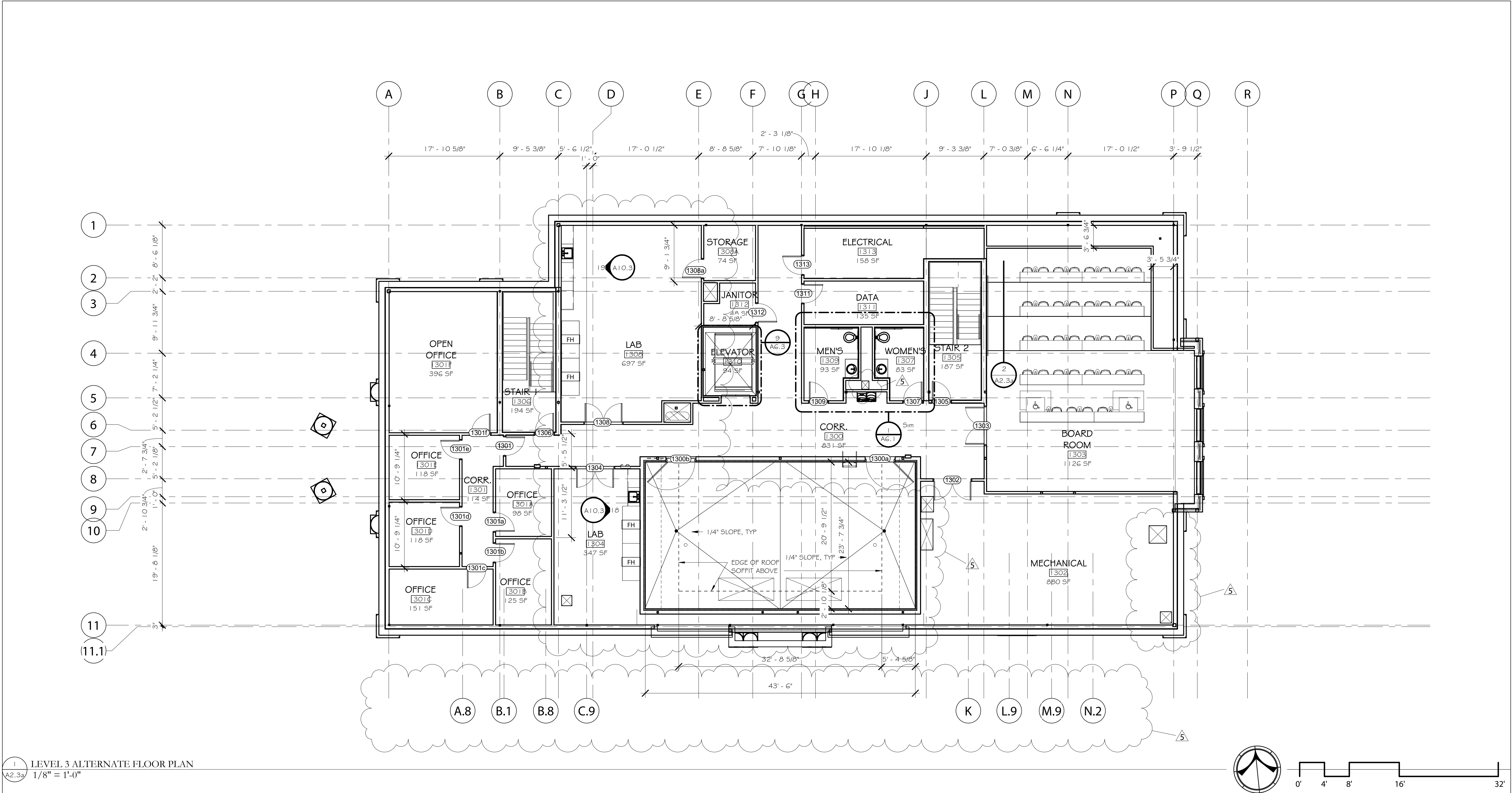
## A2.2





1. TYPICAL AT COLUMNS AND STRUCTURAL ELEMENTS PROTRUDING FROM WALLS: PROVIDE METAL STUD AND GYPSUM WALL BOARD FURR OUT AS REQUIRED TO FULLY CONCEAL.
2. REFER TO LIFE SAFETY PLAN FOR LOCATIONS OF FIRE EXTINGUISHERS WITH RECESSED CABINETS.



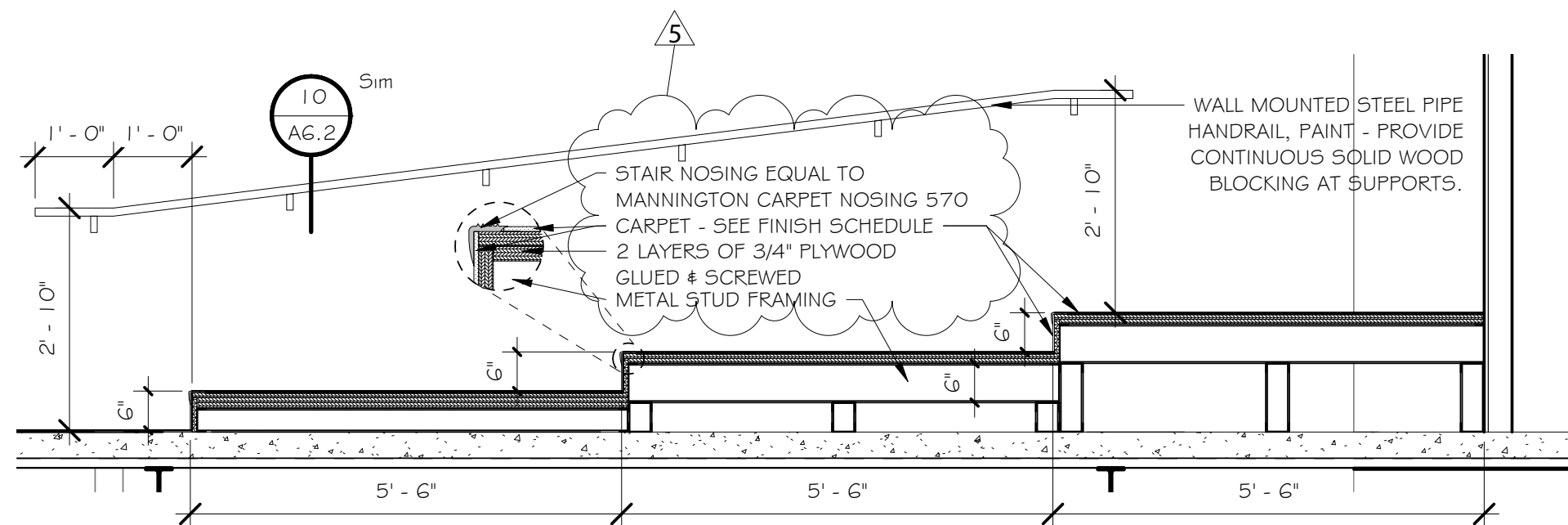


1 LEVEL 3 ALTERNATE FLOOR PLAN  
1/8" = 1'-0"

## GENERAL NOTES:

1. TYPICAL AT COLUMNS AND STRUCTURAL ELEMENTS PROTRUDING FROM WALLS: PROVIDE METAL STUD AND GYPSUM WALL BOARD FURR OUT AS REQUIRED TO FULLY CONCEAL.
2. REFER TO LIFE SAFETY PLAN FOR LOCATIONS OF FIRE EXTINGUISHERS WITH RECESSED CABINETS.

2 TIERED SEATING PLATFORM DETAIL  
1/2" = 1'-0"



Rev.	Description	Date
5	Add. 5	01/15/2021

Job Number	18144
Date	11/17/2020
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Project Title

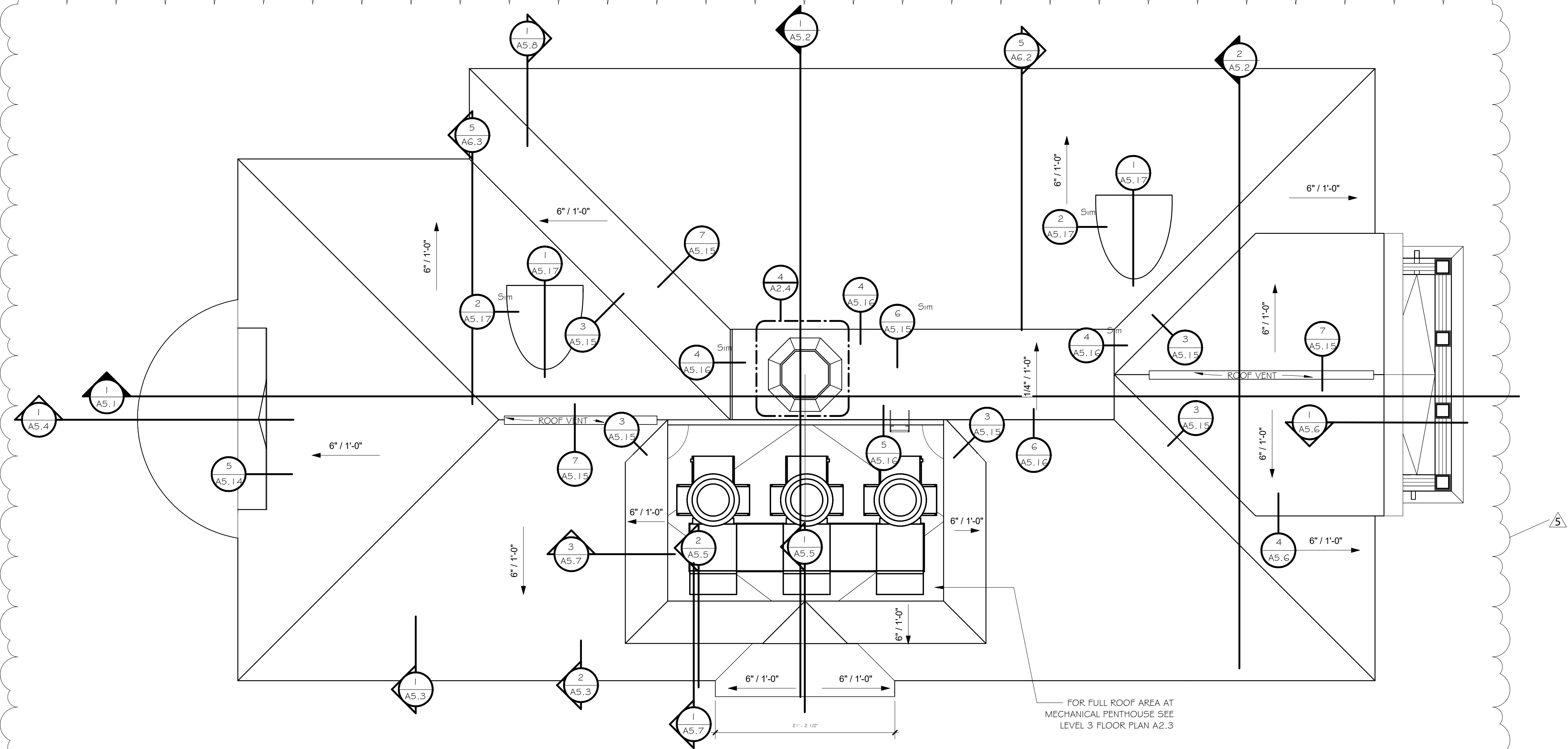
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Sheet Title  
LEVEL 3  
ALTERNATE  
FLOOR PLAN

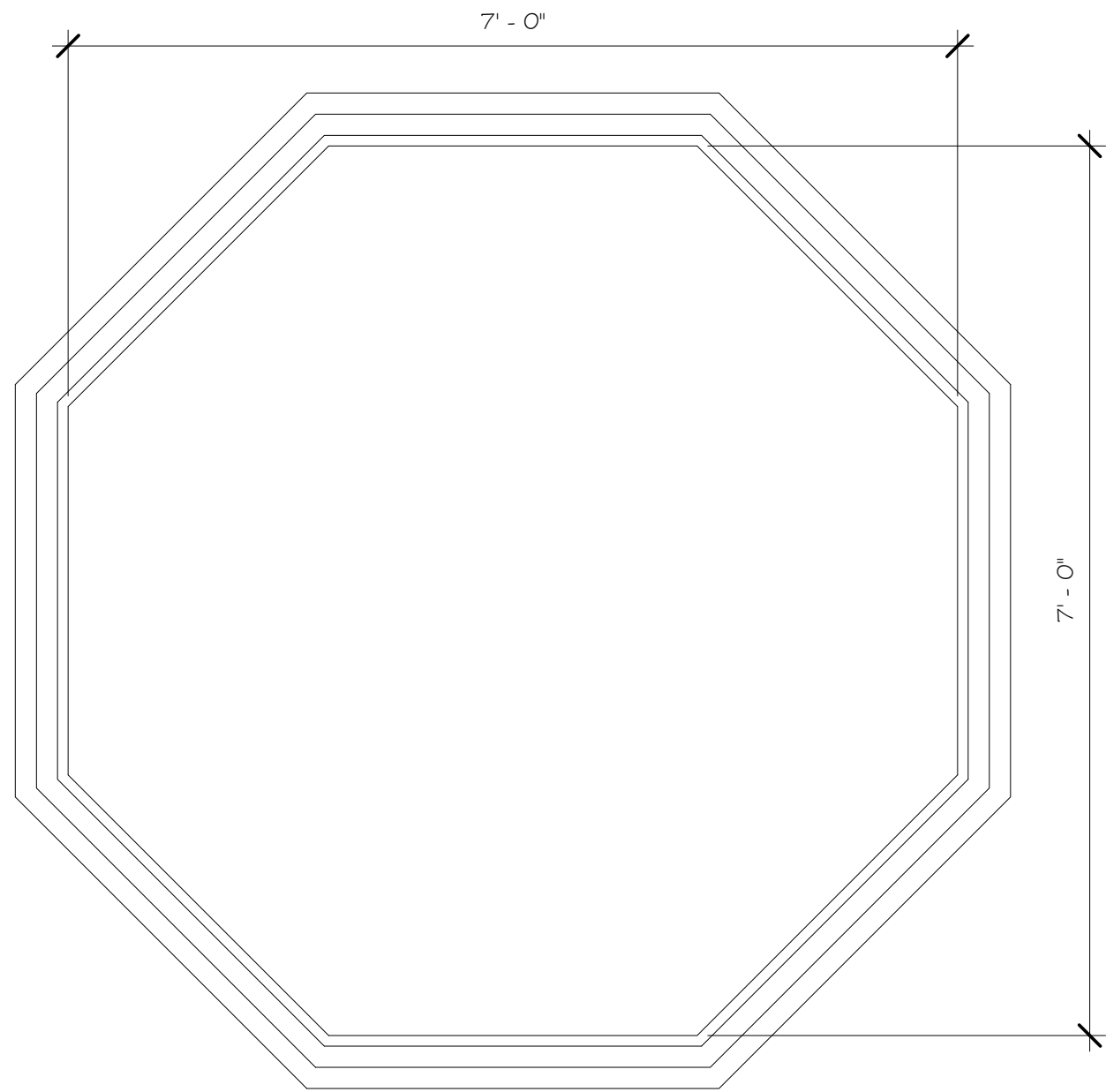
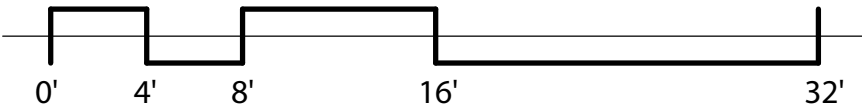
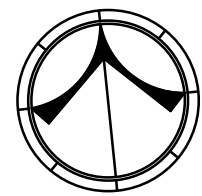
Sheet Number

A2.3a

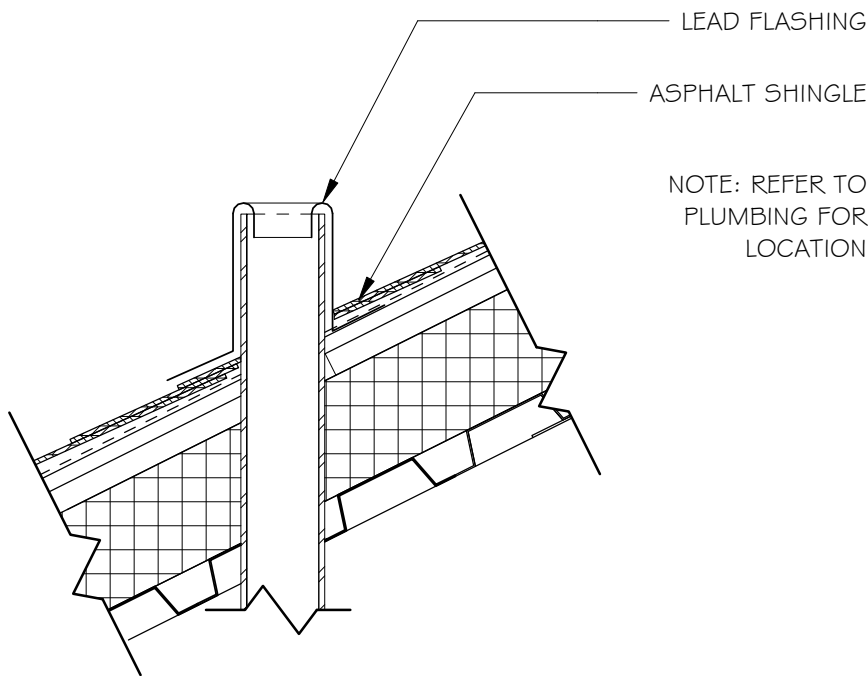




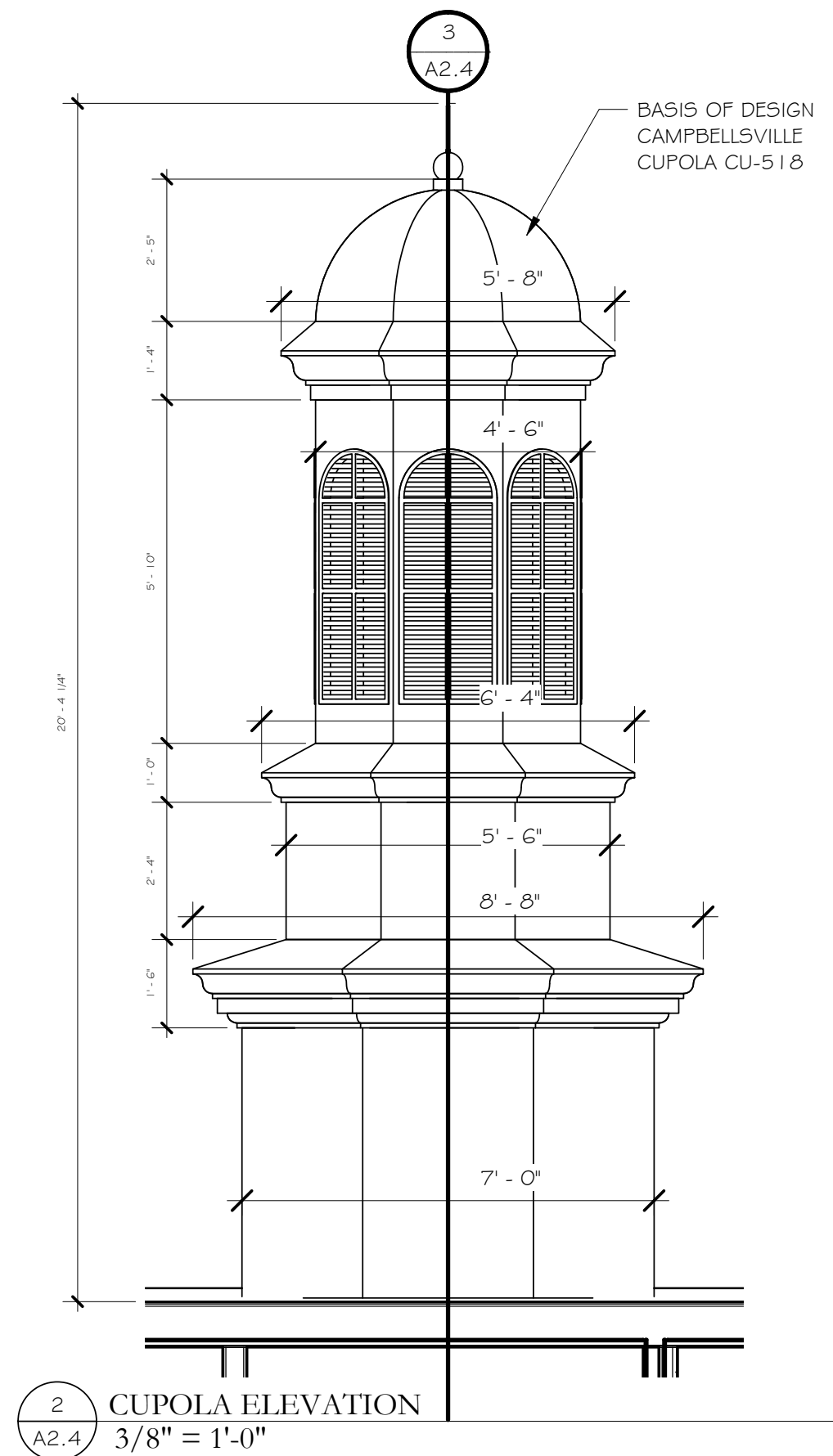
1 ROOF PLAN  
1/8" = 1'-0"



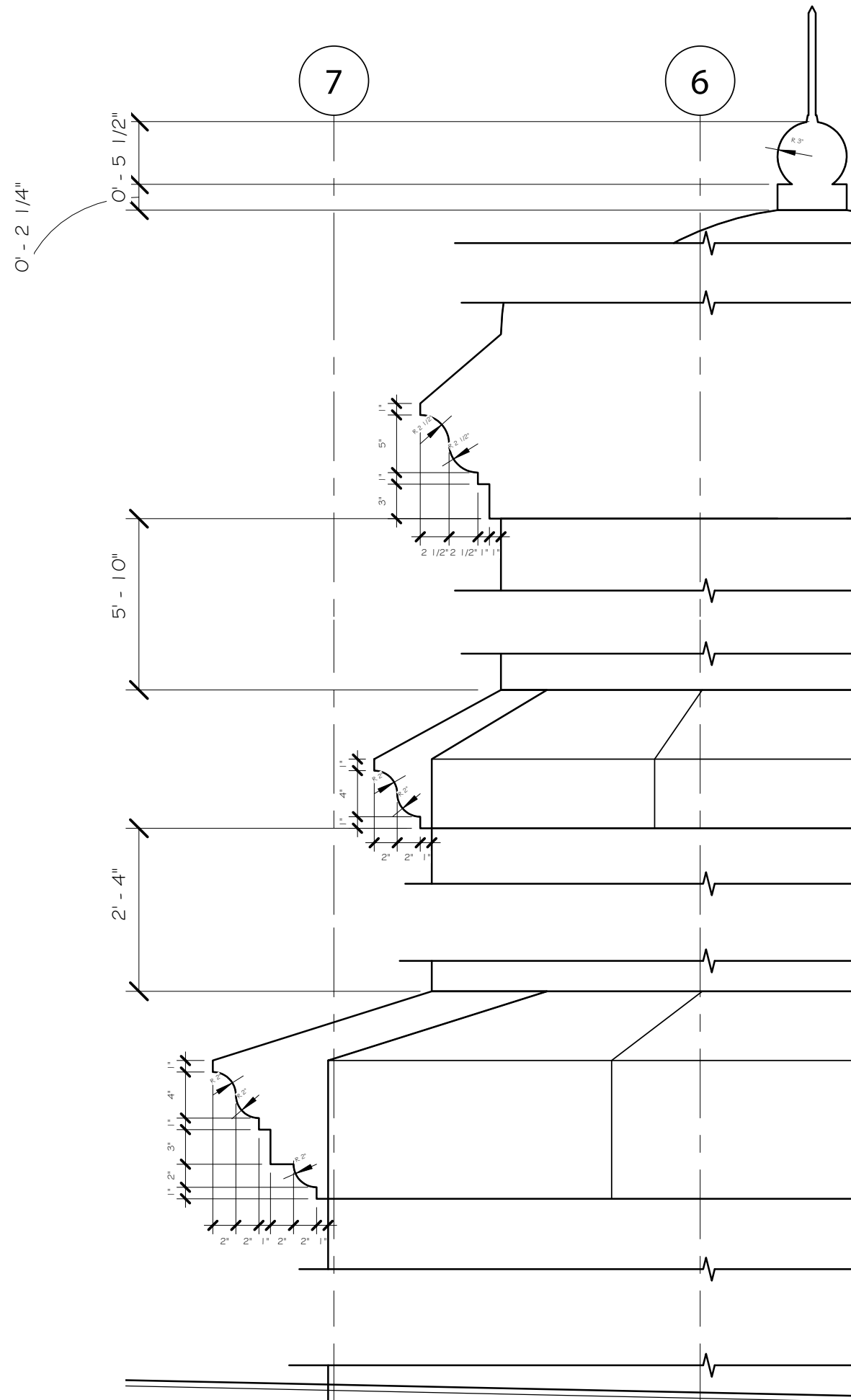
4 CUPOLA PLAN DETAIL  
3/4" = 1'-0"



5 STACK VENT DETAIL - TYPICAL  
1 1/2" = 1'-0"



2 CUPOLA ELEVATION  
3/8" = 1'-0"



3 CUPOLA SECTION DETAIL  
1" = 1'-0"

Rev.	Description	Date
5	Add. 5	01/15/2021

Job Number 18144

Date 11/17/2020

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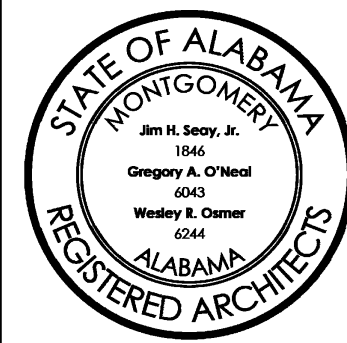
Project Title

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Sheet Title  
ROOF PLAN

Sheet Number

A2.4



FINISH SCHEDULE LEGEND

CARPET

CPT1: Manufacturer: Mannington Commercial  
Style: Gansey  
Color: Purl 15731  
Size: 12" x 48"  
Install Method: Ashlar

FLOOR TILE

HT1: Manufacturer: South Cypress  
Style: Vulcan  
Color: Slate  
Size: 12" x 24"  
Install Pattern: Ashlar 1/3 offset

TOILET PARTITIONS

PPI: Manufacturer: Roppe  
Color: To match Formica Platinum 902-58

TERRAZZO

TZ1: White Terrazzo  
Manufacturer: Terrazzco  
Custom Color: JB2167

TZ2: Light Gray Terrazzo  
Manufacturer: Terrazzco  
Custom Color: JB2169

TZ3: Dark Gray Terrazzo  
Manufacturer: Terrazzco  
Custom Color: JB2170

TZ4: Red Terrazzo  
Manufacturer: Terrazzco  
Custom Color: JB2166

DECORATIVE MOSAIC EPOXY COATING

DMEC1: Manufacturer: Sherwin Williams  
Style: Decorative Mosaic WB  
Color: "D" CU 14

DMEC2: Manufacturer: Sherwin Williams  
Style: Decorative Mosaic WB  
Color: Custom

DMEC3: Manufacturer: Sherwin Williams  
Style: Decorative Mosaic WB  
Color: Custom

RUBBER BASE

RB1: Manufacturer: Roppe  
Color: Light Gray P195

ACOUSTIC CEILING

ACT1: Manufacturer: Armstrong  
Style: Cortega (#704)  
Size: 24" x 24"  
Suspension System: Armstrong Prelude  
15/16" White  
Edge: Angular Tegular

ACT2: Manufacturer: Armstrong  
Style: Clean Room VL  
Size: 24" x 24"  
Suspension System: Armstrong Prelude  
15/16" White

RUBBER FLOORING

RF1: Manufacturer: Nora Flooring  
Type: Norament Satura  
Color: Arcturus 5116

PAINT

PNT1: Wall Paint  
Manufacturer: Sherwin Williams  
Color: Repose Gray SW 7015

PNT2: Door Casings / Trim Paint  
Manufacturer: Sherwin Williams  
Color: Donan Gray SW 7017

PNT3: Manufacturer: Sherwin Williams  
Color: Wall Street SW 7665

PNT4: Gypsum Board Ceiling Paint  
Manufacturer: Sherwin Williams  
Color: Ceiling Bright White SW 7007

WALL TILE

WT1: Manufacturer: Concept Surfaces  
Style: Bottega  
Color: White  
Size: 12" x 24"  
Install Pattern: Ashlar 1/3 offset

PLASTIC LAMINATE CASEWORK

PL1: Manufacturer: Formica  
Color: Citadel Warp 5882-58

COUNTERTOPS

SS1: Natural Quartz:  
Manufacturer: Silestone  
Color: Lagoon  
Edge Finish: Straight

SS2: Solid Surfacing Window Sills:  
Manufacturer: Conan  
Color: Deep Titanium  
Edge Finish: Square Edge

ER: Epoxy Resin Countertop:  
See Specification Section: 12 3600

SEALED CONCRETE

SC: See Specification Section: 03 3000

STAIN

WDST1: Manufacturer: Masonite Architectural/  
Graham  
Style: Plain Sliced Natural Birch  
Color: 425 (552 Stain Group)

PROTECTIVE WALL PANEL

FRP1: Fiber Reinforced Paneling  
See Specification Section 06 8316

LAB CASEWORK

LC1: See Specification Sections  
12 3450 and 12 3553.  
Determind by if Alternate is selected.  
Finish to be selected by Architect from  
manufacturers color range.

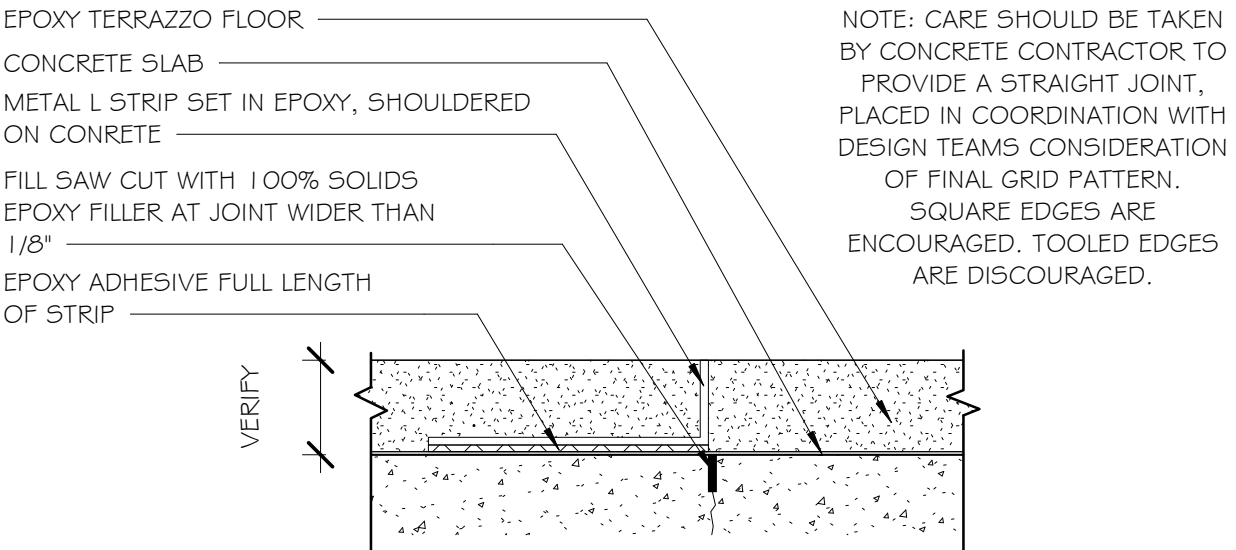
WINDOW SHADES

SH1: See Specification Section: 12 2115  
Operable Mesh Shades &  
Specification Section 01 2300

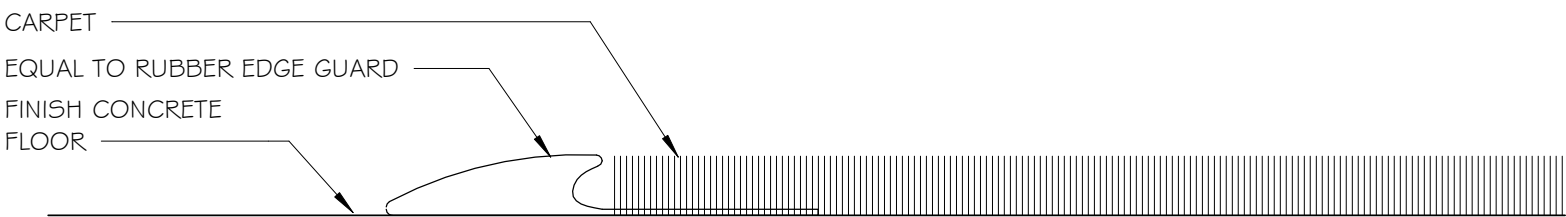
\*EXP: Exposed Ceiling

BASE BID FINISH SCHEDULE LEVEL 0 & LEVEL 1

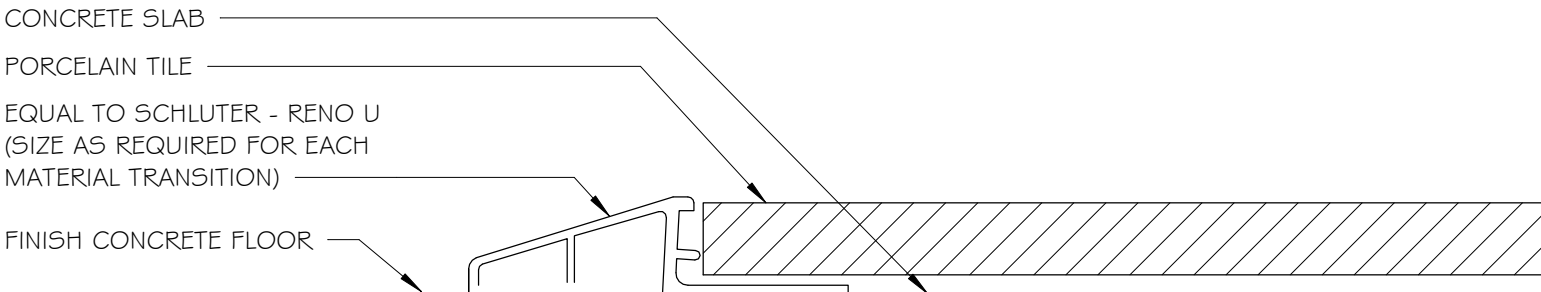
NO.	ROOM NAME	FLOOR		WALL FINISH	CEILING FINISH	WINDOW		DOOR FINISH	MILLWORK			Area	NOTES
		FINISH	BASE FINISH			SHADE	SILL		CASEWORK	COUNTER	TOP		
									UPPER	LOWER			
LEVEL 0													
1000	CORR.					SH1	SS2	PNT2				1356 SF	
1001	JANITOR							PNT2				127 SF	
1003	ELEVATOR	RF1										94 SF	
1005	ELECTRICAL							PNT2				378 SF	
1007	DATA							PNT2				130 SF	
1008	STAIR 1	SC	RB	PNT1	EXP/PNT3			PNT2				201 SF	
1009	FUTURE LAB							PNT2				3000 SF	
1010	MECH							PNT2				2288 SF	
1011	ELEVATOR ROOM							PNT2				80 SF	
1012	FUTURE MEN'S				ACT-2			PNT2				95 SF	
1013	FUTURE WOMEN'S				ACT-2			PNT2				84 SF	
1014	STAIR 2	SC	RB	PNT1	EXP/PNT3			PNT2				160 SF	
LEVEL 1													
1100	LOBBY	TZ1, TZ2, TZ3, TZ4	WOOD	PNT1	PNT4		SS2	PNT2				740 SF	
1101	MECHANICAL TESTING LAB	DMEC3	RUBBER	PNT1	EXP/PNT3	SH1	SS2	PNT2		LC1	ER	311 SF	
1102	MICROSCOPY LAB	CPT1	RUBBER	PNT1	ACT1	SH1	SS2	PNT2		LC1	ER	294 SF	
1103	POLYMER CHEMISTRY LAB	DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2	LC1	LC1	ER	298 SF	
1104	SPECTROSCOPY LAB	DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2	LC1	LC1	ER	309 SF	
1105	CHEMICAL STORAGE	DMEC2, DMEC3	RUBBER	PNT1	ACT1			PNT2		LC1	ER	360 SF	SHELVING TO BE PNT5
1106	STAIR 2	SC	RUBBER	PNT1	EXP/PNT3			PNT2				237 SF	
1107	MEDICAL POLYMER PROCESSING LAB	DMEC2, DMEC3	RUBBER	PNT1	EXP/PNT3	SH1	SS2	PNT2	LC1	LC1	ER	410 SF	
1108	WOMEN'S RESTROOM	HT1	HT1	HT1, WT1	ACT-2			PNT2		PL1	SS1	88 SF	SEE ENLARGED FLOOR PLANS & ELEVATIONS
1109	FACULTY RESEARCH LAB	DMEC2, DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2	LC1	LC1	ER	326 SF	
1110	MEN'S RESTROOM	HT1	HT1	HT1, WT1	ACT-2			PNT2		PL1	SS1	94 SF	SEE ENLARGED FLOOR PLANS & ELEVATIONS
1111	POLYMER PROCESSING LAB III	DMEC2, DMEC3	RUBBER	PNT1	EXP/PNT3	SH1	SS2	PNT2	LC1	LC1	ER	527 SF	
1112	DATA	SC	RUBBER	PNT1				PNT2				135 SF	
1113	POLYMER PROCESSING LAB II	DMEC2, DMEC3	RUBBER	PNT1	EXP/PNT3	SH1	SS2	PNT2	LC1	LC1	ER	486 SF	
1114	ELECTRICAL	SC	RUBBER	PNT1				PNT2				156 SF	
1115	CIRCULATION	DMEC1, DMEC2	RUBBER	PNT1	ACT1		SS2	PNT2				1135 SF	
1116	SHOWER ROOM	HT1	HT1	HT1, WT1	ACT-2			PNT2		PL1	SS1	69 SF	SEE ENLARGED FLOOR PLANS & ELEVATIONS
1118	JANITOR	SC	RUBBER	PNT1, FRP1	ACT-2			PNT2				57 SF	I.
1120	PILOT PLANT LAB	DMEC2, DMEC3	RUBBER	PNT1	EXP/PNT3	SH1	SS2	PNT2	LC1	LC1	ER	708 SF	
1122	STAIR 1	SC	RUBBER	PNT1	EXP/PNT3		SS2	PNT2				194 SF	
1124	POLYMER PROCESSING LAB I	DMEC2, DMEC3	RUBBER	PNT1	EXP/PNT3	SH1	SS2	PNT2		LC1	ER	390 SF	
1126	ELEVATOR	RF1										94 SF	SEE SPECIFICATIONS



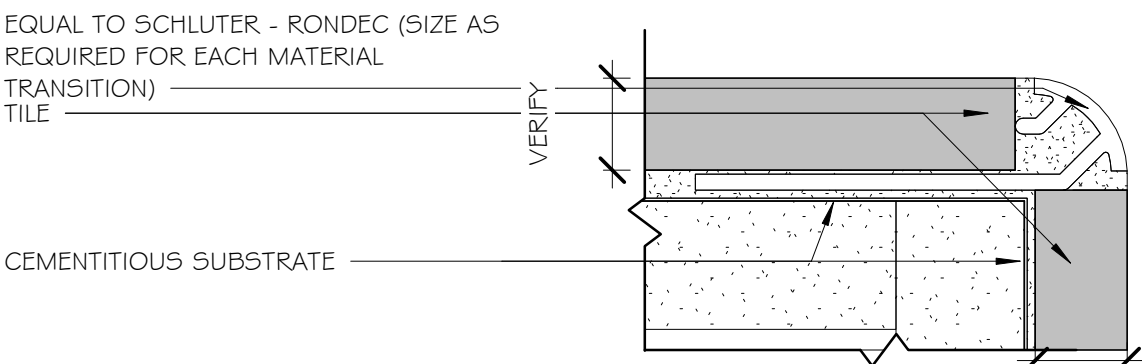
1 TERRAZZO JOINT DETAIL  
1" = 1'-0"



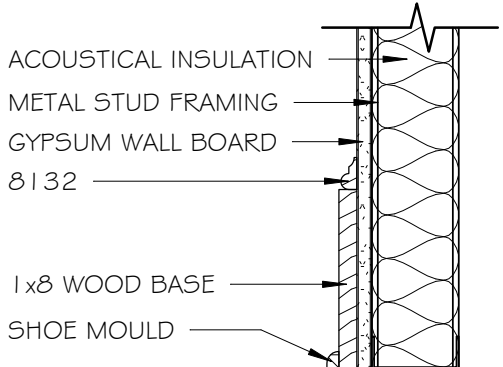
2 CONCRETE TO CARPET TRANSITION STRIP  
12" = 1'-0"



3 CONCRETE TO TILE TRANSITION STRIP  
12" = 1'-0"



4 TILE TO TILE OUTSIDE CORNER DETAIL  
1" = 1'-0"



5 WOOD BASE DETAIL  
1 1/2" = 1'-0"

Rev.	Description	Date
5	Add. 5	01/15/2021

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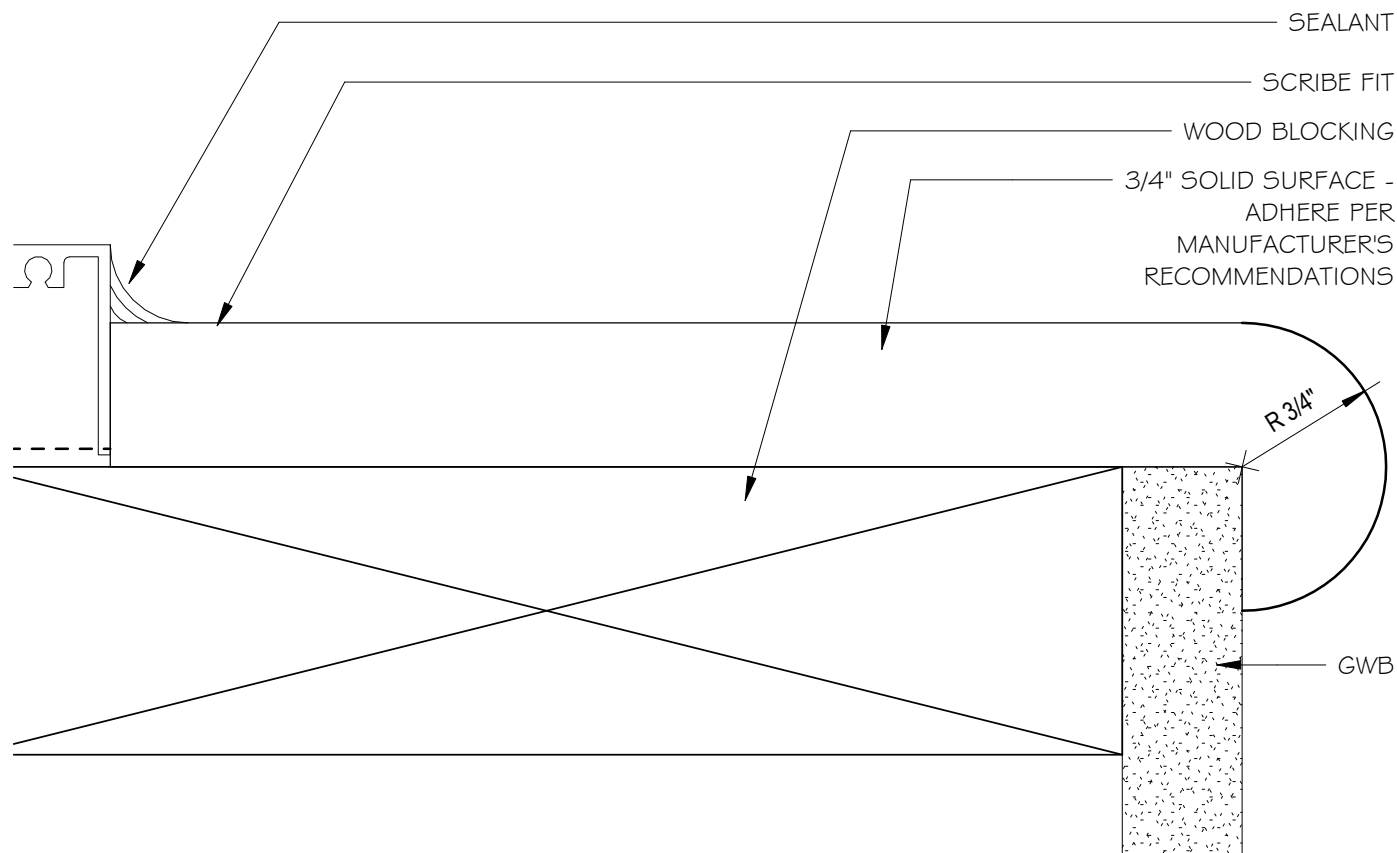
Project Title

Sheet Title  
FINISH LEGEND  
AND LEVEL 0 & 1  
BASE BID FINISH  
SCHEDULE

Sheet Number

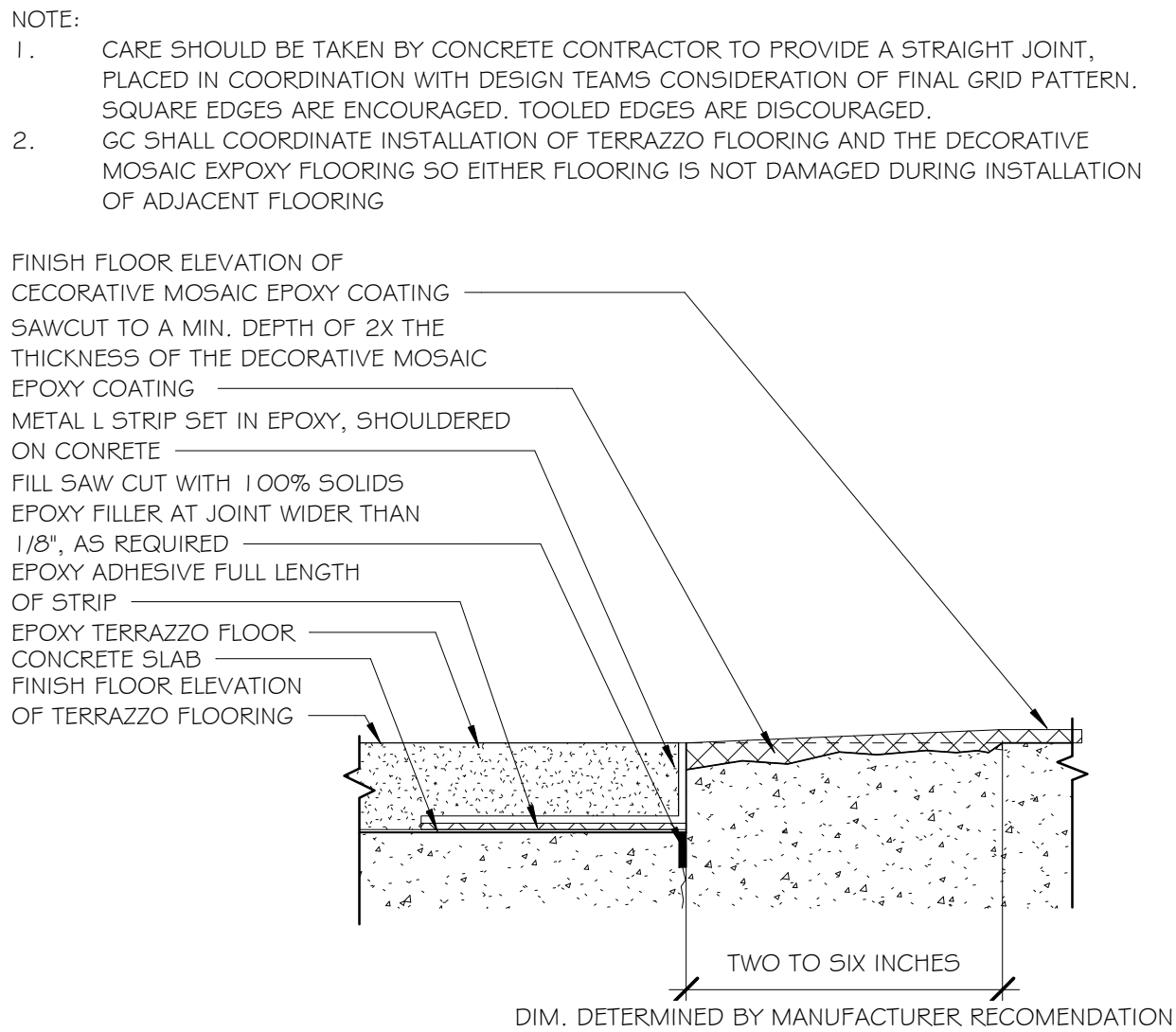
A3.0

BASE BID FINISH SCHEDULE LEVEL 2 & LEVEL 3														
NO.	ROOM NAME	FLOOR		WALL FINISH	CEILING FINISH	WINDOW		DOOR FINISH	MILLWORK			TOILET PARTITIONS	NOTES	
		FINISH	BASE FINISH			SHADE	SILL		CASEWORK		COUNTER TOP			
									UPPER	LOWER				
LEVEL 2														
1200	CIRCULATION	DMEC1, DMEC2	RUBBER	PNT1	ACT1		SS2	PNT2						
1201	CONFERENCE ROOM	CPT	RUBBER	PNT1	ACT1	SH2	SS2	PNT2		PL1	SS1			
1202	THERMAL ANALYSIS LAB	DMEC2, DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2		LC1	ER			
1202A	STORAGE	DMEC3	RUBBER	PNT1				PNT2						
1203	CIRC.	CPT1	RUBBER	PNT1	ACT1			PNT2		PL1	SS1			
1203A	OFFICE	CPT1	RUBBER	PNT1	ACT1			PNT2						
1203B	OFFICE	CPT1	RUBBER	PNT1	ACT1			PNT2						
1203C	OFFICE	CPT1	RUBBER	PNT1	ACT1	SH1	SS2	PNT2						
1203D	OFFICE	CPT1	RUBBER	PNT1	ACT1	SH1	SS2	PNT2						
1203E	DIRECTOR OFFICE	CPT1	RUBBER	PNT1	ACT1	SH1	SS2	PNT2						
1203F	OFFICE	CPT1	RUBBER	PNT1	ACT1			PNT2						
1204	STAIR 2	SC	RUBBER	PNT1	EXP/PNT3			PNT2						
1205	THERMAL LAB	DMEC2, DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2		LC1	ER			
1206	WOMEN'S	HT1	HT1	HT1, WT1	ACT-2			PNT2		PL1	SS1	PP1		SEE ENLARGED FLOOR PLANS & ELEVATIONS
1207	FACULTY RESEARCH LAB	DMEC2, DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2	LC1	LC1	ER			
1208	MEN'S	HT1	HT1	HT1, WT1	ACT-2			PNT2		PL1	SS1	PP1		SEE ENLARGED FLOOR PLANS & ELEVATIONS
1209	FACULTY RESEARCH LAB	DMEC2, DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2	LC1	LC1	ER			
1210	DATA	SC	RUBBER	PNT1				PNT2						
1211	FACULTY RESEARCH LAB	DMEC2, DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2	LC1	LC1	ER			
1212	ELECTRICAL	SC	RUBBER	PNT1				PNT2						
1216	JANITOR	SC	RUBBER	PNT1, FRP1	ACT-2			PNT2					1.	
1218	CHROMATOGRAPHY ANALYTICAL LAB	DMEC2, DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2		LC1	ER			
1220	STAIR 1	SC	RUBBER	PNT1	EXP/PNT3		SS2	PNT2						
1222	FACULTY RESEARCH LAB	DMEC2, DMEC3	RUBBER	PNT1	ACT1	SH1	SS2	PNT2	LC1	LC1	ER			
1224	ELEVATOR	RF1												SEE SPECIFICATIONS
LEVEL 3														
1305	STAIR 2	SC	RUBBER	PNT1	EXP/PNT3			PNT2						
1306	STAIR 1	SC	RUBBER	PNT1	PNT3			PNT2						
1307	FUTURE WOMEN'S	SC			ACT-2			PNT2						
1308A	STORAGE	SC						PNT2						
1309	FUTURE MEN'S	SC			ACT-2			PNT2						
1310	ELEVATOR	RF1												SEE SPECIFICATIONS
1311	DATA	SC						PNT2						
1312	JANITOR	SC						PNT2						
1313	ELECTRICAL	SC						PNT2						



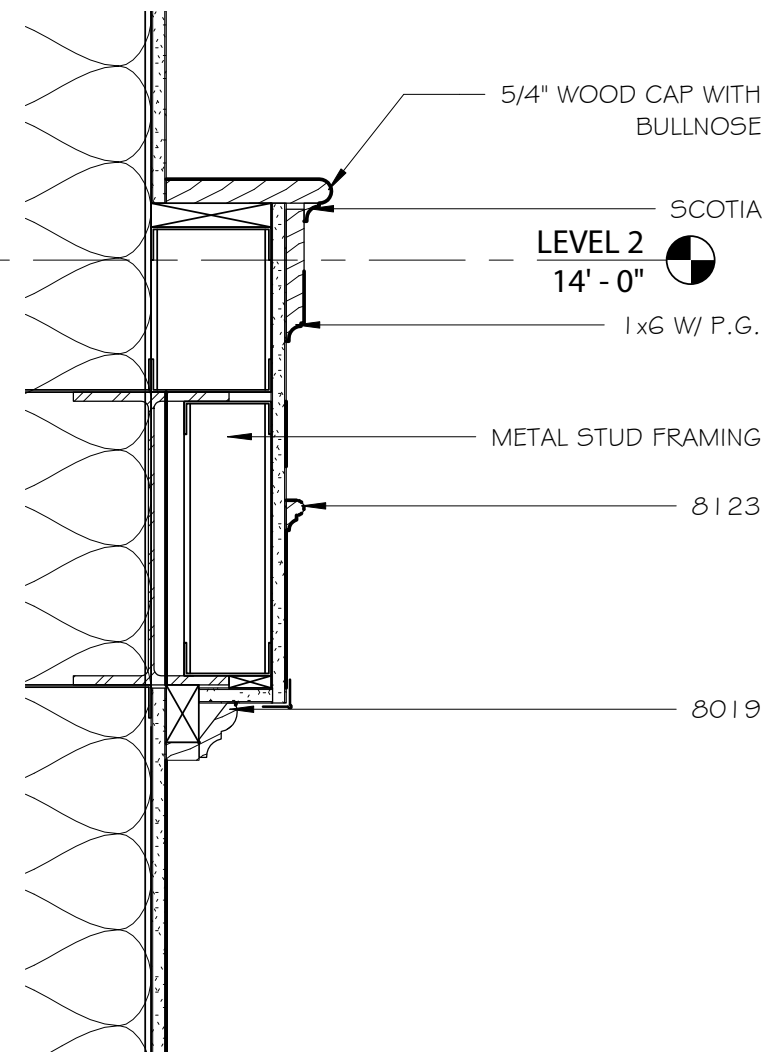
3  
A3.1

TYPICAL SILL DETAIL  
12" = 1'-0"



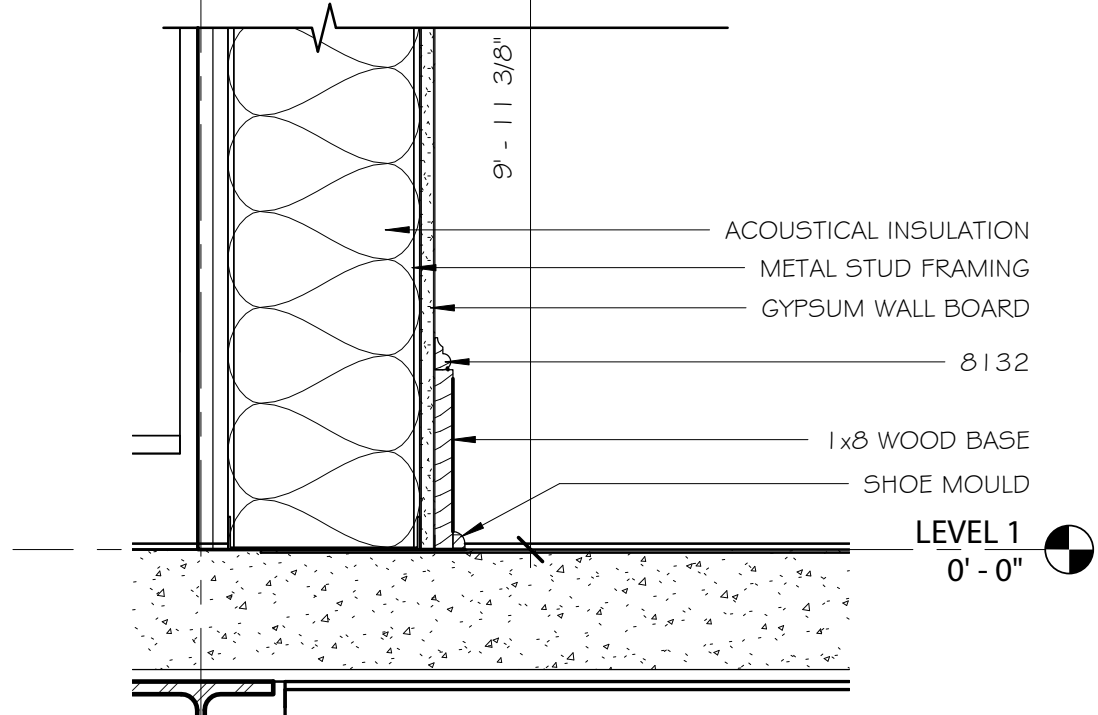
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A3.1

TERRAZZO TO EPOXY FLOOR TRANSITION DETAIL



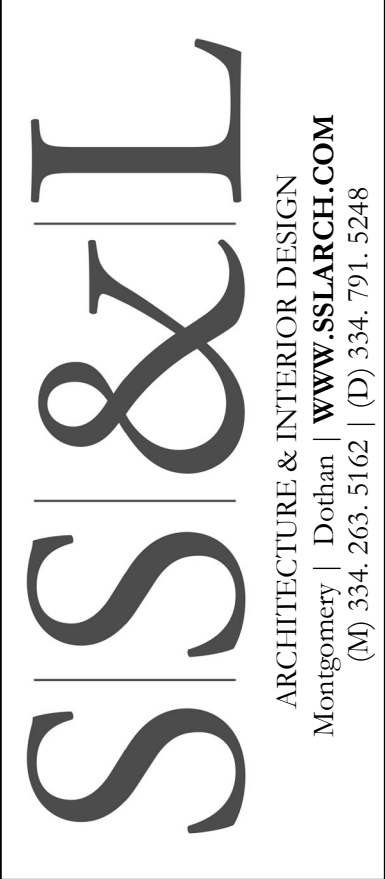
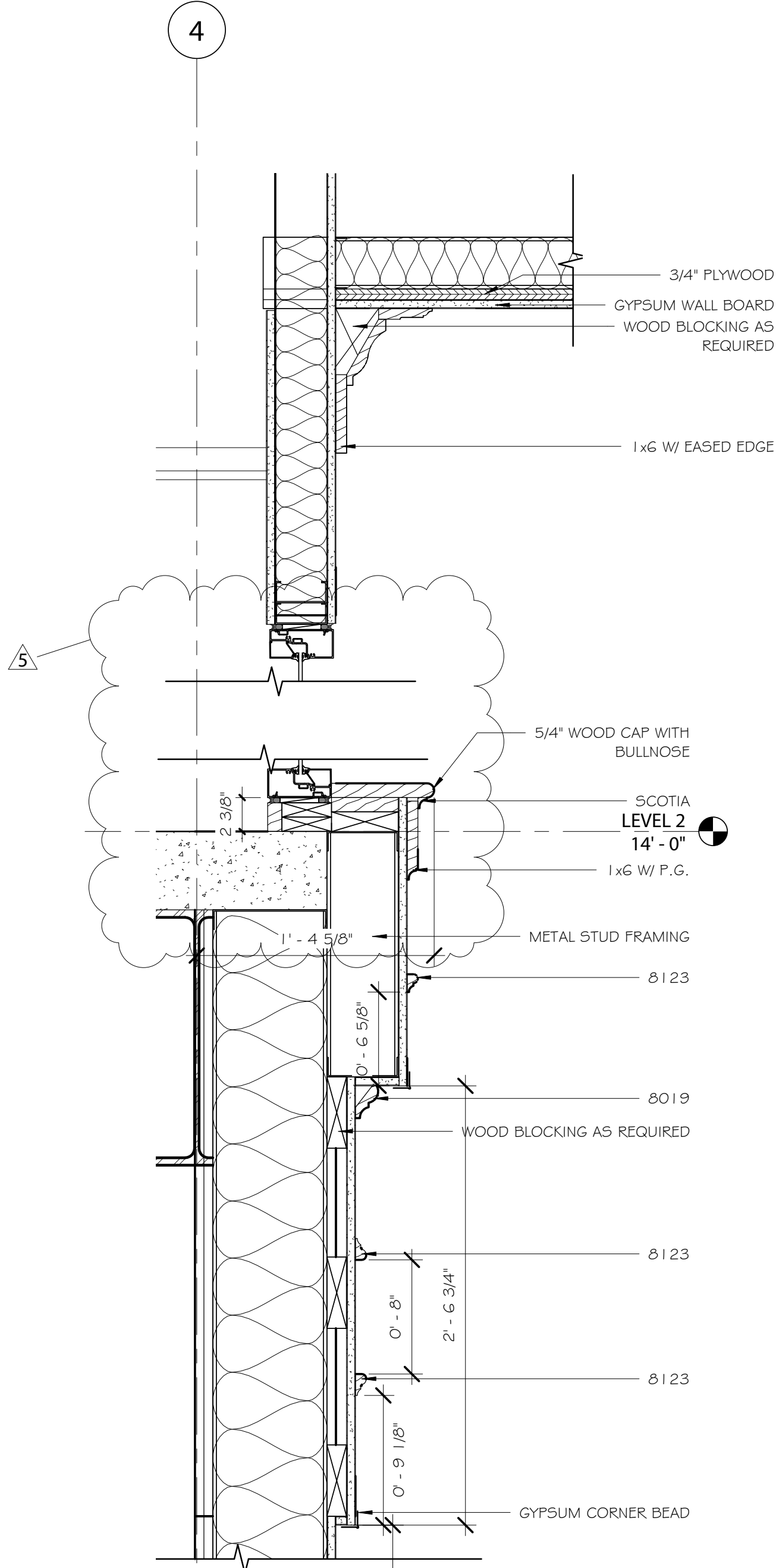
2  
A3.1

LOBBY TRIM DETAIL 1  
1 1/2" = 1'-0"



1  
A3.1

LOBBY TRIM DETAIL 2  
1 1/2" = 1'-0"



Rev.	Description	Date
5	Add. 5	01/15/2021

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Checked By	JS, FL

Project Title	CENTER FOR MATERIALS AND MANUFACTURING SCIENCES TROY UNIVERSITY   TROY, AL
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Sheet Title	FINISH SCHEDULE - LEVEL 2 & 3 BASE BID
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Sheet Number	A3.1
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BASEMENT ALTERNATE FINISH SCHEDULE

BASEMENT ALTERNATE FINISH SCHEDULE														
NO.	ROOM NAME	FLOOR		WALL FINISH	CEILING FINISH	WINDOW		DOOR FINISH	MILLWORK			NOTES	Occupancy Load Factor	
		FINISH	BASE FINISH			SHADE	SILL		CASEWORK		COUNTER TOP			
									UPPER	LOWER				
LEVEL 0														
1000	CORR.	DMEC1 , DMEC2	RUBBER	PNT1	EXP/PNT3			PNT2						
1001	JANITOR	SC	RUBBER	PNT1 , FRP1				PNT2				1.		
1002	OFFICE	CPT1	RUBBER	PNT1	ACT1	SH1	SS2	PNT2						
1003	ELEVATOR	RF1										SEE SPECIFICATIONS		
1005	ELECTRICAL	SC	RUBBER	PNT1				PNT2						
1006	STORAGE	SC	RUBBER	PNT1	EXP/PNT3			PNT2						
1007	DATA	SC	RUBBER	PNT1				PNT2						
1008	STAIR 1	SC	RUBBER	PNT1	EXP/PNT3			PNT2						
1009	3D PRINTING	DMEC2, DMEC3	RUBBER	PNT1	EXP/PNT3			PNT2	LC1	LC1	ER			
1010	MECHANICAL	SC	RUBBER	PNT1				PNT2						
1011	ELEVATOR ROOM	SC	RUBBER		PNT4			PNT2						
1012	MENS	HT1	HT1	HT1 , WT1	ACT2			PNT2		PL1	SS1			
1013	WOMENS	HT1	HT1	HT1 , WT1	ACT2			PNT2		PL1	SS1			
1014	STAIR 2	SC	RUBBER	PNT1	EXP/PNT3			PNT2						
1015	STORAGE / FUTURE LAB	SC	RUBBER	PNT1	EXP/PNT3			PNT2						

ATTIC ALTERNATE FINISH SCHEDULE

ATTIC ALTERNATE FINISH SCHEDULE														
NO.	ROOM NAME	FLOOR		WALL FINISH	CEILING FINISH	WINDOW		DOOR FINISH	MILLWORK			NOTES	Occupancy Load Factor	
		FINISH	BASE FINISH			SHADE	SILL		CASEWORK		COUNTER TOP			
									UPPER	LOWER				
LEVEL 3														
1300	CORR.	DMEC1, DMEC2	RUBBER	PNT1	ACT1			PNT2						
1301	CORR.	CPT1	RUBBER	PNT1	ACT1			PNT2						
1301A	OFFICE	CPT1	RUBBER	PNT1	EXP/PNT3			PNT2						
1301B	OFFICE	CPT1	RUBBER	PNT1	EXP/PNT3			PNT2						
1301C	OFFICE	CPT1	RUBBER	PNT1	EXP/PNT3			PNT2						
1301D	OFFICE	CPT1	RUBBER	PNT1	EXP/PNT3			PNT2						
1301E	OFFICE	CPT1	RUBBER	PNT1	EXP/PNT3			PNT2						
1301F	OPEN OFFICE	CPT1	RUBBER	PNT1	EXP/PNT3			PNT2						
1302	MECHANICAL	SC	RUBBER	PNT1				PNT2						
1303	BOARD ROOM	CPT1	RUBBER	PNT1	EXP/PNT3	SH1	SS2	PNT2						
1304	LAB	DMEC2, DMEC3	RUBBER	PNT1	EXP/PNT3			PNT2		LC1	ER			
1305	STAIR 2	SC	RUBBER	PNT1	EXP/PNT3			PNT2						
1306	STAIR 1	SC	RUBBER	PNT1	EXP/PNT3			PNT2						
1307	WOMEN'S	HT1	HT1	HT1, WT1	ACT2			PNT2				SEE ENLARGED FLOOR PLANS & ELEVATIONS		
1308	LAB	DMEC2, DMEC3	RUBBER	PNT1	EXP/PNT3			PNT2		LC1	ER			
1308A	STORAGE	DMEC3						PNT2						
1309	MEN'S	HT1	HT1	HT1, WT1	ACT2			PNT2				SEE ENLARGED FLOOR PLANS & ELEVATIONS		
1310	ELEVATOR	RF1										SEE SPECIFICATIONS		
1311	DATA	SC	RUBBER	PNT1				PNT2						
1312	JANITOR	SC	RUBBER	PNT1, FRP1				PNT2				1.		
1313	ELECTRICAL	SC	RUBBER	PNT1				PNT2						

GENERAL NOTES:

- 1.) ALL WALL PAINT TO EXTEND TO DECK WHEN CEILING IS EXPOSED. PAINT EVERYTHING EXPOSED TO VIEW INCLUDING BUT NOT LIMITED TO FIRE PROTECTION, STRUCTURAL, MECHANICAL, ELECTRICAL.
- 2.) AT ALL ROOMS TO RECEIVE ACCENT WALLS, G.C. TO COORDINATE EXACT LOCATION WITH OWNER AND ARCHITECT.
- 3.) PAINT TEST AREA OF ALL PAINT COLORS FOR ARCHITECTS APPROVAL BEFORE PROCEEDING.
- 4.) RUBBER BASE @ CASEWORK TO MATCH RUBBER BASE IN ROOM, UNLESS NOTED OTHERWISE.
- 5.) PROVIDE WINDOW SILL AT ALL WINDOW SILLS 7'-0" AFF OR BELOW.

SPECIFIC NOTES:

- 1.) FRP1 TO BE PLACED ON SOUTH AND WEST WALLS AT THE MOP SINK. THE FRP1 SHOULD RECEED 1'-0" PAST THE MOP SINK.

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Rev.	Description	Date
5	Add. 5	01/15/2021

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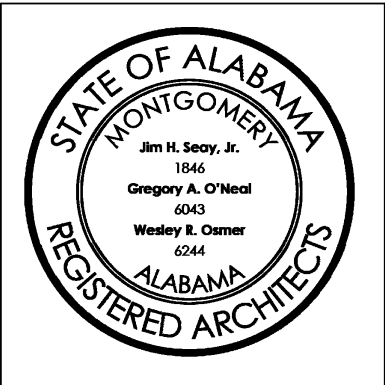
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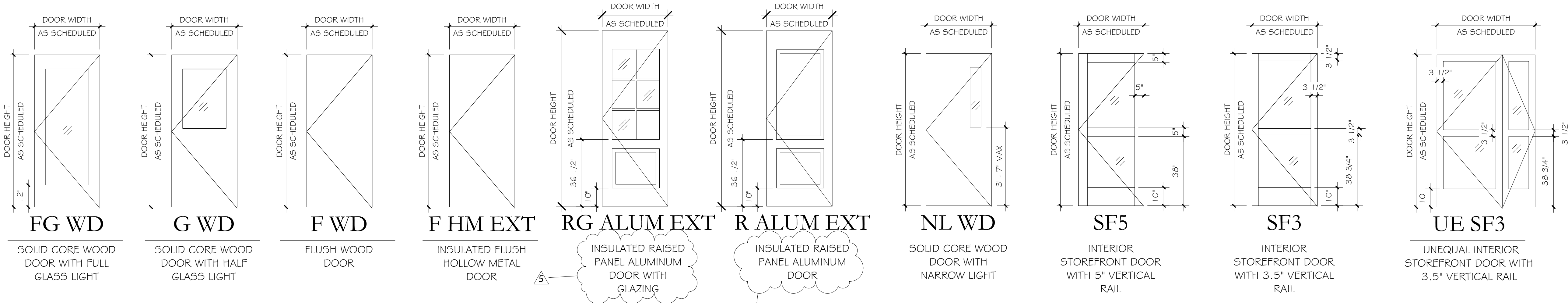
Sheet Title  
FINISH SCHEDULE  
- LEVEL 0 & 3  
ALTERNATE

Sheet Number

A3.2

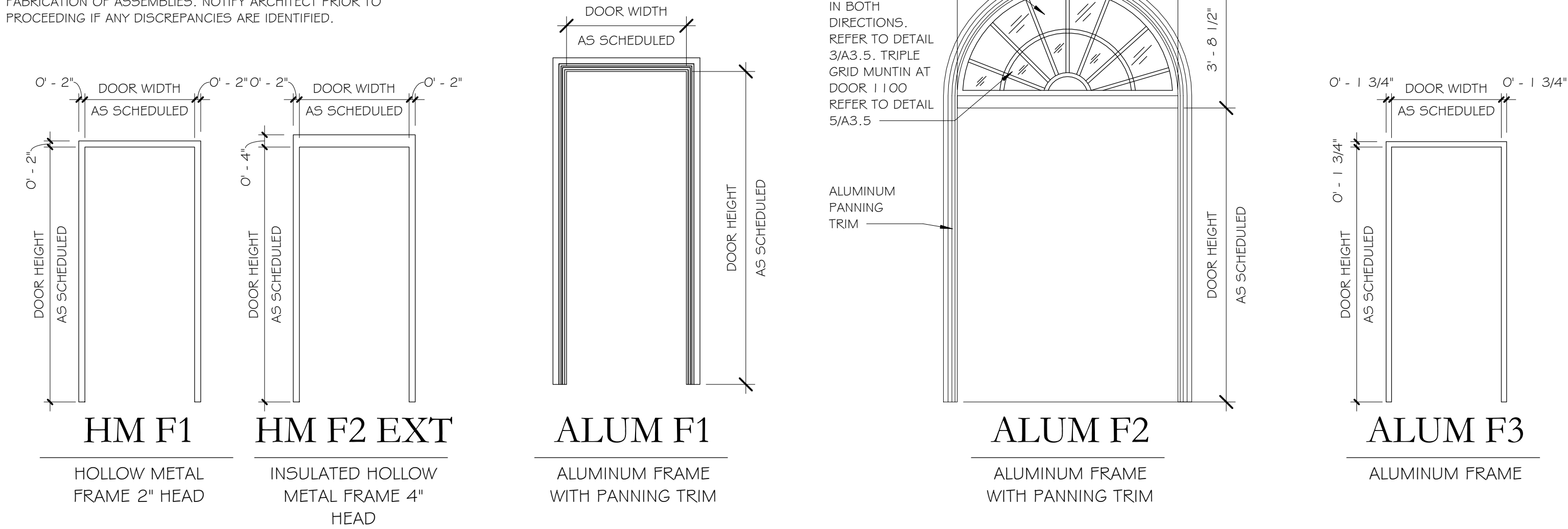


DOOR SCHEDULE



FRAME SCHEDULE

1. REFER TO SPEC SECTION 08 5113 ALUMINUM WINDOWS, DOORS & FRAMES AND 08 8000 GLAZING.
2. FIELD VERIFY AND COORDINATE ALL DIMENSIONS PRIOR TO FABRICATION OF ASSEMBLIES. NOTIFY ARCHITECT PRIOR TO PROCEEDING IF ANY DISCREPANCIES ARE IDENTIFIED.



DOOR, OPENING & FRAME SCHEDULE LEVEL 0

DOOR								ACCESS CONTROL	FRAME ELEVATION TYPE	DETAILS			FIRE RATING	GLAZIN G TYPE	STC RATING	NOTES
DOOR NO.	LEAVES	LEAF 1 WIDTH	LEAF 2 WIDTH	TOTAL WIDTH	HEIGHT	THICKNESS	ELEVATION TYPE			HEAD DETAIL	JAMB DETAIL	SILL DETAIL				
LEVEL 0																
1000	2	3' - 0"	3' - 0"	6' - 0"	8' - 4"	0' - 1 3/4"	RG ALUM EXT	ELECTRIFIED HARDWARE	ALUM F2	3/A3.6	3/A3.6	4/A3.6		IG-1		HANDICAP OPERATOR
1001	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1002	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1005	1	4' - 0"		4' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6		1 HR			
1005a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6		1 HR			
1006	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	F WD	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6					ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1007	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1008	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	NL WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR	S-2		
1008a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	RG ALUM EXT		ALUM F1	3/A3.6	3/A3.6			IG-1		
1009	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7	1/A3.7		S-1		
1010a	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	R ALUM EXT		ALUM F1	3/A3.6	3/A3.6	4/A3.6				
1010b	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1010c	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F HM EXT		HM F2 EXT	1 1/A3.6	1 2/A3.6	8/A5.1 1				
1011	1	4' - 0"		4' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR			
1012	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1013	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1014	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	NL WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR	S-2		
1015	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7	1/A3.7		S-1		

DOOR SCHEDULE NOTE:  
PRIOR TO ORDERING AND FABRICATION OF ALL DOORS AND ASSOCIATED FRAMES THE CONTRACTOR SHALL ILLUSTRATE DIAGRAMMATICALLY FINAL CEILING HEIGHTS THROUGH VERIFICATION OF ALL BUILDING SYSTEMS AND PROJECT CONDITIONS, AND RECEIVE WRITTEN APPROVAL OF THE DIAGRAMS BY THE ARCHITECT.

Rev.	Description	Date
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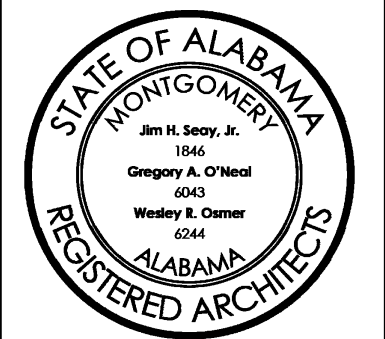
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DOOR SCHEDULE

Sheet Number

A3.3



DOOR, OPENING & FRAME SCHEDULE LEVEL 1 & 2															
DOOR								ACCESS CONTROL	FRAME ELEVATION TYPE	DETAILS			FIRE RATING	GLAZING TYPE	NOTES
DOOR NO.	LEAVES	LEAF 1 WIDTH	LEAF 2 WIDTH	TOTAL WIDTH	HEIGHT	THICKNESS	ELEVATION TYPE			HEAD DETAIL	JAMB DETAIL	SILL DETAIL			
LEVEL 1															
1100	2	3' - 0"	3' - 0"	6' - 0"	8' - 4"	0' - 1 3/4"	RG ALUM EXT	ELECTRIFIED HARDWARE	ALUM F2	3/A5.13	3/A5.13	4/A3.6		IG-1	HANDICAP OPERATOR
1101	1	4' - 0"		4' - 0"	8' - 0"	0' - 1 3/4"	SF5	PREP FRAME FOR FUTURE ELECTRIC STRIKE		7/A3.7	7/A3.7	7/A3.7		S-1	STC 45 RATED DOOR
1102	1	4' - 0"		4' - 0"	8' - 0"	0' - 1 3/4"	SF5	PREP FRAME FOR FUTURE ELECTRIC STRIKE		7/A3.7	7/A3.7	7/A3.7		IG-3	
1103	1	4' - 0"		4' - 0"	8' - 0"	0' - 1 3/4"	SF5	PREP FRAME FOR FUTURE ELECTRIC STRIKE		7/A3.7	7/A3.7	7/A3.7		S-1	
1104	1	4' - 0"		4' - 0"	8' - 0"	0' - 1 3/4"	SF5	PREP FRAME FOR FUTURE ELECTRIC STRIKE		7/A3.7	7/A3.7	7/A3.7		S-1	
1105	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	F WD	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6				
1106	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	NL WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR	S-2	
1106a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	RG ALUM EXT		ALUM F1	14/A3.6 SIM	14/A3.6	4/A3.6		IG-1	
1107	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7	1/A3.7		S-1	
1108	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6				
1109	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7	1/A3.7		S-1	
1110	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6				
1111	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7	1/A3.7		IG-3	
1112	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6				
1113	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7	1/A3.7		IG-3	
1114	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6		1 HR		
1115	2	3' - 0"	3' - 0"	6' - 0"	8' - 4"	0' - 1 3/4"	RG ALUM EXT	ELECTRIFIED HARDWARE	ALUM F2	13/A3.6	10/A3.6	4/A3.6		IG-1	
1115a	2	3' - 0"	3' - 0"	6' - 0"	8' - 4"	0' - 1 3/4"	RG ALUM EXT	ELECTRIFIED HARDWARE	ALUM F2	13/A3.6	13/A3.6 SIM	4/A3.6		IG-1	
1116	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6				
1118	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6				
1120	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7	1/A3.7		IG-3	
1122	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	NL WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR	S-2	
1124	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7	1/A3.7		IG-3	
LEVEL 2															
1201	1	4' - 0"		4' - 0"	8' - 0"	0' - 1 3/4"	SF5	PREP FRAME FOR FUTURE ELECTRIC STRIKE		1/A3.7	1/A3.7			S-1	
1201a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	FG WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1	
1202	1	4' - 0"		4' - 0"	8' - 0"	0' - 1 3/4"	SF5	PREP FRAME FOR FUTURE ELECTRIC STRIKE		1/A3.7	1/A3.7			S-1	
1202a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD		HM F1	1/A3.6	1/A3.6			S-1	
1203	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	FG WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1	
1203a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	FG WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1	
1203b	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	FG WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1	
1203c	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	FG WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1	
1203d	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	FG WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1	
1203e	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	FG WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1	
1203f	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	FG WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1	
1204	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	NL WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR	S-2	
1205	2	3' - 0"	1' - 6"	4' - 6"	7' - 0"	0' - 1 3/4"	UE SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7			S-1	
1206	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6				
1207	2	3' - 0"	1' - 6"	4' - 6"	7' - 0"	0' - 1 3/4"	UE SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7			S-1	
1208	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6				
1209	2	3' - 0"	1' - 6"	4' - 6"	7' - 0"	0' - 1 3/4"	UE SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7			S-1	
1210	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6				
1211	2	3' - 0"	1' - 6"	4' - 6"	7' - 0"	0' - 1 3/4"	UE SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7			S-1	
1212	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6		1 HR		
1216	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6				
1218	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE		1/A3.7				S-1	
1218a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD		HM F1	1/A3.6	1/A3.6			S-1	
1220	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	NL WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR	S-2	
1222	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7			S-1	

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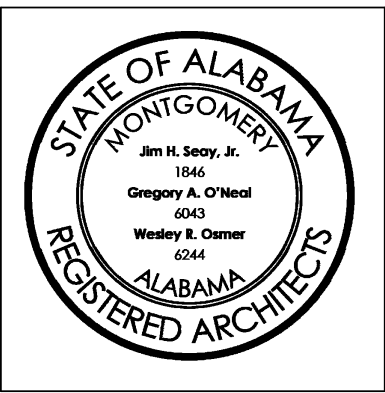
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Sheet Title  
DOOR SCHEDULE  
LEVEL 1 & LEVEL 2

Sheet Number

A3.4



DOOR, OPENING & FRAME SCHEDULE LEVEL 3

DOOR								ACCESS CONTROL	FRAME ELEVATION TYPE	DETAILS			FIRE RATING	GLAZING TYPE	STC RATING	NOTES
DOOR NO.	LEAVES	LEAF 1 WIDTH	LEAF 2 WIDTH	TOTAL WIDTH	HEIGHT	THICKNESS	ELEVATION TYPE			HEAD DETAIL	JAMB DETAIL	SILL DETAIL				
LEVEL 3																
1300a	1	4' - 6"		4' - 6"	7' - 0"	0' - 1 3/4"	F HM EXT		HM F2 EXT	5/A5.1.1	6/A5.1.1	7/A5.1.1				
1300b	1	4' - 6"		4' - 6"	7' - 0"	0' - 1 3/4"	F HM EXT		HM F2 EXT	5/A5.1.1	6/A5.1.1	7/A5.1.1				
1301	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1301a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1301b	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1301c	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1301d	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1301e	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1301f	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	G WD	PREP FRAME FOR FUTURE ELECTRIC STRIKE	HM F1	1/A3.6	1/A3.6			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1302	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1303	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7			IG-3		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1304	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1305	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	NL WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR	S-2		
1306	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	NL WD		HM F1	1/A3.6	1/A3.6		1 1/2 HR	S-2		
1307	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1308	2	3' - 0"	3' - 0"	6' - 0"	7' - 0"	0' - 1 3/4"	SF3	PREP INACTIVE DOOR FOR FUTURE ELECTRIC STRIKE	ALUM F3	1/A3.7	1/A3.7			S-1		ALTERNATE ONLY - ADD IF ALTERNATE ACCEPTED
1308a	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1309	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1311	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1312	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6					
1313	1	3' - 0"		3' - 0"	7' - 0"	0' - 1 3/4"	F WD		HM F1	1/A3.6	1/A3.6		1 HR			

DOOR SCHEDULE NOTE:  
PRIOR TO ORDERING AND FABRICATION OF ALL DOORS AND ASSOCIATED FRAMES THE CONTRACTOR SHALL ILLUSTRATE DIAGRAMATICALLY FINAL CEILING HEIGHTS THROUGH VERIFICATION OF ALL BUILDING SYSTEMS AND PROJECT CONDITIONS, AND RECEIVE WRITTEN APPROVAL OF THE DIAGRAMS BY THE ARCHITECT.



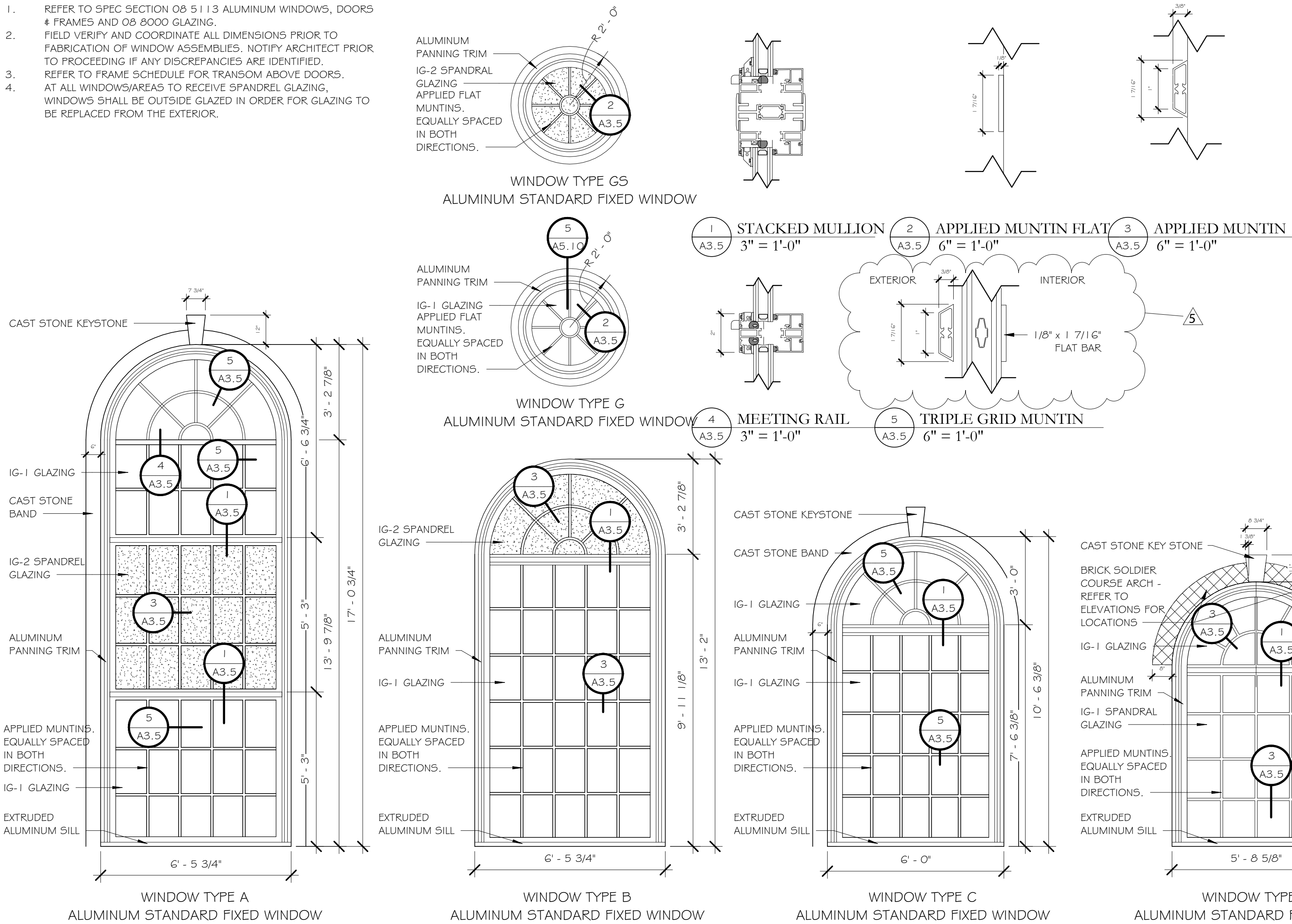
Rev.	Description	Date
5	Add. 5	01/15/2021

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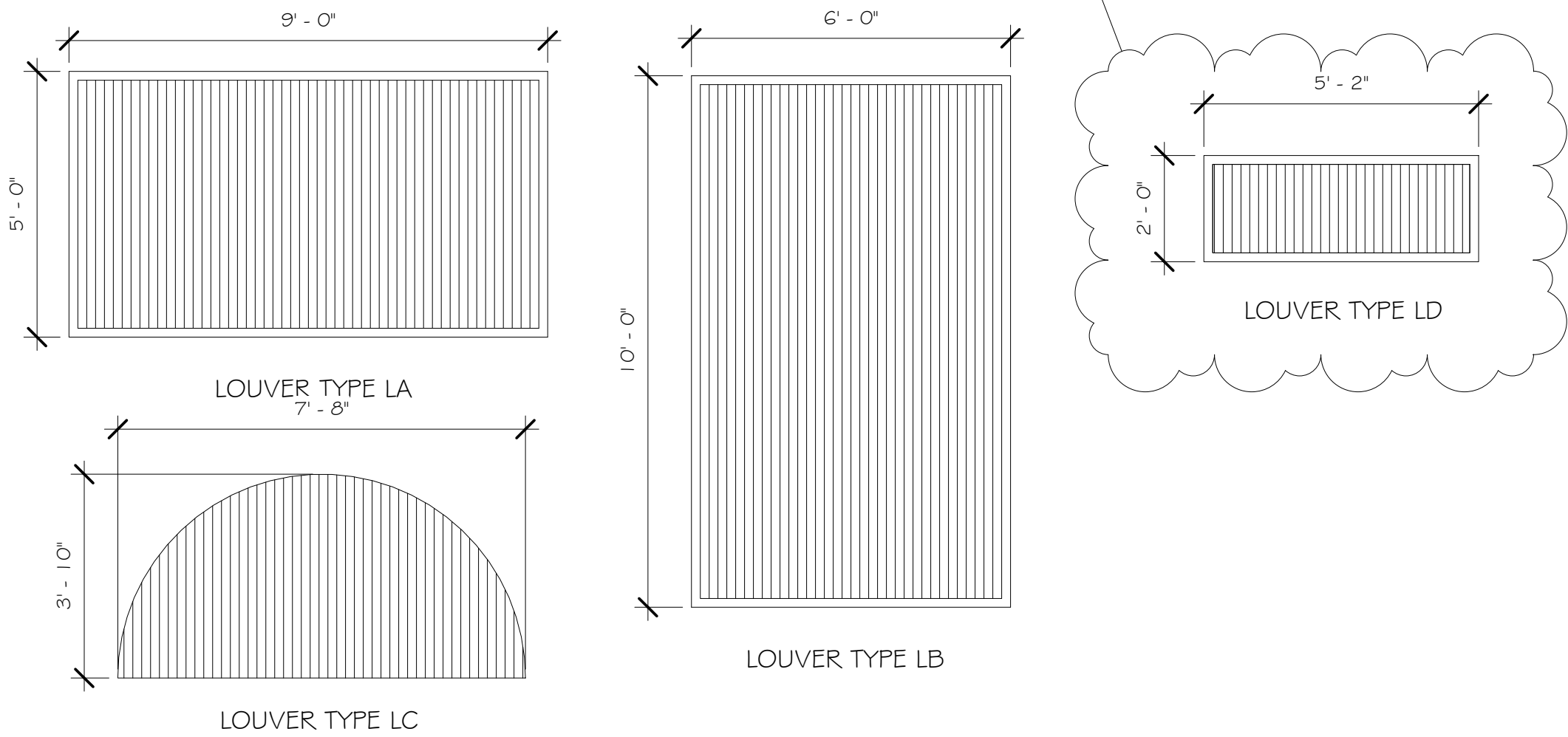
WINDOW SCHEDULE

- REFER TO SPEC SECTION 08 5113 ALUMINUM WINDOWS, DOORS & FRAMES AND 08 8000 GLAZING.
- FIELD VERIFY AND COORDINATE ALL DIMENSIONS PRIOR TO FABRICATION OF WINDOW ASSEMBLIES. NOTIFY ARCHITECT PRIOR TO PROCEEDING IF ANY DISCREPANCIES ARE IDENTIFIED.
- REFER TO FRAME SCHEDULE FOR TRANSOM ABOVE DOORS.
- AT ALL WINDOWS/AREAS TO RECEIVE SPANDREL GLAZING, WINDOWS SHALL BE OUTSIDE GLAZED IN ORDER FOR GLAZING TO BE REPLACED FROM THE EXTERIOR.



LOUVER SCHEDULE

- REFER TO SPEC SECTION 08 9100 LOUVERS.
- FIELD VERIFY AND COORDINATE ALL DIMENSIONS PRIOR TO FABRICATION OF LOUVER ASSEMBLIES. NOTIFY ARCHITECT PRIOR TO PROCEEDING IF ANY DISCREPANCIES ARE IDENTIFIED.
- COORDINATE WITH MECHANICAL & STRUCTURAL.
- GC TO PROVIDE SUPPORT STRUCTURE AS REQUIRED BY LOUVER MANUFACTURER.



Sheet Title  
DOOR SCHEDULE  
LEVEL 3 &  
WINDOW  
SCHEDULE

Sheet Number

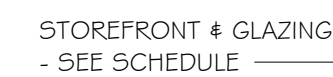
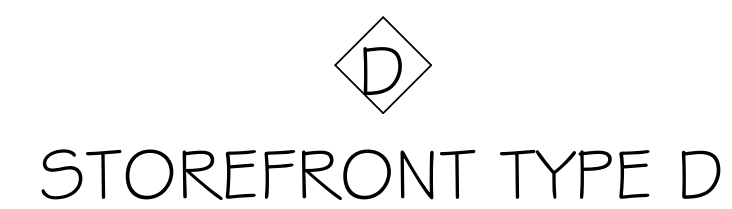
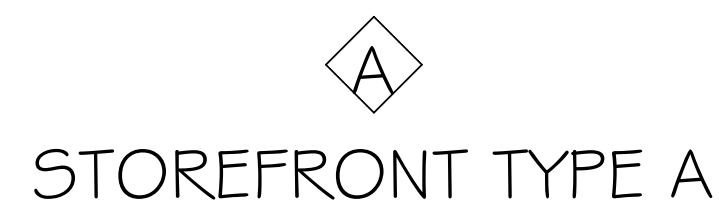
A3.5





NOTE:

1. VERIFY ALL DIMENSIONS PRIOR TO FABRICATION AND INSTALLATION.
2. INSTALL STOREFRONT IN ACCORDANCE WITH STOREFRONT MANUFACTURE'S WRITTEN AND RECOMMENDATIONS.



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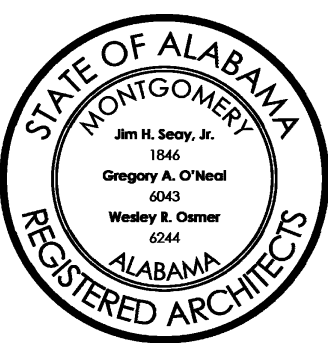
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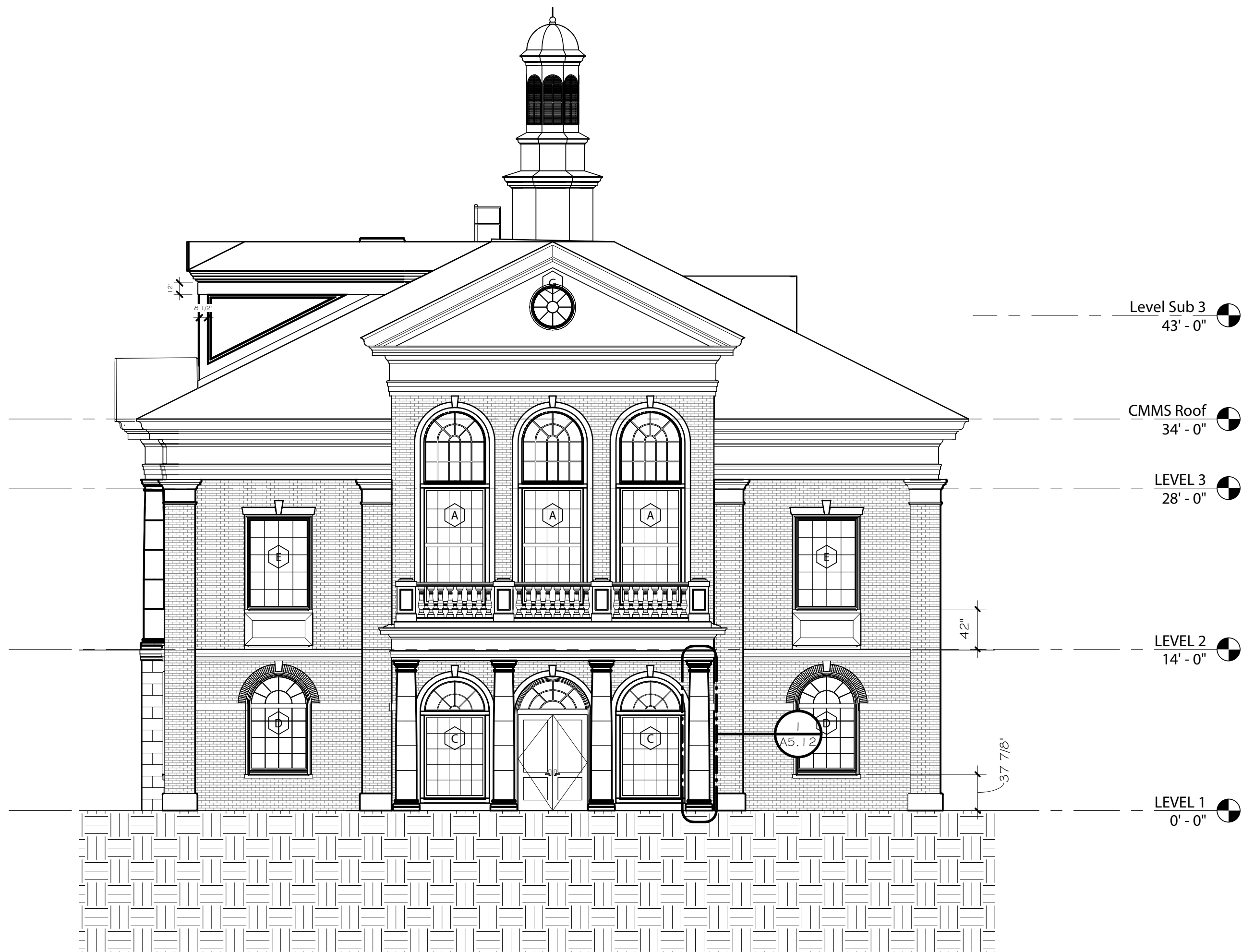
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Sheet Title  
STOREFRONT  
SCHEDULE &  
DETAILS

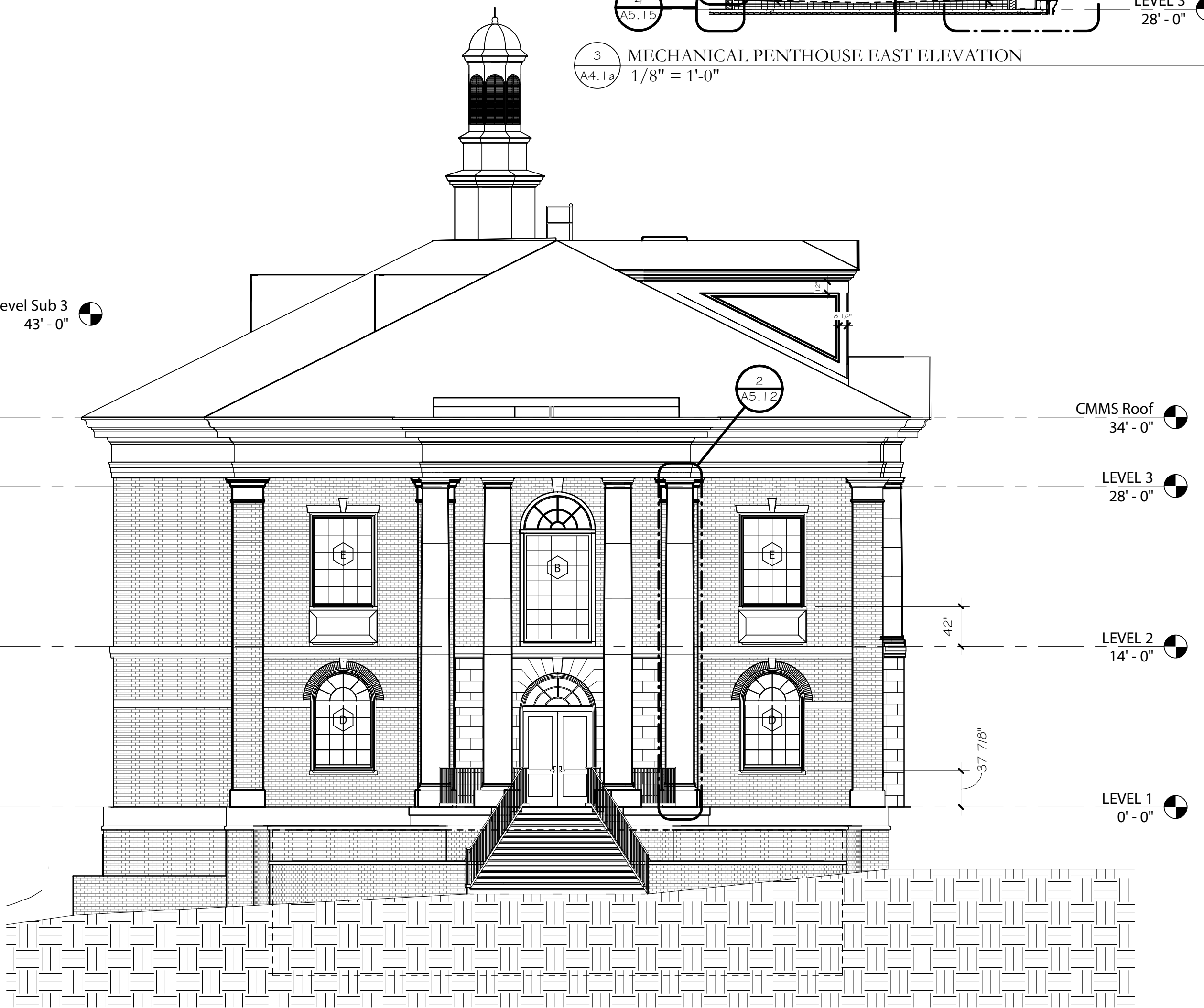
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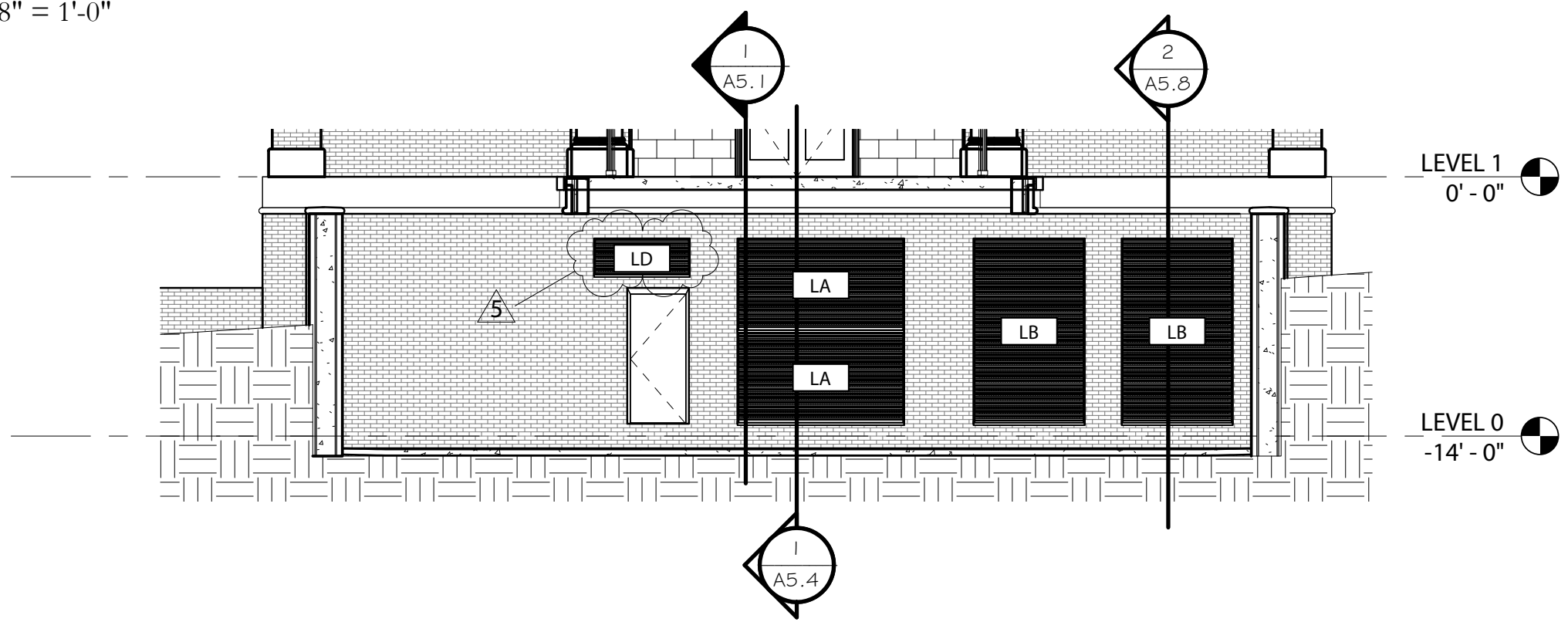




1 EAST ELEVATION  
1/8" = 1'-0"

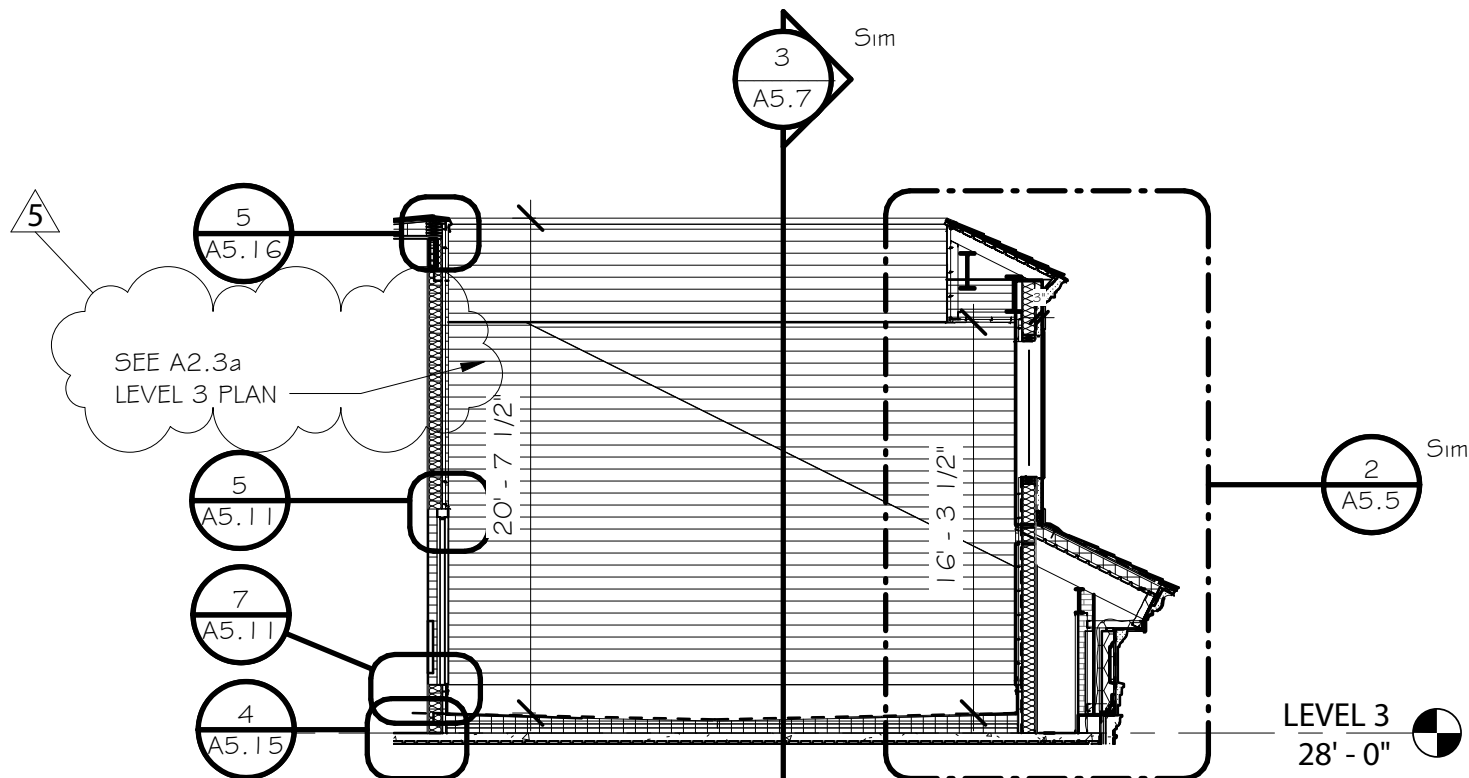


2 WEST ELEVATION  
1/8" = 1'-0"



3 MECHANICAL PENTHOUSE EAST ELEVATION  
1/8" = 1'-0"

4 Elevation 6 - a  
1/8" = 1'-0"



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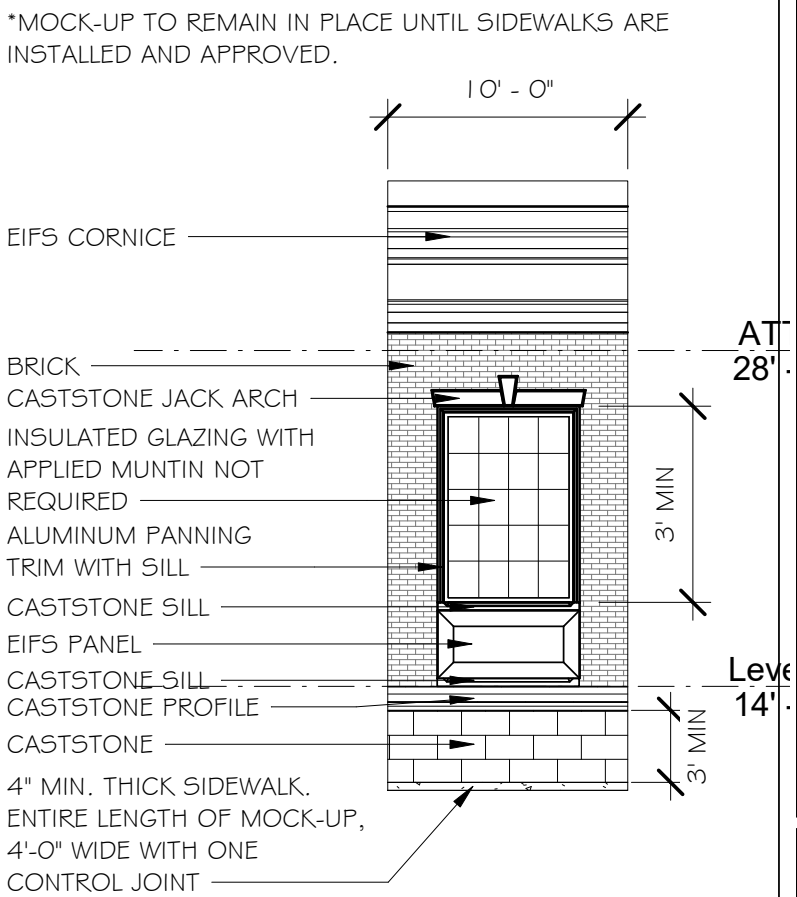
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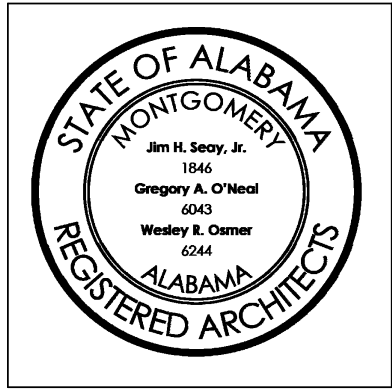
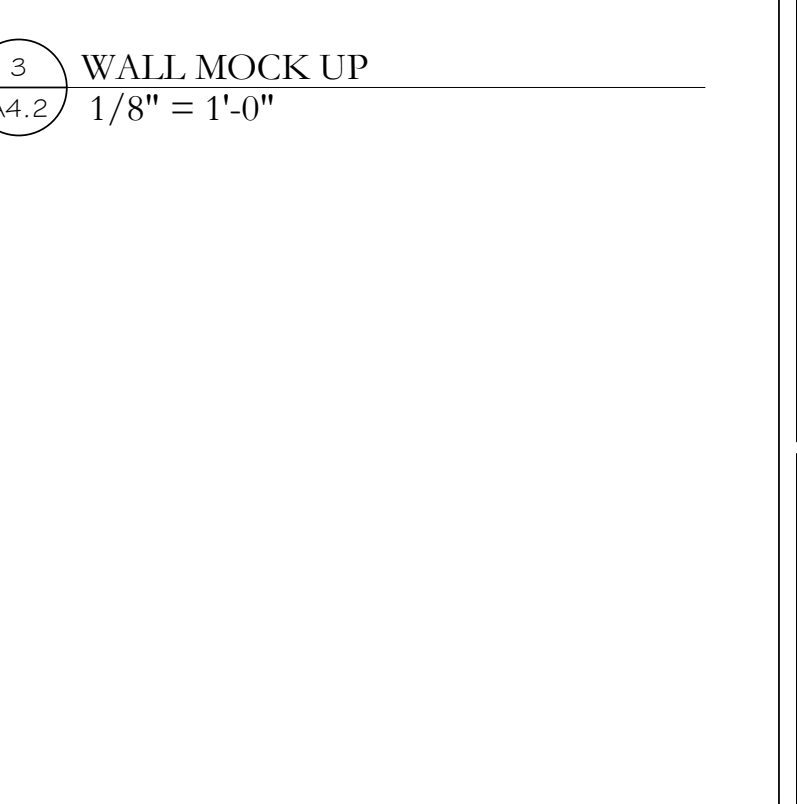
Sheet Title	ALTERNATE EXTERIOR ELEVATIONS
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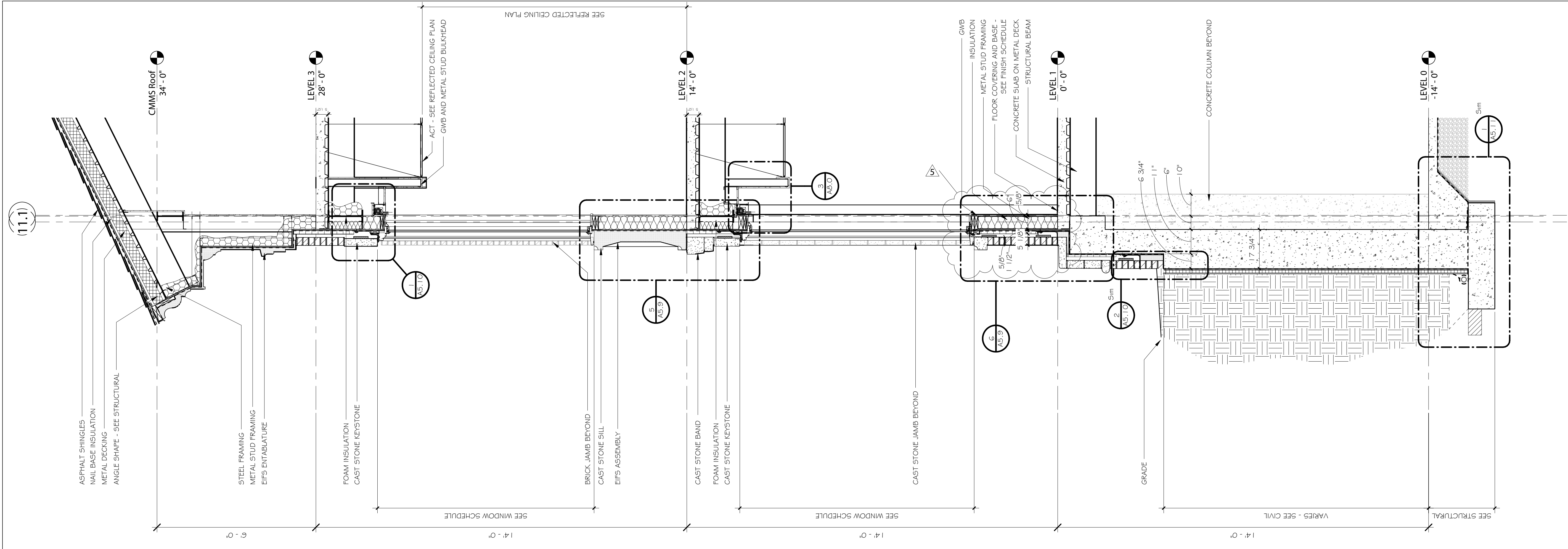
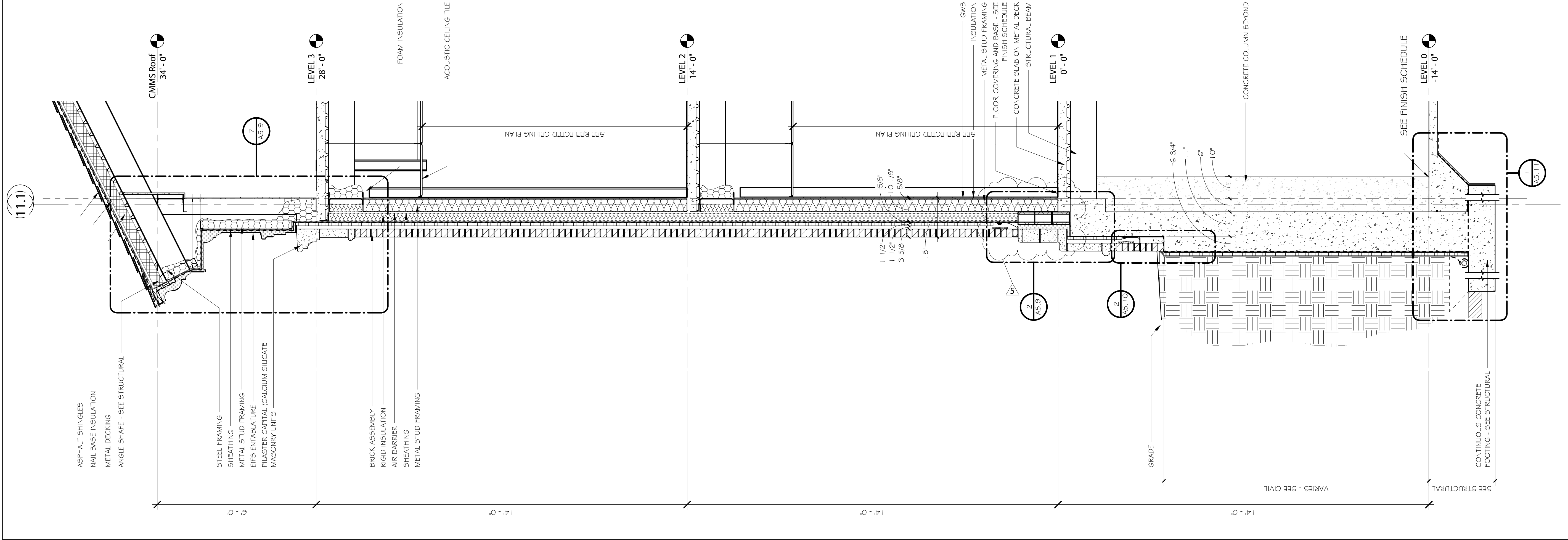
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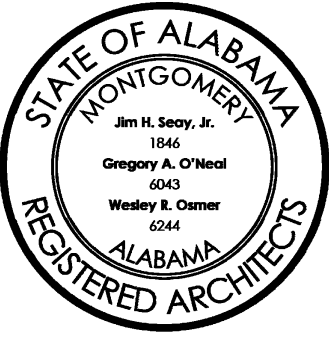
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1 WALL SECTION - THROUGH PILASTER  
A5.3 1/2" = 1'-0"

2 WALL SECTION - THROUGH WINDOW /CAST STONE BASE  
A5.3 1/2" = 1'-0"



Sheet Title

WALL SECTIONS

Sheet Number

A5.3

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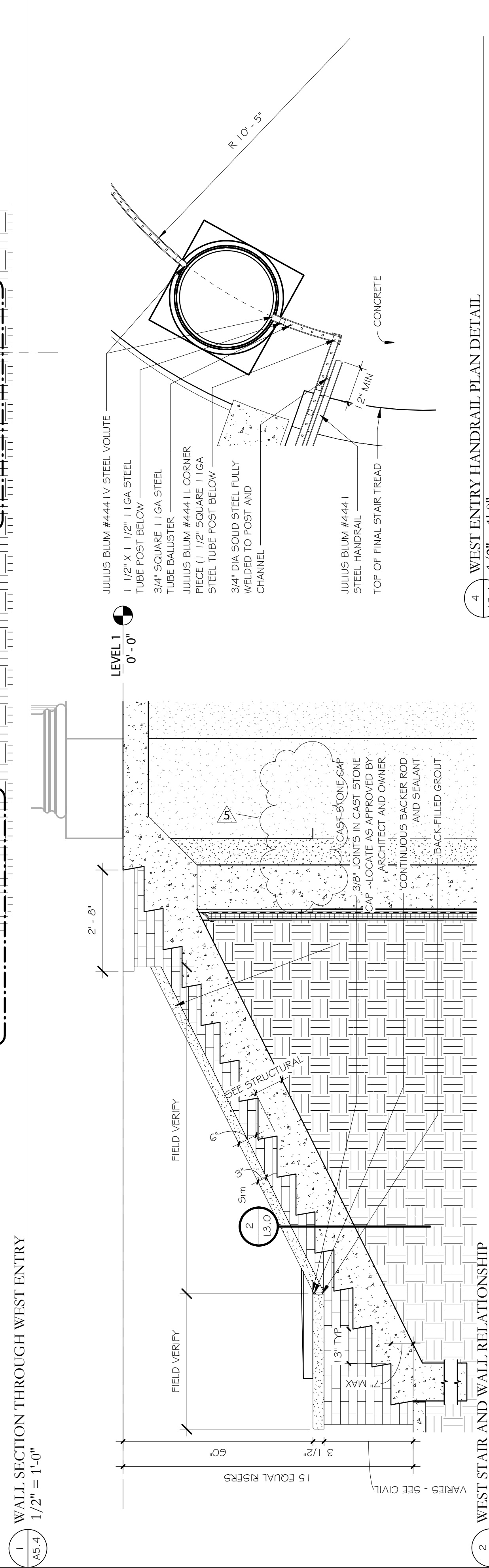
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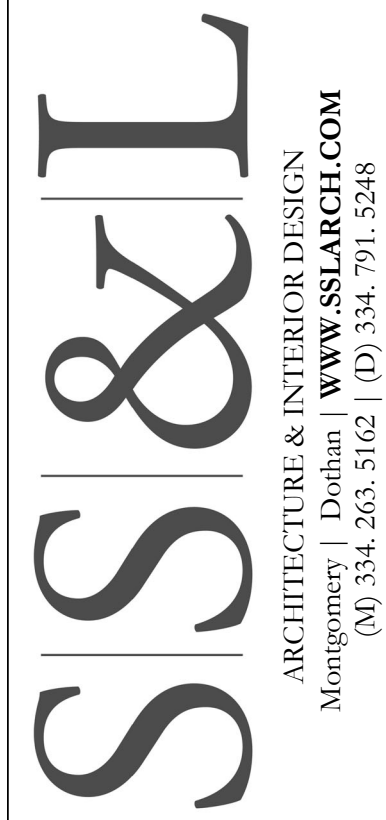
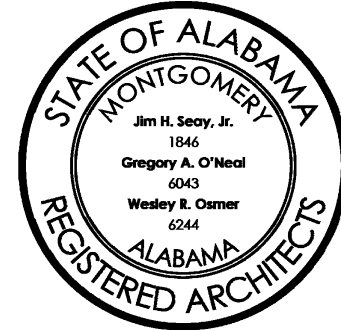




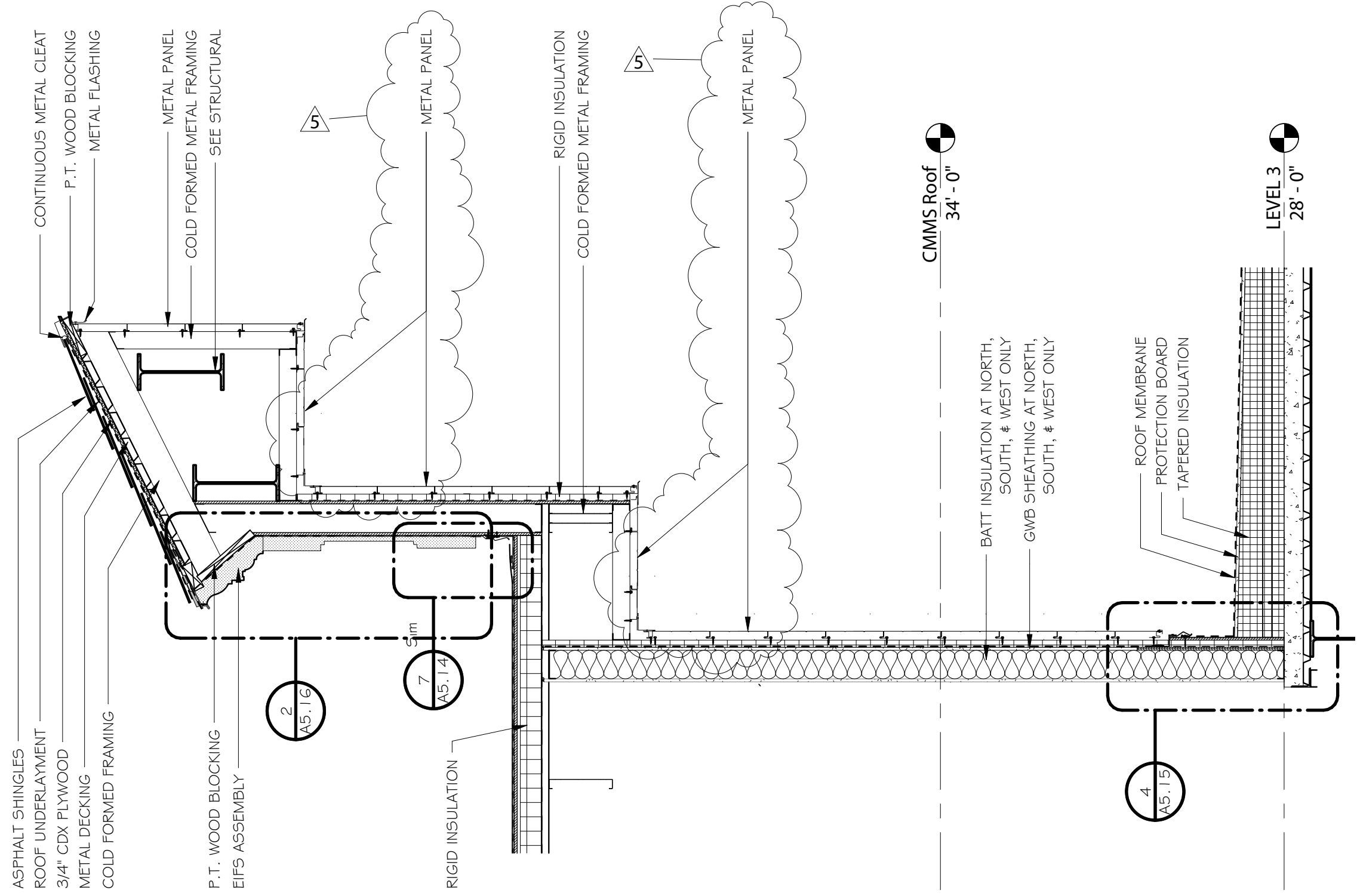


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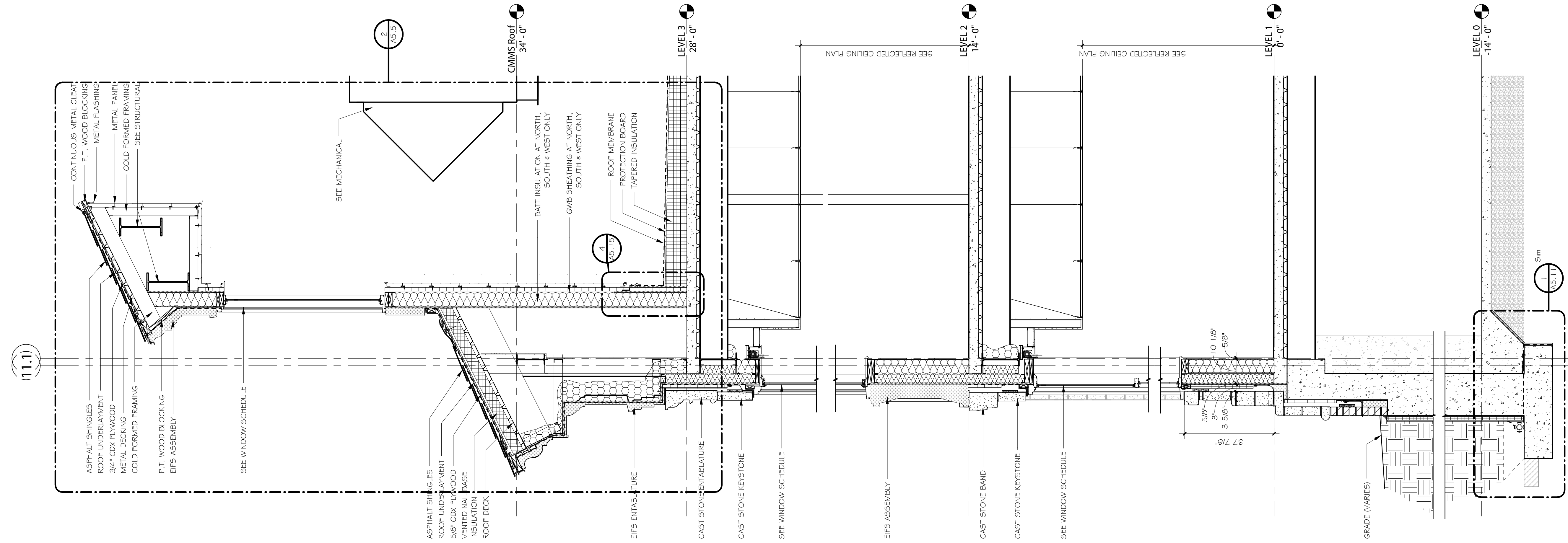
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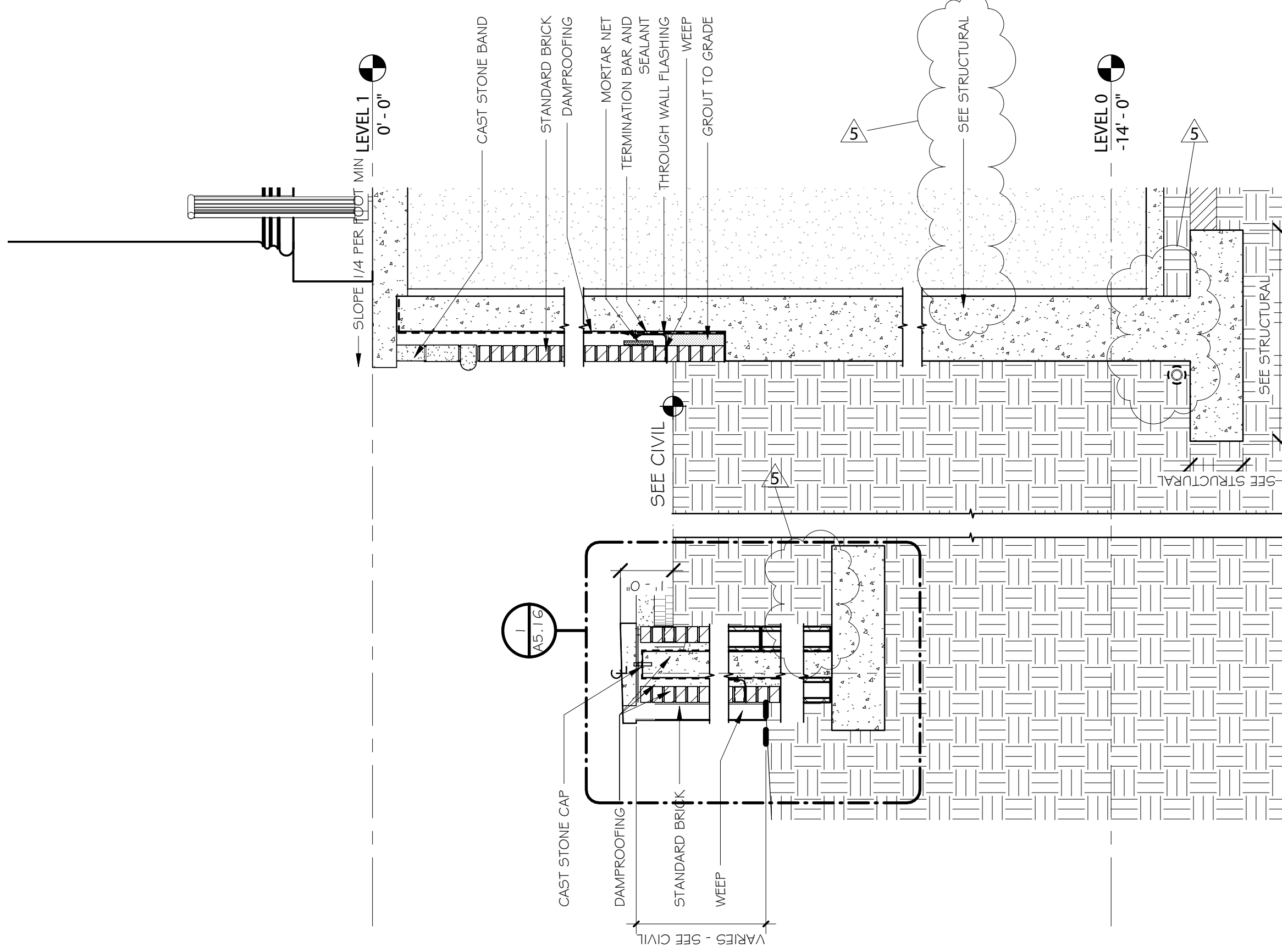




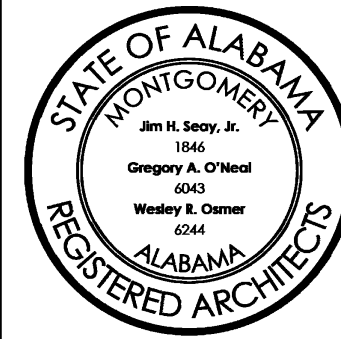
3 WALL SECTION AT WEST MECHANICAL PENTHOUSE  
A5.7 1/2" = 1'-0"



2 SECTION THROUGH WEST ENTRY RETAINING WALL  
A5.7 1/2" = 1'-0"



1 WALL SECTION AT SOUTH ENTRY  
A5.7 1/2" = 1'-0"



Sheet Number

A5.7

Sheet Title

WALL SECTIONS

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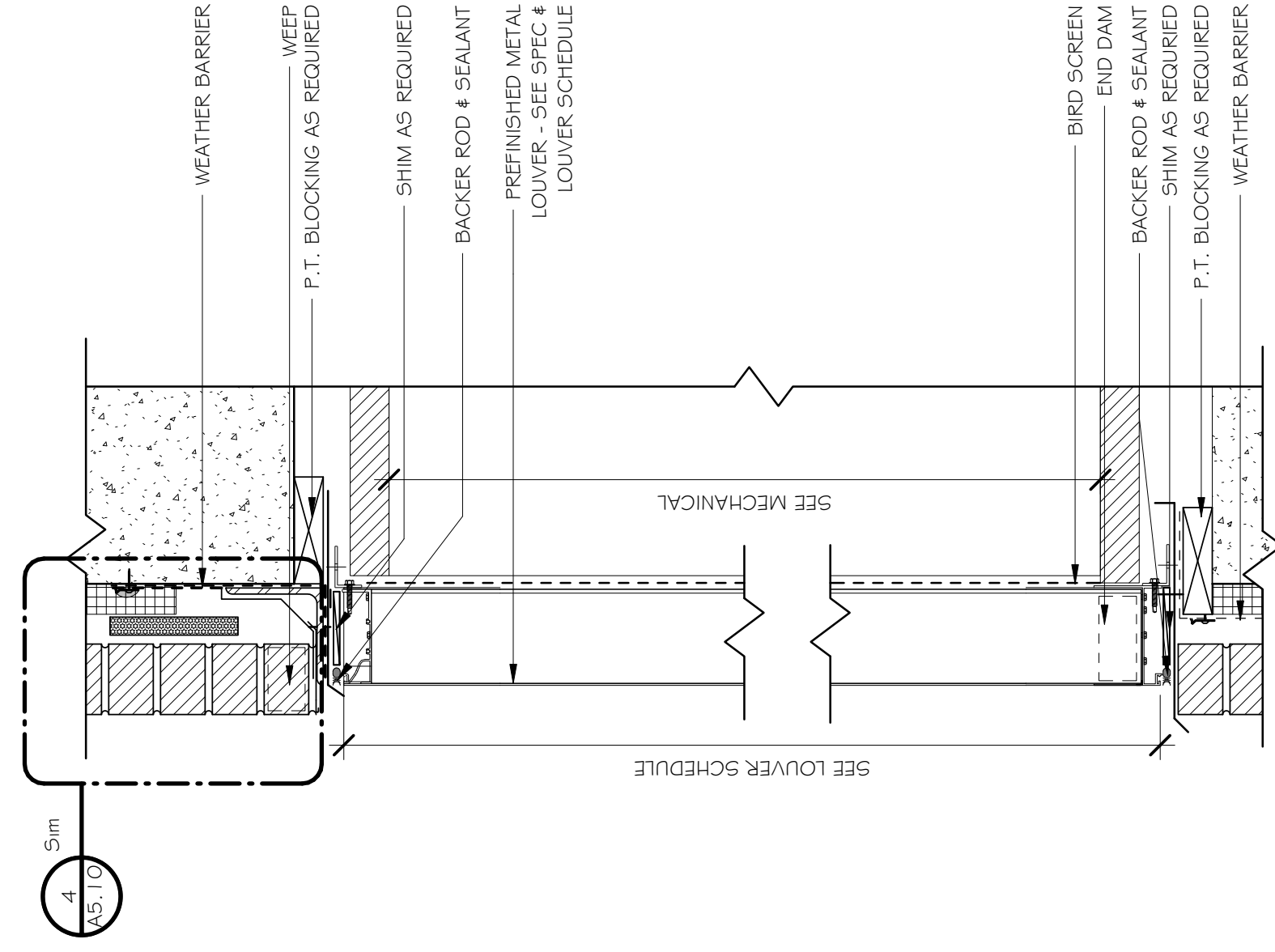
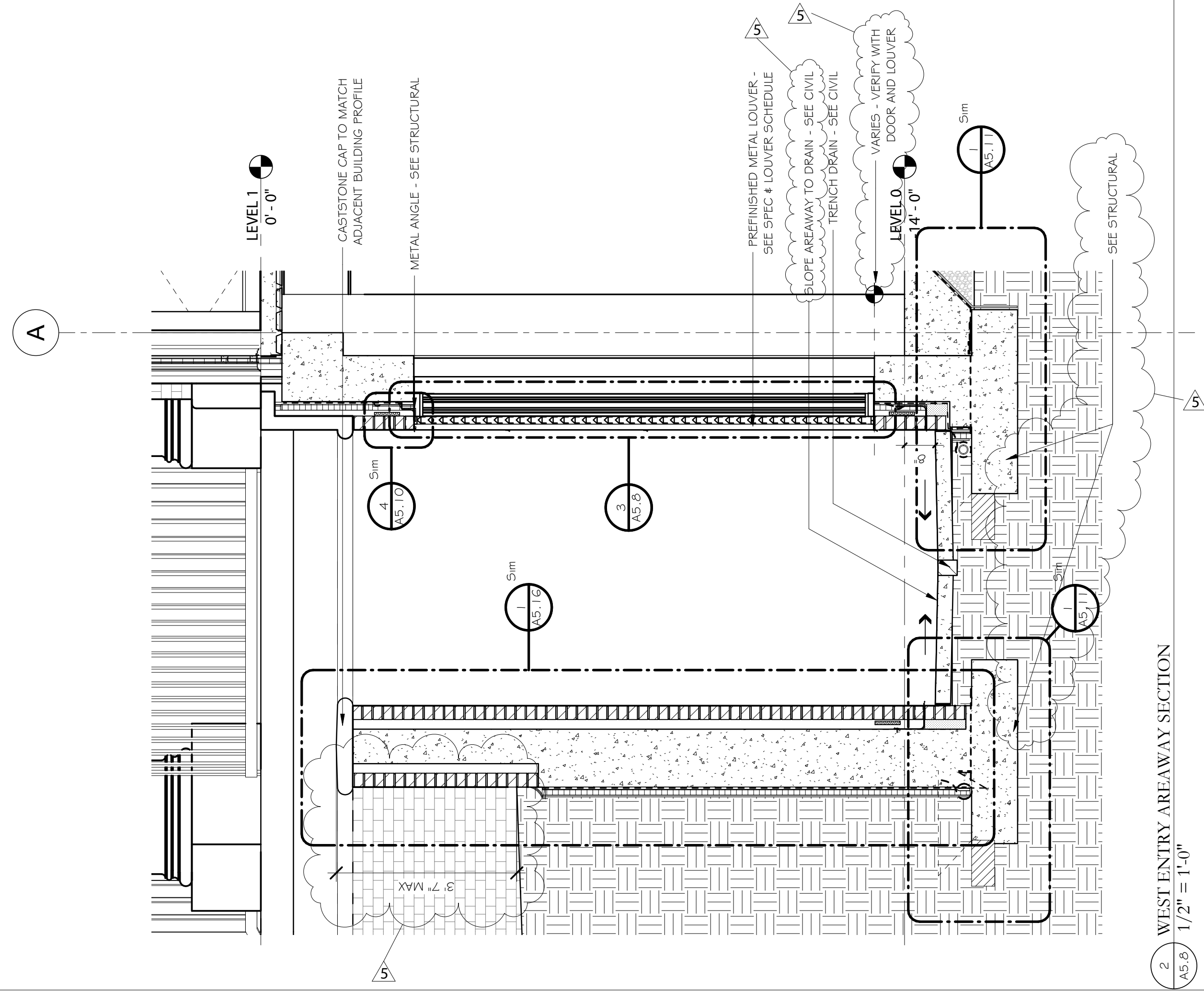
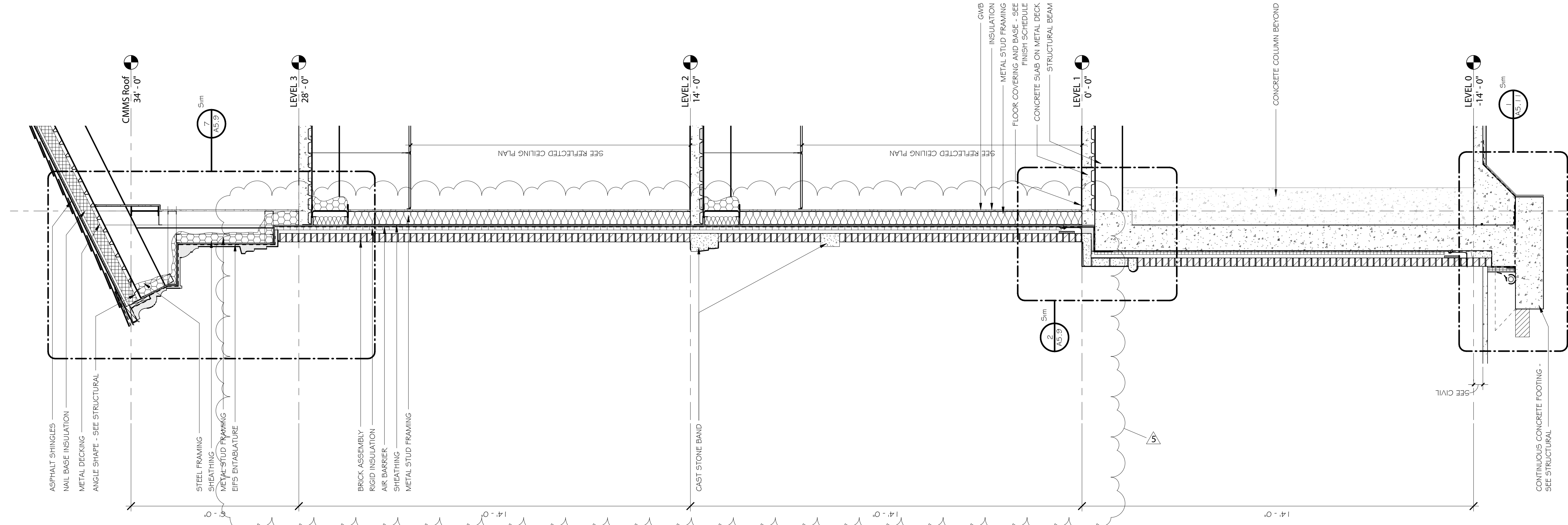
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1 WALL SECTION AT BASEMENT DAYLIGHT  
A5.8 1/2" = 1'-0"

3 LOUVER HEAD & SILL DETAIL  
A5.8 1 1/2" = 1'-0"

[illegible]

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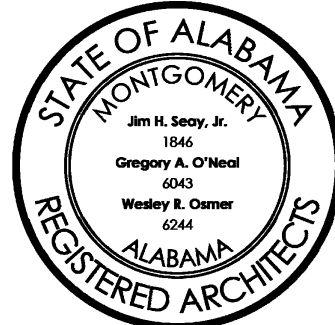
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## A5.8

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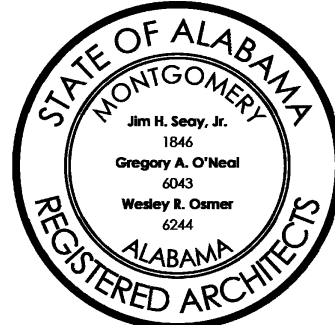
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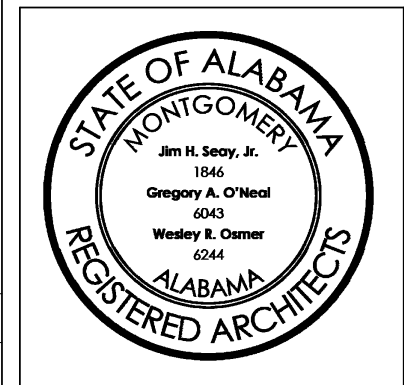
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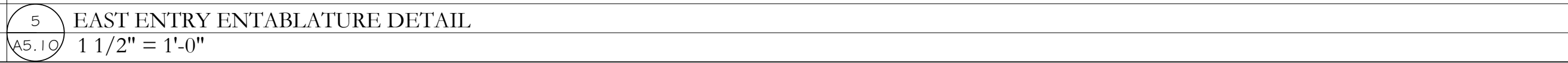
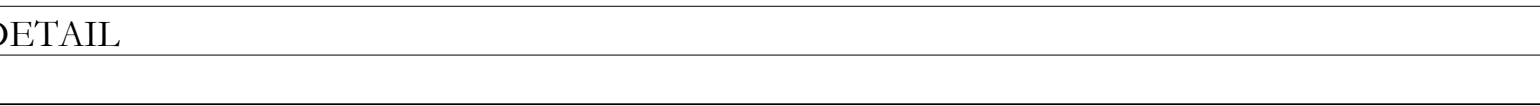
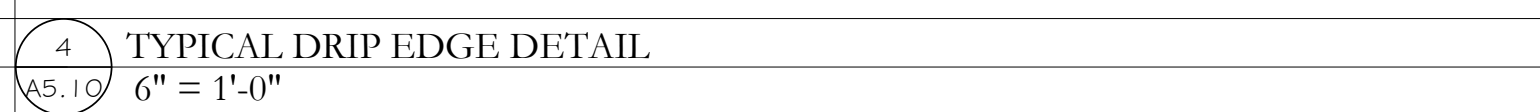
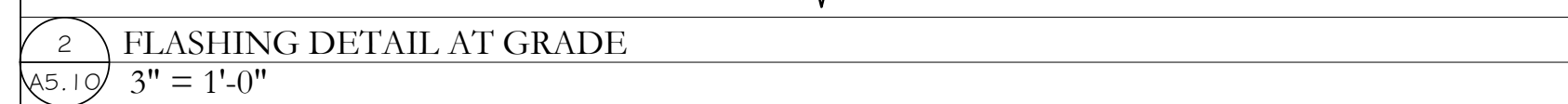
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WALL SECTIONS

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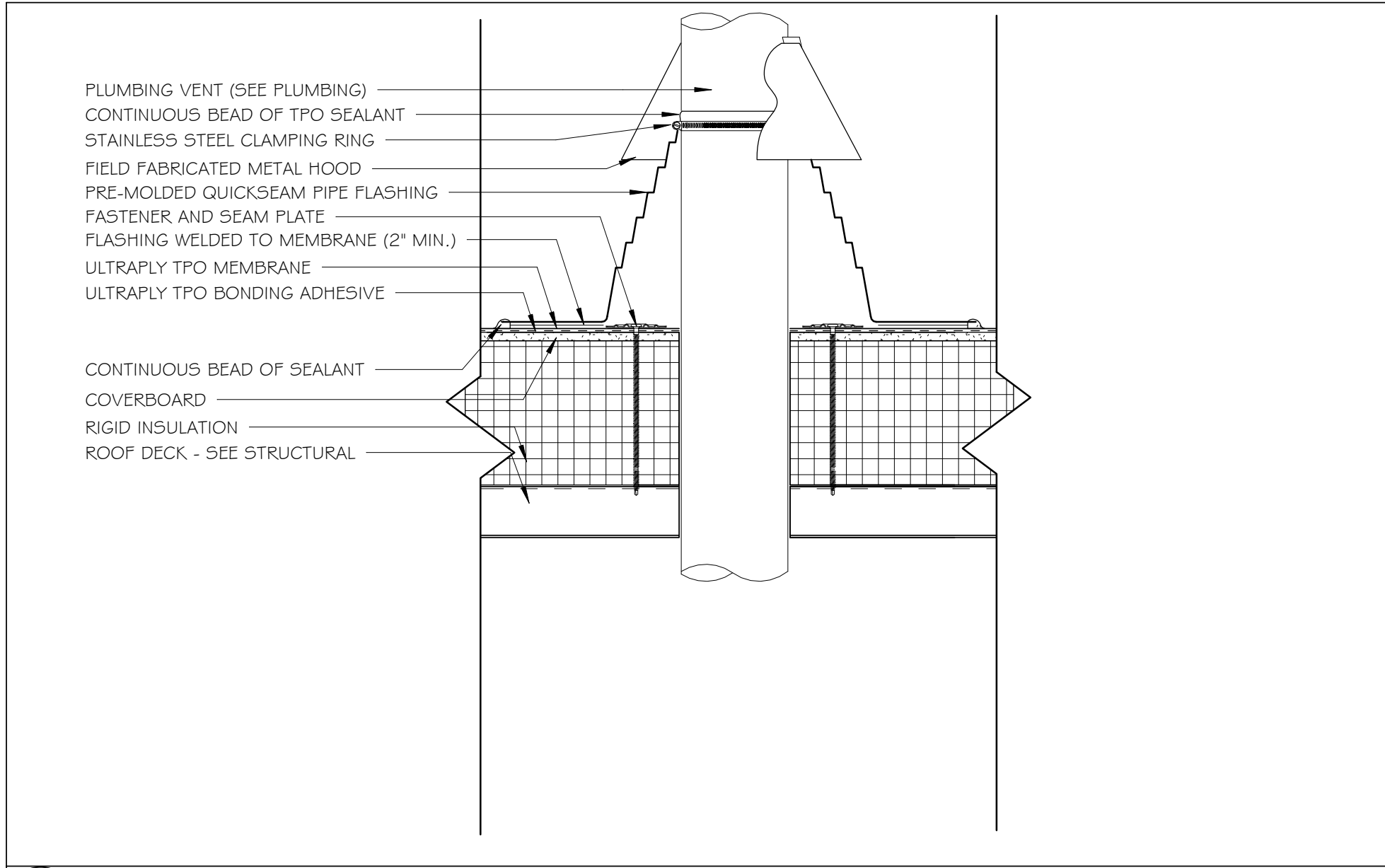
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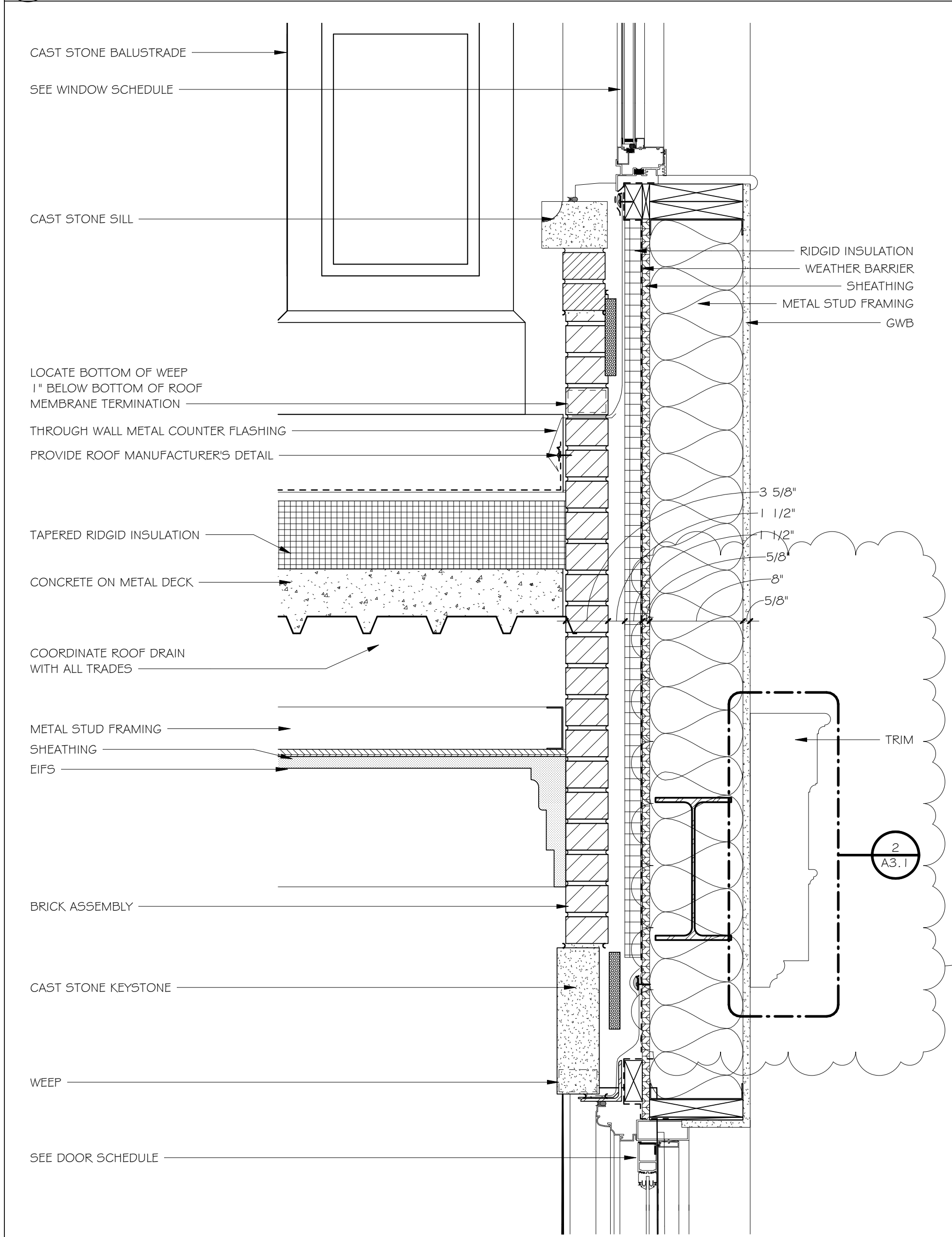




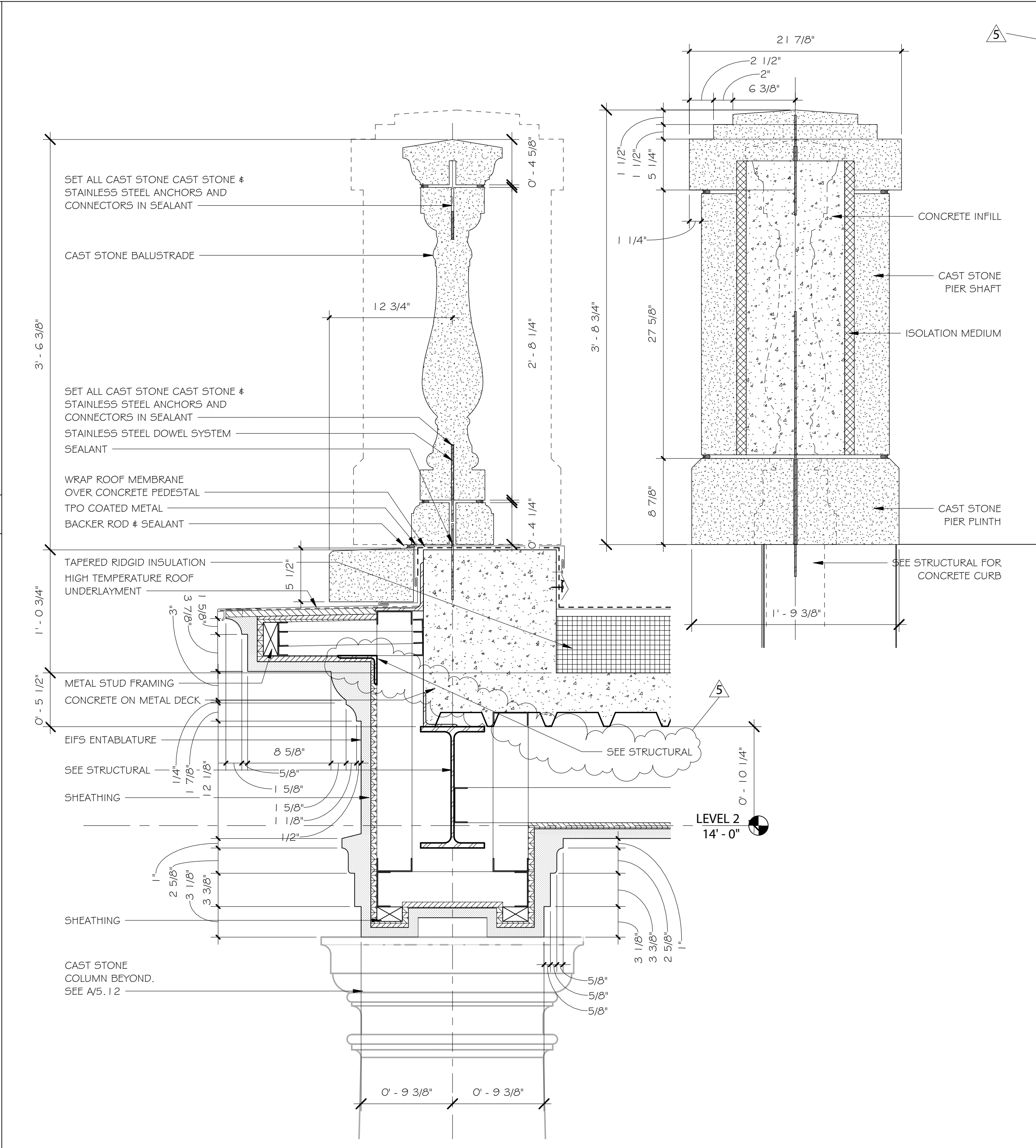




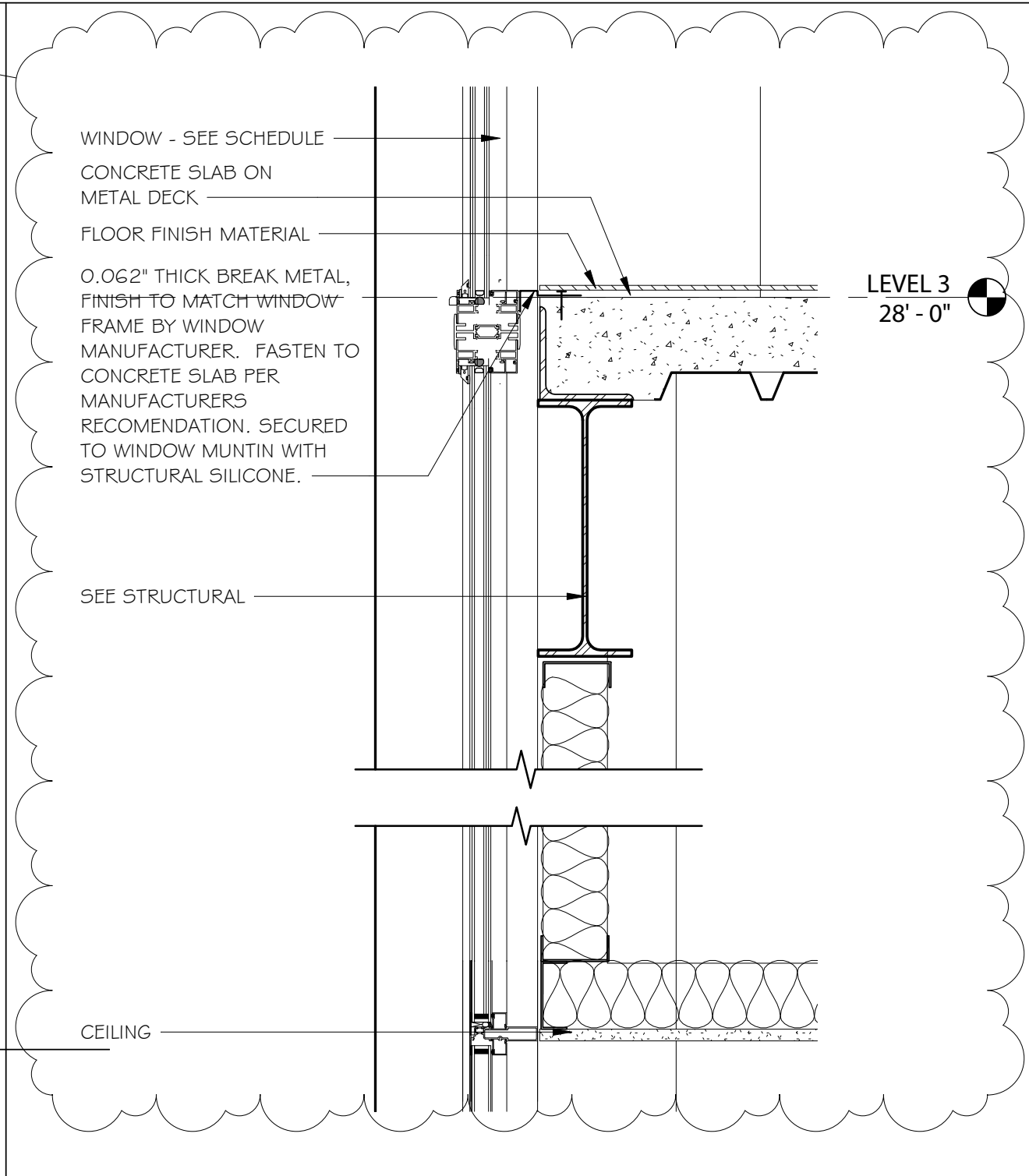
1  
A5.13 TYPICAL ROOF PENETRATION DETAIL AT TPO  
3" = 1'-0"



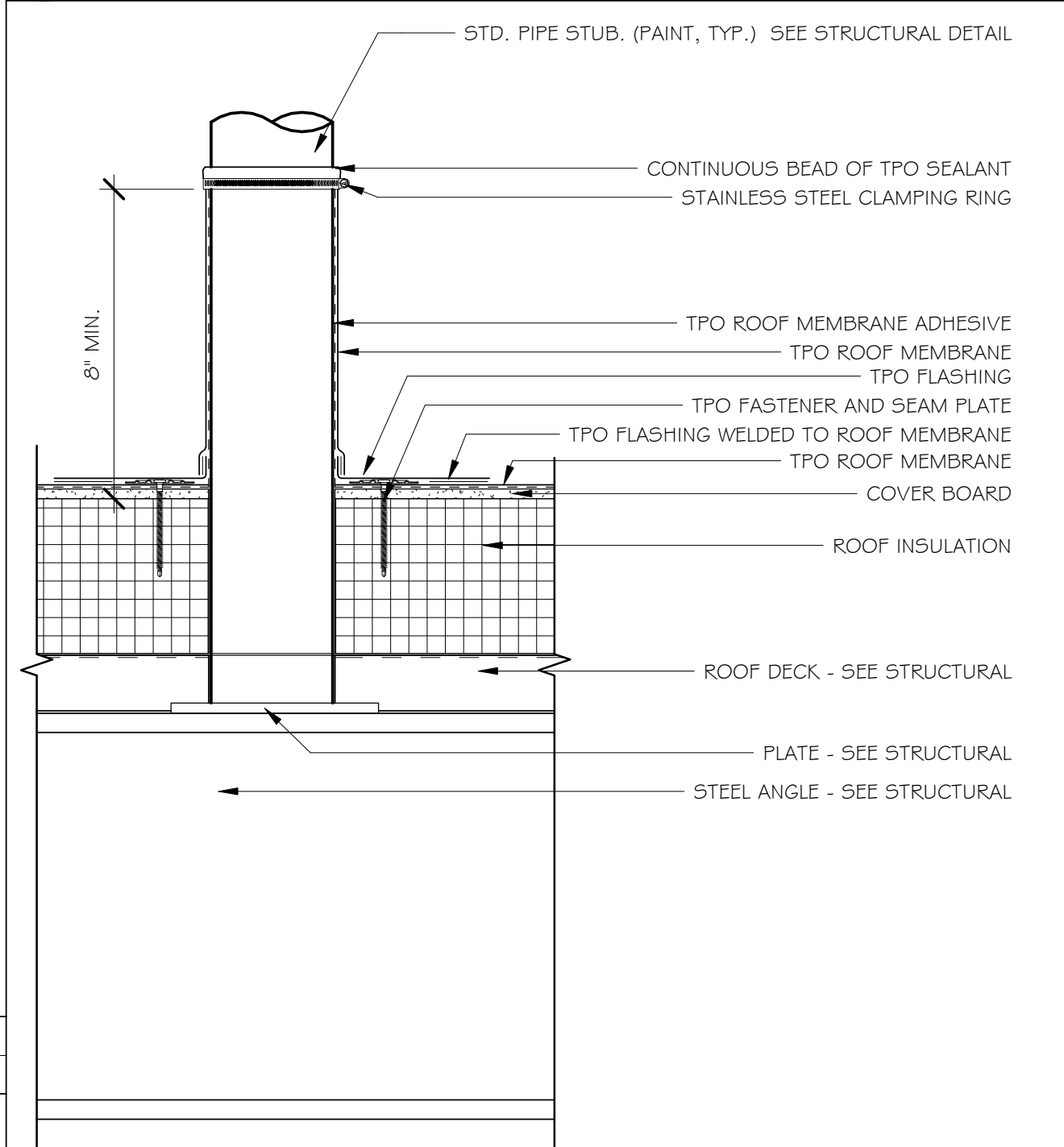
3  
A5.13 EAST ENTRY DETAIL C  
1 1/2" = 1'-0"



2  
A5.13 EAST ENTRY DETAIL B  
1 1/2" = 1'-0"



5  
A5.13 EAST ENTRY DETAIL E  
1 1/2" = 1'-0"



6  
A5.13 STD. PIPE STUB PENETRATION  
3" = 1'-0"

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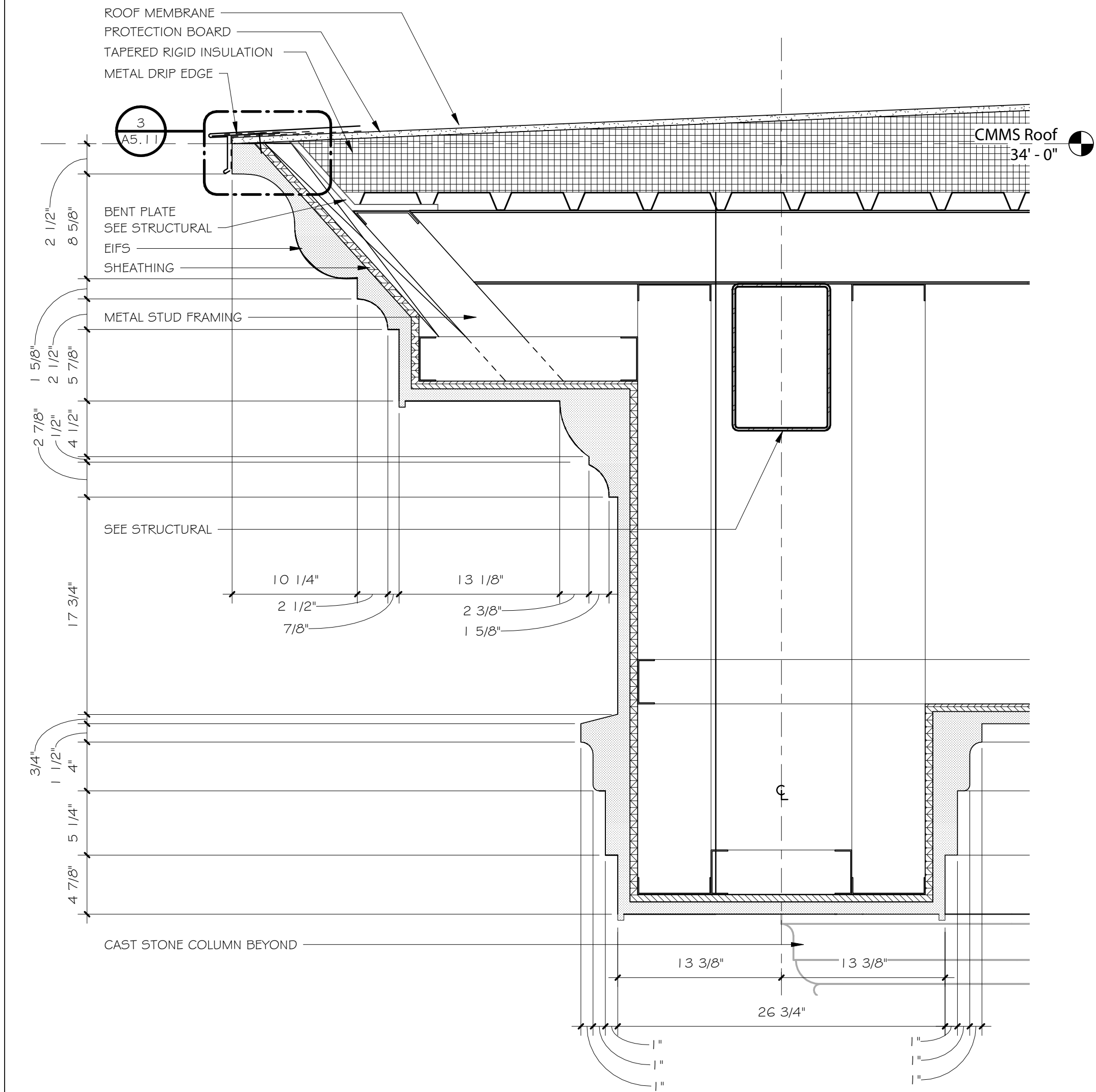
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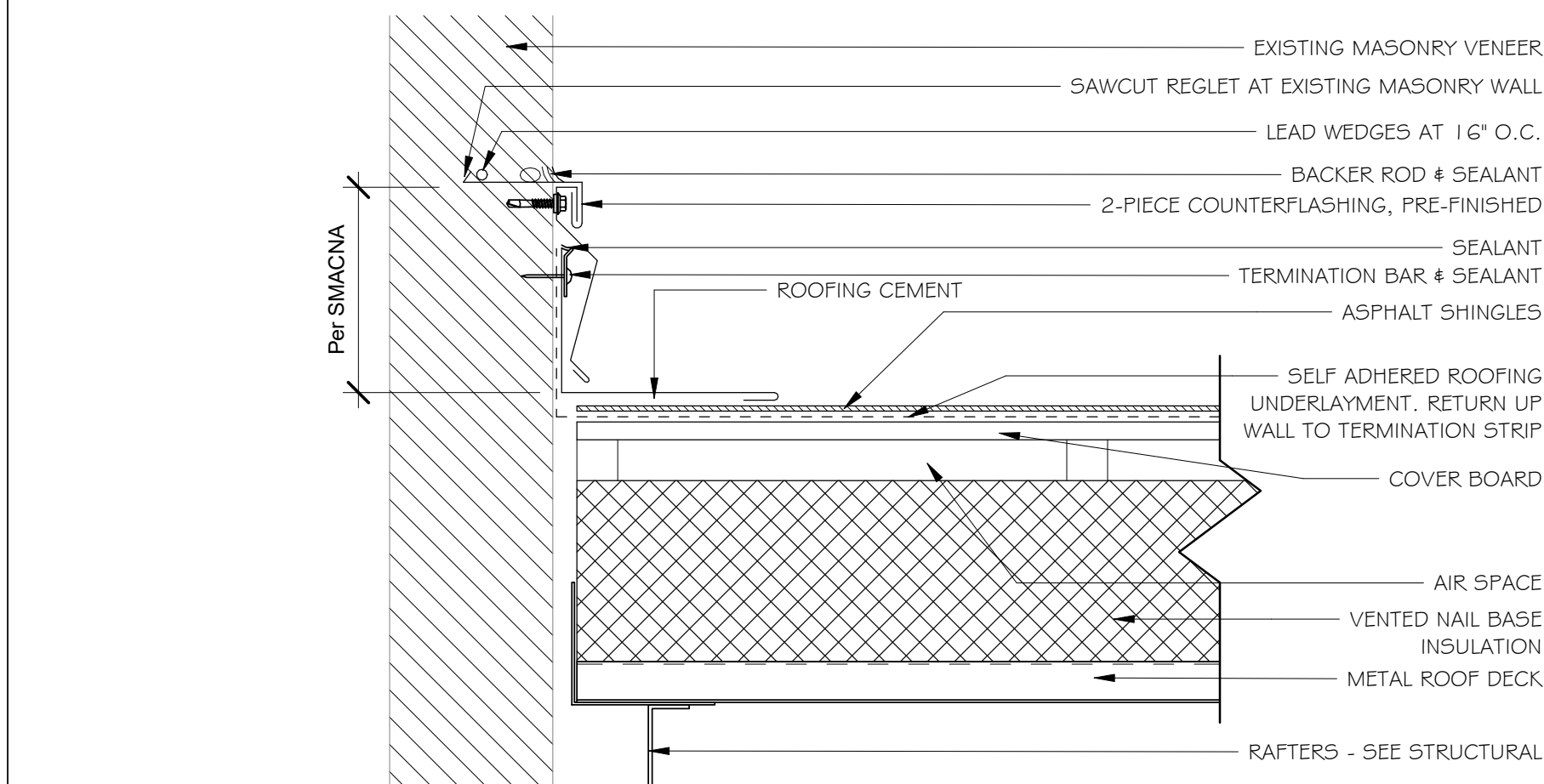
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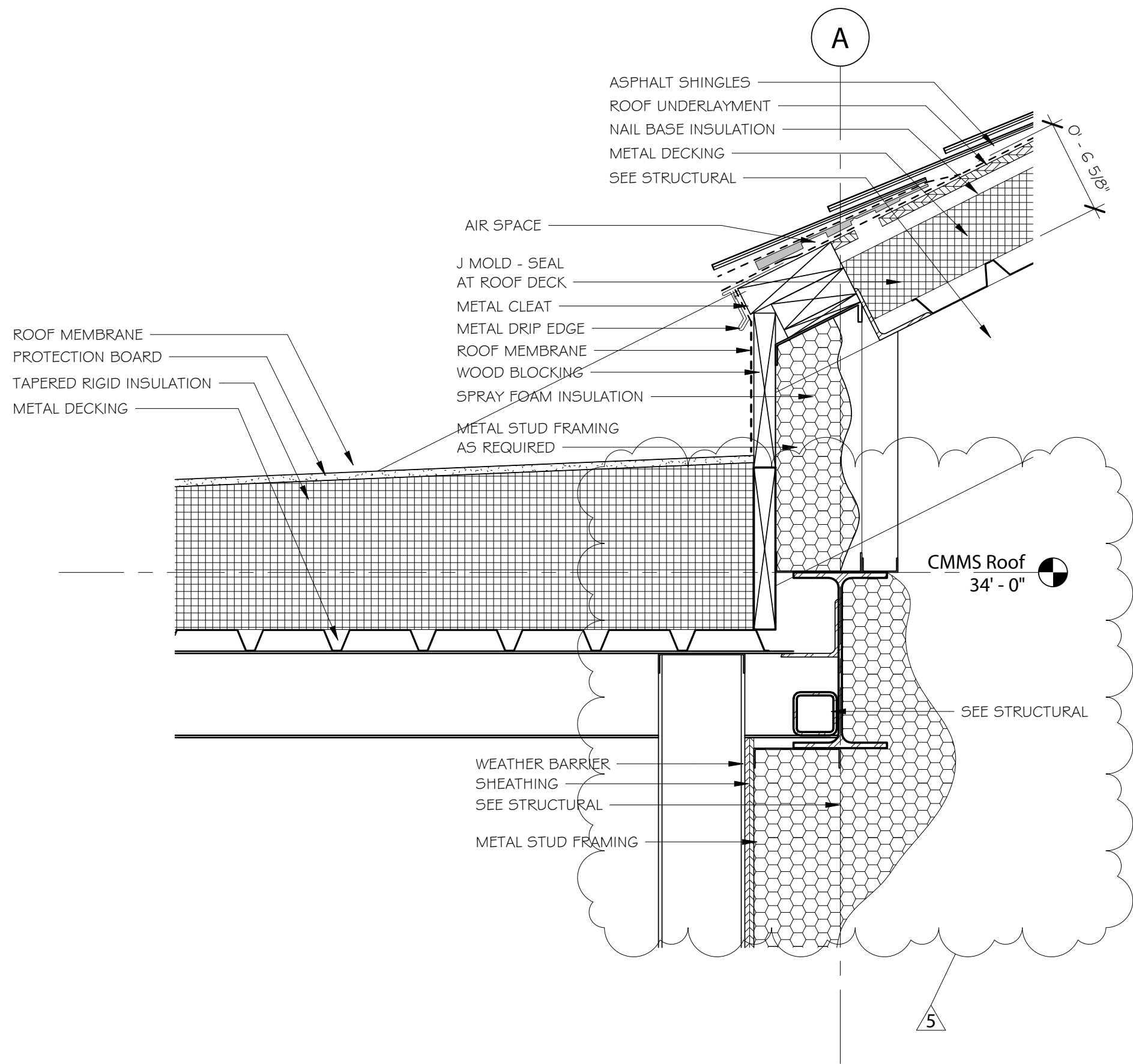




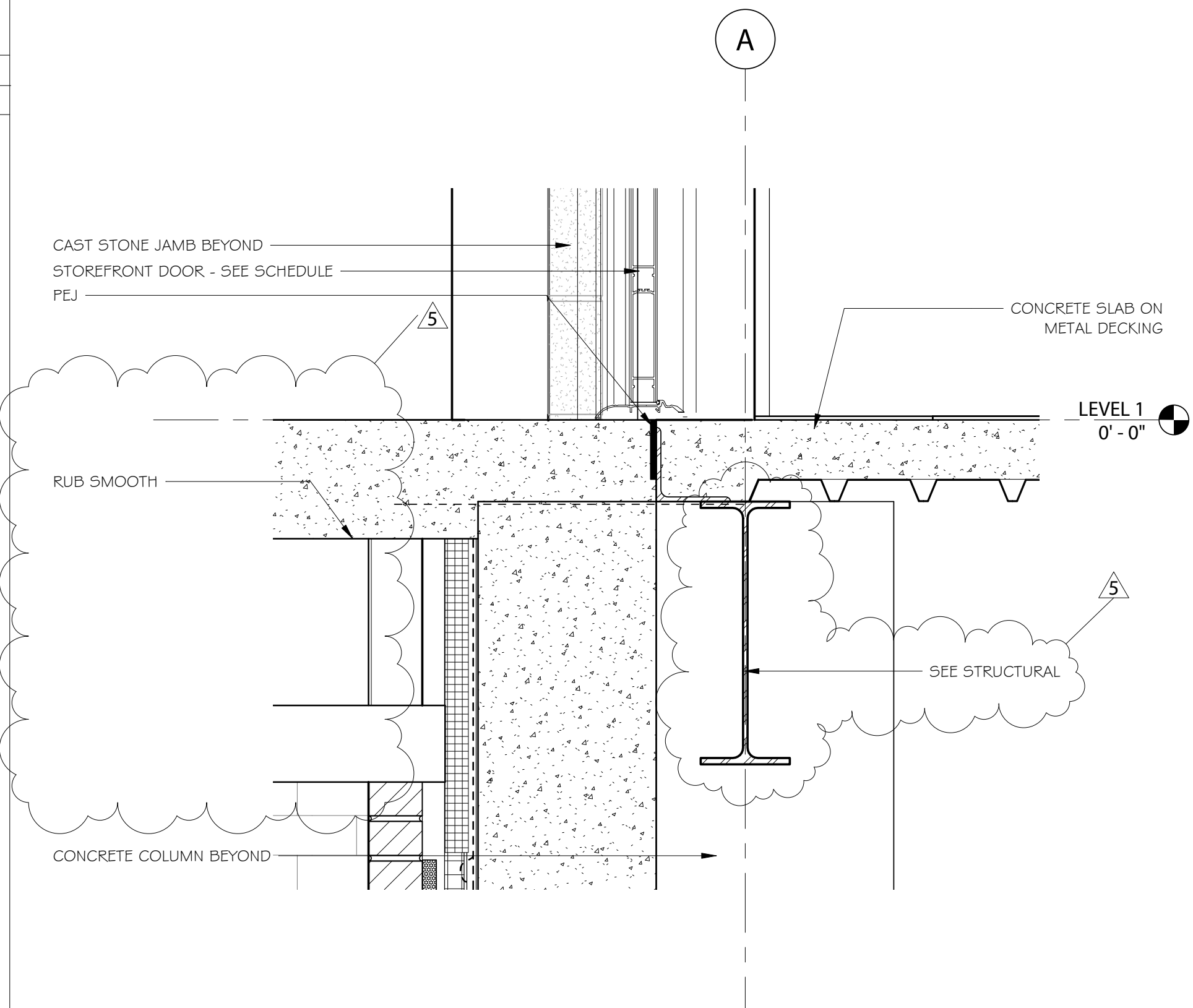
1 WEST ENTRY DETAIL A  
1 1/2" = 1'-0"



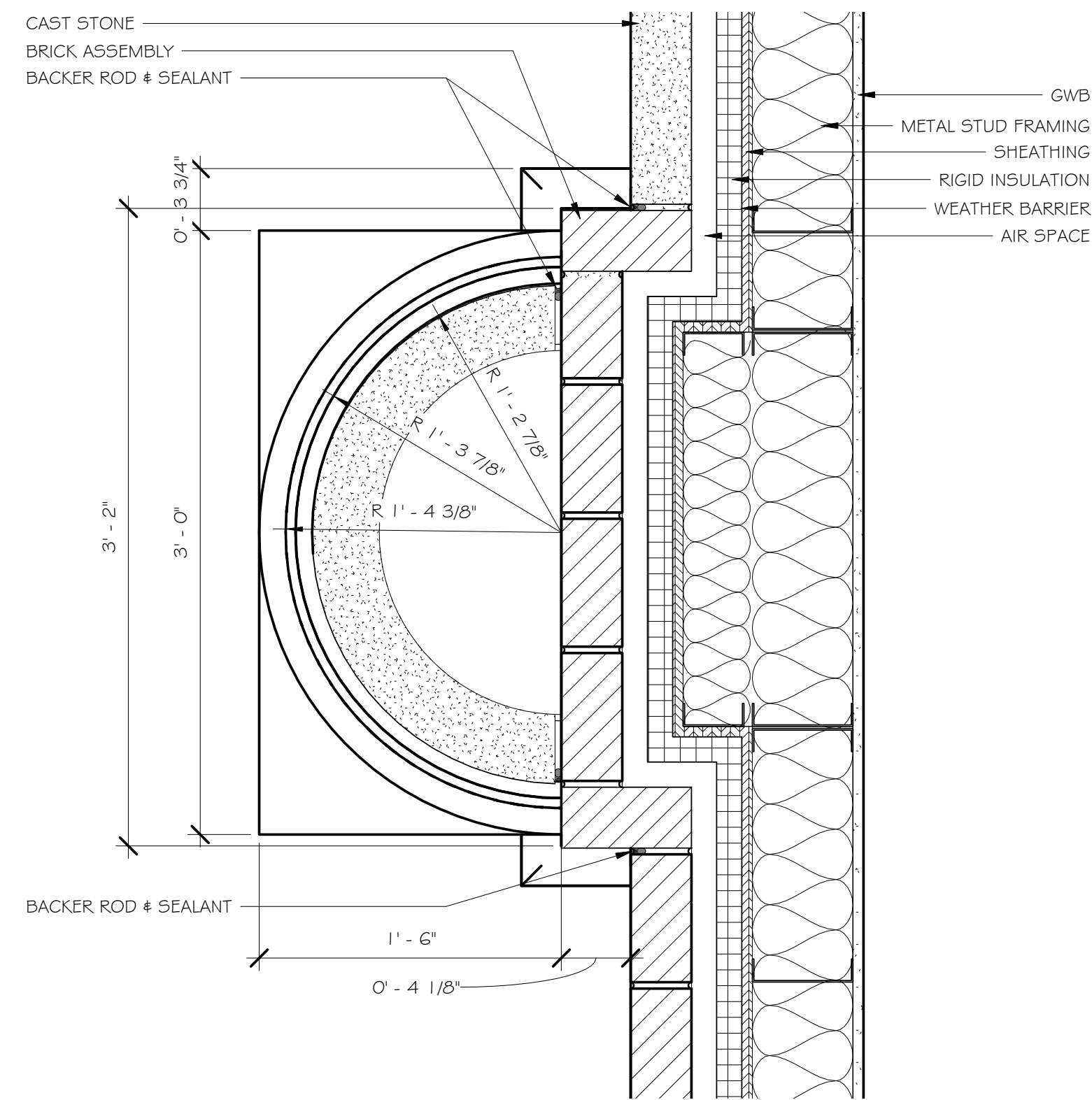
7 STEP FLASHING DETAIL  
3" = 1'-0"



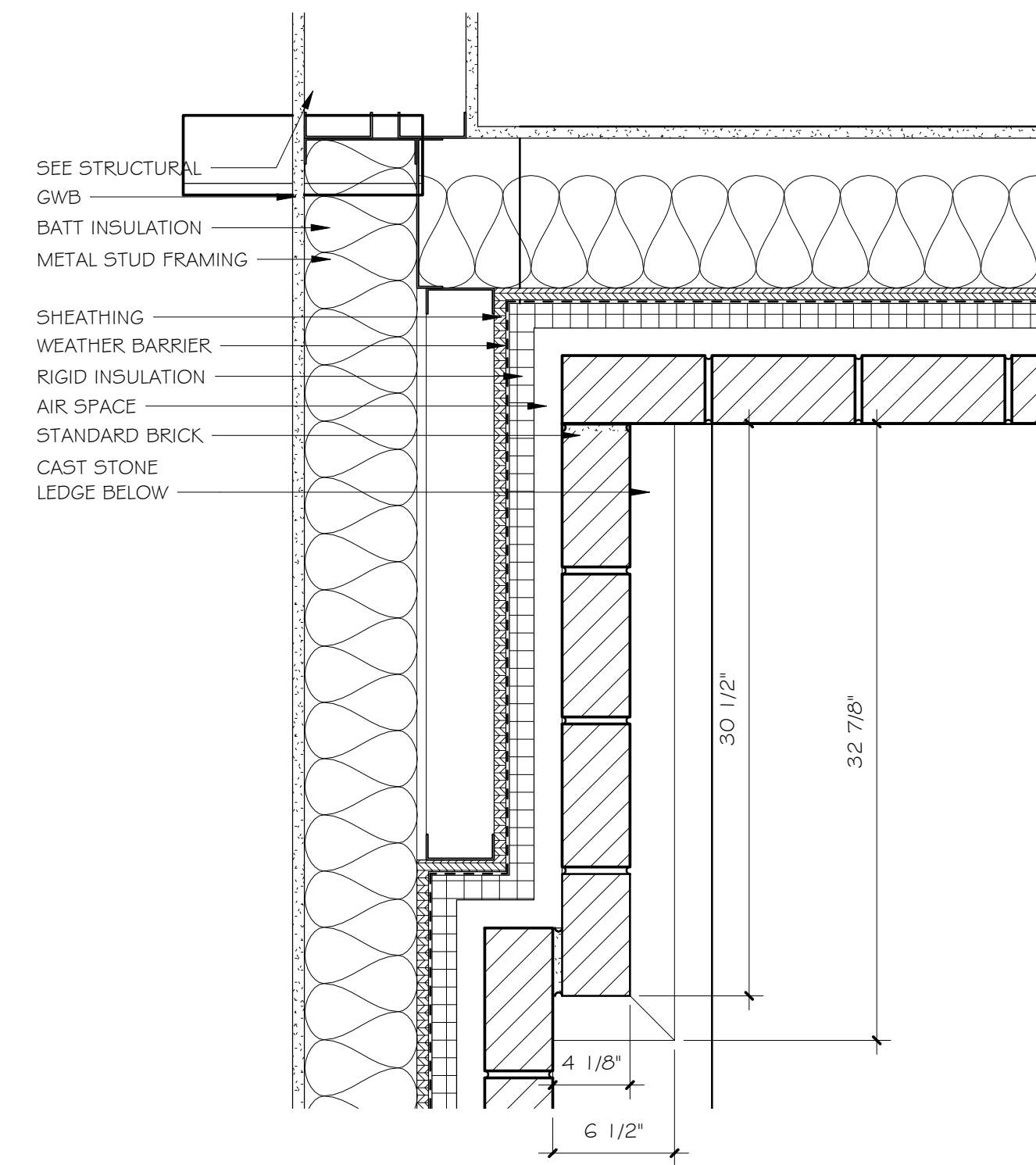
5 WEST ENTRY ROOF TRANSITION DETAIL  
1 1/2" = 1'-0"



3 WEST ENTRY DETAIL C  
1 1/2" = 1'-0"



4 CAST STONE ENGAGED COLUMN AT WEST ENTRY AT BASE  
1 1/2" = 1'-0"



2 INSIDE CORNER PILASTER DETAIL  
1 1/2" = 1'-0"

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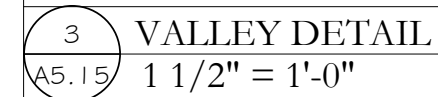
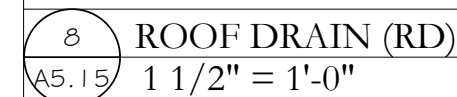
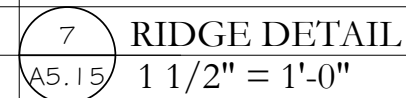
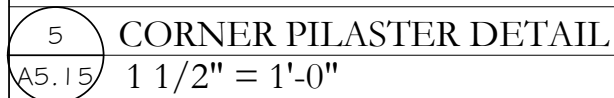
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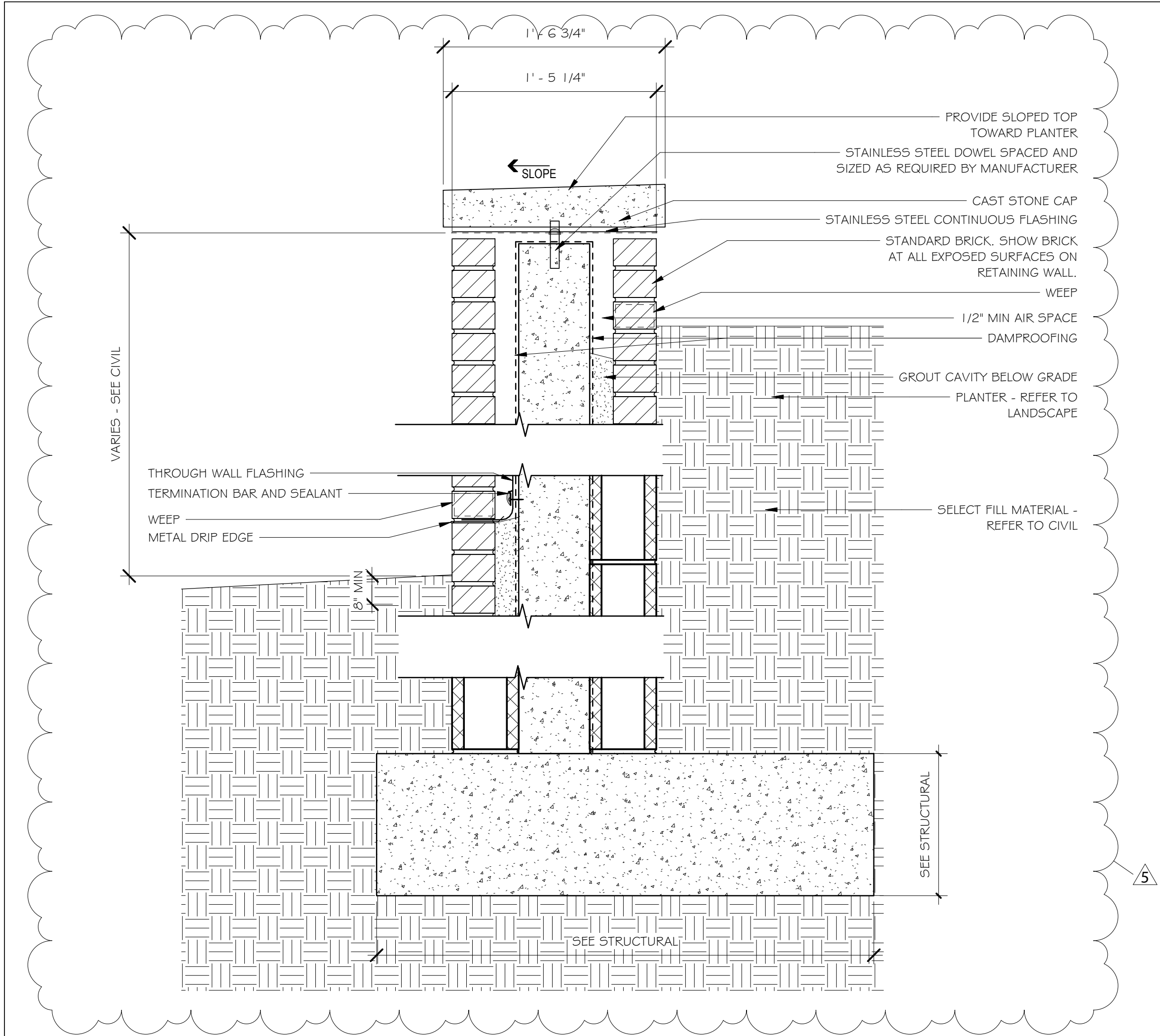
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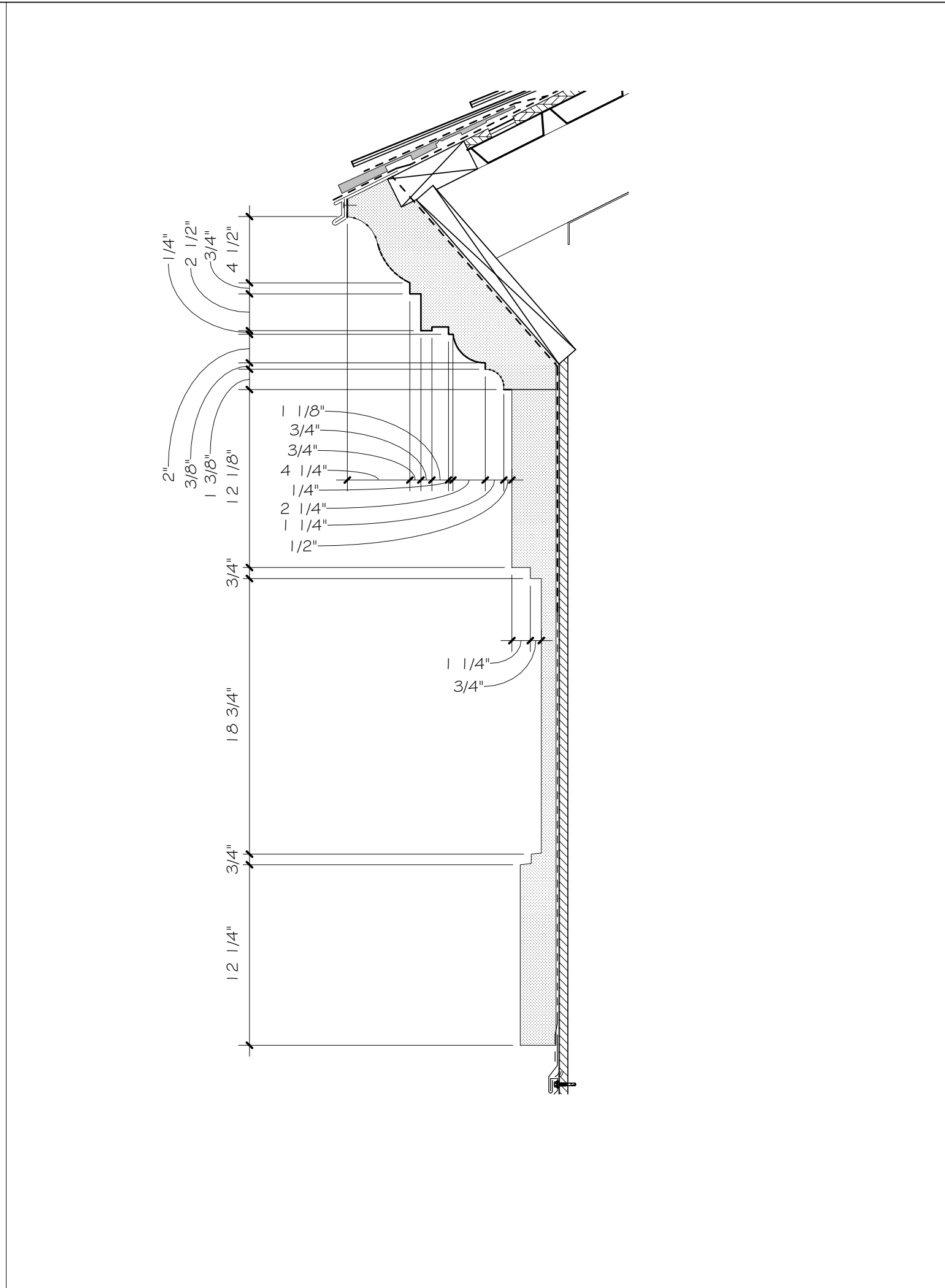




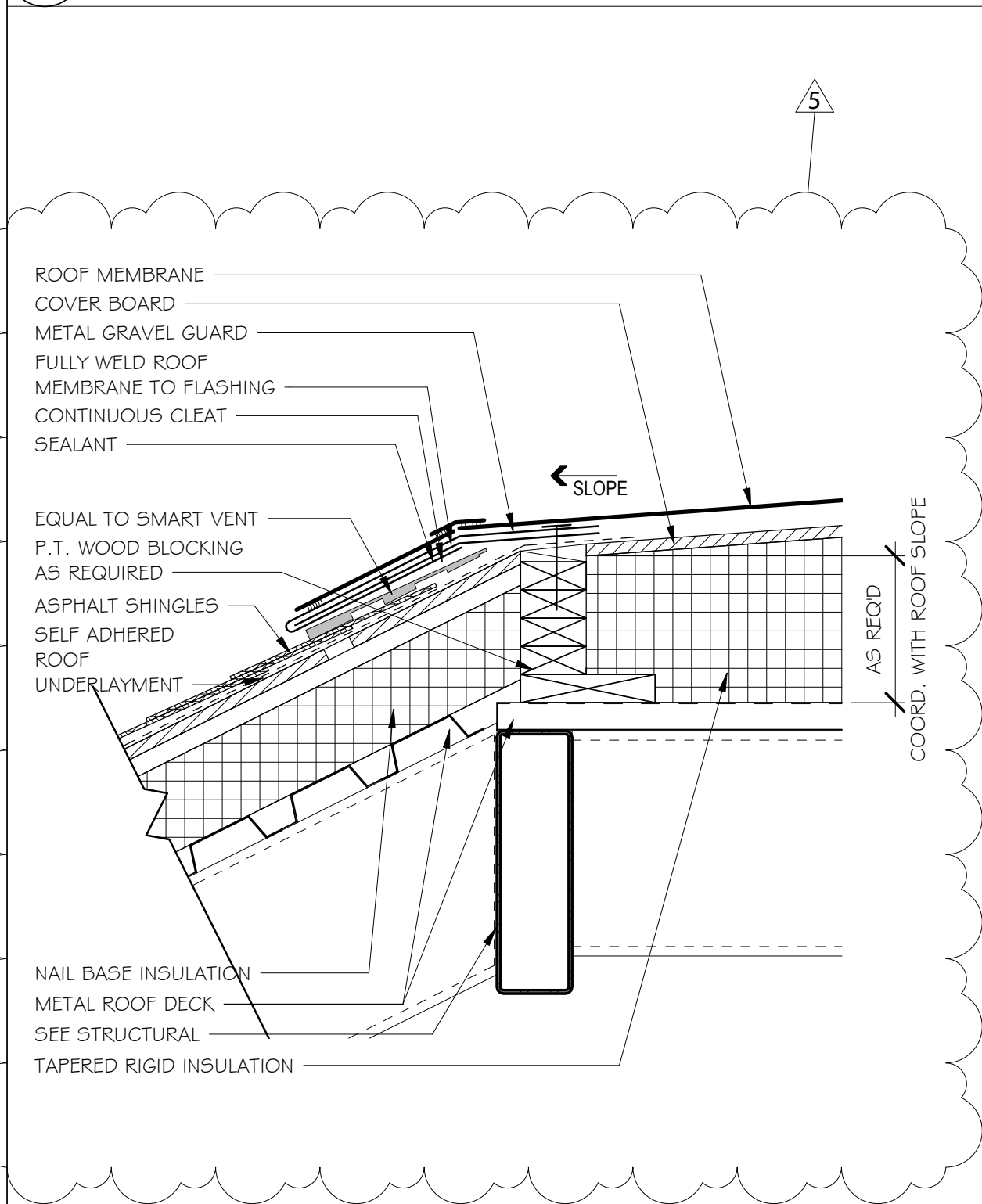




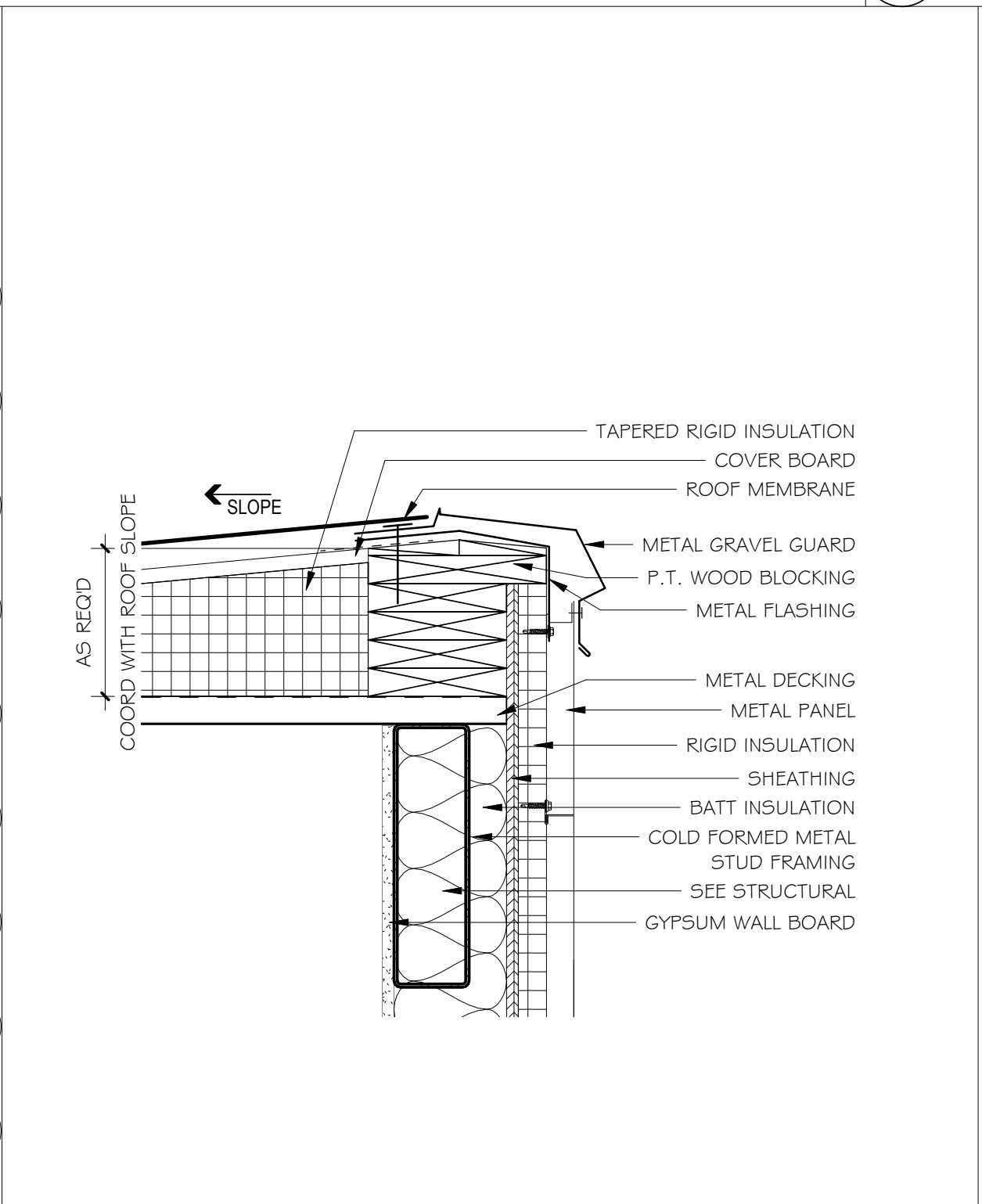
1 RETAINING WALL DETAIL  
A5.16 1 1/2" = 1'-0"



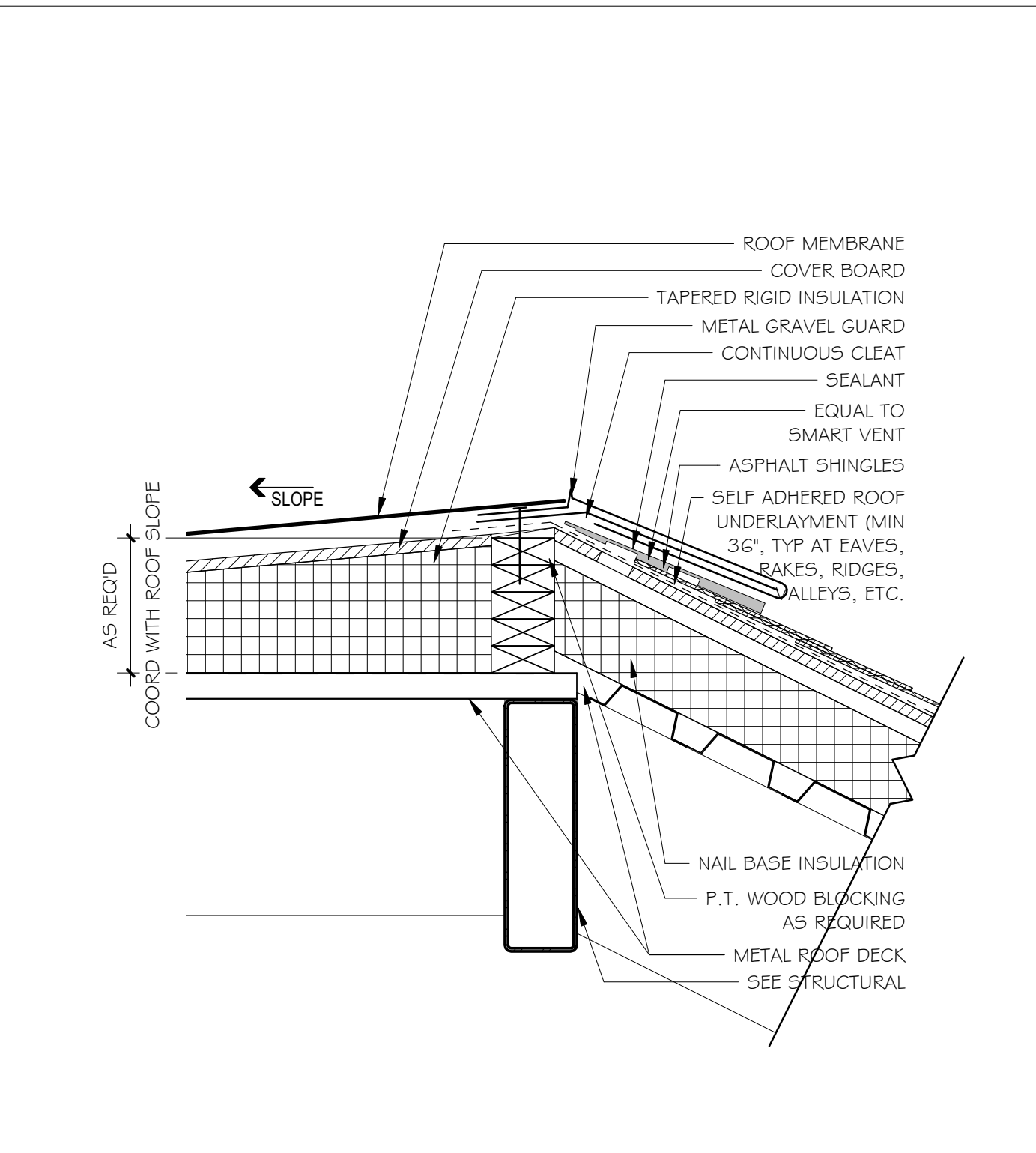
2 EIFS PROFILE DETAIL  
A5.16 1 1/2" = 1'-0"



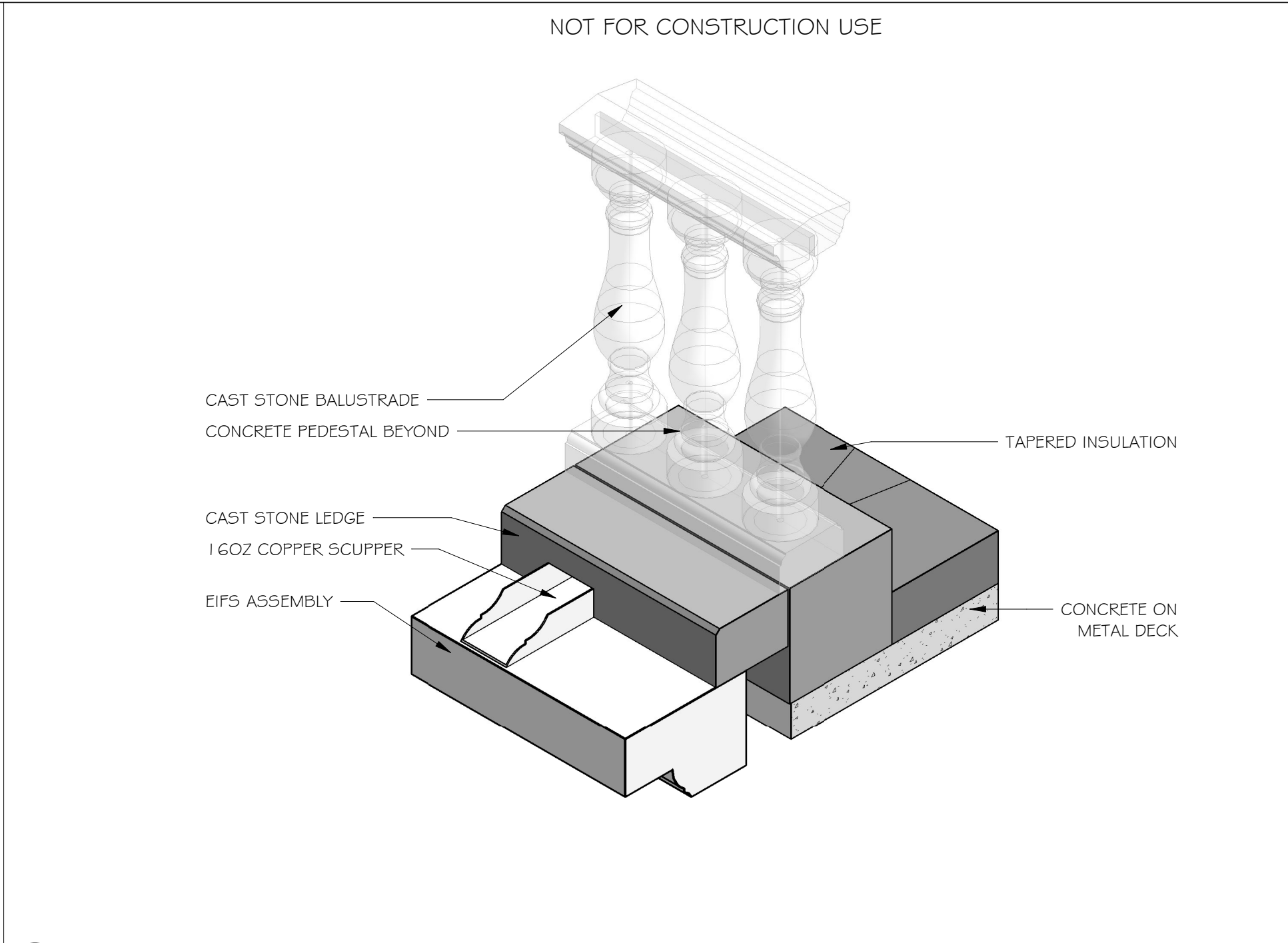
4 FLAT TO SLOPED ROOF DETAIL A  
A5.16 1 1/2" = 1'-0"



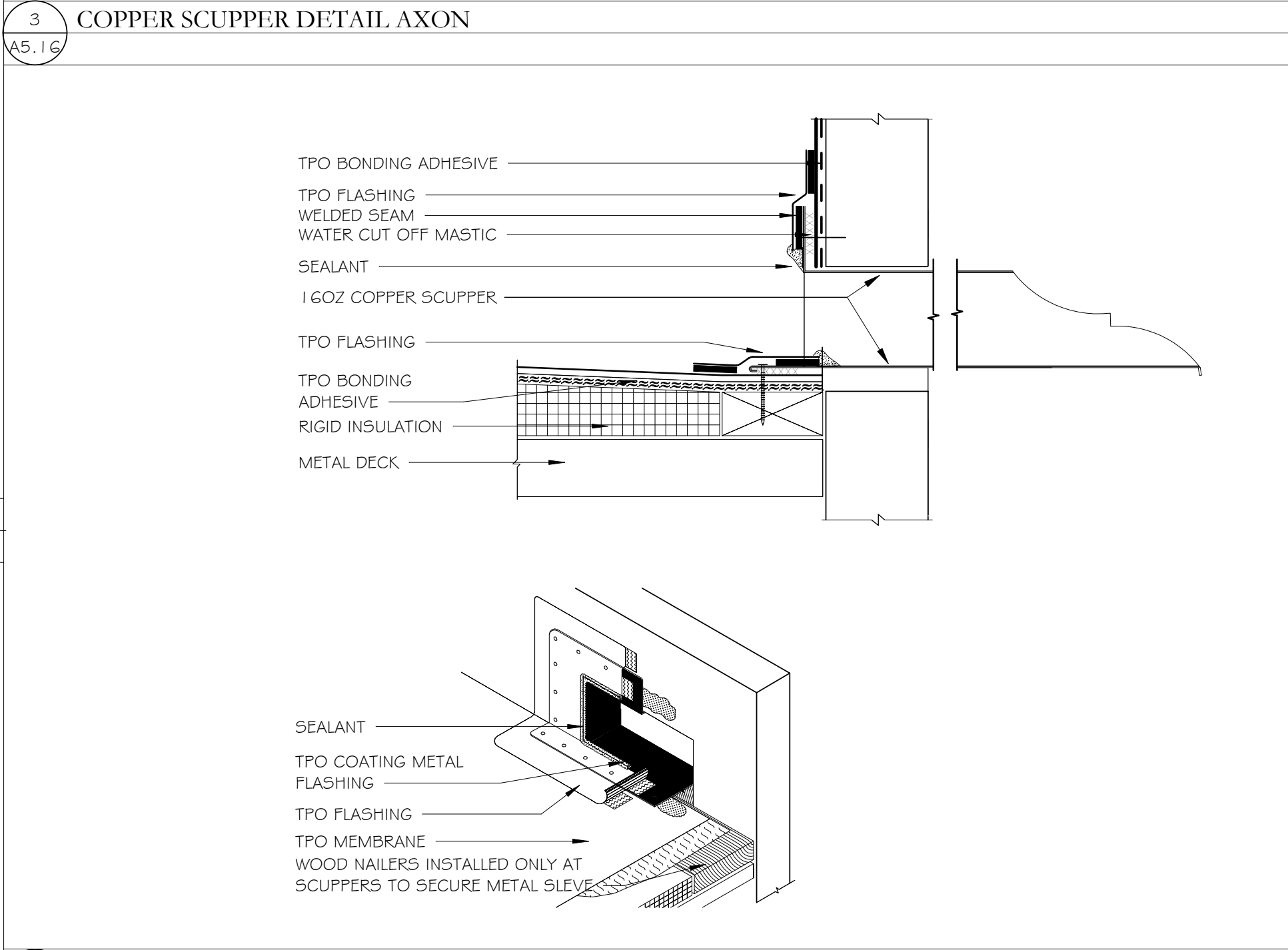
5 FLAT ROOF TO METAL SIDING DETAIL  
A5.16 1 1/2" = 1'-0"



6 FLAT TO SLOPED ROOF DETAIL B  
A5.16 1 1/2" = 1'-0"



3 COPPER SCUPPER DETAIL AXON  
A5.16



7 TYPICAL SCUPPER DETAIL  
A5.16 1/2" = 1'-0"

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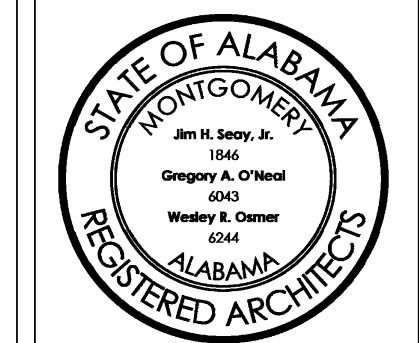
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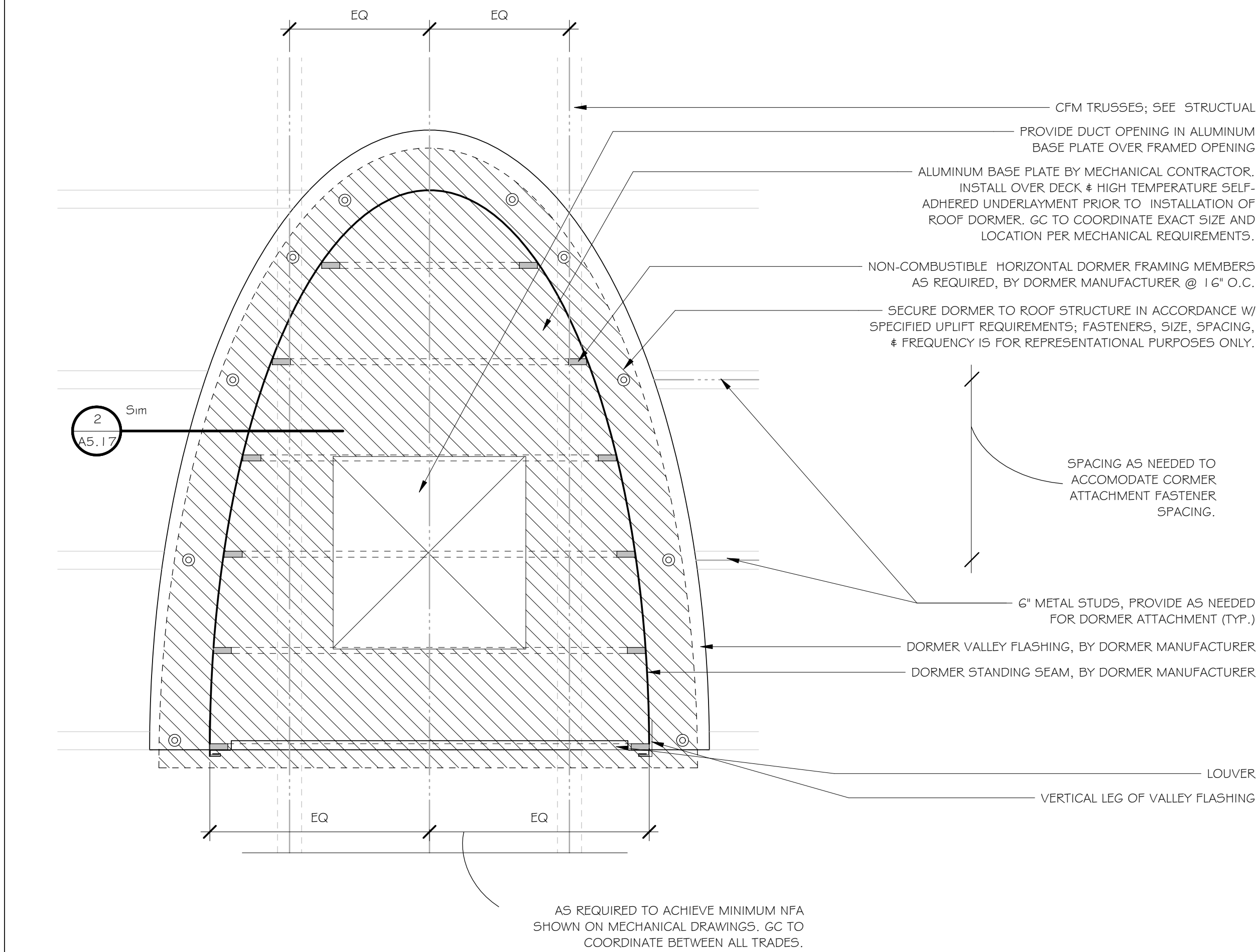
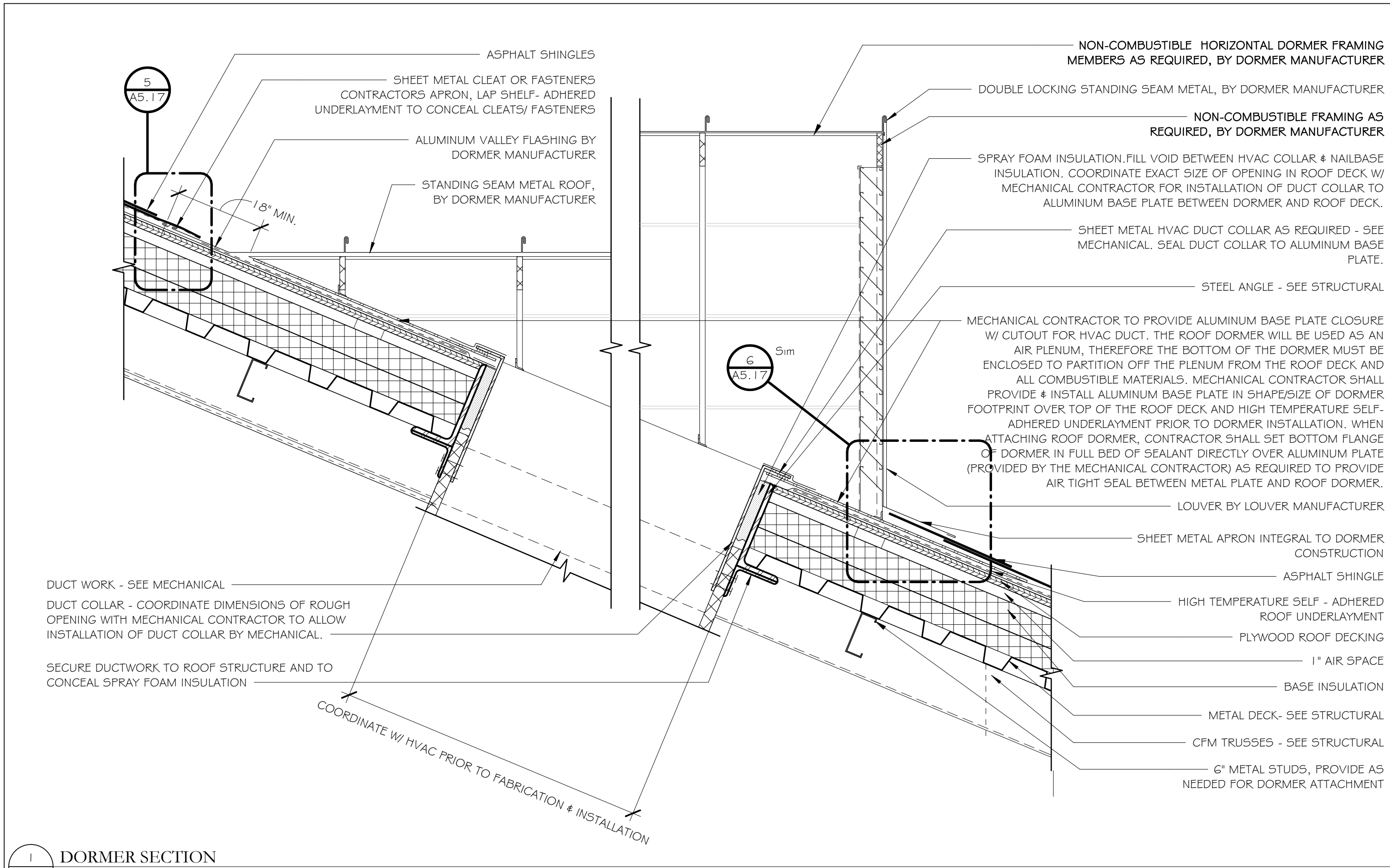
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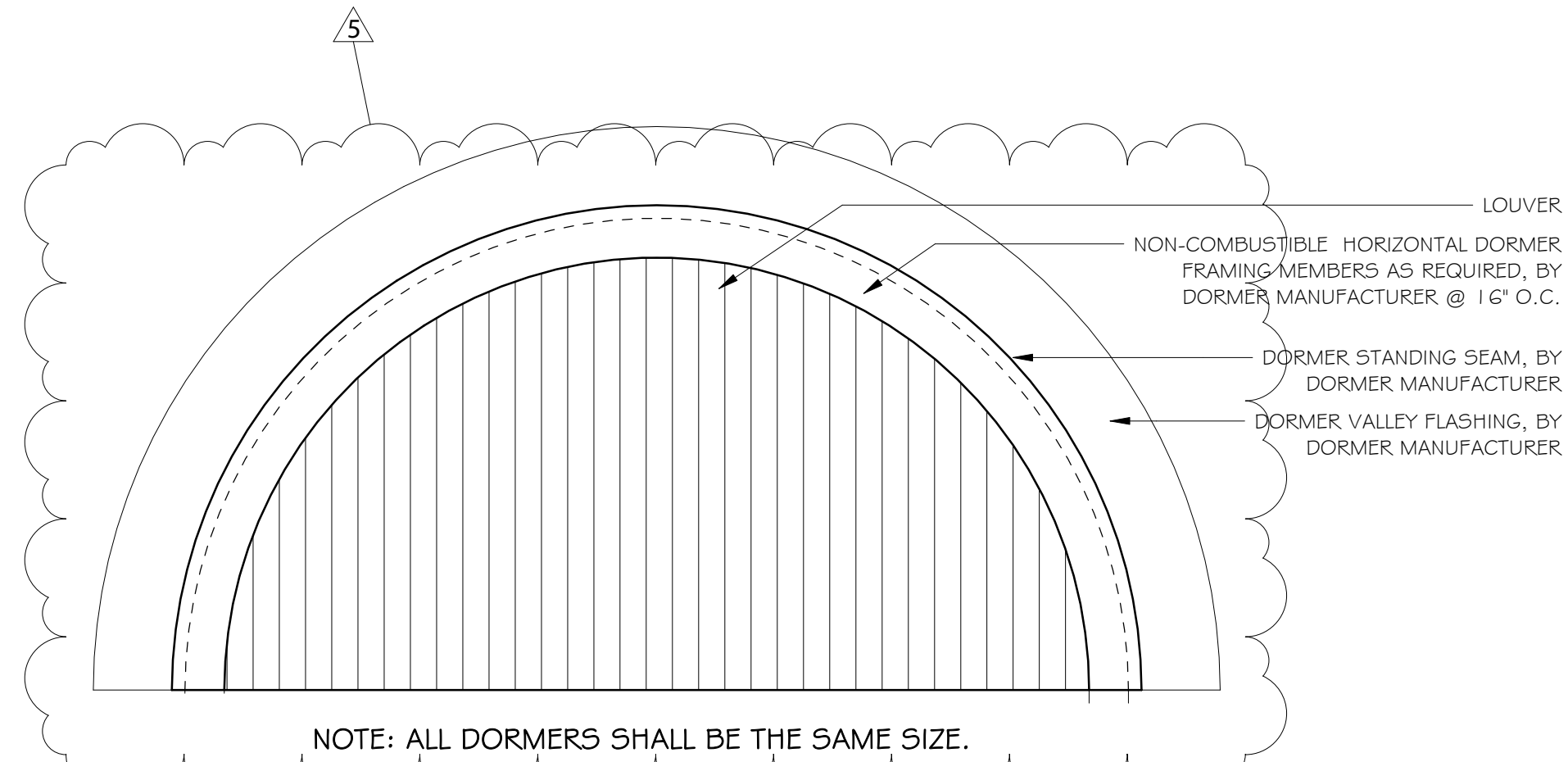
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A5.16





3  
A5.17  
DORMER PLAN  
3/4" = 1'-0"



4  
A5.17  
DORMER ELEVATION 1  
1" = 1'-0"

1/2" X 1" STEEL CHANNEL @ 16" O.C.  
DORMER STANDING SEAM, BY DORMER MANUFACTURER  
NON-COMBUSTIBLE DORMER FRAMING MATERIAL @ 16" O.C.

ALUMINUM VALLEY FLASHING BY DORMER MANUFACTURER  
SECURE DORMER TO ROOF IN ACCORDANCE W/ SPECIFIED UPLIFT REQUIREMENTS, FASTENERS, SIZE, SPACING, & FREQUENCY IS FOR REPRESENTATIONAL PURPOSES ONLY. SET SCREW IN BED OF SEALANT.  
ASPHALT SHINGLE  
ALUMINUM SHEET METAL CLOSURE  
DORMER ATTACHMENT FLANGE  
HIGH TEMPERATURE SELF- ADHERED ROOF UNDERLAYMENT  
PLYWOOD ROOF DECKING  
1" AIR SPACE  
R-25 NAIL BASE INSULATION  
METAL DECK- SEE STRUCTURAL

6" METAL TRUSS - SEE STRUCTURAL

2  
A5.17  
DORMER FLASHING AND CONNECTION DETAIL  
3" = 1'-0"

METAL FLASHING (VALLEY FLASHING, CRICKET, ETC.)  
HIGH TEMPERATURE SELF-ADHERED UNDERLAYMENT BELOW METAL FLASHING  
LEAVE FLASHING UP TO FORM CONTINUOUS WATER STOP ON SIDES WITH DOWN SLOPE CONDITIONS.  
CLEAT USING SAME MATERIAL AS FLASHING  
LAP ROOFING UNDERLAYMENT ON METAL FLASHING  
CDX PLYWOOD ROOF DECKING

5  
A5.17  
TYP. CLEAT DETAIL  
6" = 1'-0"

METAL COUNTERFLASHING  
HOOK BOTTOM EDGE OF COUNTER FLASHING TO ADJACENT COUNTER FLASHING (TYP.)  
ANCHOR AT 8" O.C.  
NEW METAL APRON FLASHING CONSTRUCTED PER NRCA, SMACNA, AND ASPHALT SHINGLE MANUFACTURER'S RECOMMENDATIONS  
STAINLESS METAL CLEAT  
ANCHOR AT 8" O.C.  
METAL COUNTER FLASHING ANCHOR WITH RIVET THROUGH  
ASPHALT SHINGLES  
SELF-ADHERED ROOFING UNDERLAYMENT  
PLYWOOD ROOF DECKING

6  
A5.17  
BASE FLASHING DETAIL  
3" = 1'-0"

Rev.	Description	Date
5	Add. 5	01/15/2021

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Date	11/17/2020
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Checked By	JS,FL

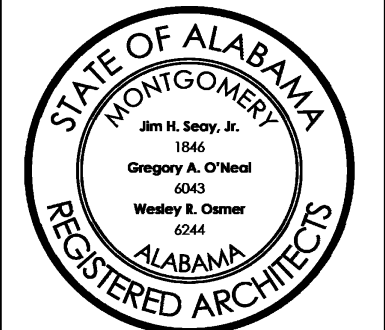
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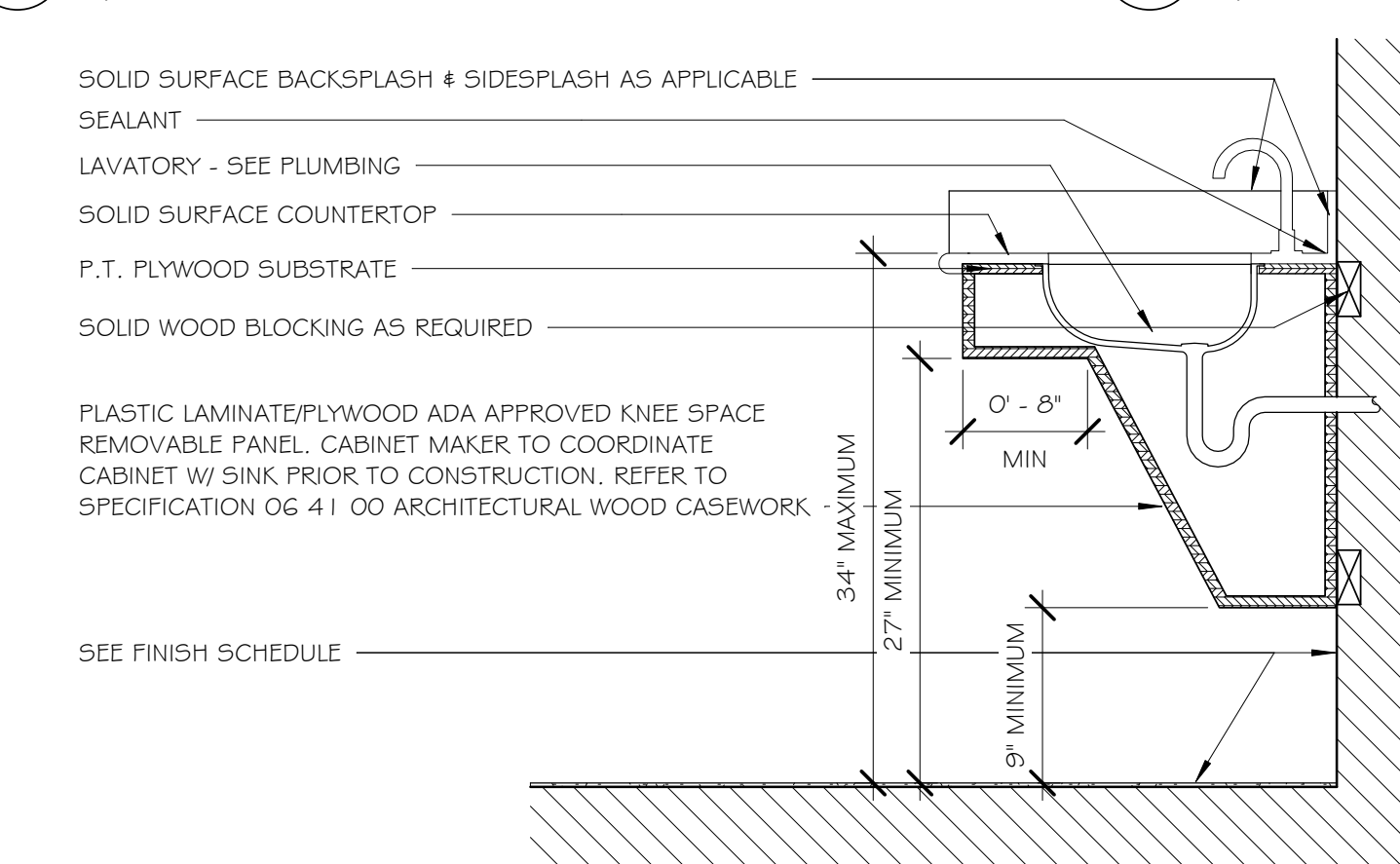
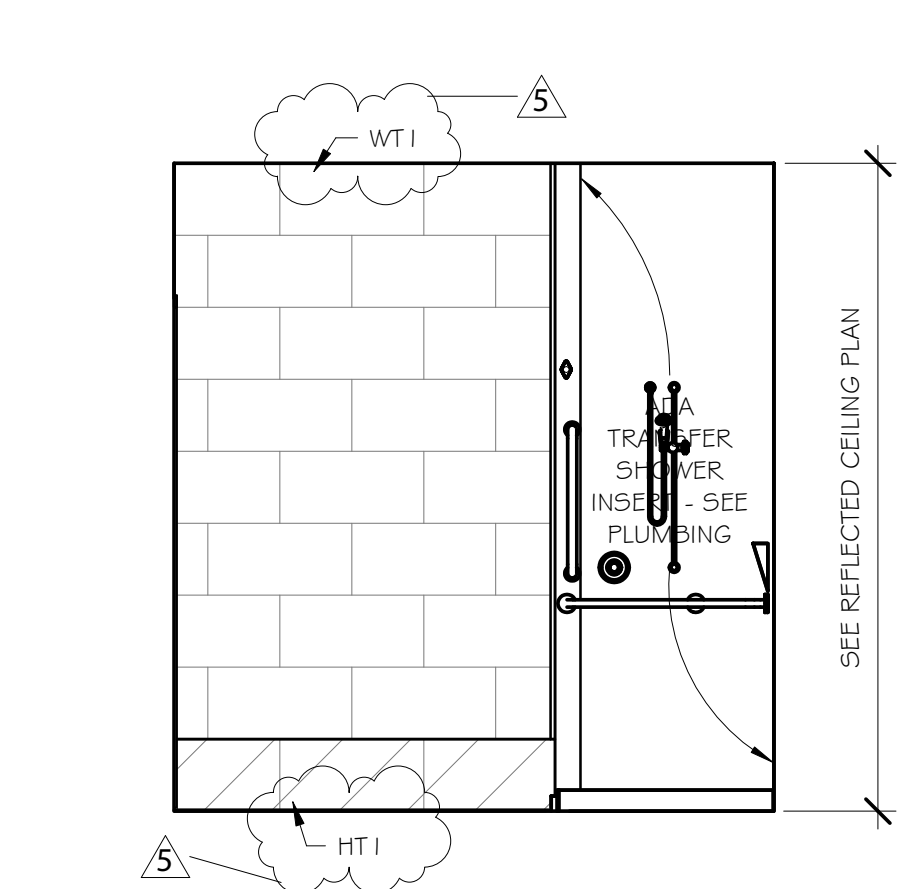
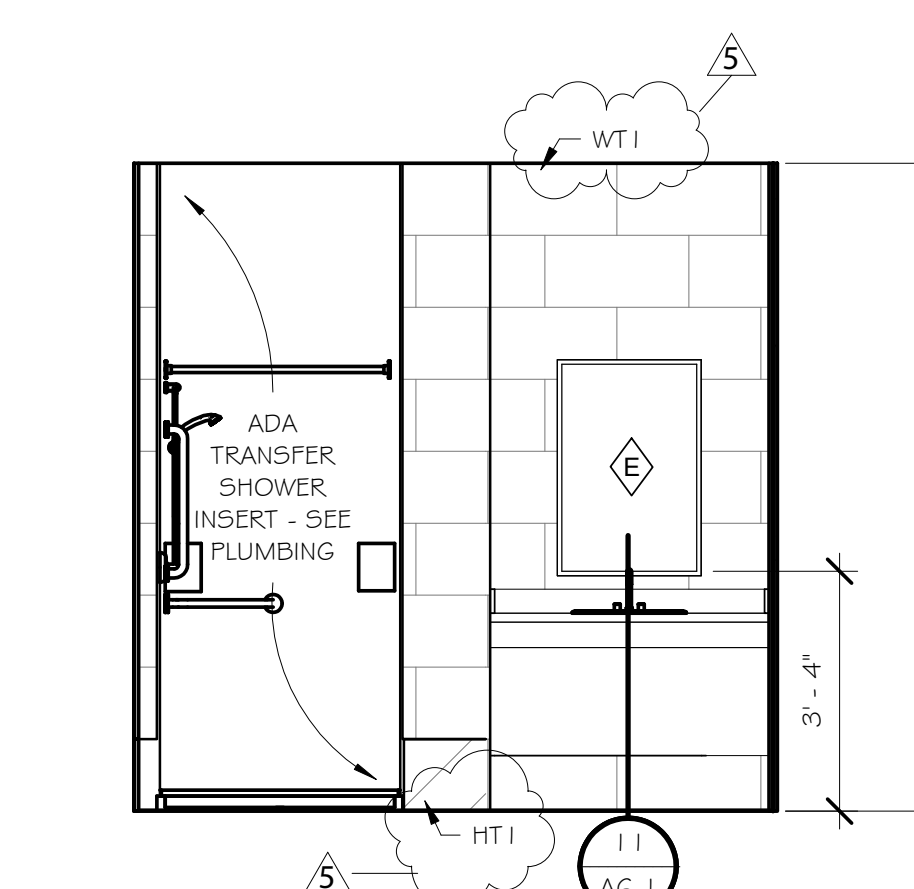
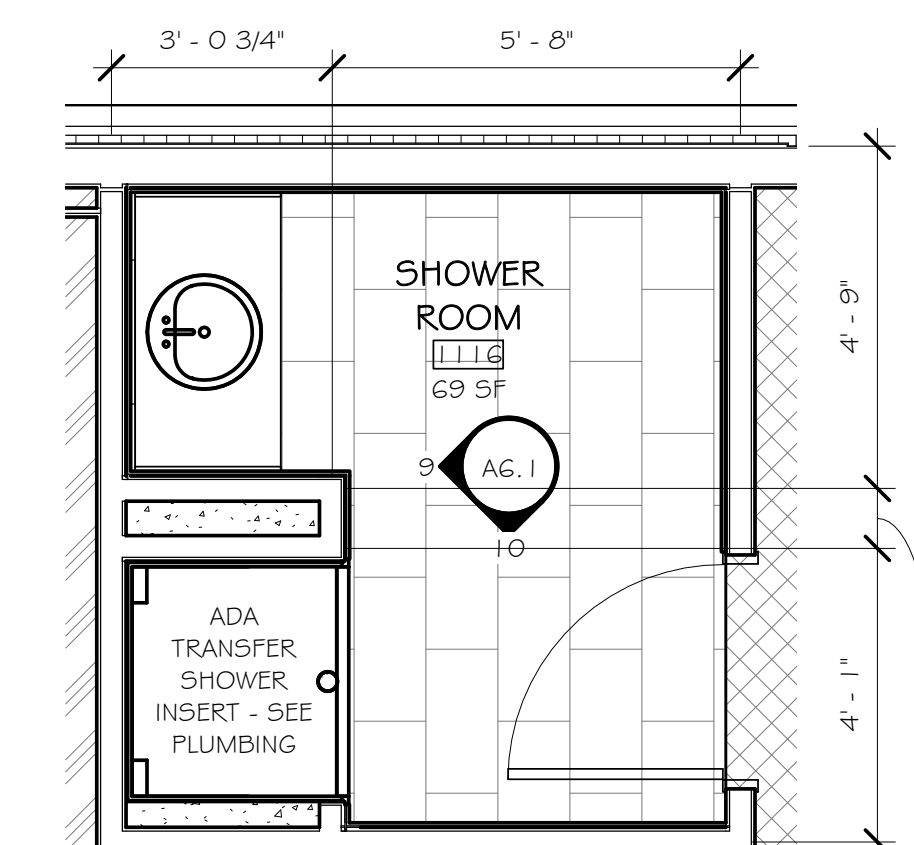
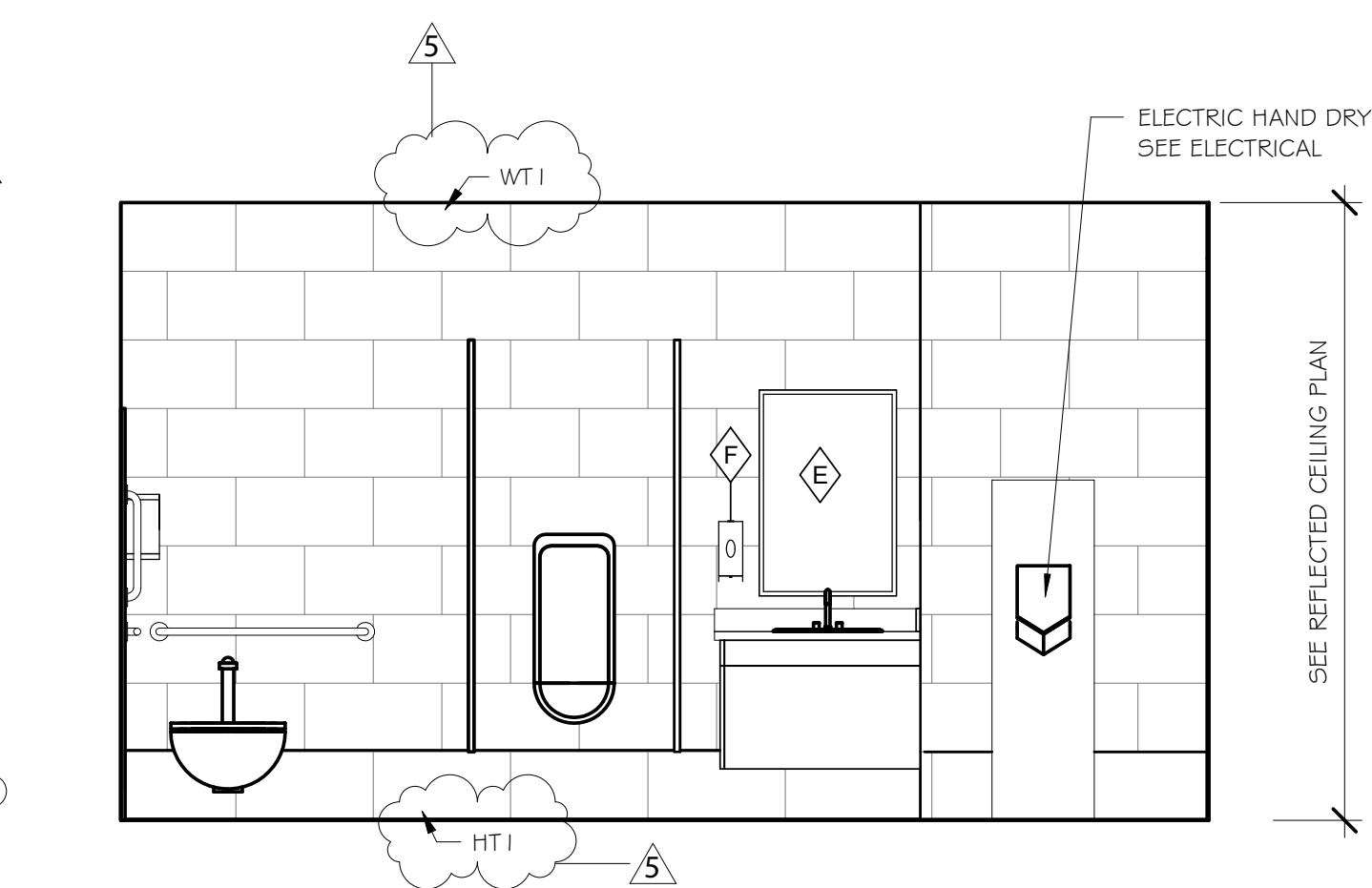
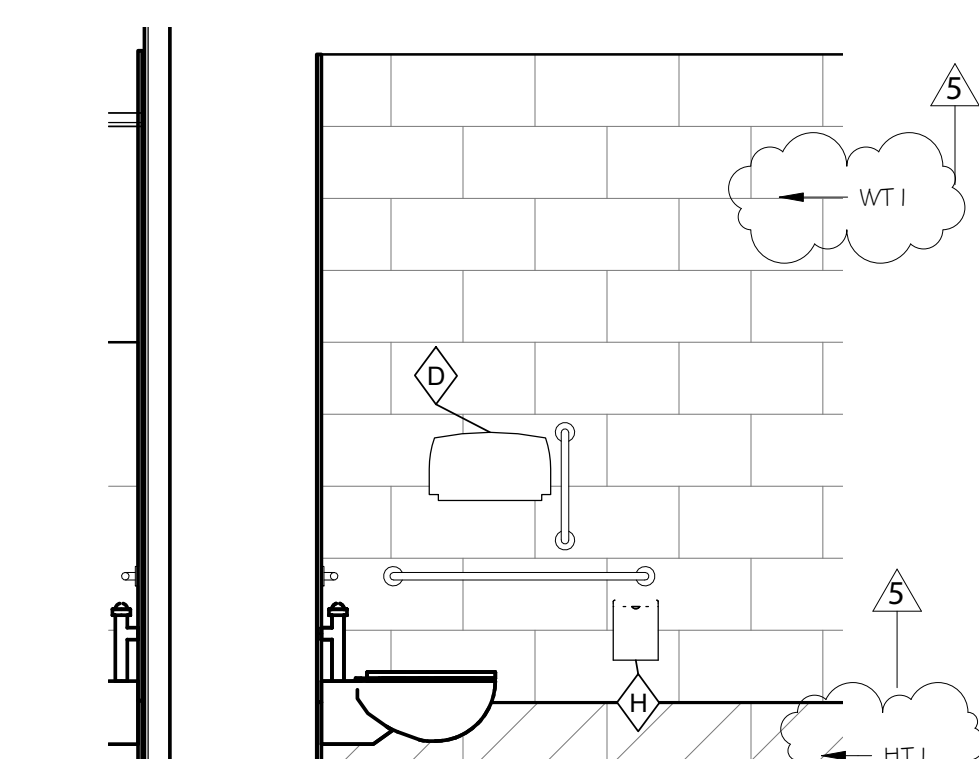
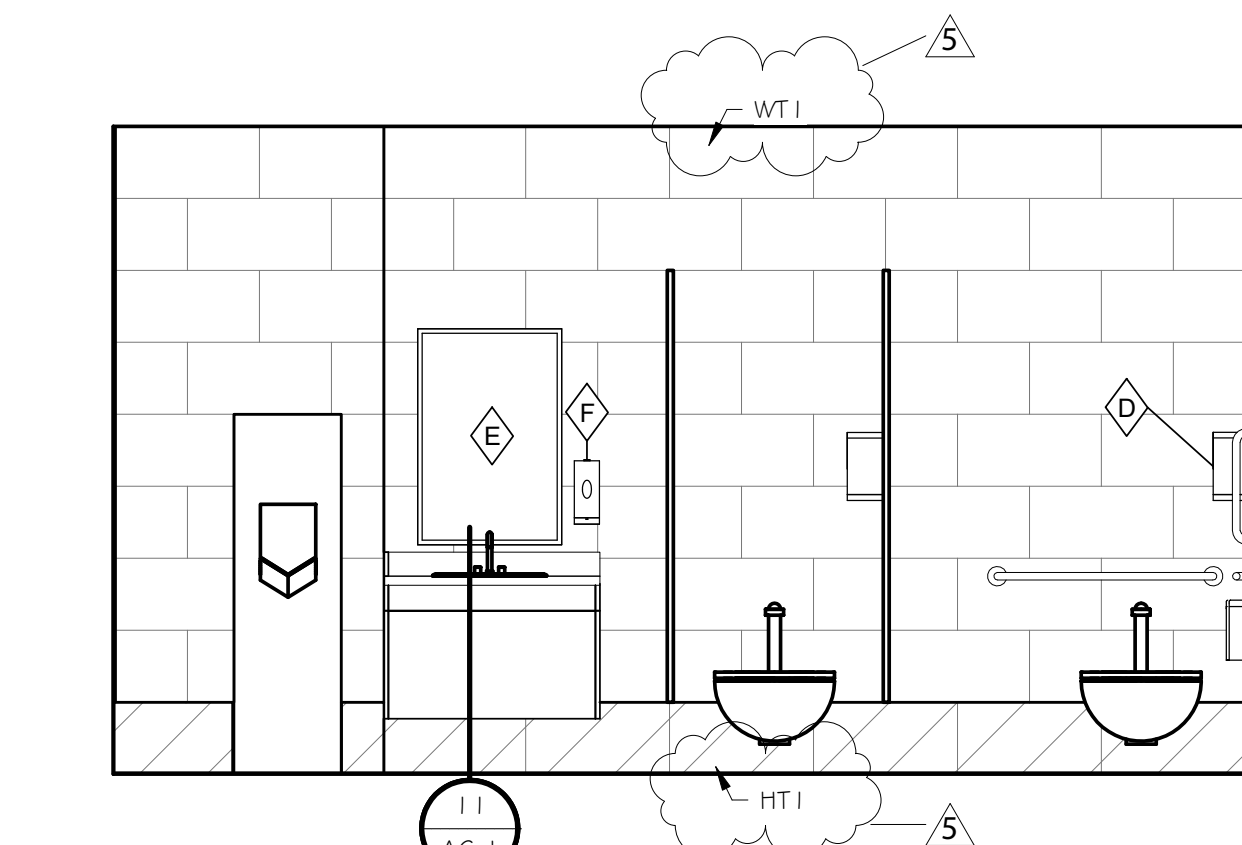
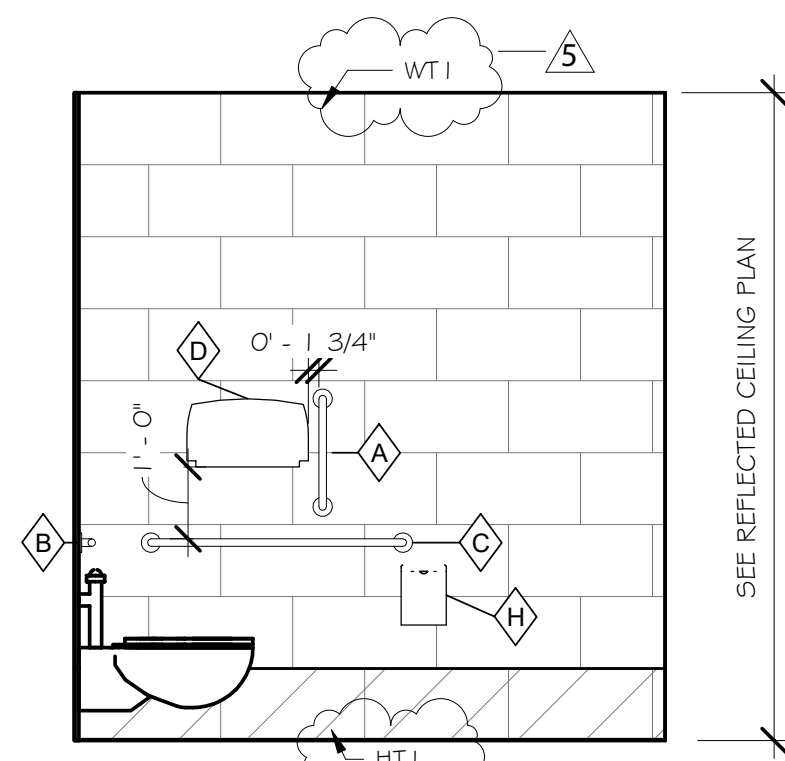
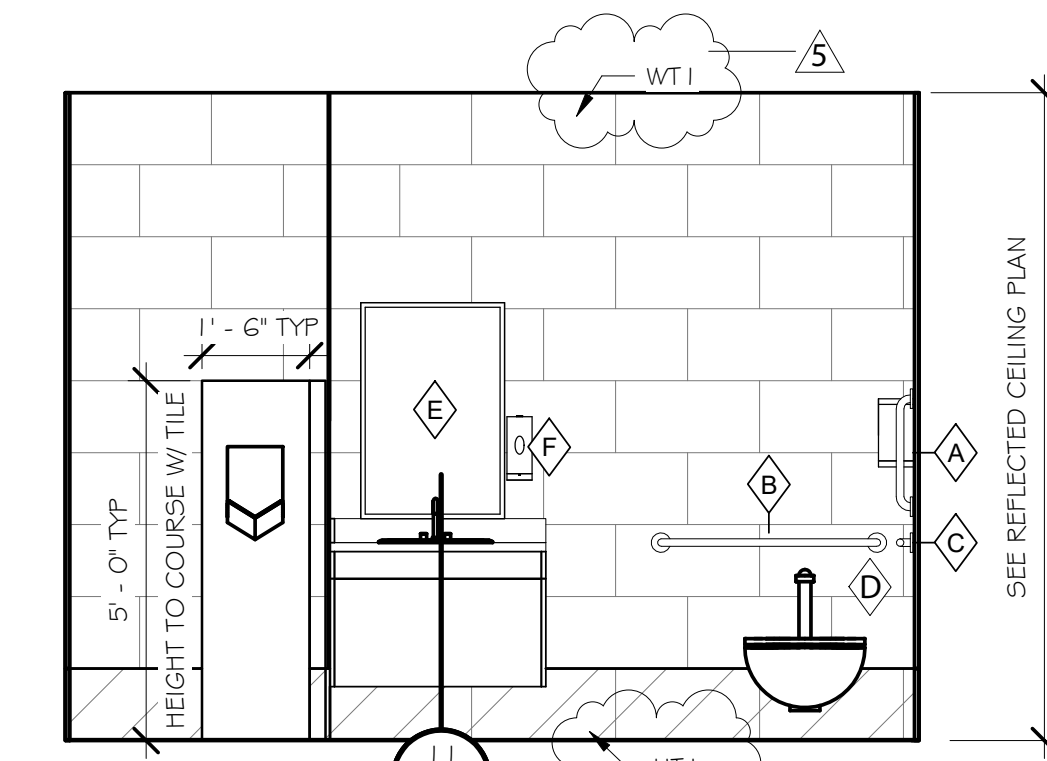
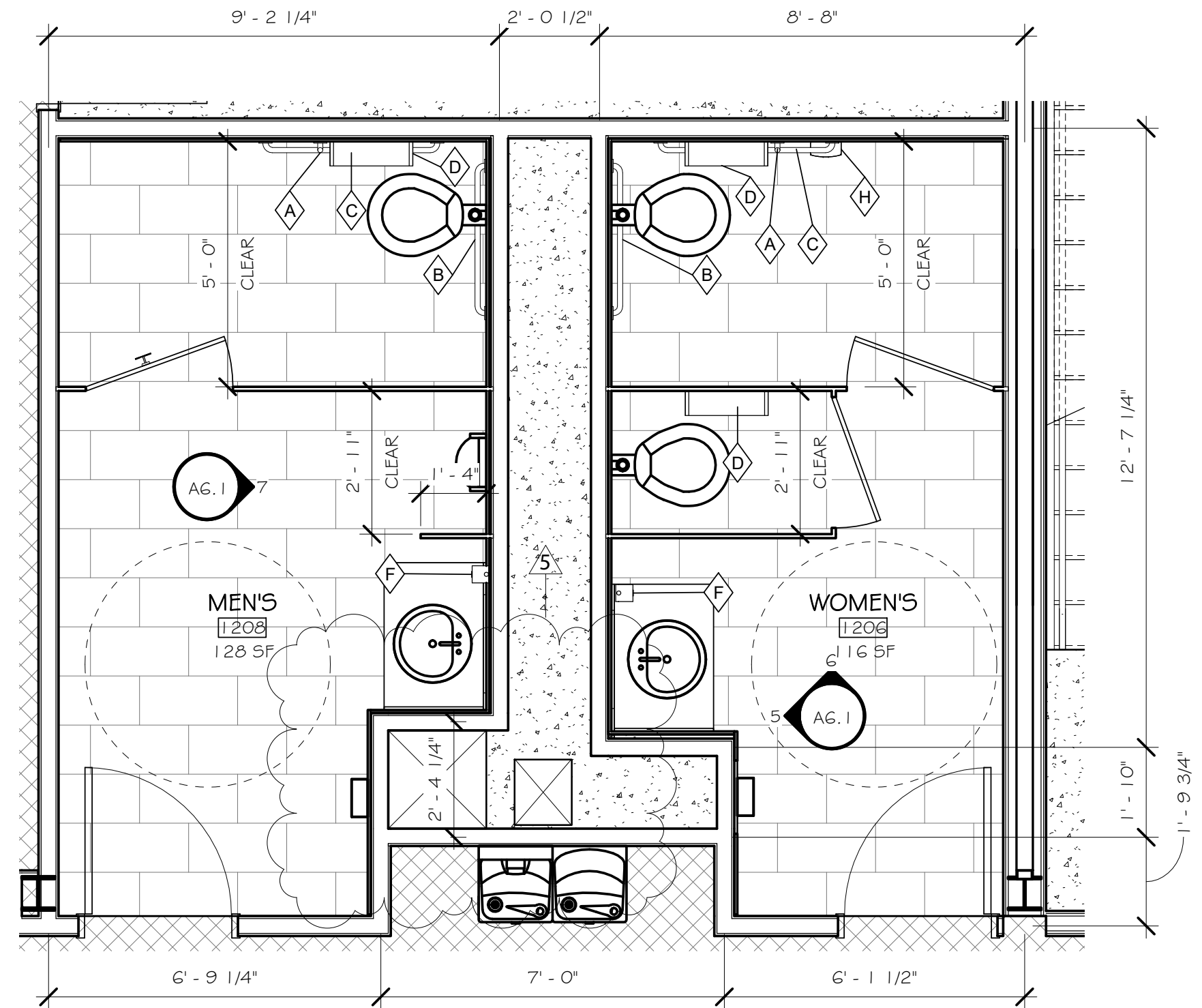
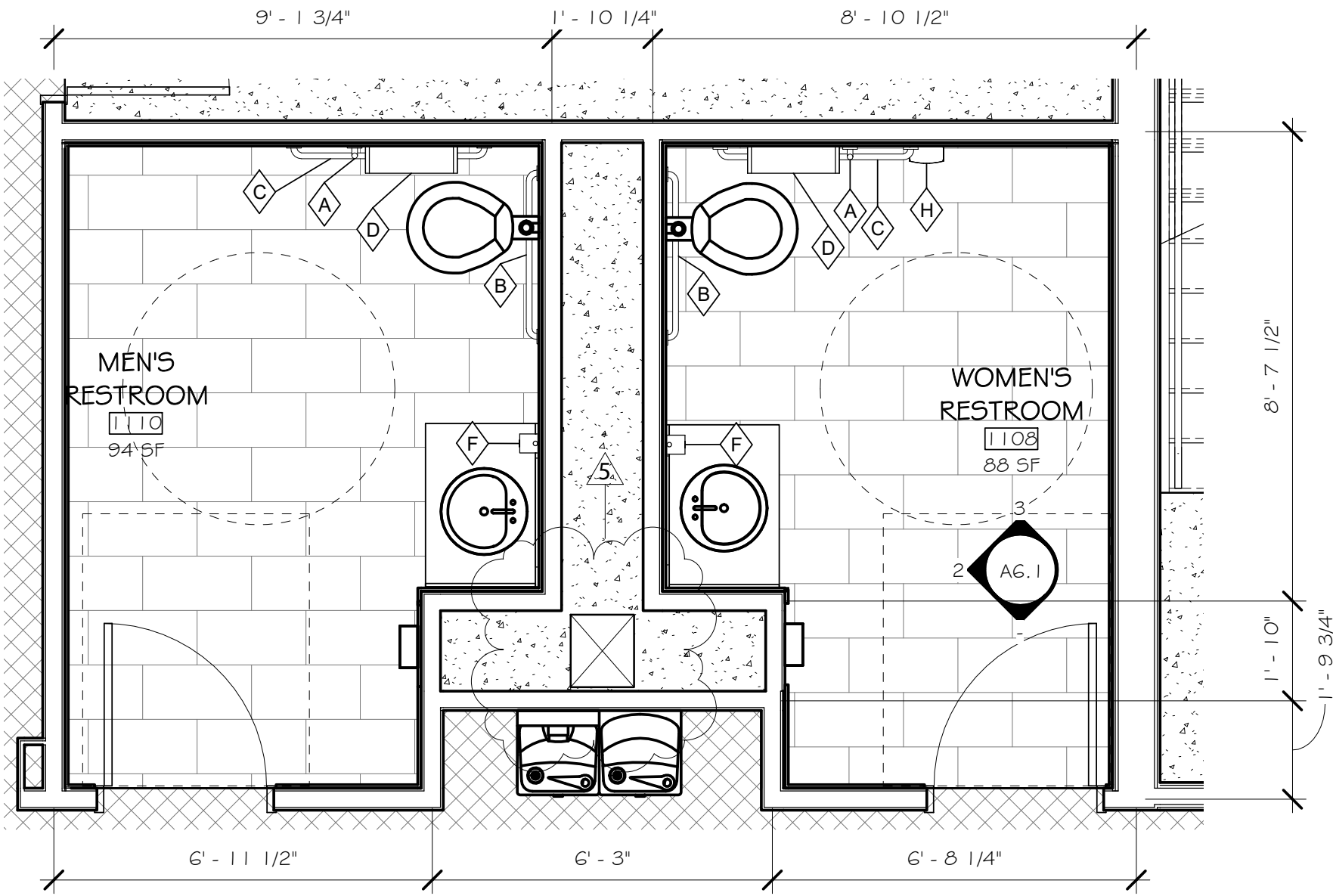
Sheet Title  
DETAILS

Sheet Number

A5.17







- GENERAL NOTES
- SEE T3.0 FOR GENERAL MOUNTING HEIGHTS AND CLEARANCES.
  - PROVIDE SOLID WOOD BLOCKING AT ALL WALL MOUNTED ACCESSORIES.
- TOILET ACCESSORIES LEGEND
- A. 18" GRAB BAR EQUAL TO BOBRICK B-580G X 18
  - B. 36" GRAB BAR EQUAL TO BOBRICK B-580G X 36
  - C. 42" GRAB BAR EQUAL TO BOBRICK B-580G X 42
  - D. OFCI - SURFACE MOUNT TOILET TISSUE DISPENSER EQUAL TO SCOTT 39731
  - E. MIRROR EQUAL TO BOBRICK B290
  - F. SOAP DISPENSER EQUAL TO BOBRICK B-2012
  - G. WALL MOUNTED COMBINATION PAPER TOWEL AND WASTE DISPOSAL EQUAL TO BOBRICK B-3942
  - H. SANITARY NAPKIN DISPOSAL EQUAL TO BOBRICK B-270

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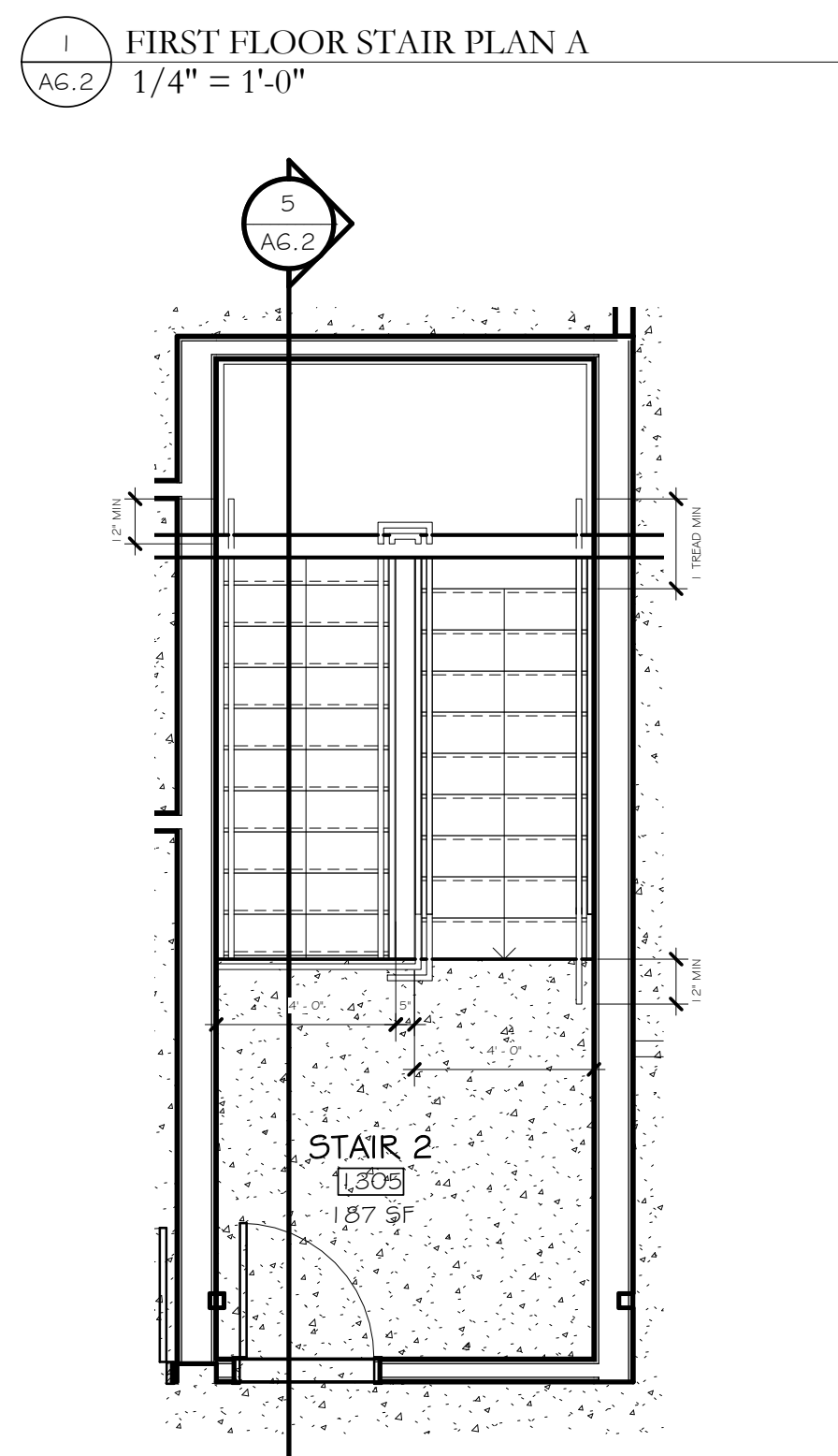
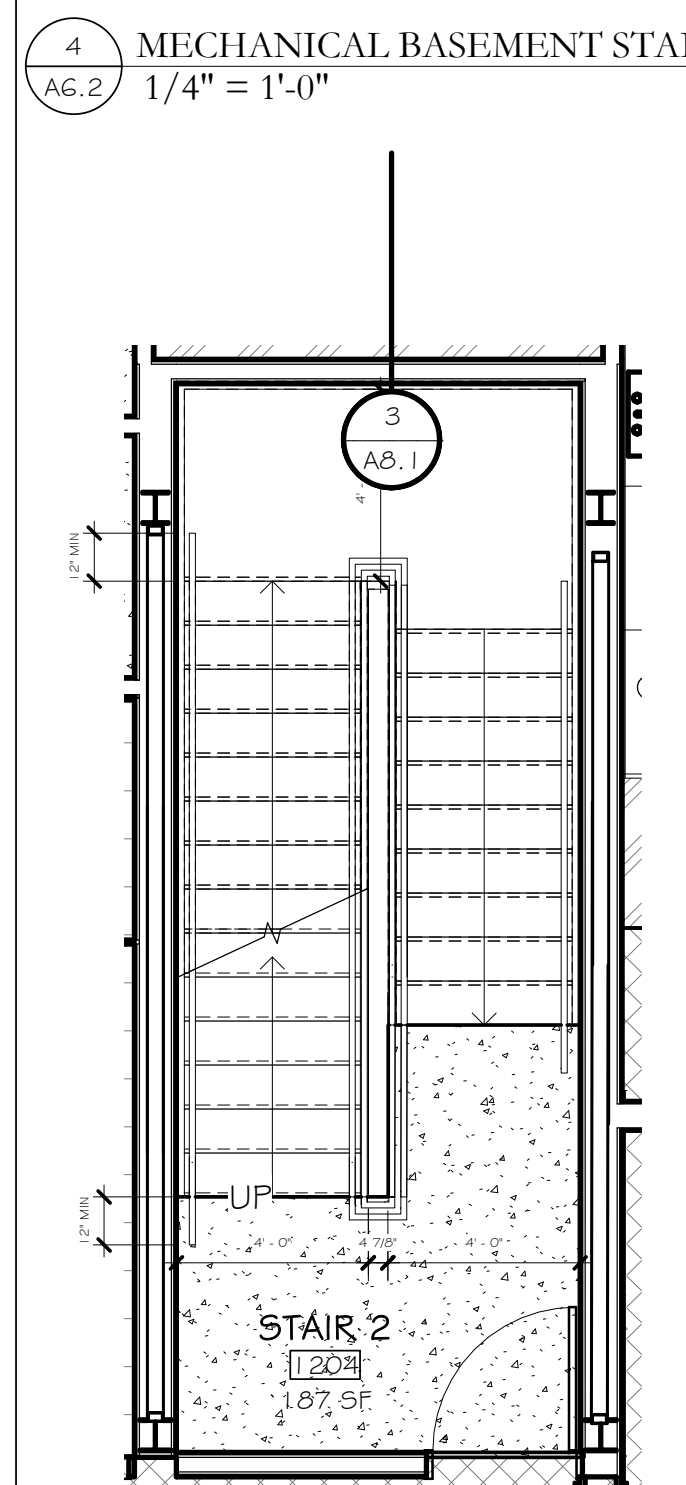
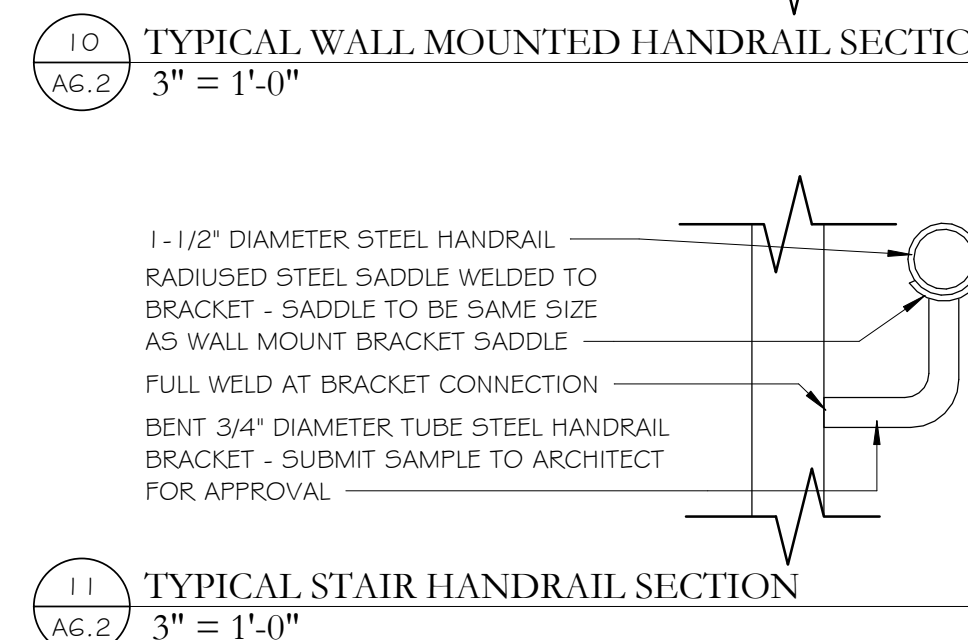
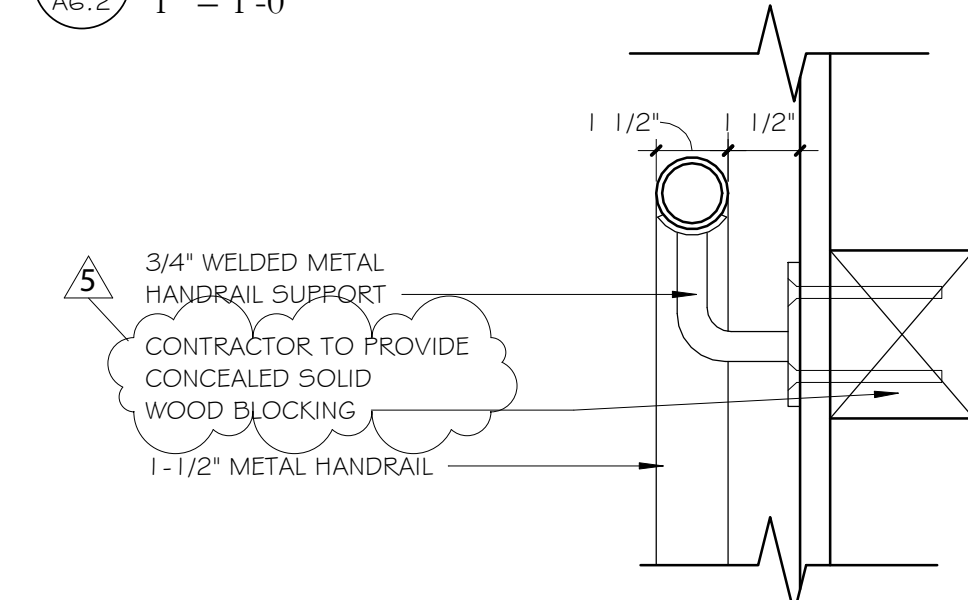
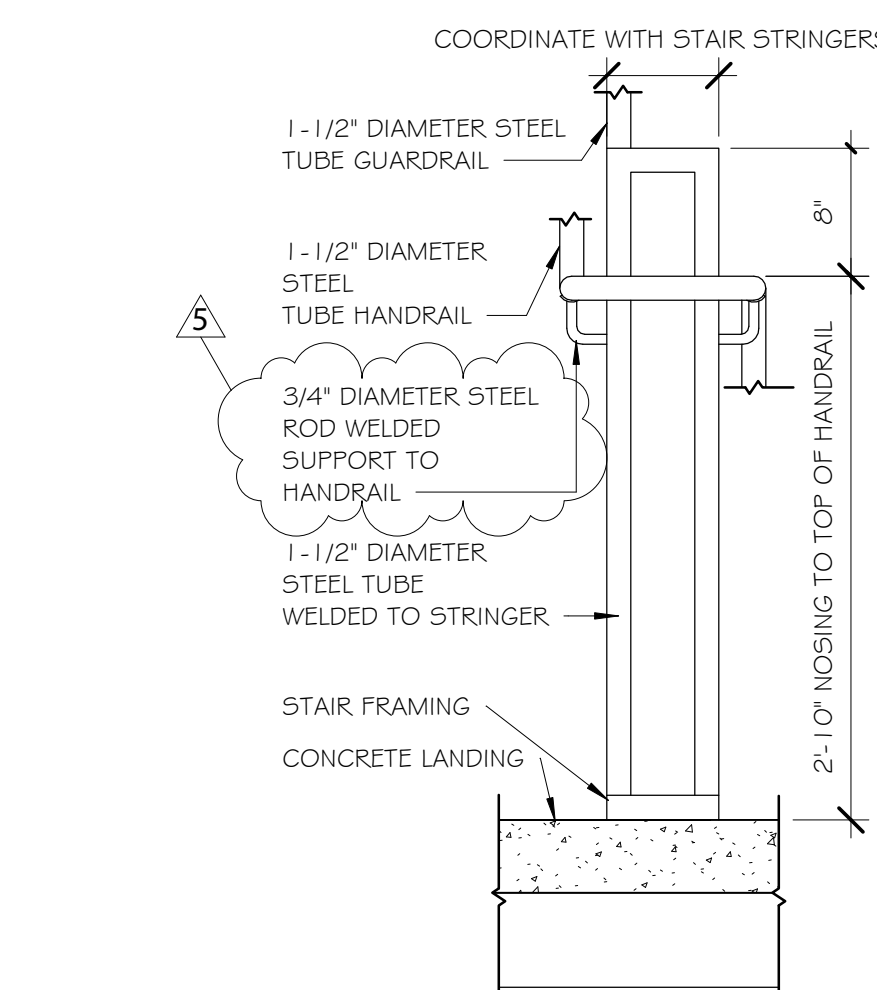
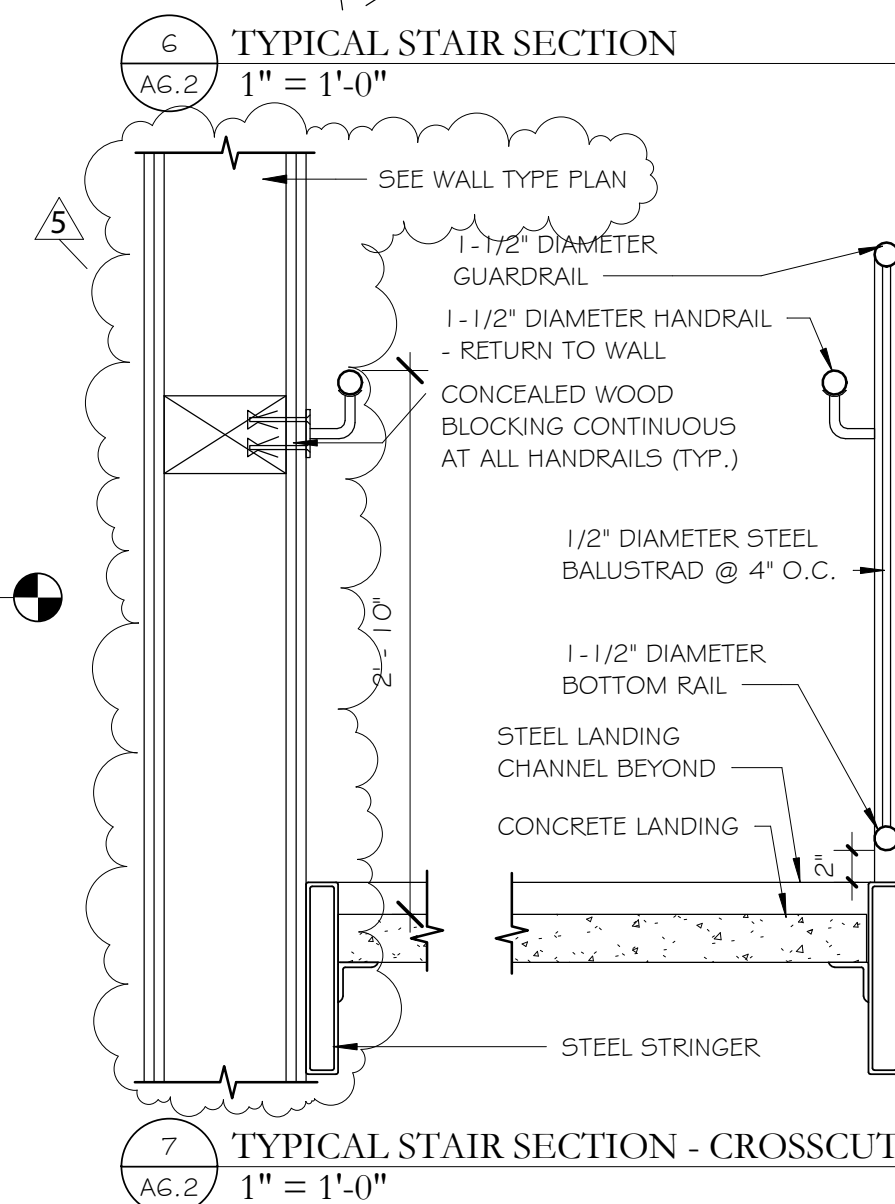
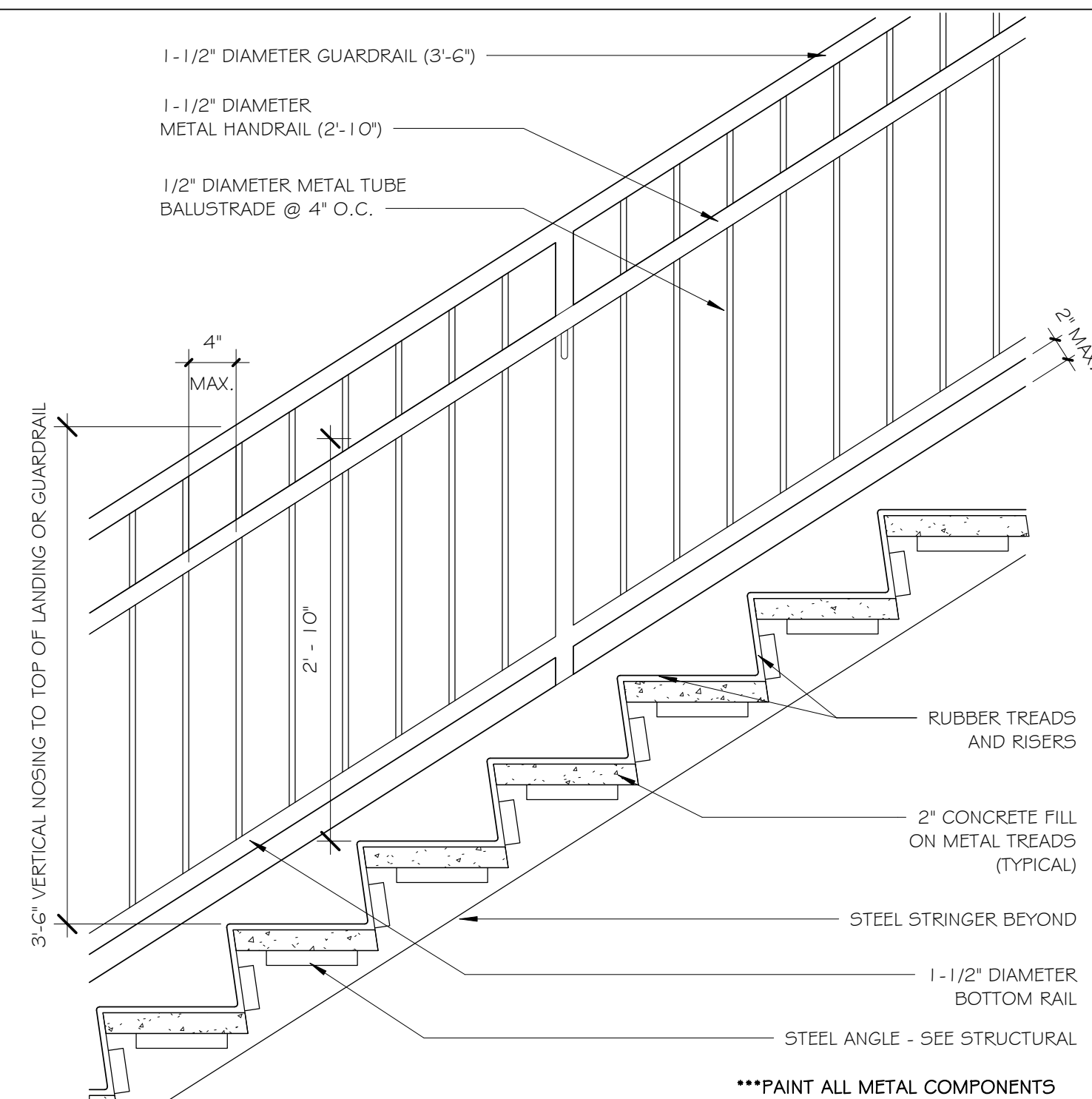
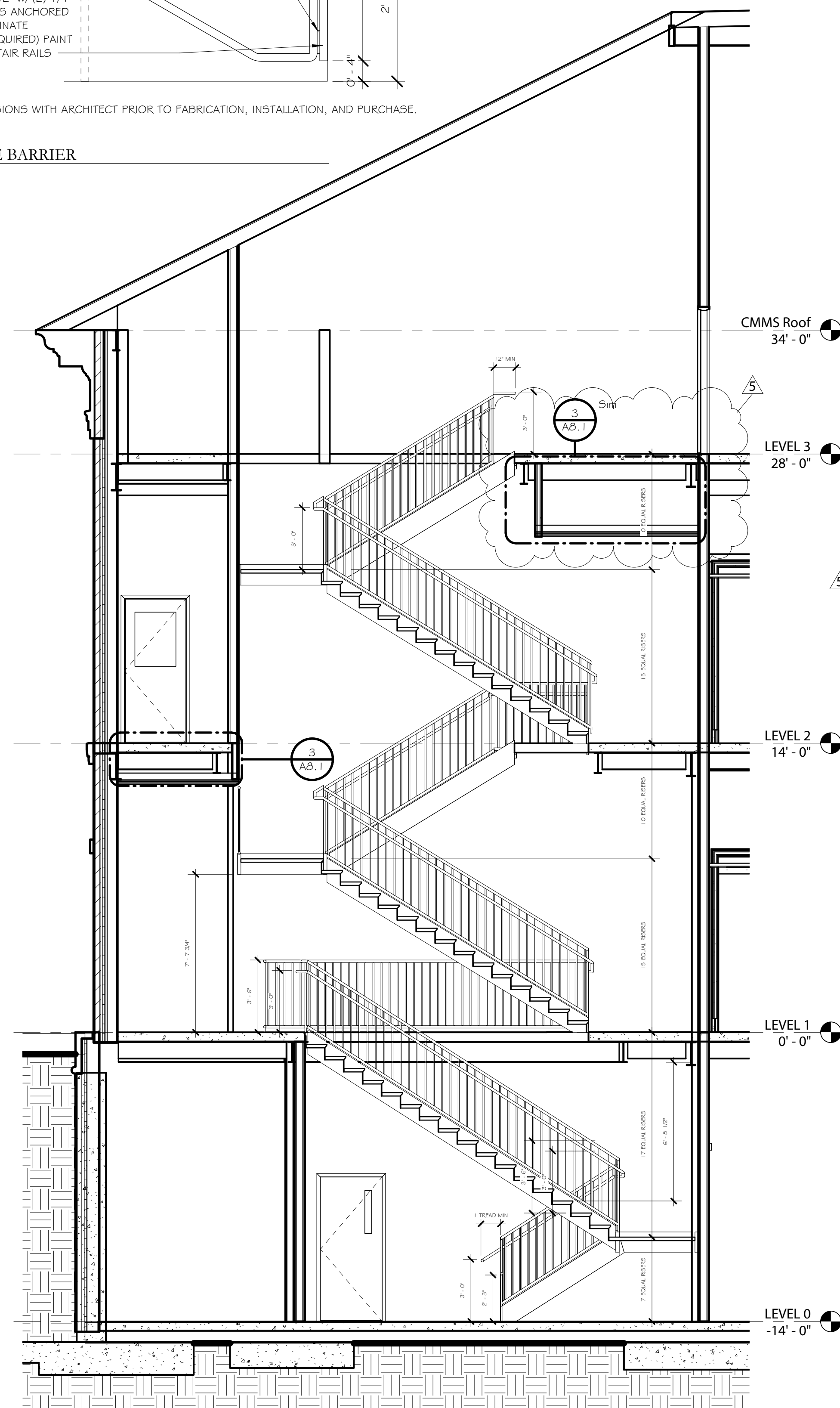
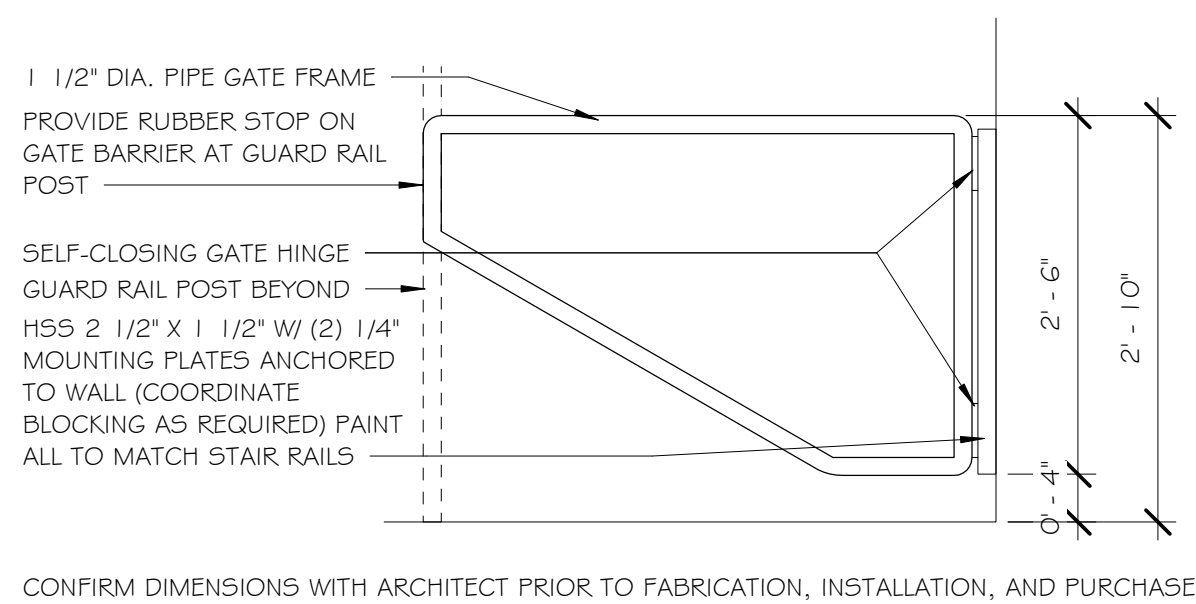
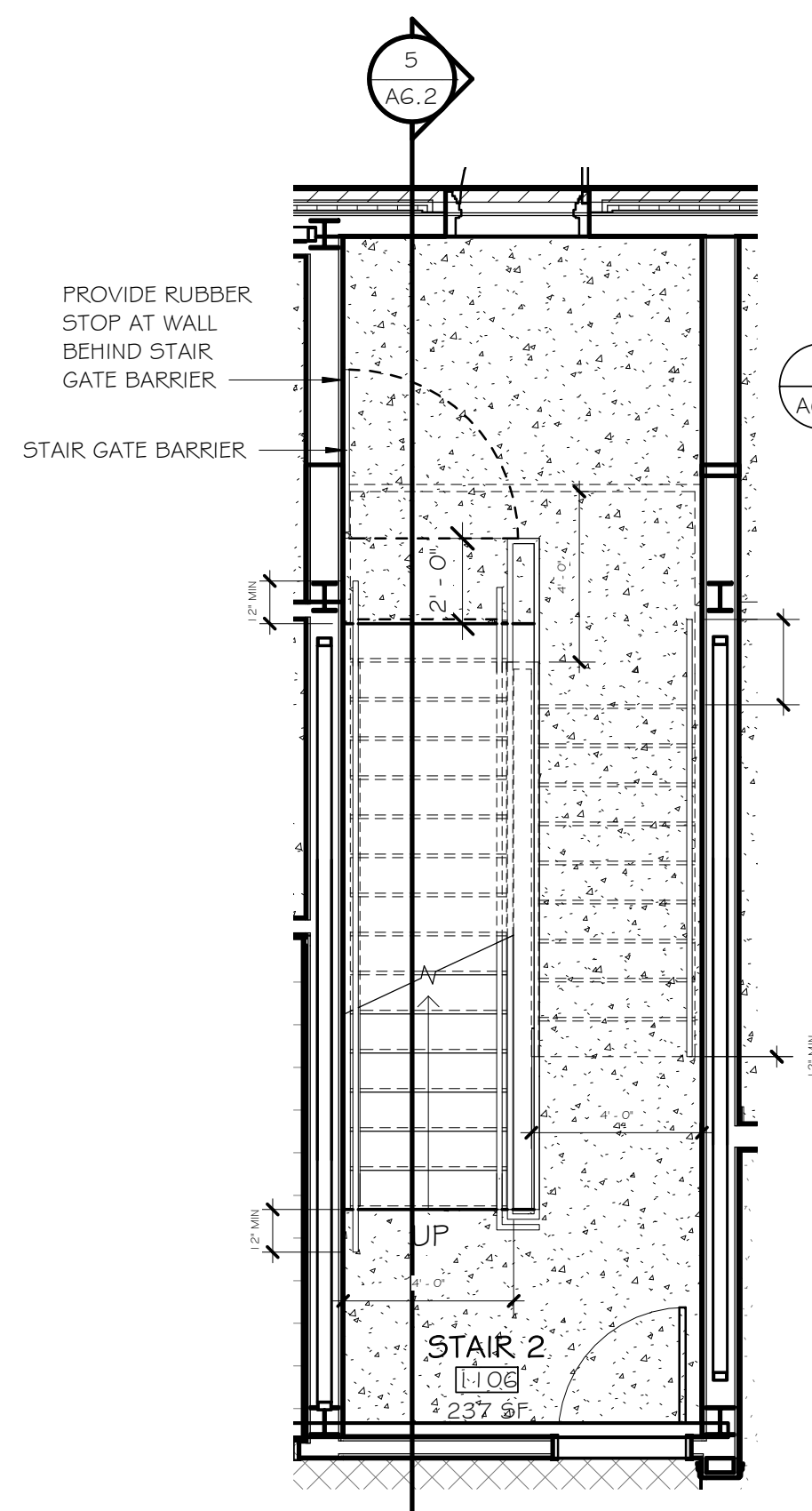
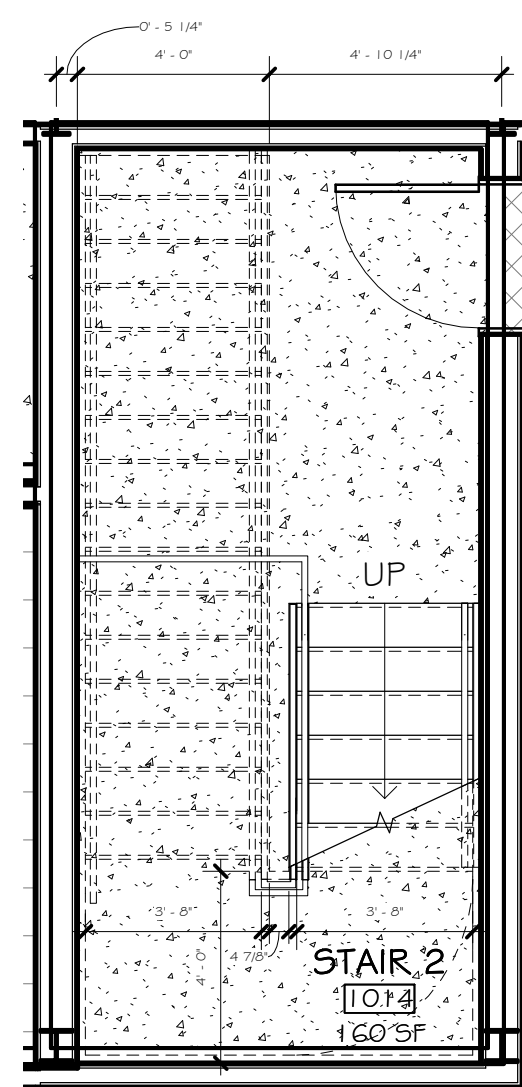
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Sheet Title  
ENLARGED  
RESTROOM PLANS  
& ELEVATIONS

Sheet Number

A6.1

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Job Number	18144
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Date	11/17/2020
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Checked By	JS, FL
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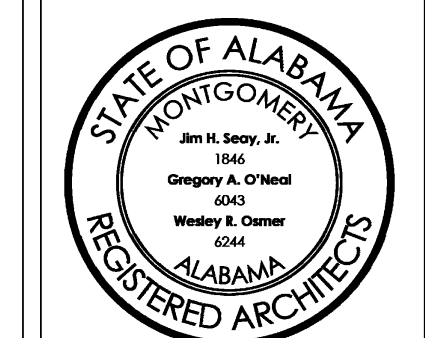
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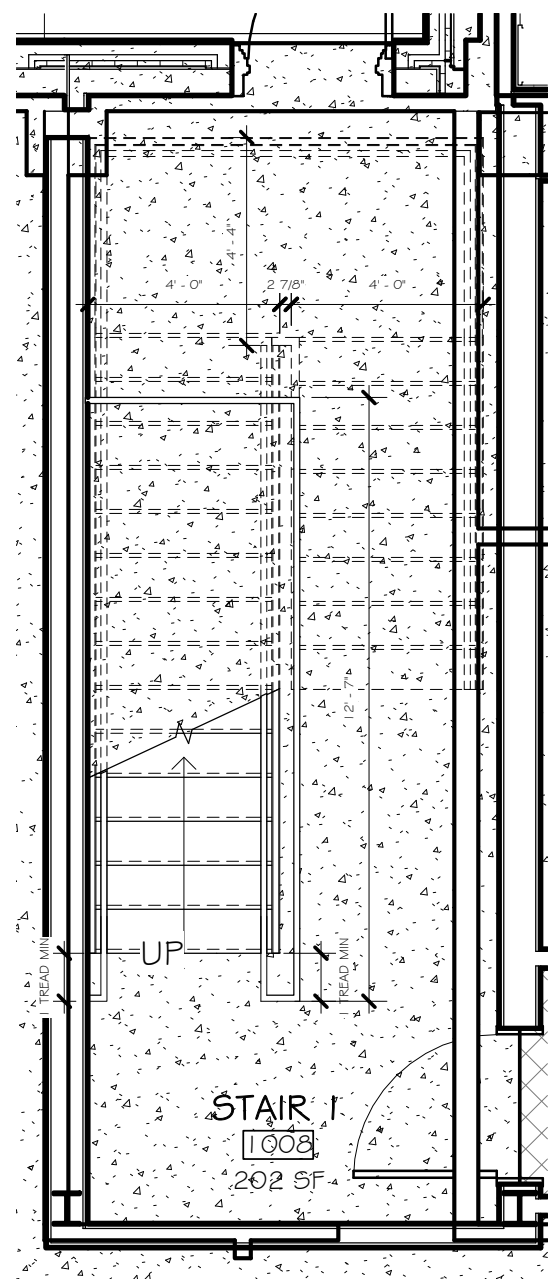
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Sheet Title  
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PLANS & SECTIONS

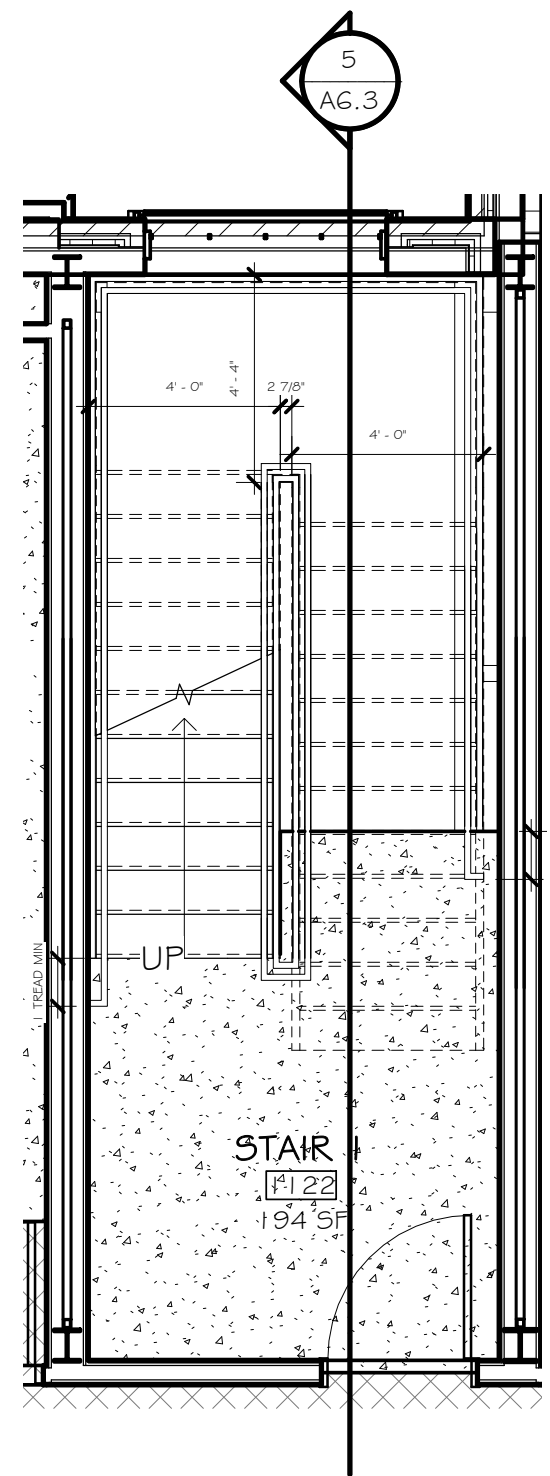
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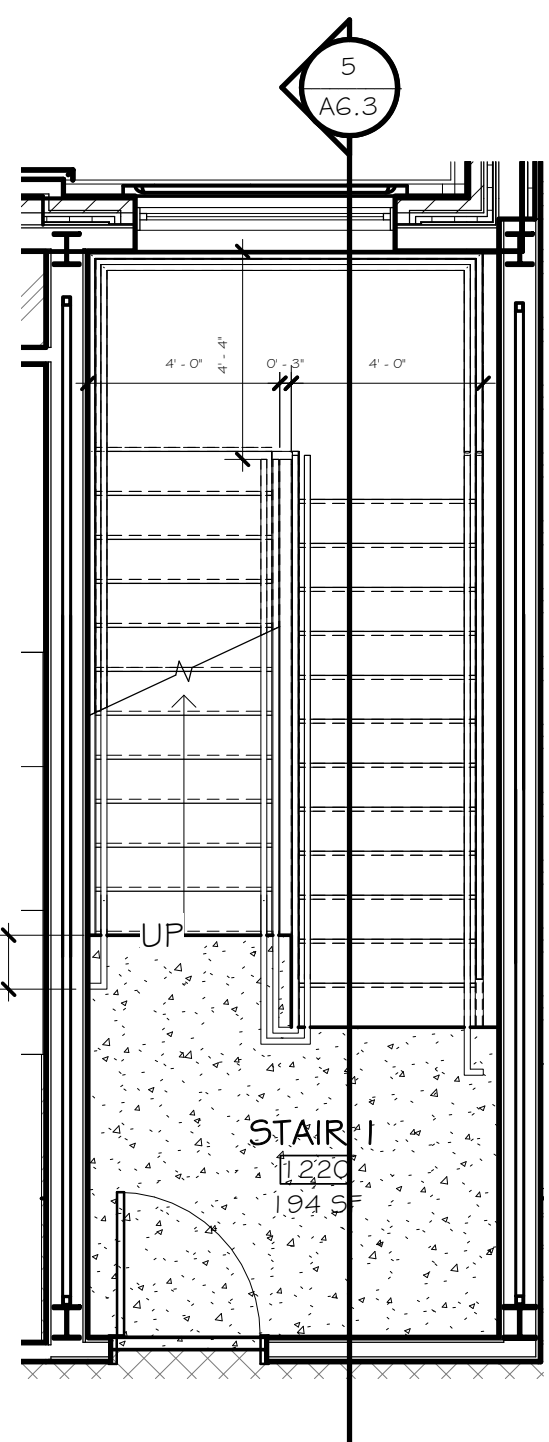




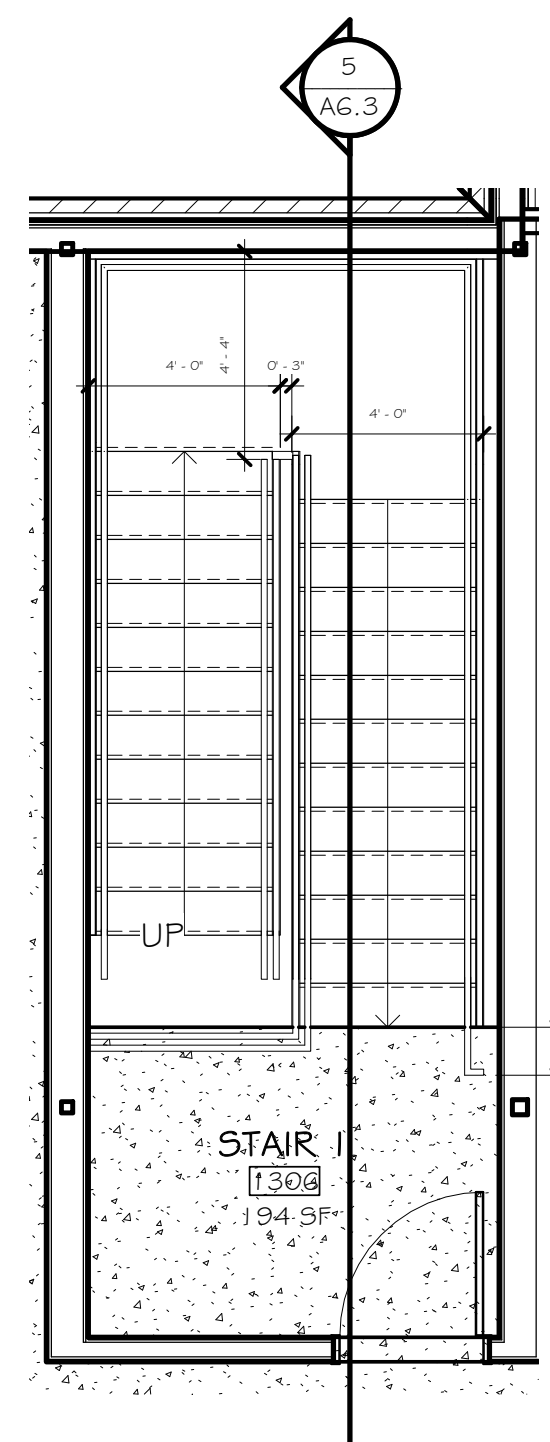
1 MECHANICAL BASEMENT STAIR PLAN B  
1/4" = 1'-0"



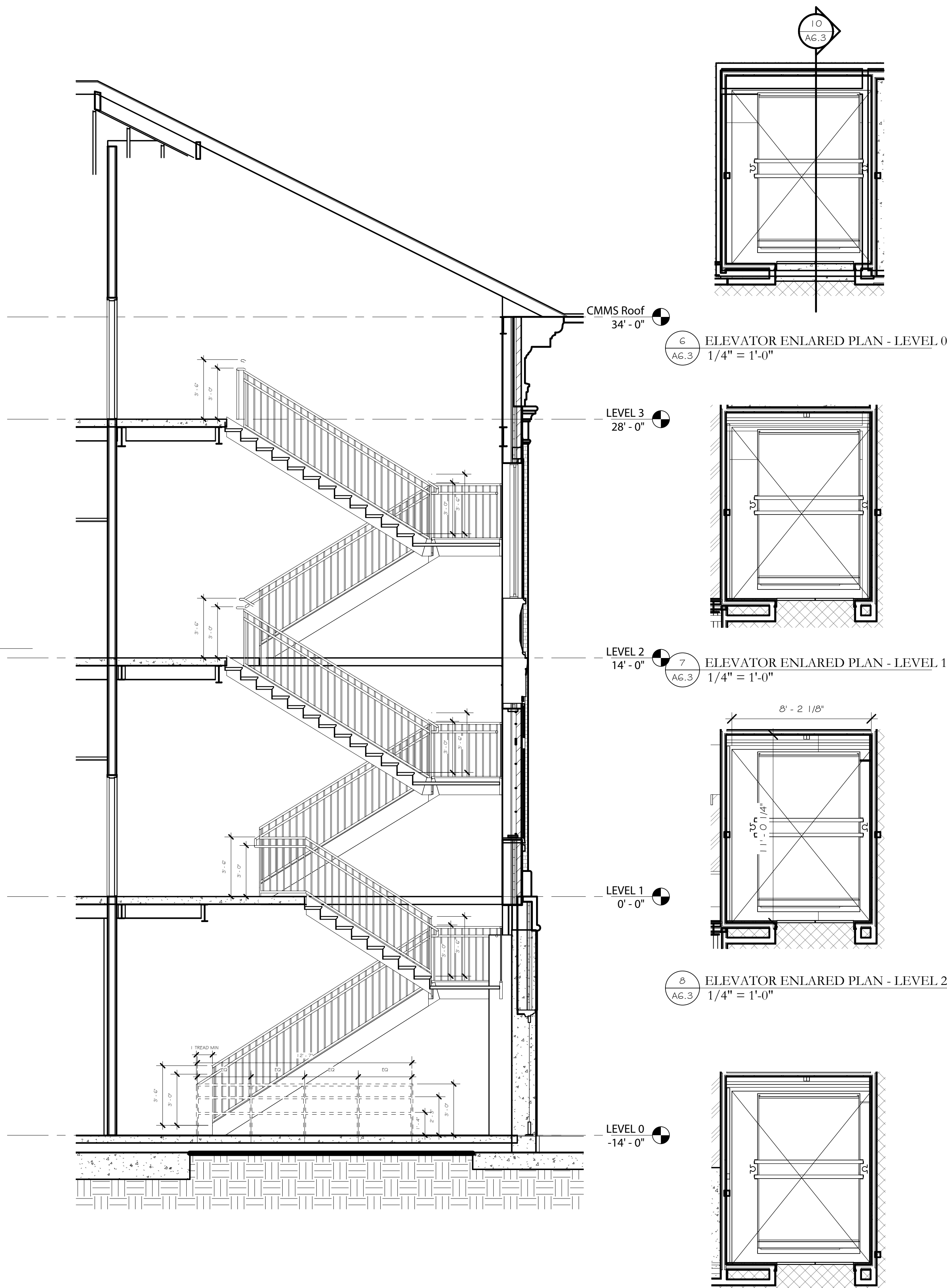
2 FIRST FLOOR STAIR PLAN B  
1/4" = 1'-0"



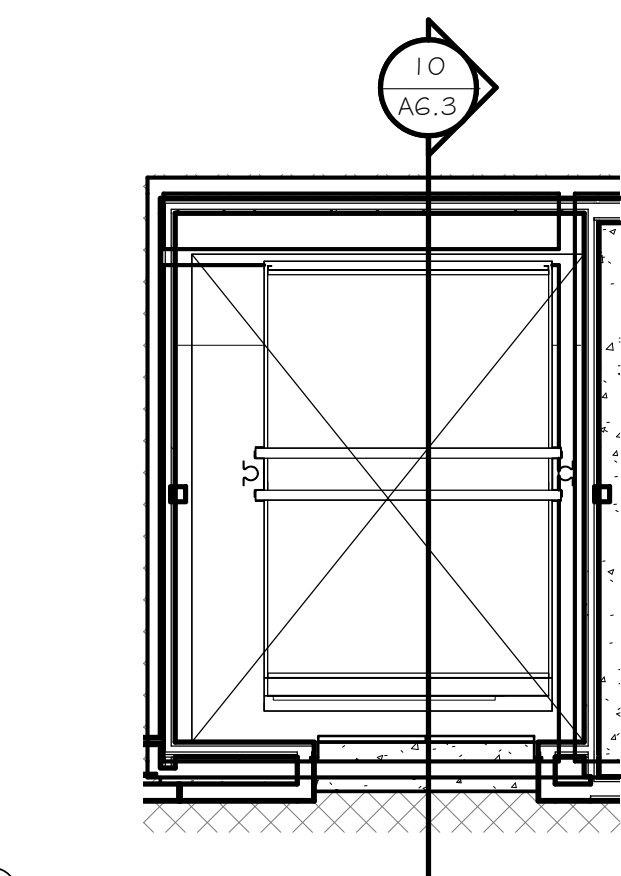
3 SECOND FLOOR STAIR PLAN B  
1/4" = 1'-0"



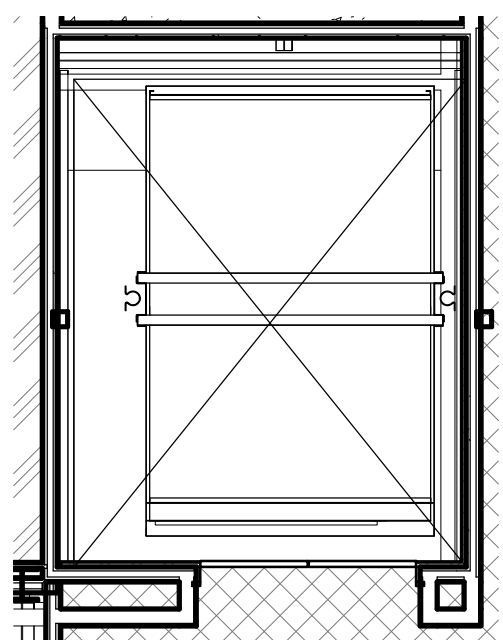
4 ATTIC FLOOR STAIR PLAN B - ALTERNATE  
1/4" = 1'-0"



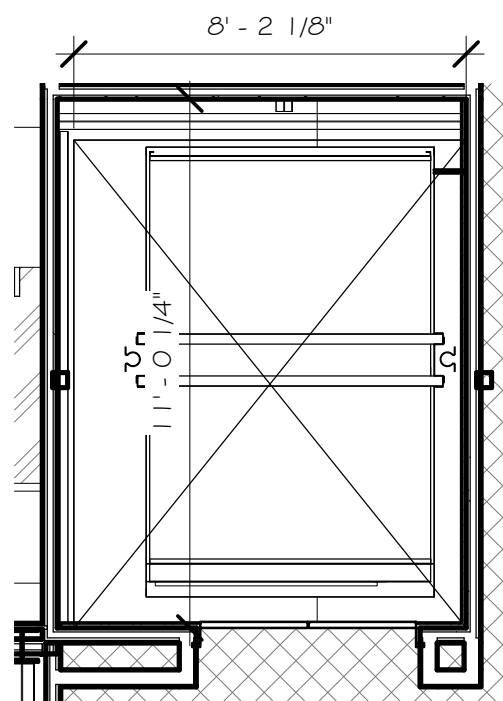
5 ENLARGED STAIR SECTION B  
1/4" = 1'-0"



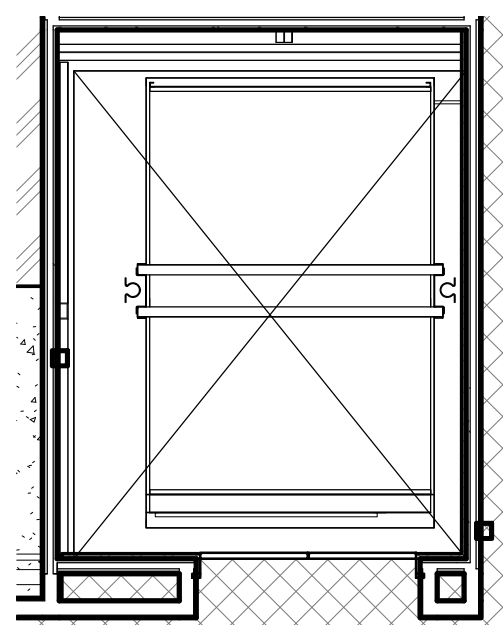
6 ELEVATOR ENLARGED PLAN - LEVEL 0  
1/4" = 1'-0"



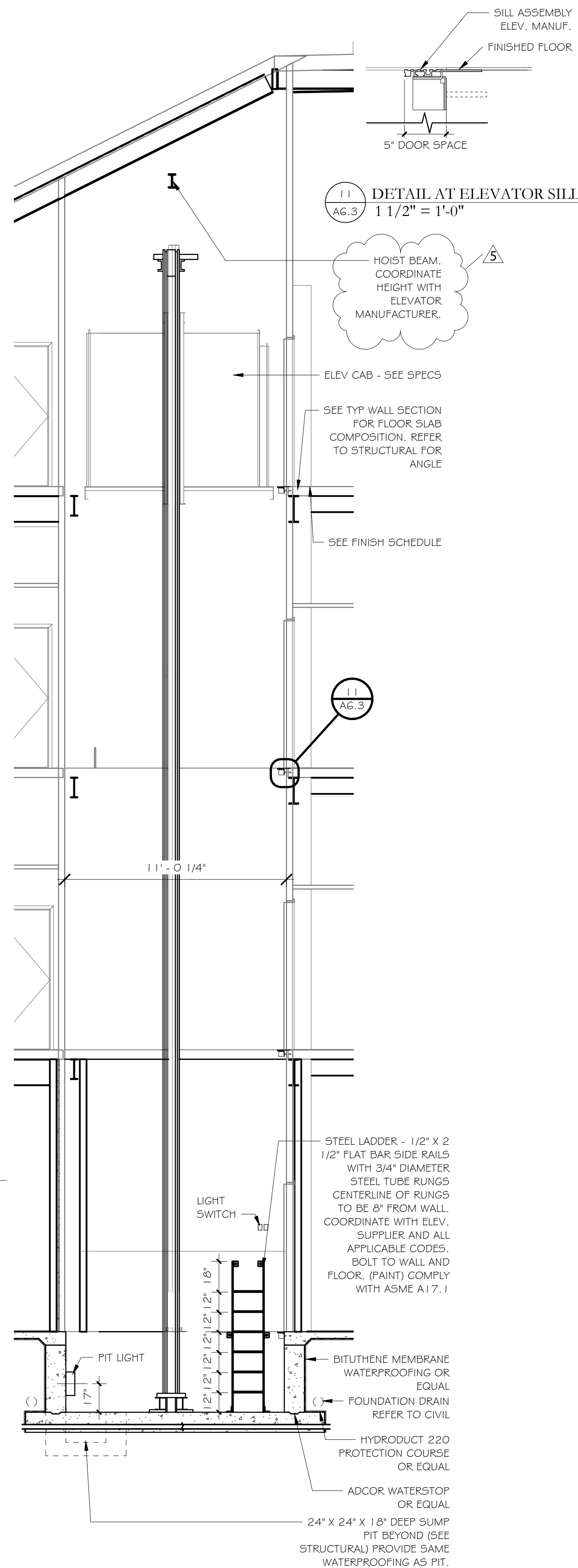
7 ELEVATOR ENLARGED PLAN - LEVEL 1  
1/4" = 1'-0"



8 ELEVATOR ENLARGED PLAN - LEVEL 2  
1/4" = 1'-0"



9 ELEVATOR ENLARGED PLAN - LEVEL 3  
1/4" = 1'-0"



10 ELEVATOR SECTION  
1/4" = 1'-0"

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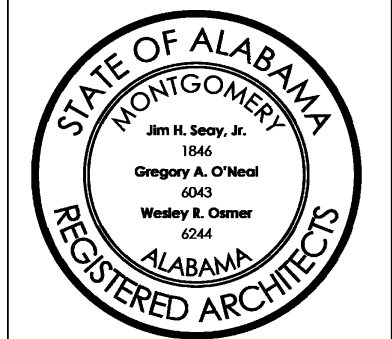
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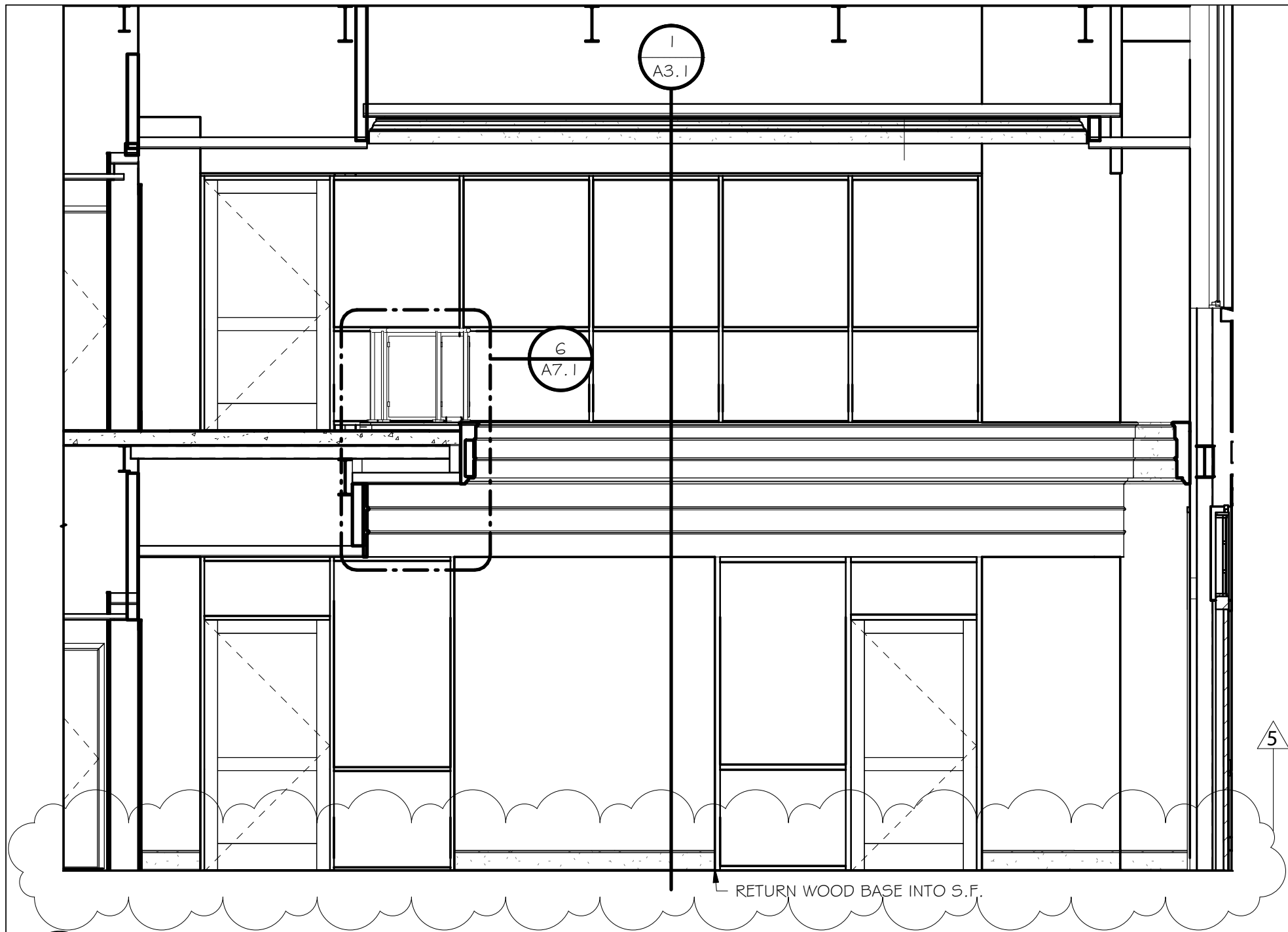
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ELEVATOR PLANS  
& SECTIONS

Sheet Number

A6.3



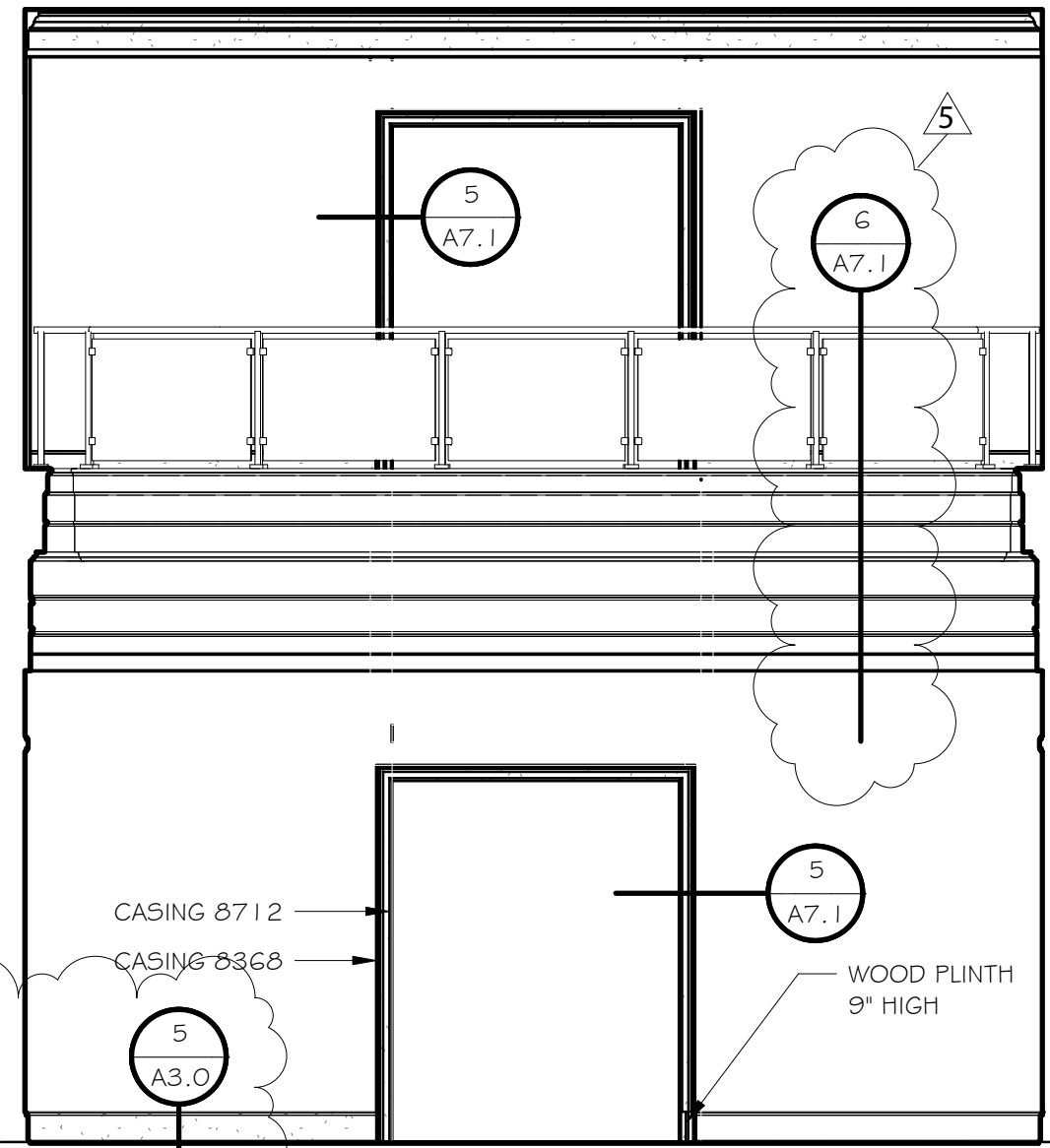




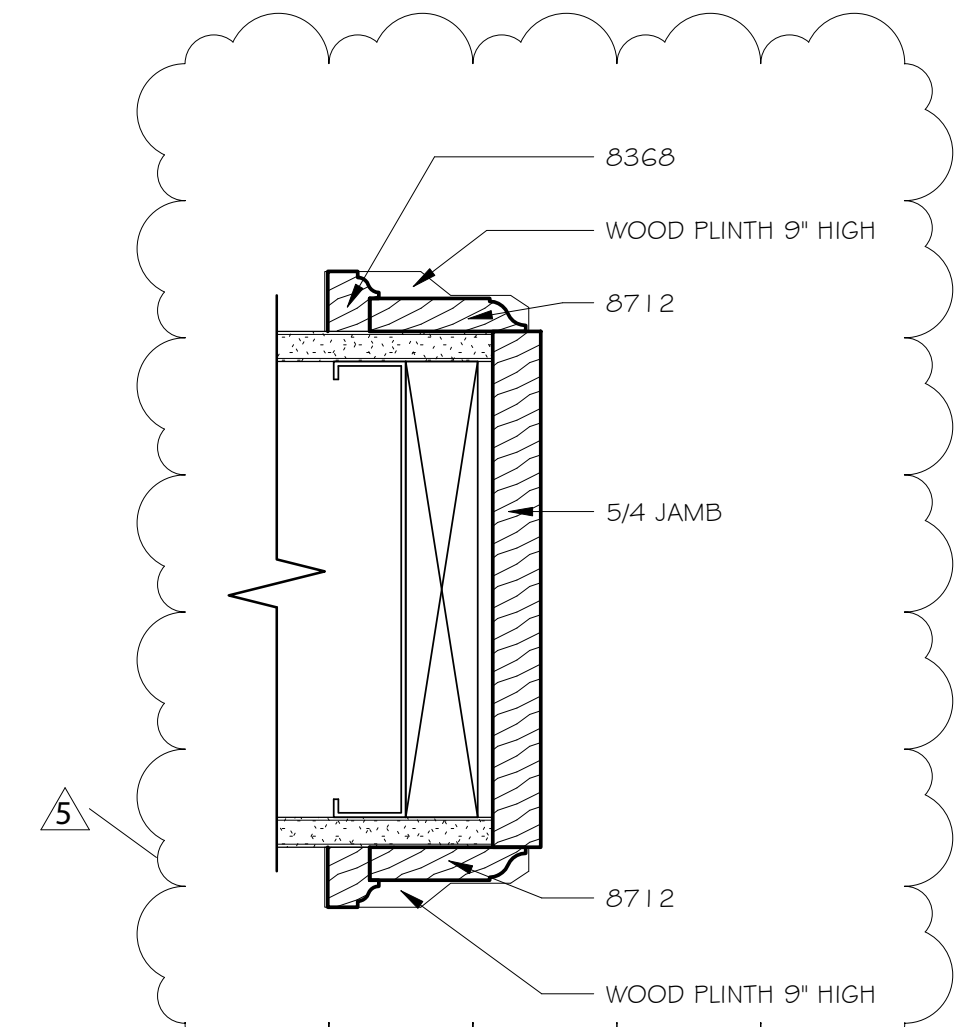
1 NORTH INTERIOR ELEVATION  
1/4" = 1'-0"



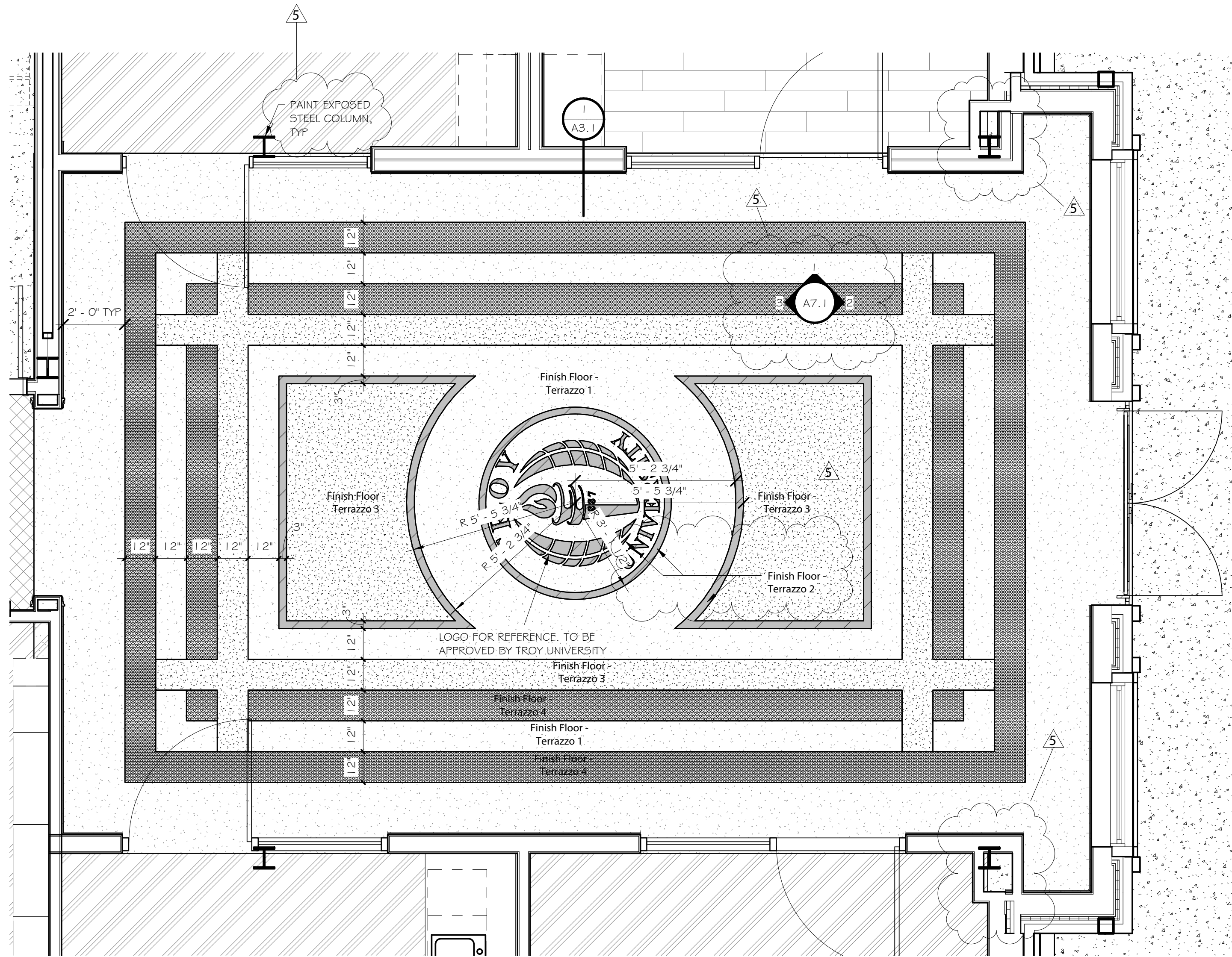
2 EAST INTERIOR ELEVATION  
1/4" = 1'-0"



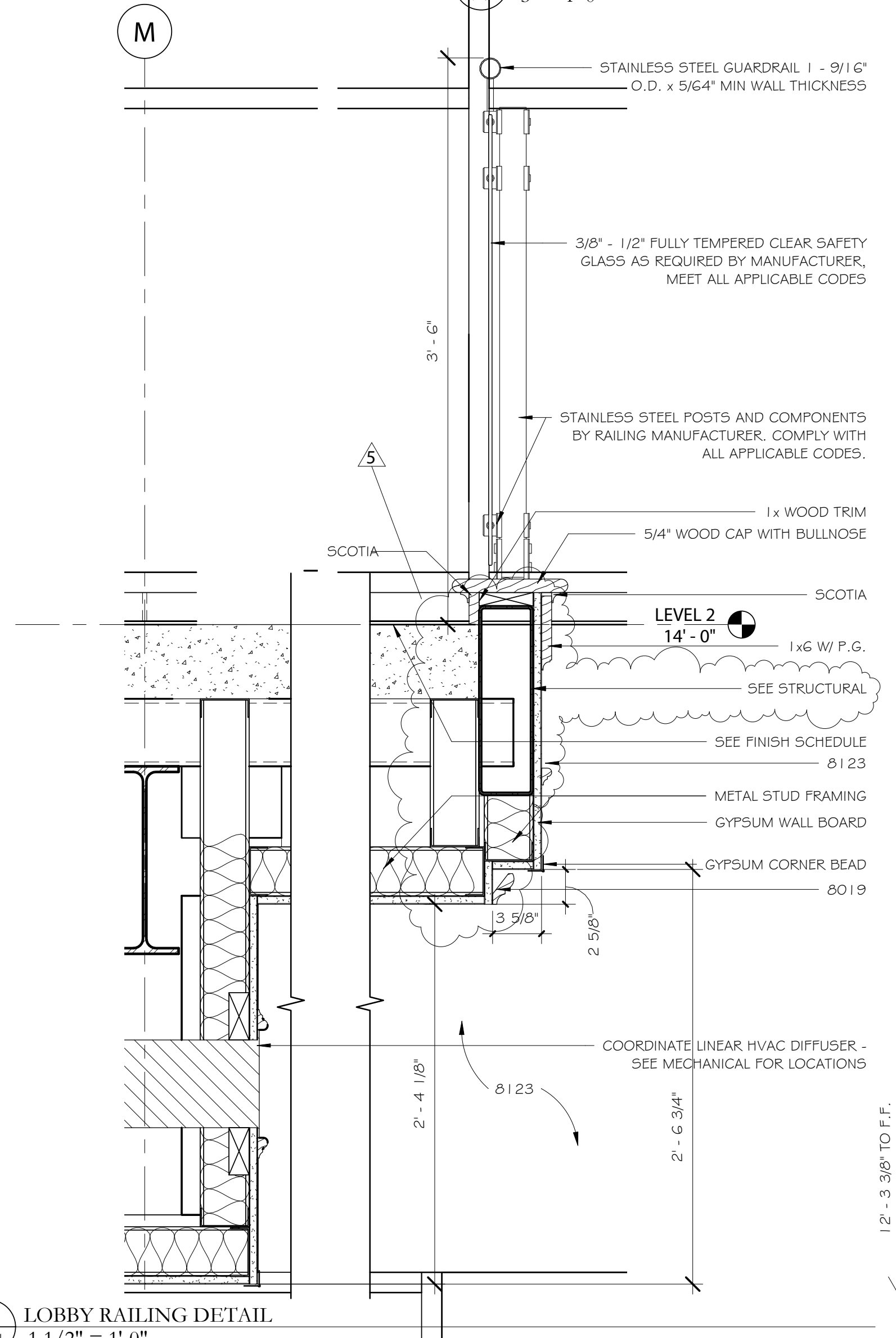
3 WEST INTERIOR ELEVATION  
1/4" = 1'-0"



5 DOOR TRIM DETAIL  
3" = 1'-0"



4 FIRST FLOOR PLAN - Callout 1  
3/8" = 1'-0"



6 LOBBY RAILING DETAIL  
1 1/2" = 1'-0"

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Sheet Title  
**INTERIOR  
ELEVATIONS**

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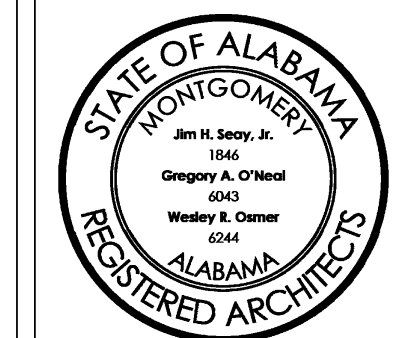
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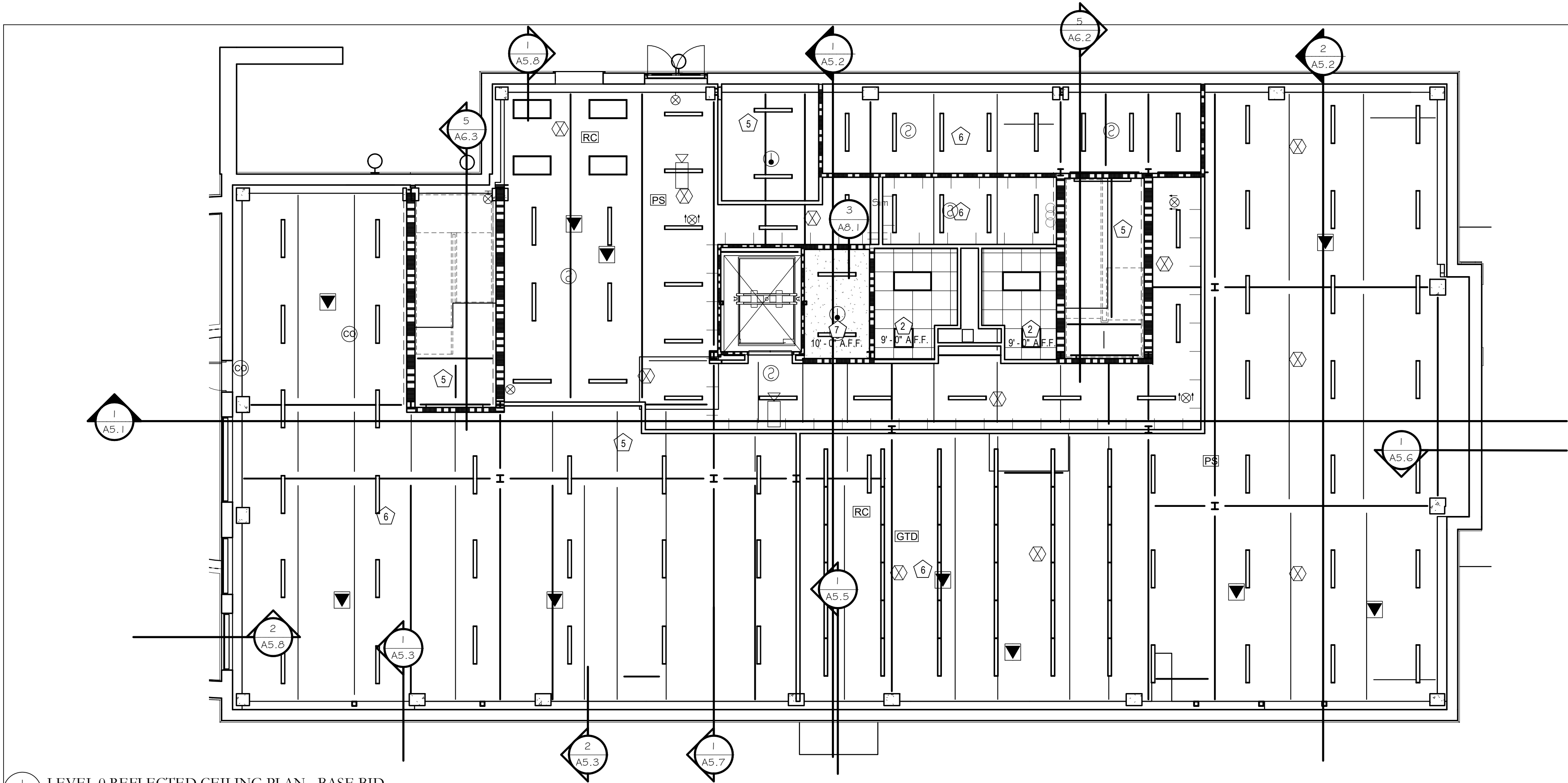


A10.3 ROOM  
BACKS ———

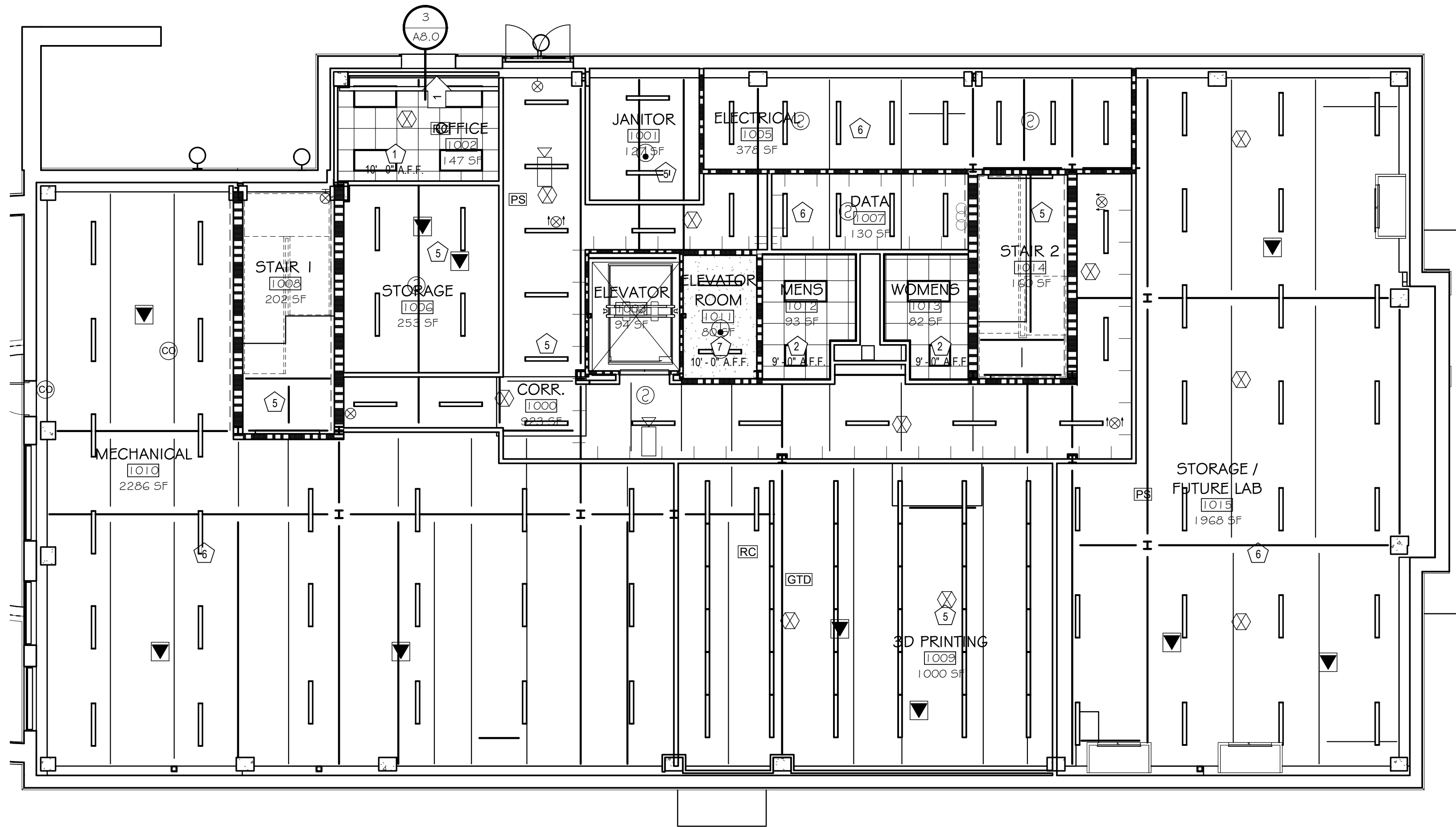
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1 LEVEL 0 REFLECTED CEILING PLAN - BASE BID  
1/8" = 1'-0"



2 LEVEL 0 ALTERNATE REFLECTED CEILING PLAN  
1/8" = 1'-0"

## GENERAL NOTES:

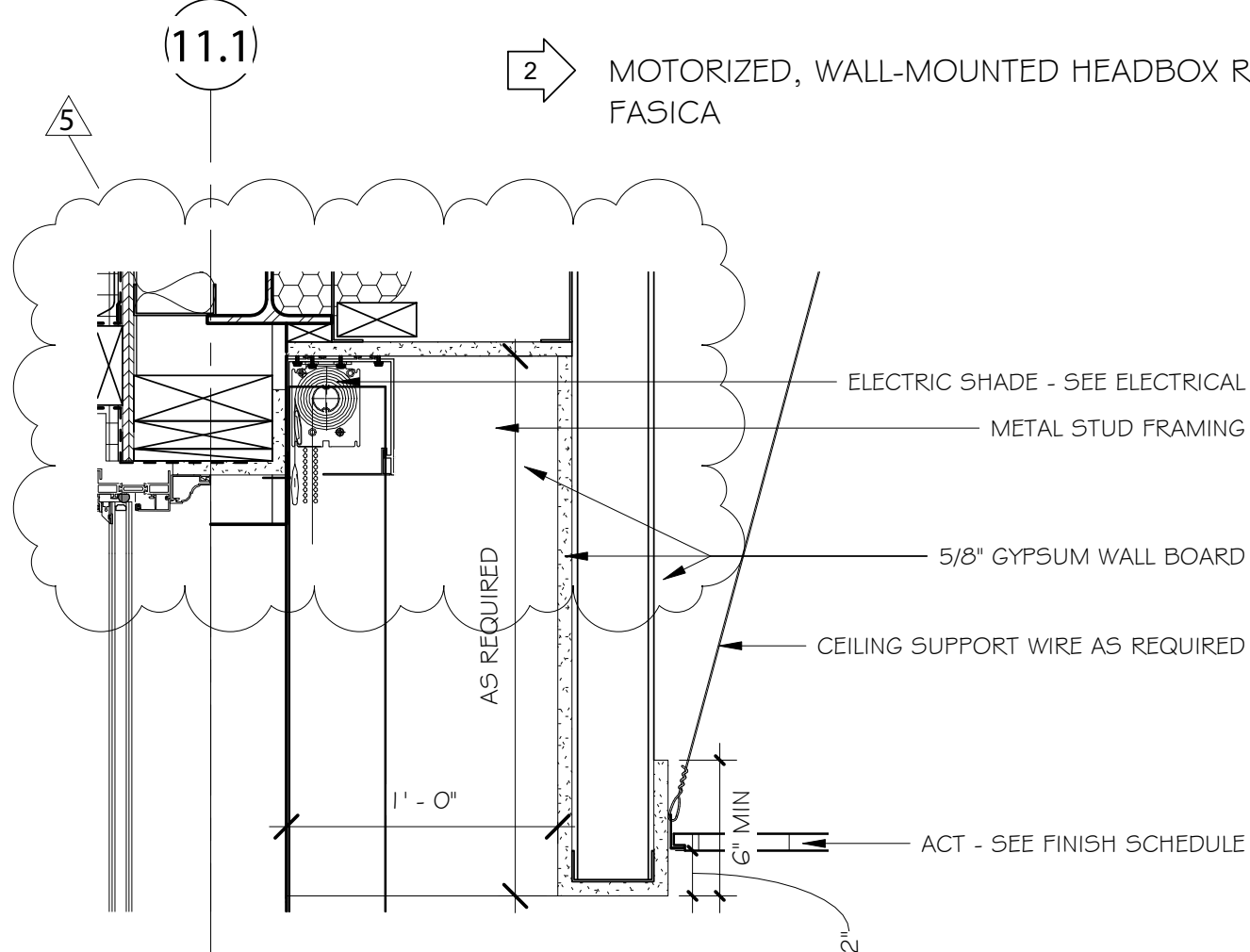
1. RETURN GYPSUM BOARDS VERTICALLY WHERE CEILING HEIGHTS OFFSET.
2. CENTER CEILING GRID EACH WAY WITHIN ROOMS AND AREAS AS SHOWN HEREIN, U.O.N.
3. PAINT ALL EXPOSED STEEL, CONDUIT, DUCTWORK, PIPING ETC. IN ROOMS/AREAS NOTED OR SCHEDULED TO RECEIVE PAINTED FINISHES.
4. REFER TO axx AND STRUCTURAL DRAWINGS FOR TOP OF WALL CONDITIONS.
5. (X'-X') DENOTES HEIGHT OF BOTTOM OF CEILING ABOVE FINISH FLOOR.
6. SEE LIFE SAFETY SHEETS FOR FIRE AND SMOKE BARRIERS.
7. NOT ALL CEILING DEVICES ARE SHOWN. SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
8. ALL CEILING DEVICES ARE TO BE CENTERED ON TILES OR SPACE UNLESS OTHERWISE INDICATED; ALIGN WITH ADJACENT DEVICES.

## CEILING TYPE KEY:

- 1 2' X 2' ACT 1 - SEE SPEC / FINISH SCHEDULE
- 2 2' X 2' ACT 2 - SEE SPEC / FINISH SCHEDULE
- 3 5/8" GYP BD ON MTL FRAMING - PAINT
- 4 5/8" GYP BD ON 3/4" PLYWOOD ON MTL FRAMING - PAINT
- 5 EXPOSED STRUCTURE - PAINT
- 6 EXPOSED STRUCTURE - NO ADDITIONAL FINISH
- 7 FIRE RATED ASSEMBLY

## RCP SPECIFIC NOTES:

- 1 MOTORIZED, CEILING RECESSED HEADBOX ROLLER SHADE WITH FASCIA
- 2 MOTORIZED, WALL-MOUNTED HEADBOX ROLLER SHADE WITH FASCIA



3 WINDOW WELL DETAIL  
1 1/2" = 1'-0"

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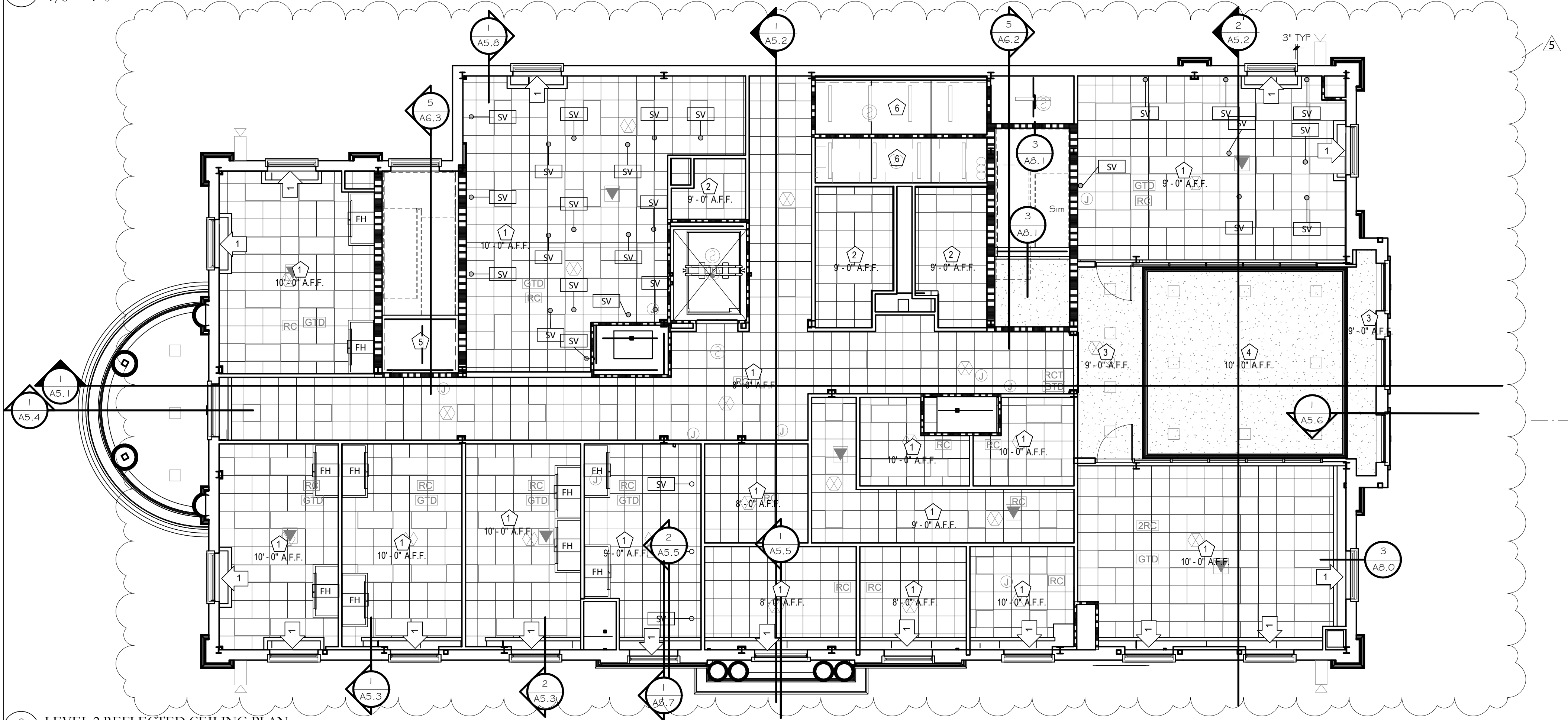
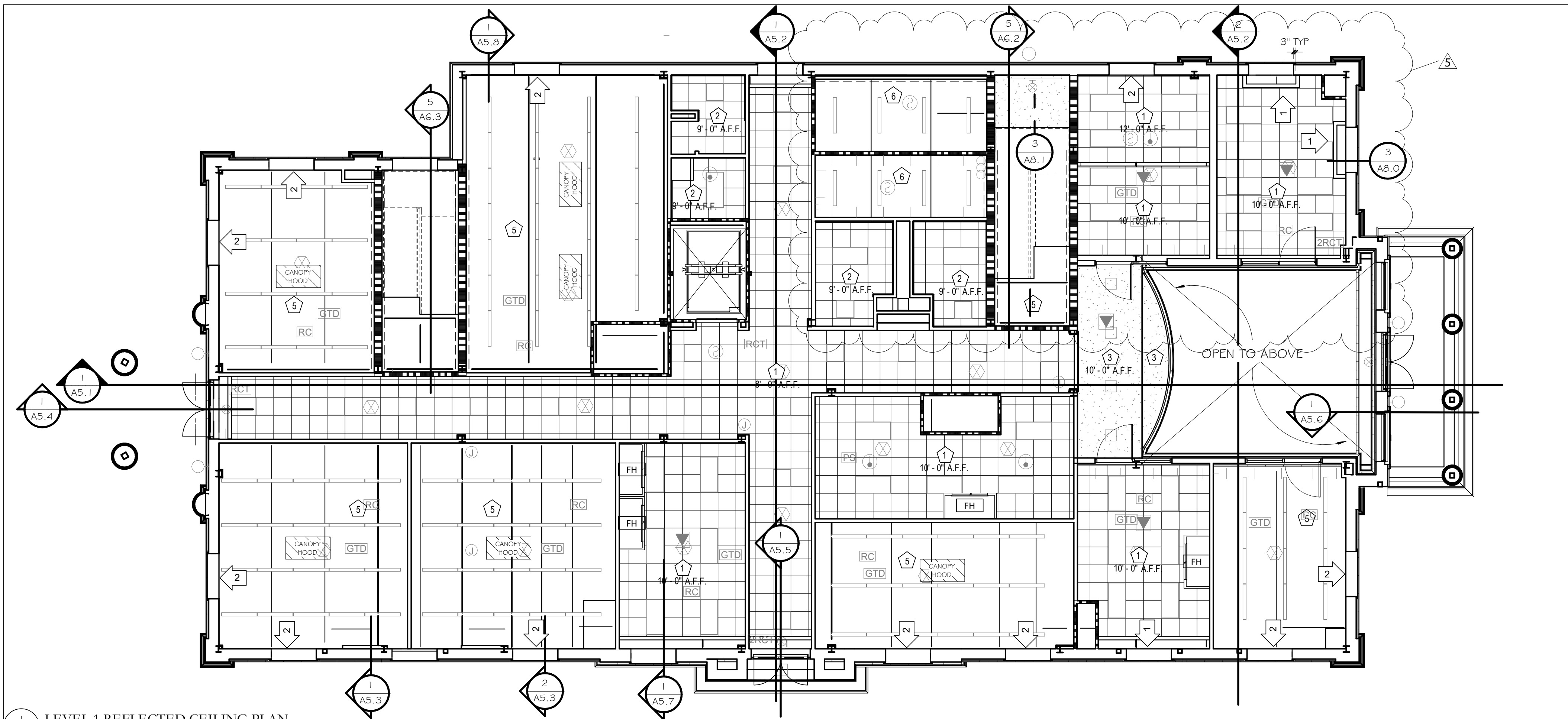
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LEVEL 0  
REFLECTED  
CEILING PLAN

Sheet Number

A8.0







GENERAL NOTES:

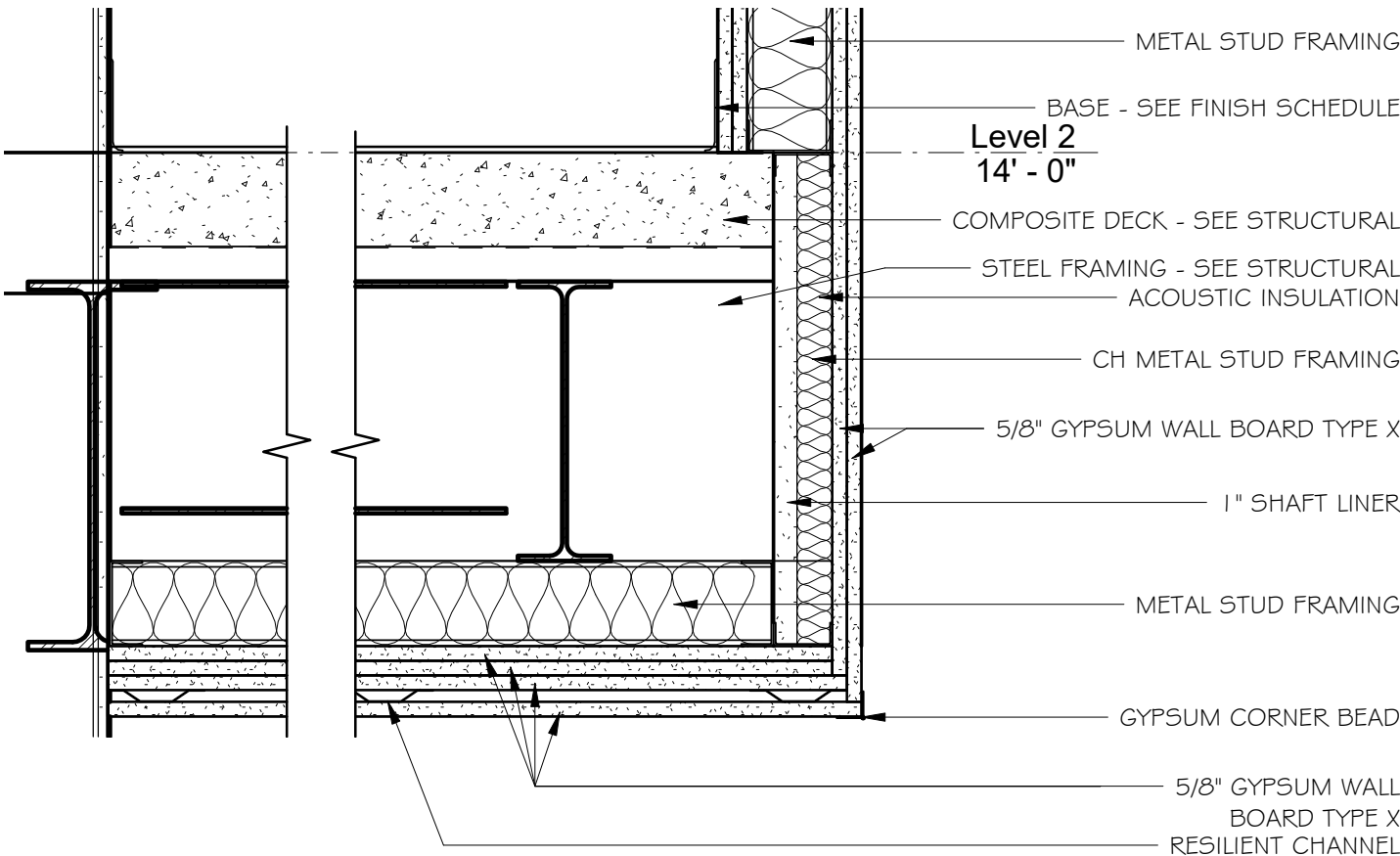
1. RETURN GYPSUM BOARDS VERTICALLY WHERE CEILING HEIGHTS OFFSET.
2. CENTER CEILING GRID EACH WAY WITHIN ROOMS AND AREAS AS SHOWN HEREIN, U.O.N.
3. PAINT ALL EXPOSED STEEL, CONDUIT, DUCTWORK, PIPING ETC. IN ROOMS/AREAS NOTED OR SCHEDULED TO RECEIVE PAINTED FINISHES.
4. REFER TO axx AND STRUCTURAL DRAWINGS FOR TOP OF WALL CONDITIONS.
5. (X'-X") DENOTES HEIGHT OF BOTTOM OF CEILING ABOVE FINISH FLOOR.
6. SEE LIFE SAFETY SHEETS FOR FIRE AND SMOKE BARRIERS.
7. NOT ALL CEILING DEVICES ARE SHOWN. SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
8. ALL CEILING DEVICES ARE TO BE CENTERED ON TILES OR SPACE UNLESS OTHERWISE INDICATED; ALIGN WITH ADJACENT DEVICES.

CEILING TYPE KEY:

- 1 2' X 2' ACT 1 - SEE SPEC / FINISH SCHEDULE
- 2 2' X 2' ACT 2 - SEE SPEC / FINISH SCHEDULE
- 3 5/8" GYP BD ON MTL FRAMING - PAINT
- 4 5/8" GYP BD ON 3/4" PLYWOOD ON MTL FRAMING - PAINT
- 5 EXPOSED STRUCTURE - PAINT
- 6 EXPOSED STRUCTURE - NO ADDITIONAL FINISH
- 7 FIRE RATED ASSEMBLY

RCP SPECIFIC NOTES:

- 1 MOTORIZED, CEILING RECESSED HEADBOX ROLLER SHADE WITH FASCIA
- 2 MOTORIZED, WALL-MOUNTED HEADBOX ROLLER SHADE WITH FASCIA



3 2 HOUR RATED HORIZONTAL TO VERTICAL ASSEMBLY DETAIL (UL DESIGN K506)  
1 1/2" = 1'-0"

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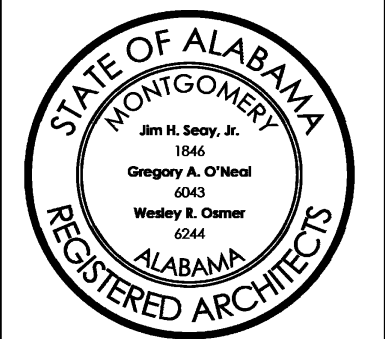
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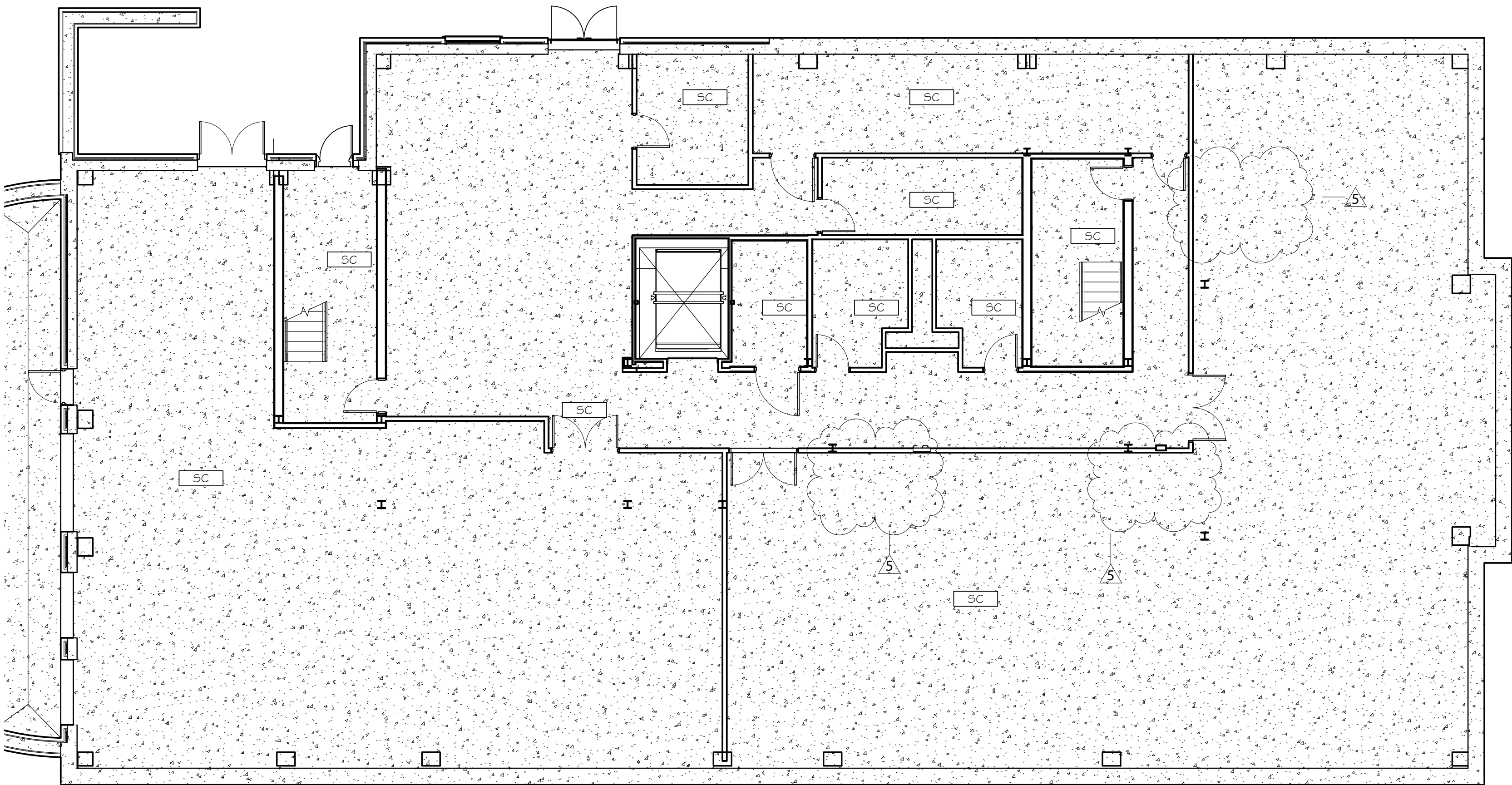
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LEVEL 1 & 2  
REFLECTED  
CEILING PLAN

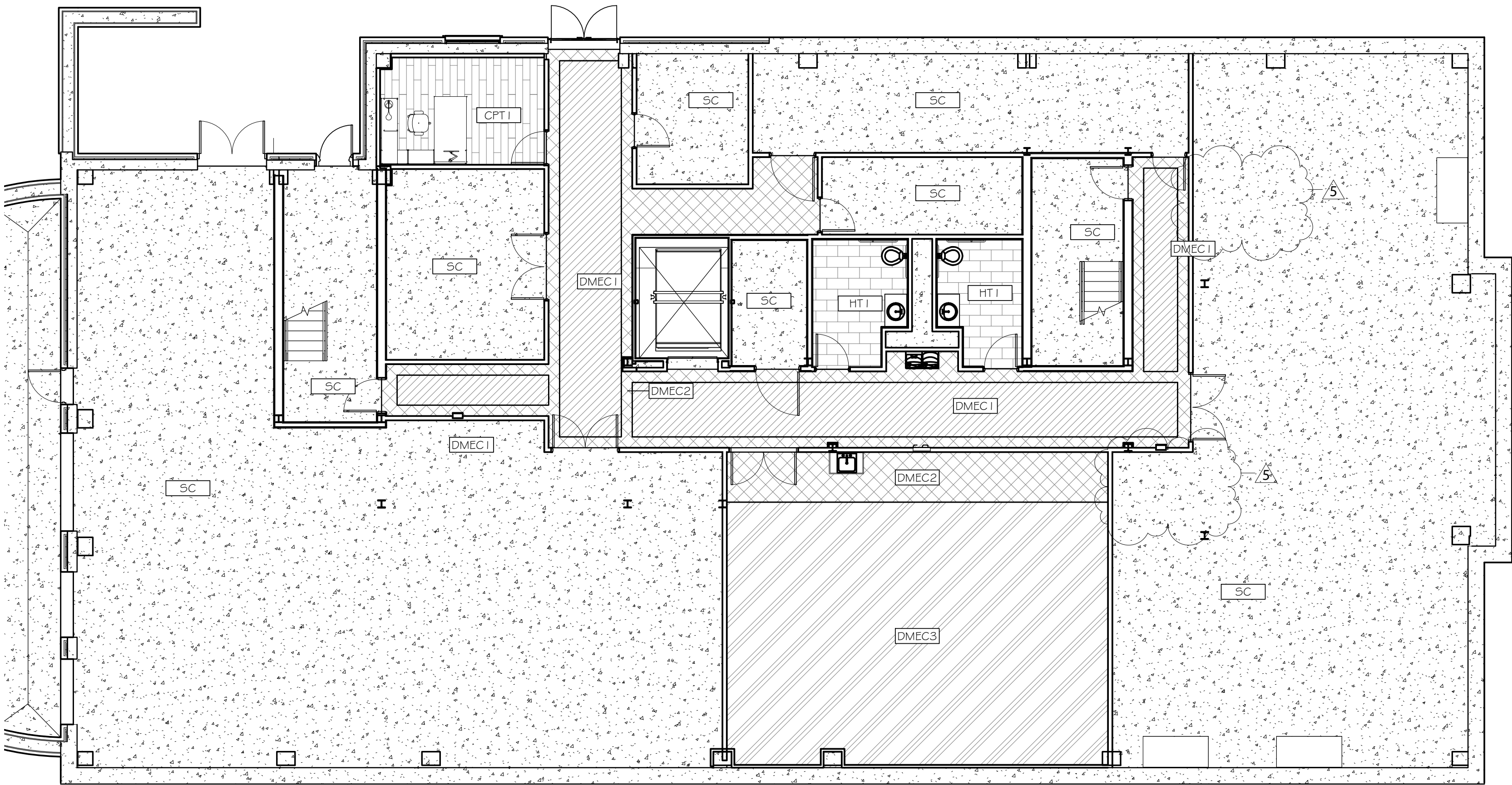
Sheet Number

A8.1





1 LEVEL 0 BASE BID FINISH FLOOR PATTERN PLAN  
A9.1 1/8" = 1'-0"



2 LEVEL 0 ALTERNATE FINISH FLOOR PATTERN PLAN  
A9.1 1/8" = 1'-0"

## GENERAL NOTES:

1. REFER TO SHEET A3.0 FOR MATERIAL AND FINISH
2. ALL INTERIOR WALLS TO BE PAINTED PT 1 , U.N.O.
3. ALL PAINTED CEILINGS AND BULKHEADS TO BE PAINTED PT2, U.N.O.
4. ALL INTERIOR HOLLOW METAL DOOR FRAMES TO BE PAINTED TO MATCH PT3, U.N.O.
5. ALL FLOORING TRANSITIONS THAT OCCUR WITHIN A DOOR FRAME SHALL BE CENTERLINE OF DOOR.
6. BASE REQUIRED AT ALL BASE CABINETS TO MATCH ROOM BASE.

## FLOORING KEY:

SC	SEALED CONCRETE
HT 1	HARD TILE 1
CPT 1	CARPET TILE 1
DMEC1	DECORATIVE MOSAIC EPOXY COATING 1
DMEC2	DECORATIVE MOSAIC EPOXY COATING 2
DMEC3	DECORATIVE MOSAIC EPOXY COATING 3

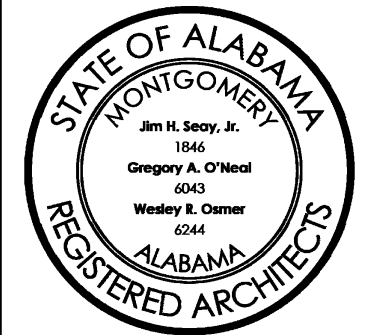
Rev.	Description	Date
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Sheet Title	LEVEL 0 FLOOR PATTERN PLANS
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Sheet Number	A9.1
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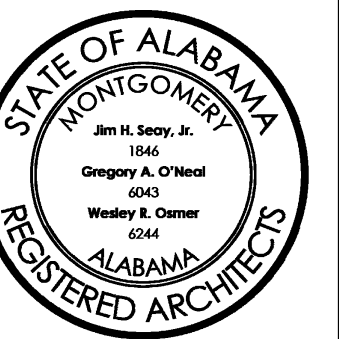
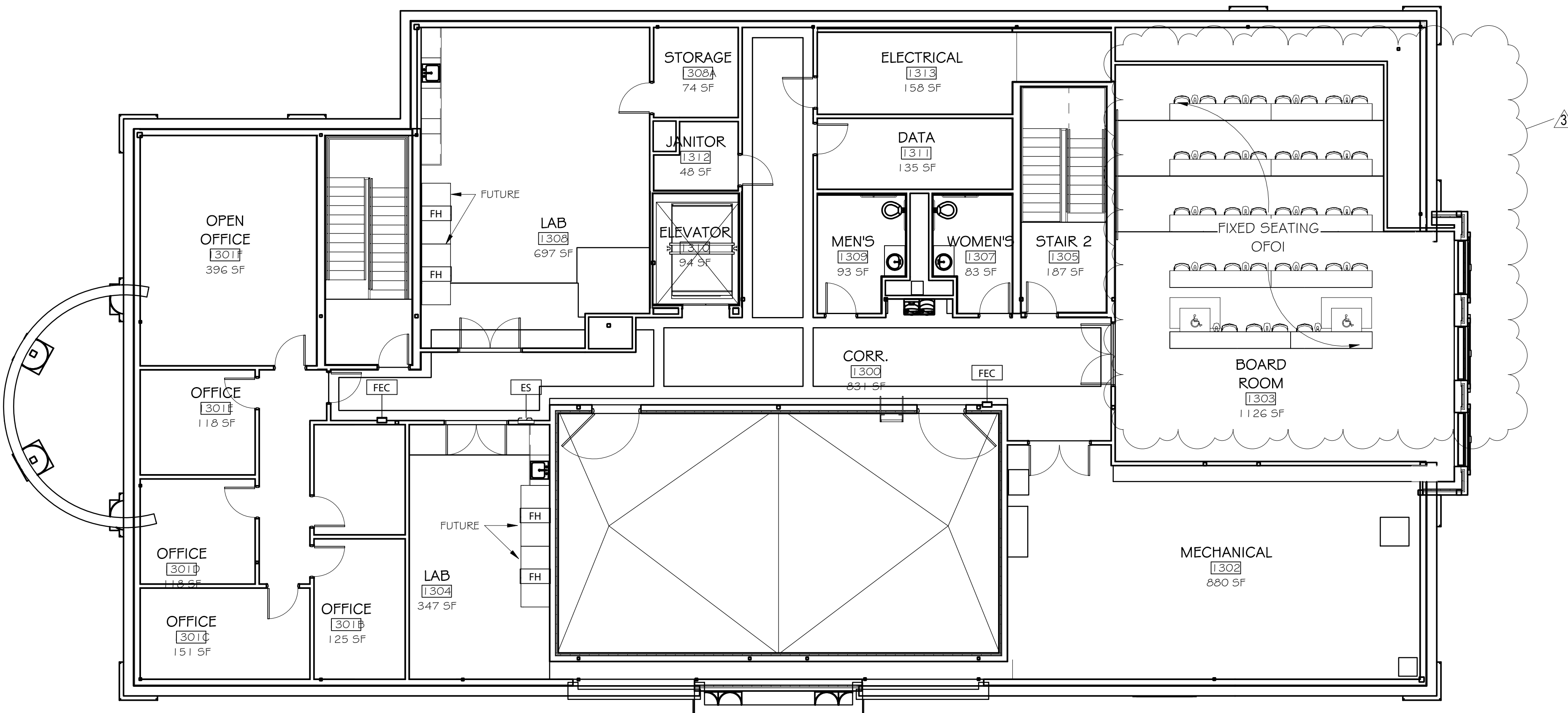
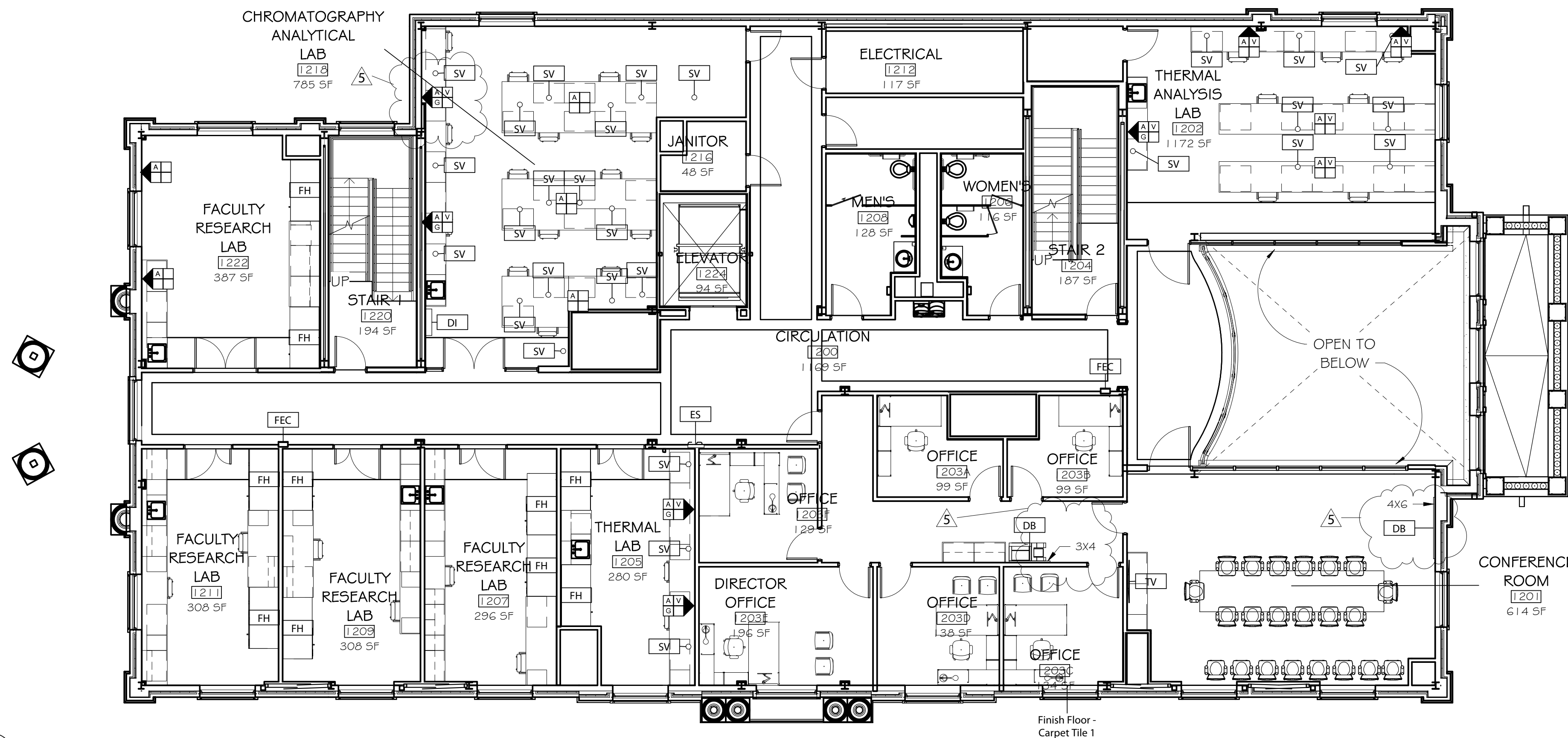


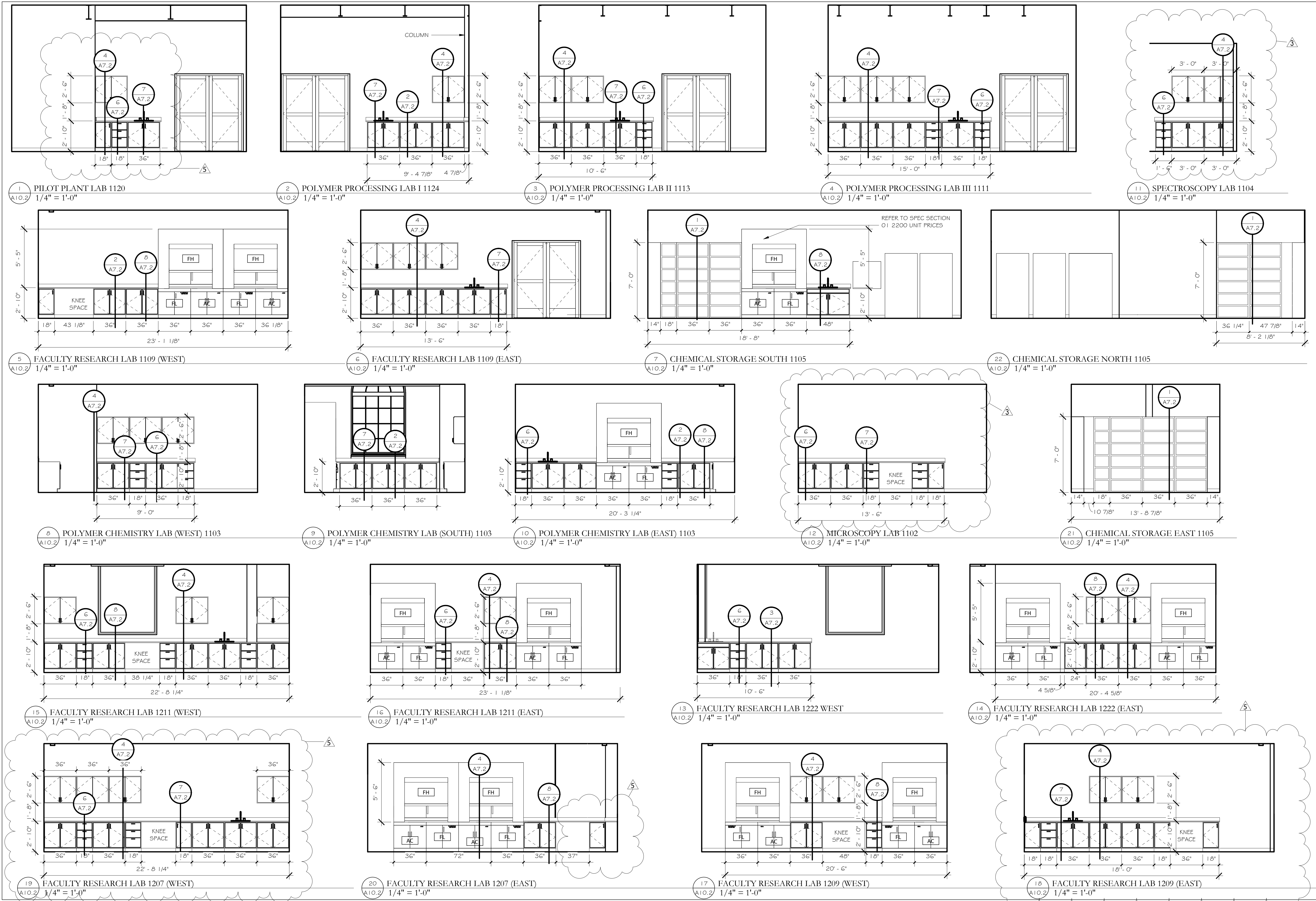
SEE CIVIL FOR FOUNDATION DRAINAGE  
SYSTEM, CONNECT TO STORM - SEE  
SPECIFICATION 02 71 00

REFER TO CIVIL FOR LOCATIONS OF PERFORATED PVC PIPE FOUNDATION DRAINS

LEVEL 0 DIAGRAM  
1/8" = 1'-0"







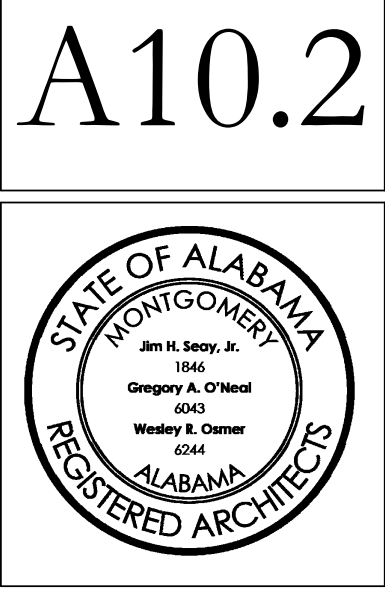
Rev.	Description	Date
3	Add. 3	12/16/2020
5	Add. 5	01/15/2021

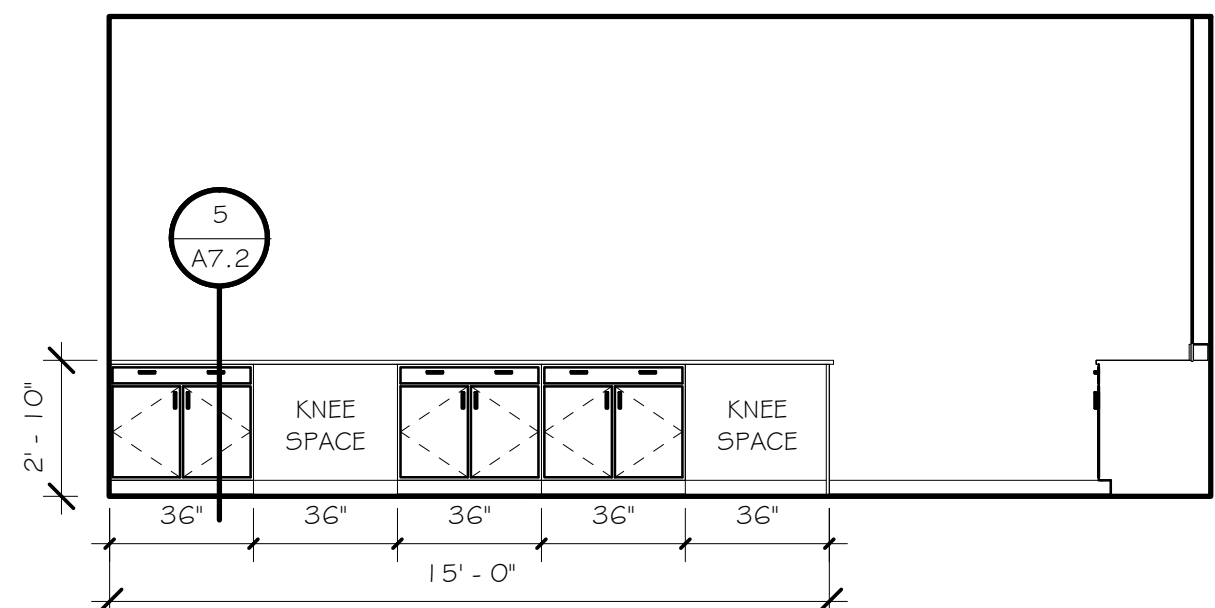
Job Number	18144
Date	11/17/2020
Drawn By	CS,JB,DB,LG
Checked By	JS,FL

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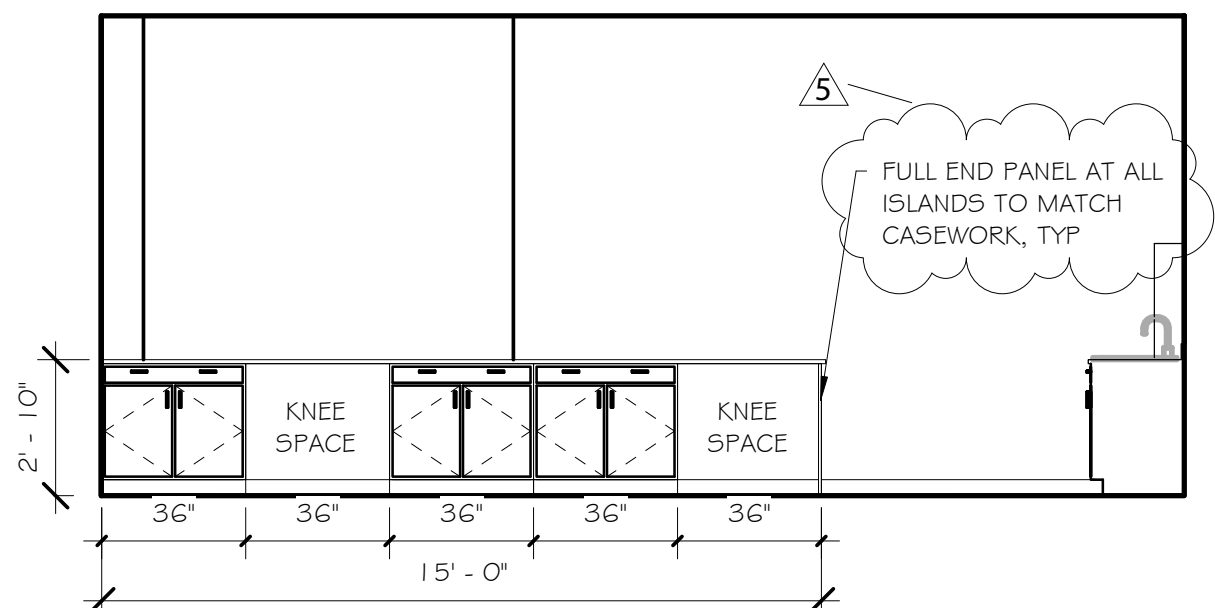
Sheet Title	LAB ELEVATIONS
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Sheet Number	A10.2
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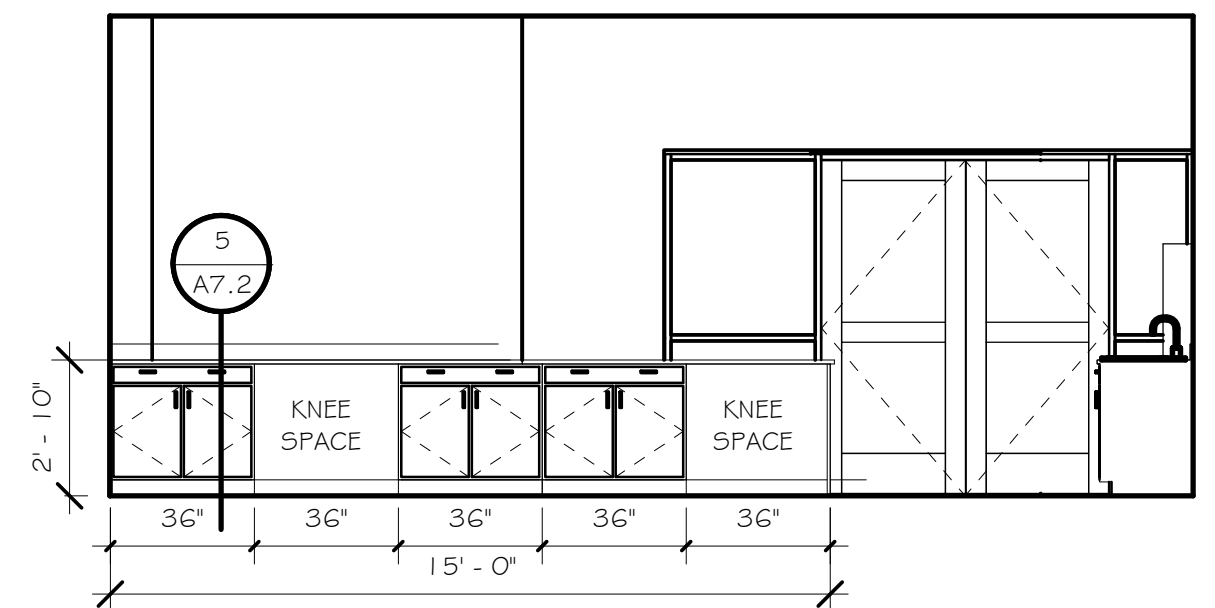




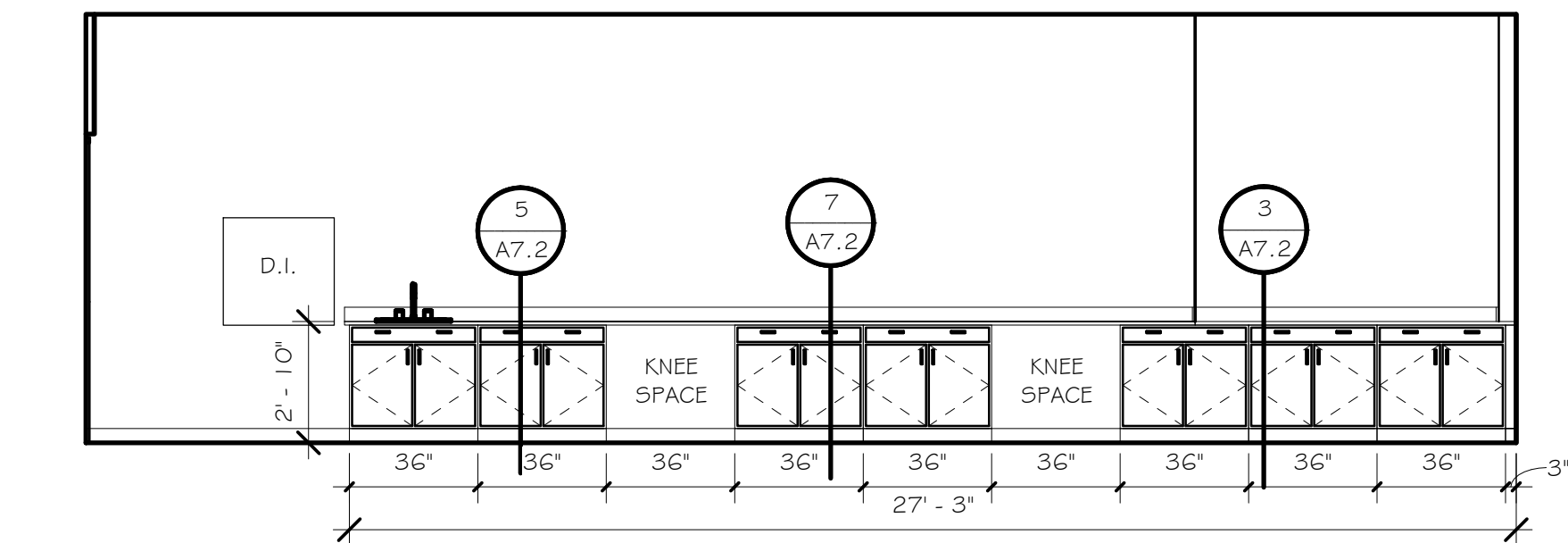
1 CHROMATOGRAPHY / ANALYTICAL LAB (SOUTH 1) 1218  
1/4" = 1'-0"



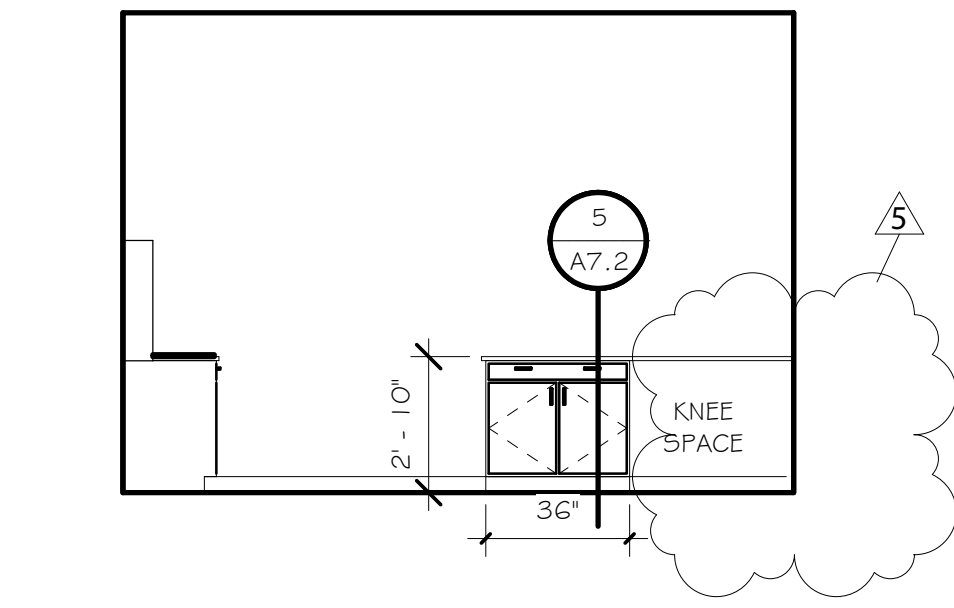
2 CHROMATOGRAPHY / ANALYTICAL LAB (SOUTH 2) 1218  
1/4" = 1'-0"



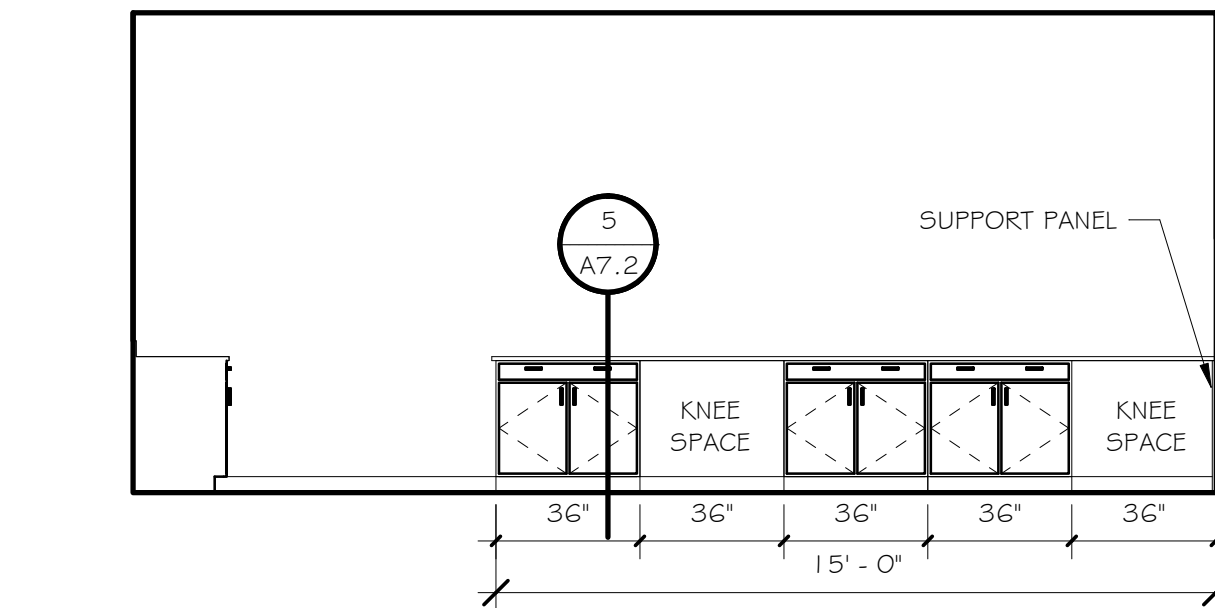
3 CHROMATOGRAPHY / ANALYTICAL LAB (SOUTH 3) 1218  
1/4" = 1'-0"



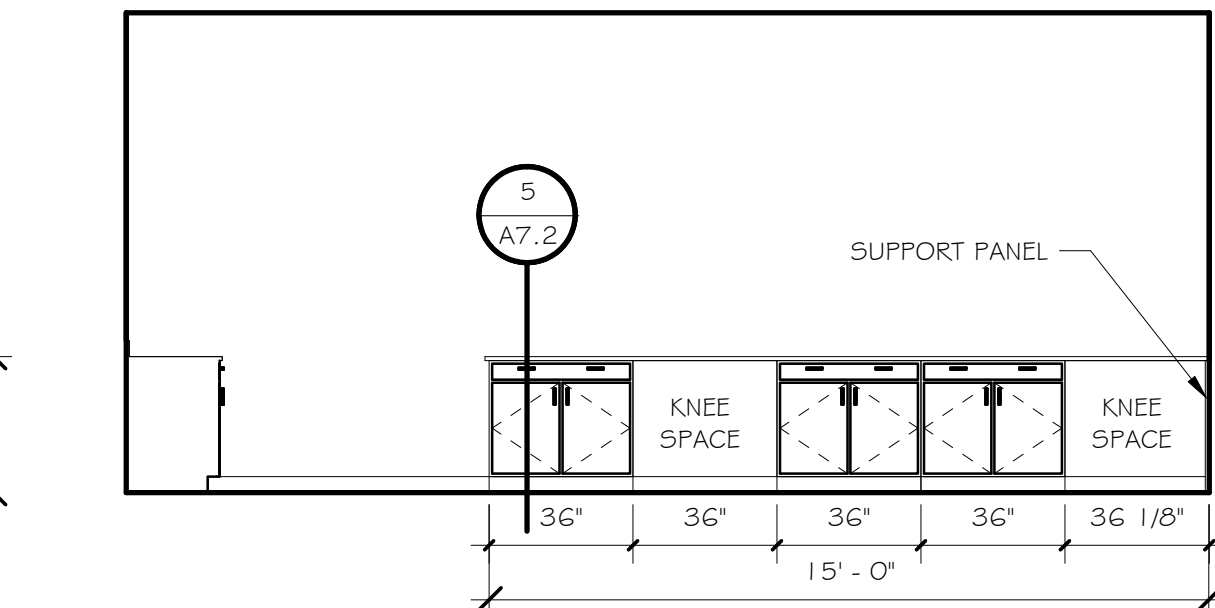
7 CHROMATOGRAPHY / ANALYTICAL LAB 1218  
1/4" = 1'-0"



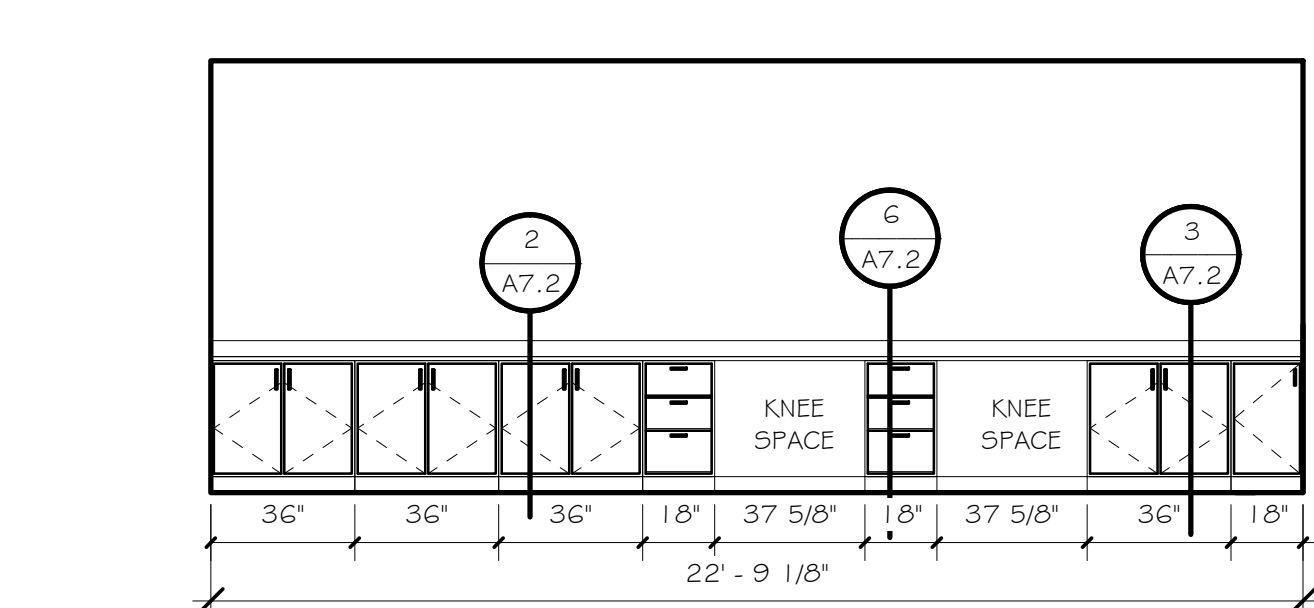
4 CHROMATOGRAPHY / ANALYTICAL LAB (NORTH 1) 1218  
1/4" = 1'-0"



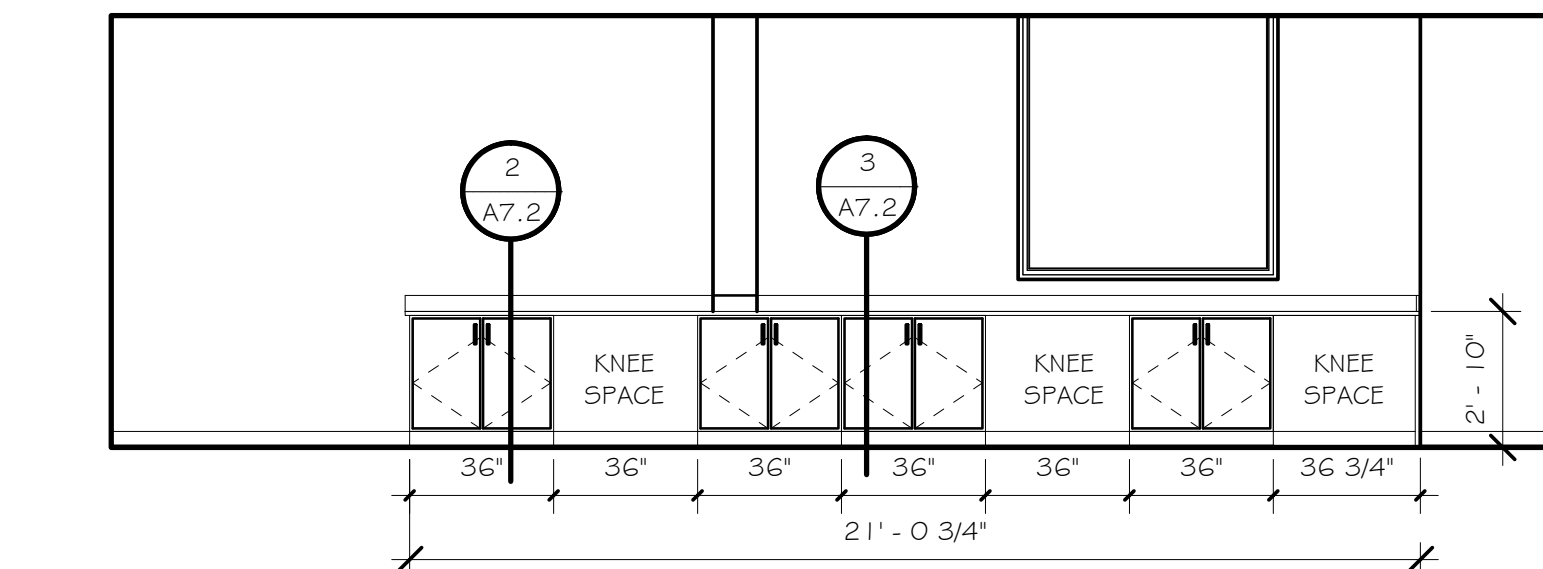
5 CHROMATOGRAPHY / ANALYTICAL LAB (NORTH 2) 1218  
1/4" = 1'-0"



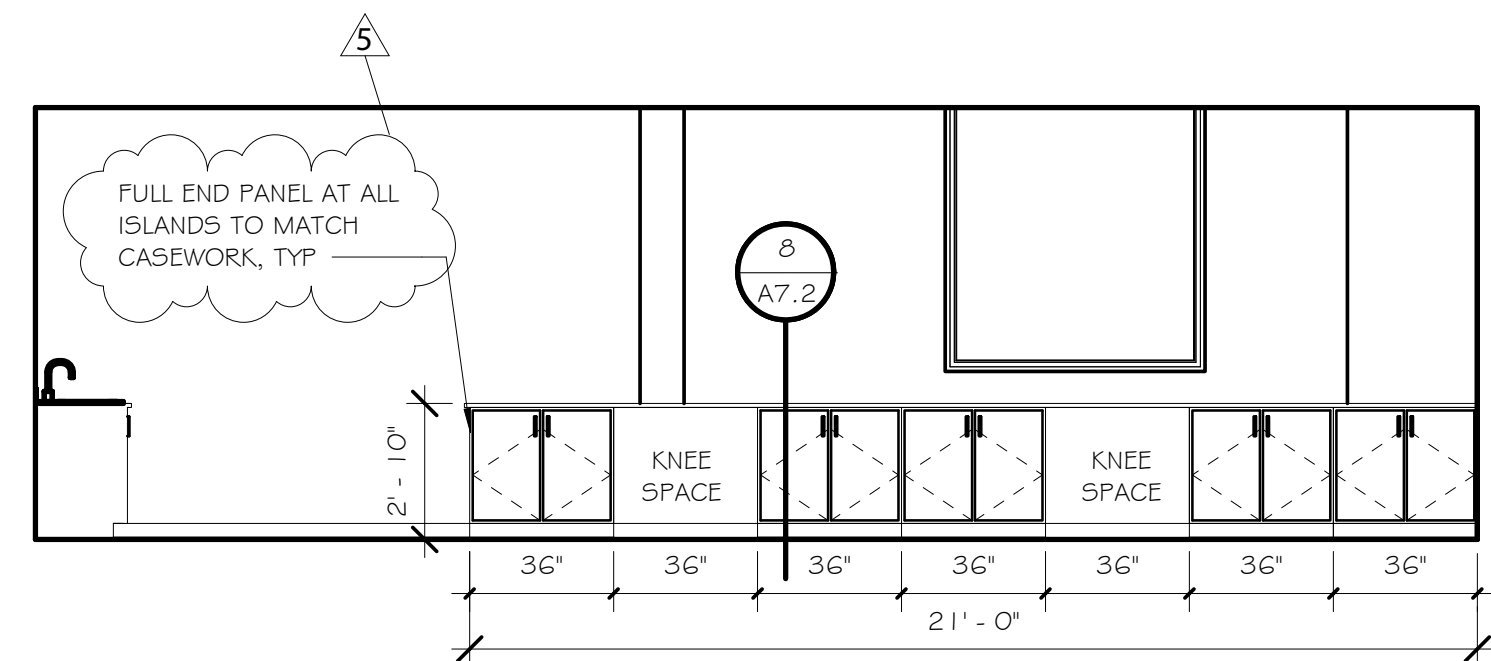
6 CHROMATOGRAPHY / ANALYTICAL LAB (NORTH 3) 1218  
1/4" = 1'-0"



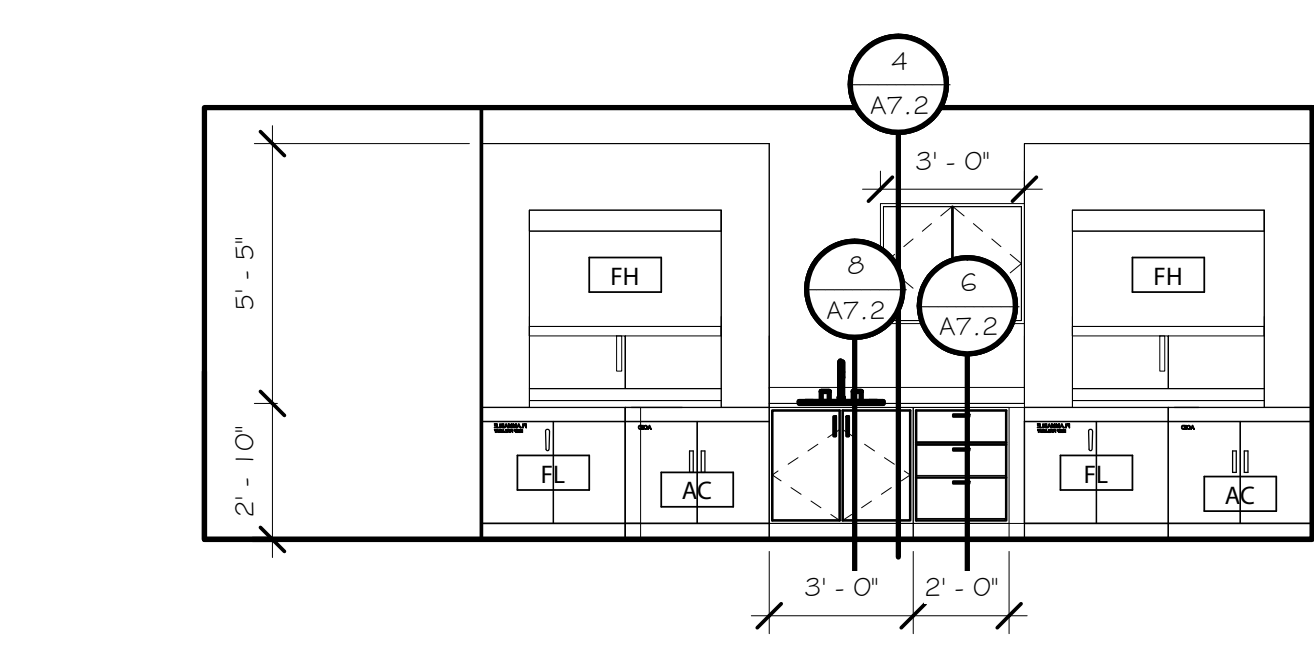
15 THERMAL LAB (EAST) 1205  
1/4" = 1'-0"



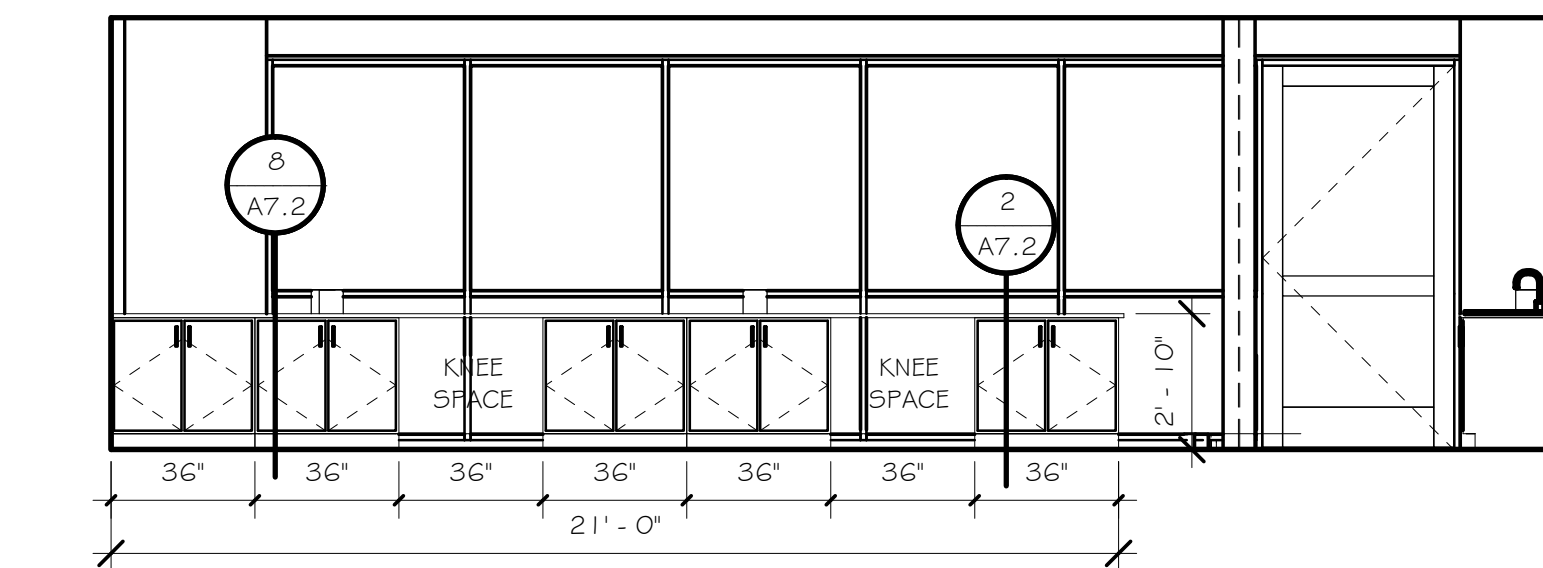
9 THERMAL ANALYSIS LAB (NORTH 1) 1202  
1/4" = 1'-0"



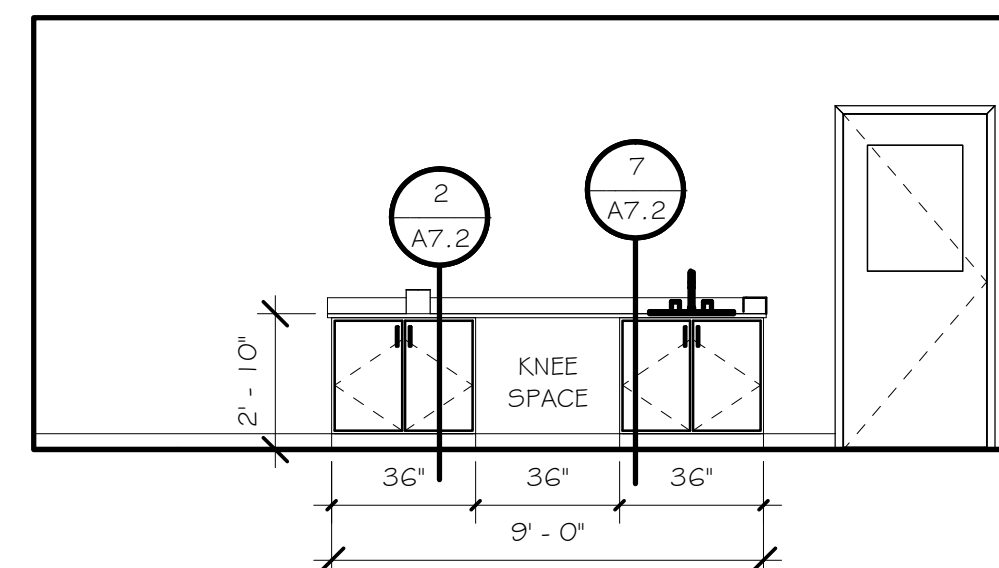
11 THERMAL ANALYSIS LAB (NORTH 3) 1202  
1/4" = 1'-0"



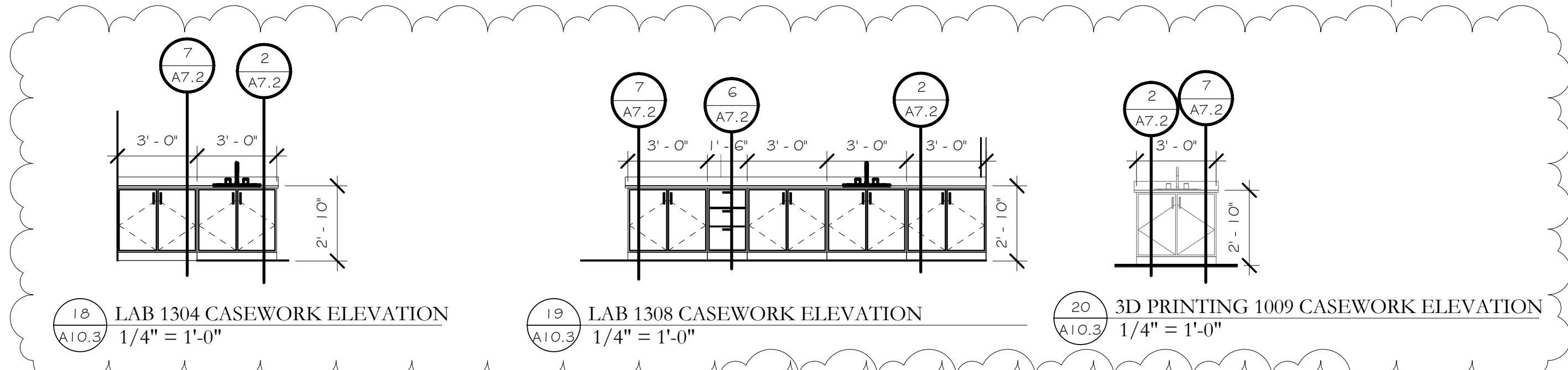
16 THERMAL LAB (WEST) 1205  
1/4" = 1'-0"



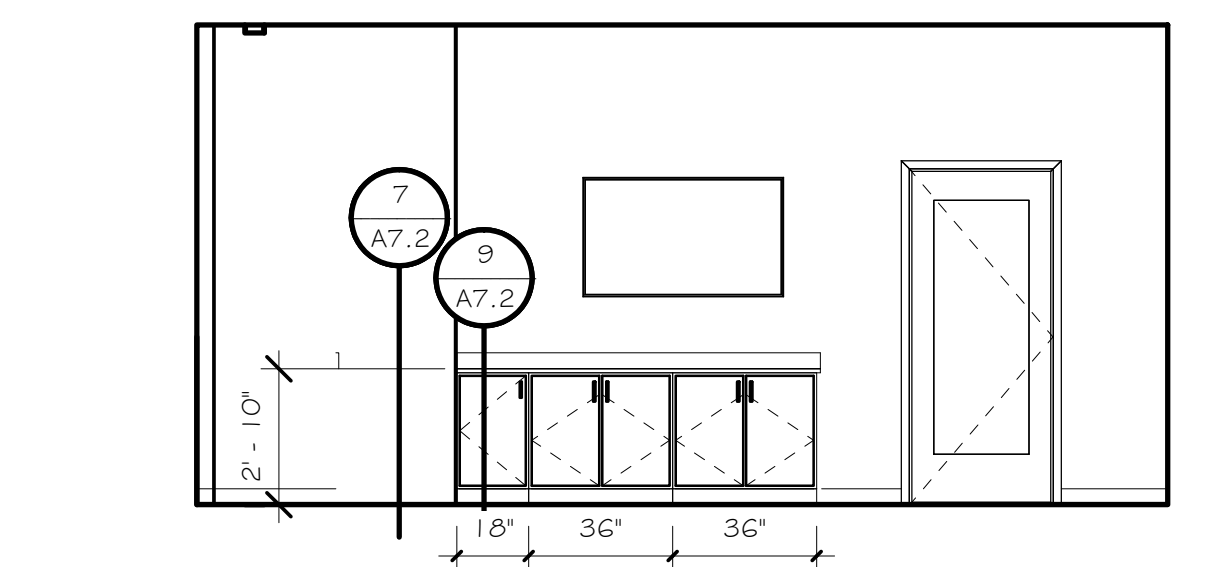
12 THERMAL ANALYSIS LAB (SOUTH 1) 1202  
1/4" = 1'-0"



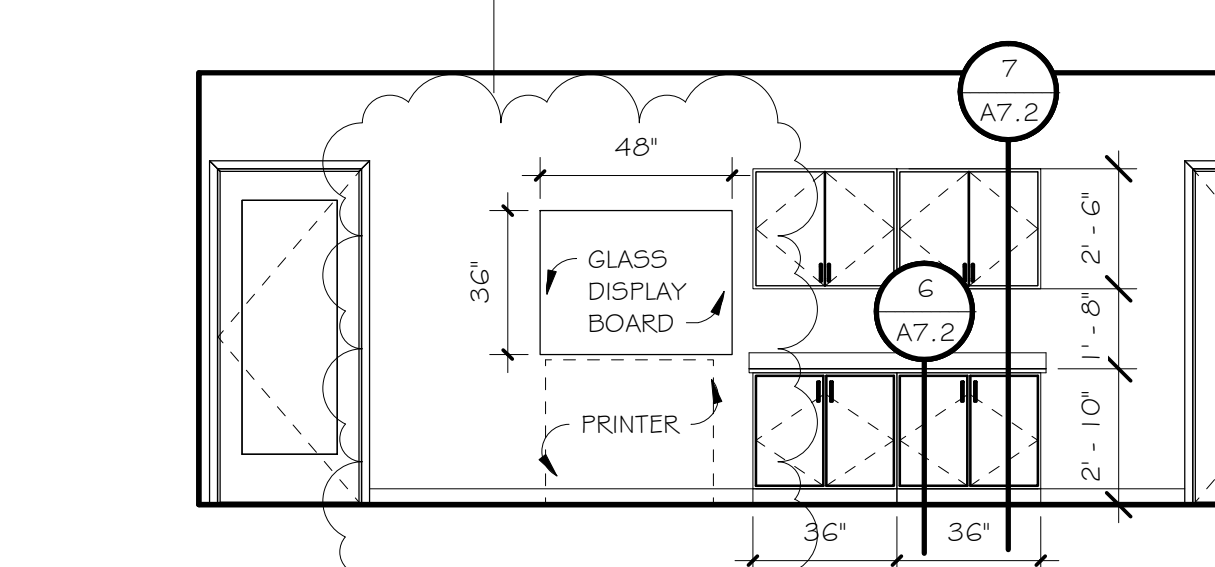
14 THERMAL ANALYSIS LAB (WEST) 1202  
1/4" = 1'-0"



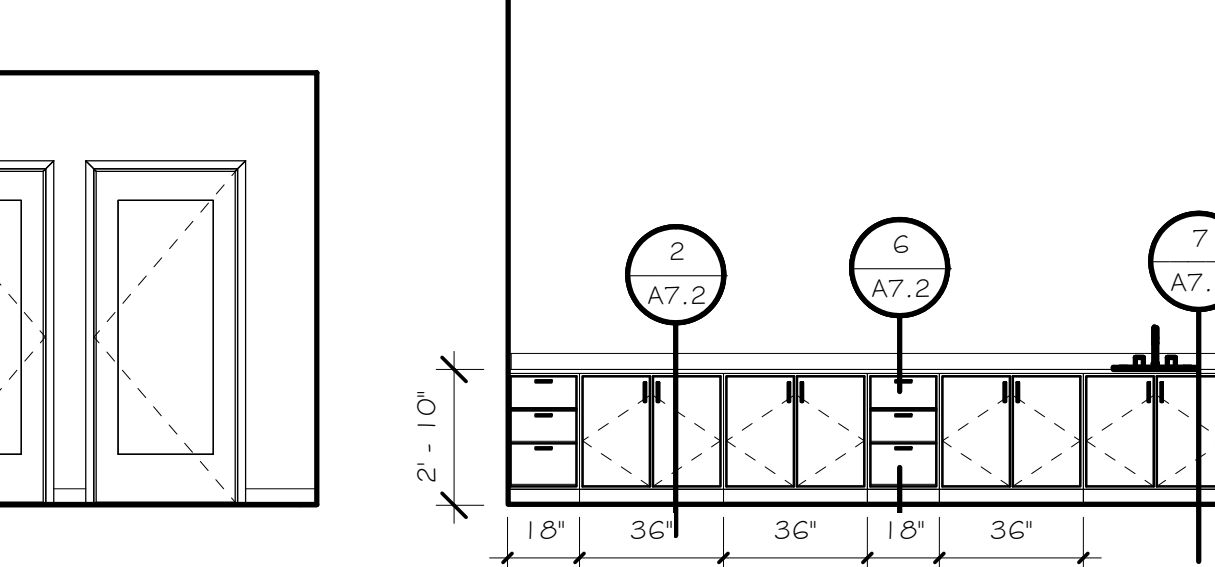
18 LAB 1304 CASEWORK ELEVATION  
1/4" = 1'-0"



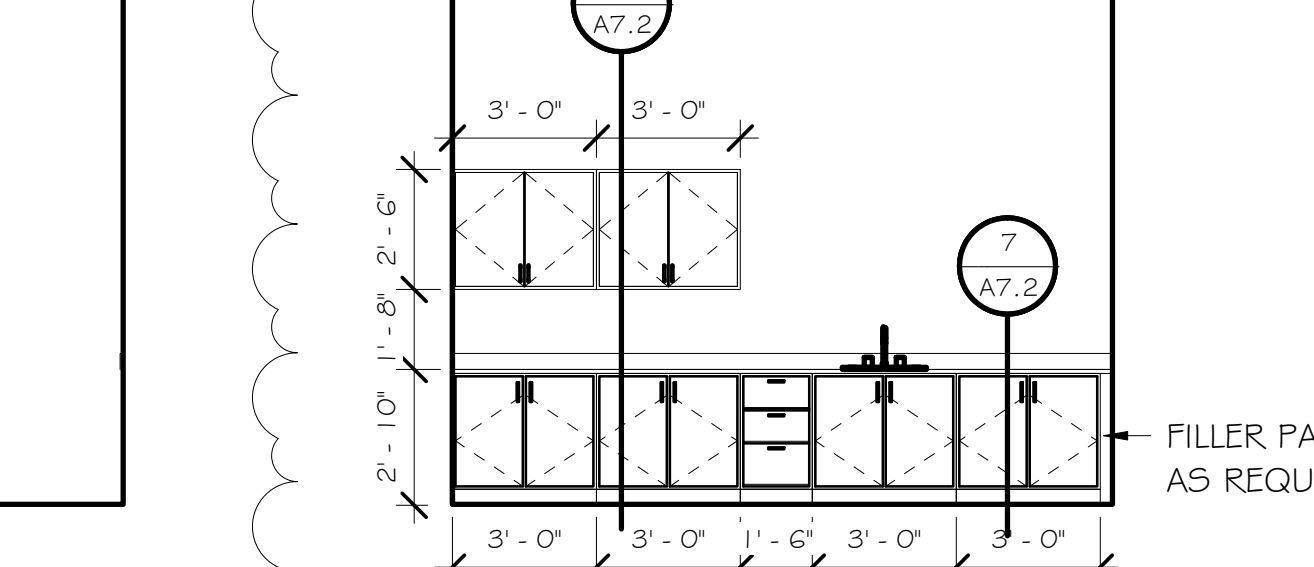
10 CONFERENCE ROOM CASEWORK ELEVATION 1201  
1/4" = 1'-0"



13 CIRCULATION CASEWORK 1203  
1/4" = 1'-0"



8 MECHANICAL TESTING LAB 1101  
1/4" = 1'-0"



17 MEDICAL POLYMER PROCESSING LAB 1107  
1/4" = 1'-0"

Rev.	Description	Date
3	Add. 3	12/16/2020
5	Add. 5	01/15/2021

Job Number	18144
Date	11/17/2020
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Checked By	JS,FL

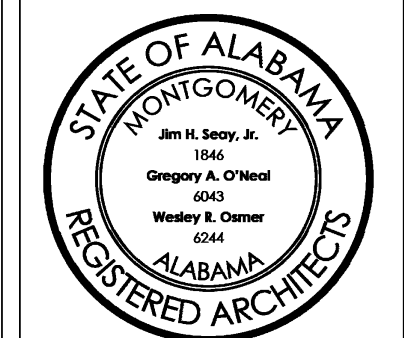
Project Title

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Sheet Title  
LAB ELEVATIONS

Sheet Number

A10.3





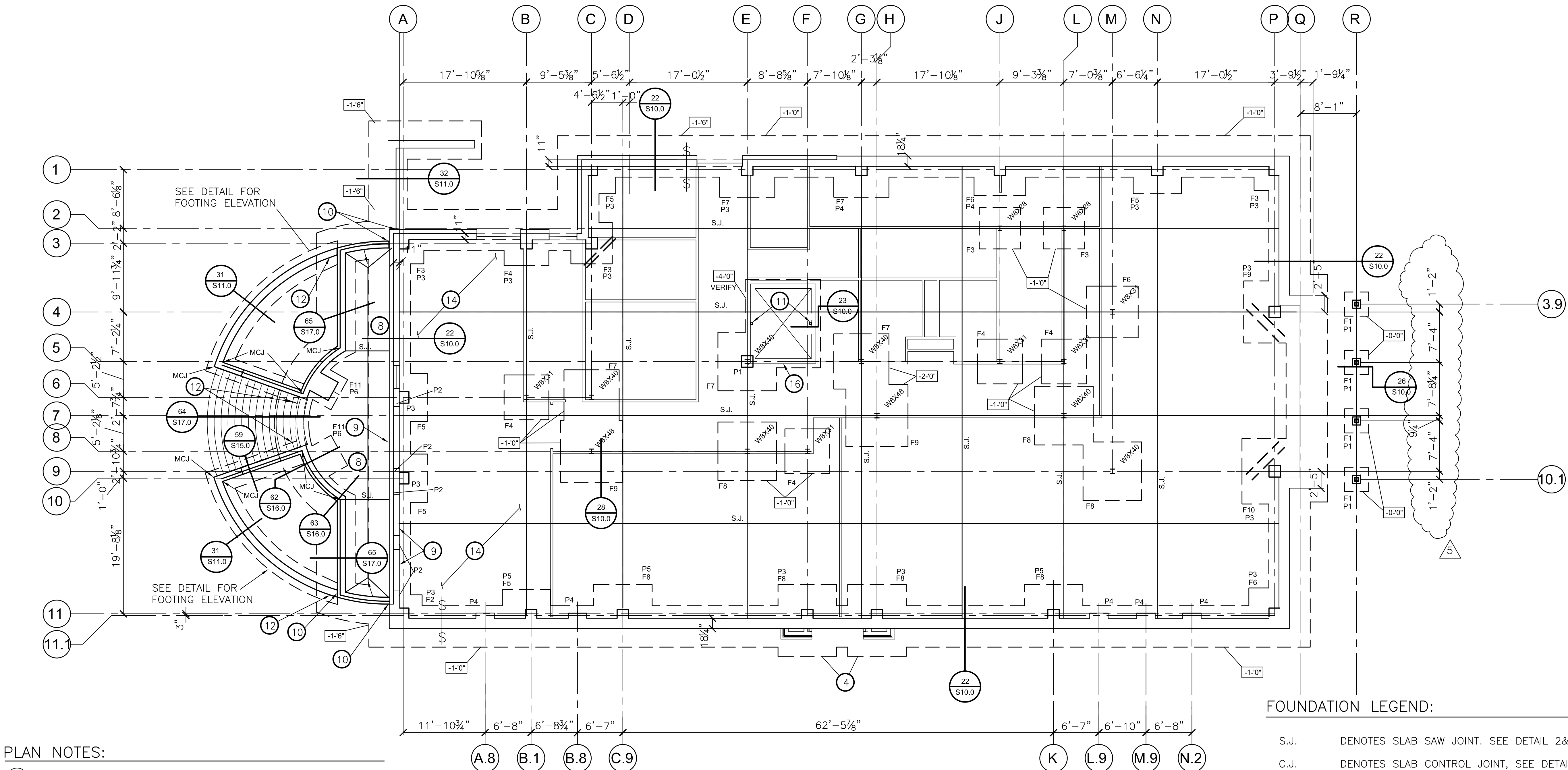
Rev.	Description	Date
A	ADD. #5	1/15/20

Job Number	18144
Date	1/17/2020
Drawn By	jrm
Checked By	TWG

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Sheet Title	BASEMENT & FOUNDATION PLAN
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Sheet Number	S2.0
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PLAN NOTES:

1. SEE SHEET S1.0 FOR GENERAL STRUCTURAL NOTES.
2. SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
3. SEE SHEET S1.1 FOR BASE PLATES & OTHER SCHEDULES
4. EXTEND SCHEDULED FOOTING AND REBAR TO EXTEND 1'-4" MIN. BEYOND ENTRY PILASTERS
5. SEE ARCH. DRAWINGS & SITE PLAN FOR SIDEWALKS, PAVING, ETC.
6. SEE S3.0 FOR COLUMN SIZES THAT BEAR ON CONCRETE PIERS, MONOLITHIC W/ BASEMENT WALL, NEAR FIRST FLOOR LEVEL
7. SEE SHEET S20.0 FOR MECHANICAL YARD PLAN
8. PROVIDE 6" THICK SLAB ON GRADE IN AREAWAY. SLOPE SLAB TO TRENCH DRAIN. SEE ARCH.
9. COORDINATE WALL OPENINGS W/ LOUVERS. SEE ARCH. & SPECS
10. PROVIDE 3/4" EXPANSION JOINT WHERE RETAINING WALL ABUTS THE MAIN BUILDING OR INTERSECTING WALL. FILL W/ COMPRESSIBLE FILLER & SEALANT.
11. PROVIDE HSS4x4x1/4" GUIDE RAIL ANCHORAGE POST IN WALL EACH SIDE OF ELEVATOR. SEE DETAIL 69/S17.0

12. SEE DETAIL 66/S17.0 FOR INTERSECTION OF HIGH FOOTING w/ TALLER WALL.
13. BASEMENT SLAB ON GRADE CONSTRUCTION:  
6" THICK SLAB w/ 6x6, W2.1xW2.1 W.W.F. OVER VAPOR BARRIER OVER 4" THICK LAYER OF CLEAN POROUS FILL. SEE SPECS FOR VAPOR BARRIER.
14. SEE DETAIL 74/S18.0 FOR TYP. CONCRETE "HOUSEKEEPING" PADS. SEE MECH. DRAWINGS FOR LOCATIONS.
15. SOIL BACKFILL AGAINST BASEMENT WALLS SHALL NOT EXTEND MORE THAN 9'-0" ABOVE BASEMENT FLOOR UNTIL FIRST FLOOR STRUCTURAL SLAB IS IN PLACE AND CURED (3) DAYS.
16. SEE DETAIL 85/S19.0 FOR TYP. ELEVATOR SUPPORT ANGLE @ DOOR. COORDINATE W/ MANUFACTURER

BASEMENT & FOUNDATION PLAN

SCALE: 1/8" = 1'-0"  
(FIN. FLR. EL. = -14'-0")

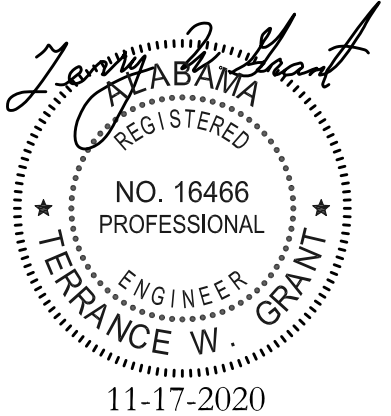


FOUNDATION LEGEND:

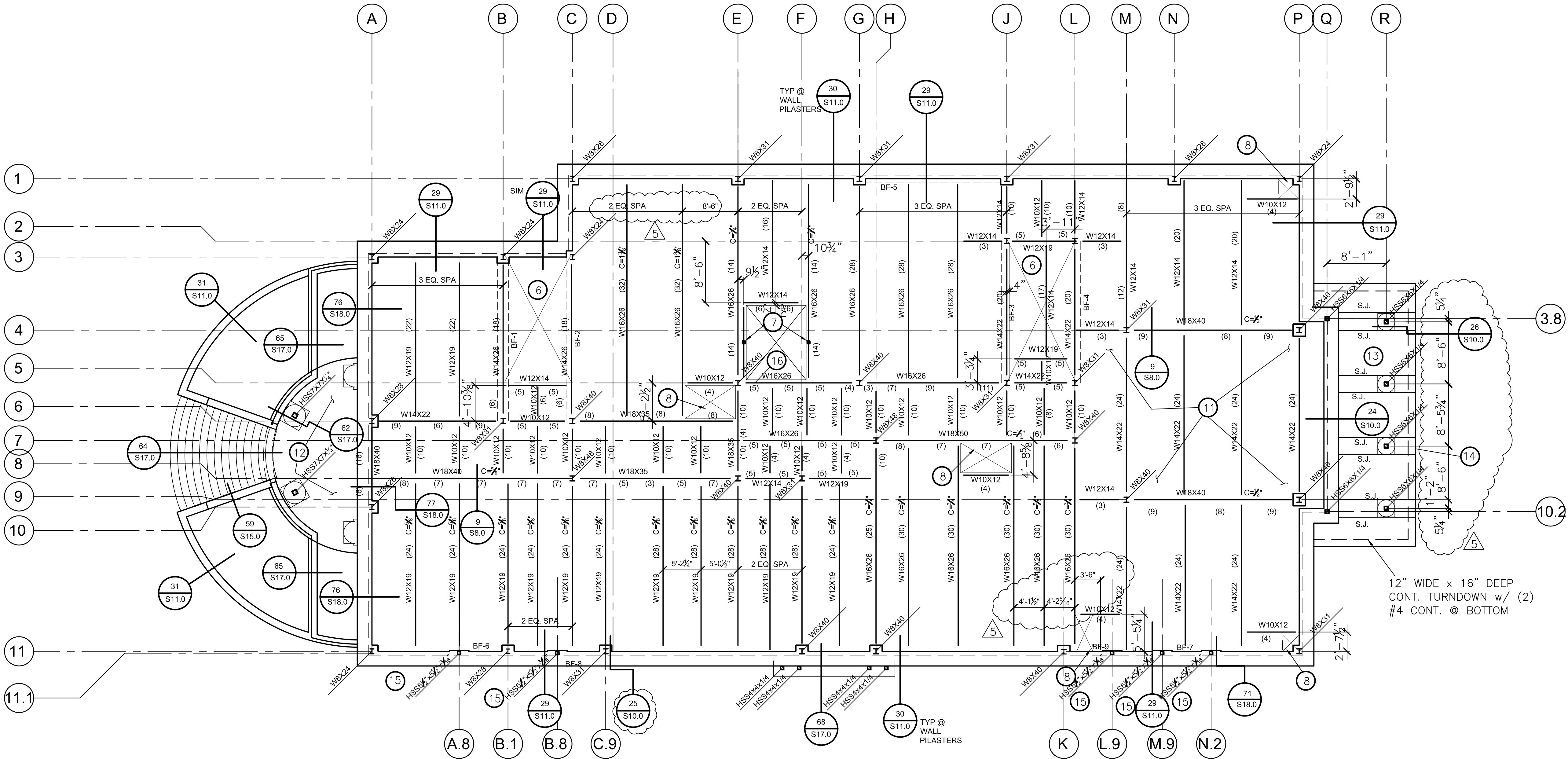
- S.J. DENOTES SLAB SAW JOINT. SEE DETAIL 2&3/S8.0.
- C.J. DENOTES SLAB CONTROL JOINT, SEE DETAIL 2&3/S8.0.
- Fx DENOTES FOOTING SIZE. SEE SCHEDULE ON SHEET S1.1
- Px DENOTES CONCRETE PIER SIZE. SEE SCHEDULE ON SHEET S1.1
- BF-x DENOTES BRACE FRAME. SEE SHEET S7.0
- X'-X" DENOTES MINIMUM DISTANCE FROM FINISH FLOOR OF BASEMENT TO TOP OF FOOTING.
- MCJ DENOTES MASONRY CONTROL JOINT IN BRICK VENEER. RAKE & CAULK TO MATCH MORTAR. SEE ARCH. FOR OTHER LOCATIONS
- DENOTES APPROX. FOOTING STEP LOCATION. SEE TYP. DETAIL
- == DENOTES (2) #4 x 4'-6" REBAR, CENTERED IN SLAB



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Consulting Structural Engineers  
432 Herron Street  
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Phone 334-265-4631  
Job No.: 20016







PLAN NOTES:

- – CIRCLED NOTES ARE KEYED TO PLAN.
- SEE SHEET S1.0 FOR GENERAL STRUCTURAL NOTES.
  - SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
  - SEE SHEET S1.1 FOR SCHEDULES
  - SEE ARCH. DRAWINGS & SITE PLAN FOR SIDEWALKS, PAVING, ETC.
  - FLOOR CONSTRUCTION:  
5/2" THICK (INCLUDING 2", 20ga COMPOSITE DECK) FLOOR SLAB w/ NORMAL WEIGHT CONCRETE. REINFORCE w/ 6x6, W2.1xW2.1 W.W.F., 1 1/2" CLEAR FROM TOP.
  - STAIR CONSTRUCTION:  
DESIGN BY FABRICATOR FOR 100psf LIVE LODE & CODE COMPLIANT HANDRAILS. SEE DETAILS & ARCH. FOR ADD'L INFORMATION. PROVIDE HSS3x3x1/4" POST IN WALL BELOW LANDINGS FOR SUPPORT OR HANGER.
  - SEE DETAIL FOR HSS4x4x1/4" GUIDE RAIL ANCHORAGE POST IN WALL EA. SIDE OF ELEVATOR. SEE DETAIL 69/S17.0
  - SEE DETAIL 37/S12.0 FOR TYP. FLOOR OPENING DETAIL
  - LOCATE BEAMS ON GRID LINES AS SHOWN AND EQUALLY SPACED, U.N.O.

- SOIL BACKFILL AGAINST BASEMENT WALLS SHALL NOT EXTEND MORE THAN 9'-0" ABOVE BASEMENT FLOOR SLAB UNTIL FIRST FLOOR STRUCTURAL SLAB IS IN PLACE AND CURED (3) DAYS.
- DEPRESS TOP OF SLAB 1/2" FOR TERRAZO FLOOR FINISH. COORDINATE EXACT LOCATION w/ ARCH.
- 8" THICK, REINFORCED STRUCTURAL SLAB @ PORCH, OVER AREAWAY, SEE DETAILS.
- 4" MIN. THICK SLAB ON COMPACTED FILL. REINFORCE w/ 6x6, W1.4xW1.4 W.W.F. SEE ARCH. FOR FINISH & SLOPE.
- PROVIDE 12" WIDE x 18" MIN. DEEP PERIMETER TURNDOWN w/ (2) #4 CONT. @ TOP & BOTT.
- CENTER HSS IN 6" STEEL STUD WALL.
- SEE DETAIL 85/S19.0 FOR TYP. ELEVATOR SUPPORT ANGLE @ DOOR. COORDINATE w/ MANUFACTURER

FIRST FLOOR FRAMING PLAN

SCALE: 1/8" = 1'-0"  
(FIN. FLR. EL. = +0'-0")

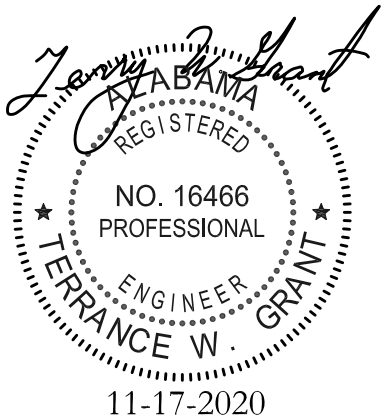


LEGEND:

- C=X DENOTES UPWARD CAMBER @ CENTER OF BEAM
- (X) DENOTES NUMBER OF 3/4" Ø HD STUDS. SEE NOTES ON S1.0. STUDS TO BE 4 1/2" LONG AFTER WELDING
- BF-X DENOTES BRACED FRAME TYPE. SEE FRAMING ELEVATIONS ON S7.0.



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Job Number	18144
Date	11/17/2020
Drawn By	jrm
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FIRST FLOOR  
FRAMING PLAN

Sheet Number  
**S3.0**







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A	ADD. #5	1/15/20

Job Number 18144

Date 1/17/2020

Drawn By jrm

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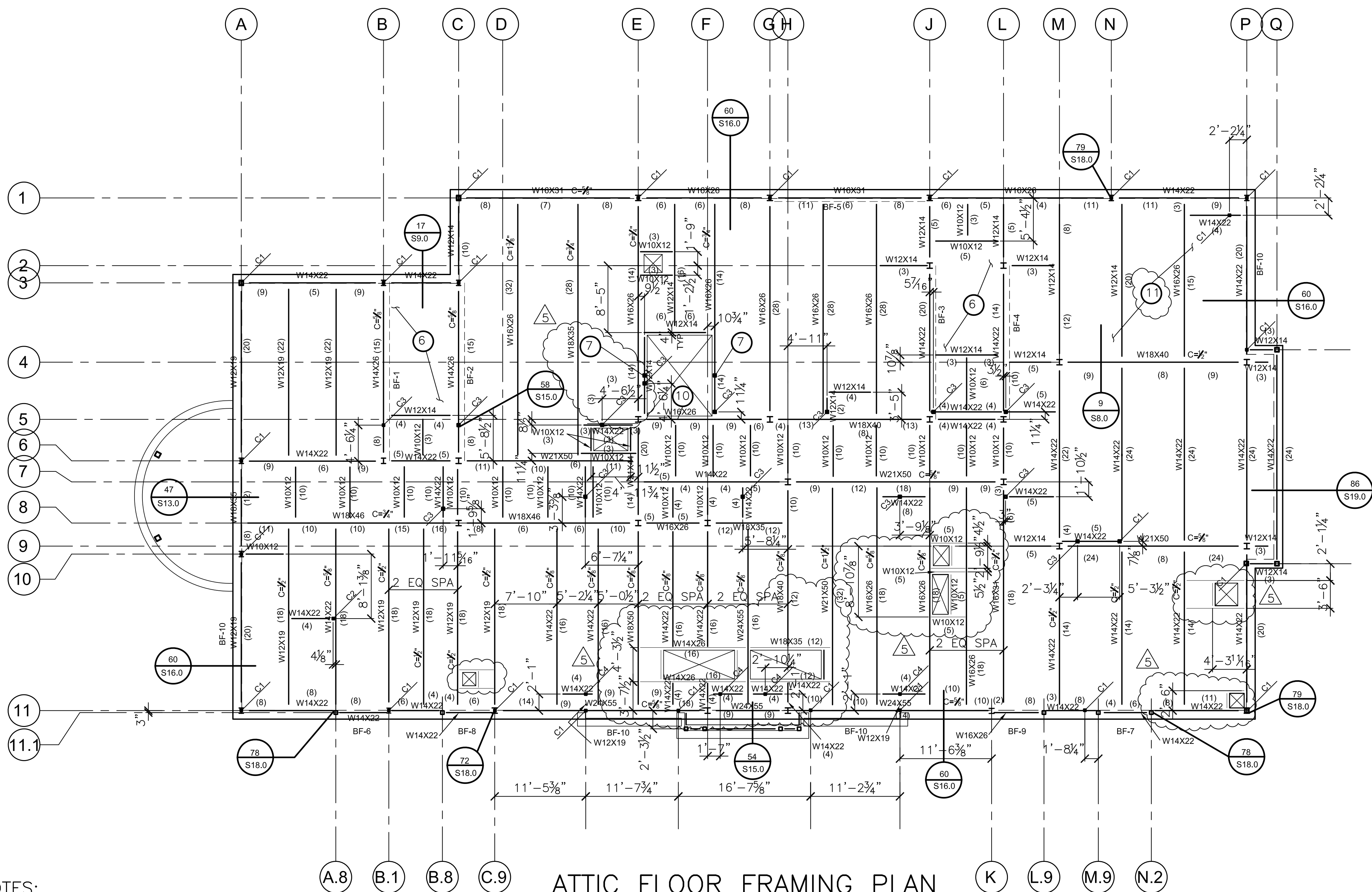
Project Title

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Sheet Title  
ATTIC FLOOR  
FRAMING PLAN

Sheet Number

**S5.0**



PLAN NOTES:

- – CIRCLED NOTES ARE KEYED TO PLAN.
- SEE SHEET S1.0 FOR GENERAL STRUCTURAL NOTES.
  - SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
  - SEE SHEET S1.1 FOR SCHEDULES
  - SEE ARCH. & MECHANICAL DRAWINGS FOR EQUIPMENT SUPPORT, ETC.
  - FLOOR CONSTRUCTION:  
5½" THICK (INCLUDING 2" 20ga. GALV COMPOSITE DECK)  
FLOOR SLAB w/ NORMAL WEIGHT CONCRETE. REINFORCE w/  
6x6, W2.1xW2.1 W.W.F., 1½" CLEAR FROM TOP.
  - STAIR CONSTRUCTION:  
DESIGN BY FABRICATOR FOR 100psf LIVE LODE & CODE  
COMPLIANT HANDRAILS. SEE DETAILS & ARCH. FOR ADD'L  
INFORMATION. PROVIDE HSS3x3x¼" POST IN WALL BELOW  
LANDINGS FOR SUPPORT OR HANGER. SEE TYP. DETAILS.
  - SEE DETAIL FOR HSS4x4x¼" GUIDE RAIL ANCHORAGE POST IN  
WALL EA. SIDE OF ELEVATOR. SEE DETAIL 69/S17.0
  - SEE DETAIL 37/S12.0 FOR TYP. FLOOR OPENING DETAIL
  - LOCATE BEAMS ON GRID LINES AS SHOWN AND EQUALLY  
SPACED, U.N.O.
  - SEE DETAIL 85/S19.0 FOR TYP. ELEVATOR SUPPORT ANGLE @  
DOOR. COORDINATE w/ MANUFACTURER

11 FOR ALTERNATE PLAN, PROVIDE STEPPED PLATFORMS IN THIS  
AREA. SEE ARCH. SECTION. USE 2 LAYERS OF ¾" T&G PLYWOOD  
w/ SCREWS @ 8" MAX. O.C. INTO SUPPORTS. USE 6", 16ga.  
FLOOR JOISTS @ 16" O.C., MAX. w/ MAX. SPAN = 5'-6".  
PROVIDE 3½", 18ga. @ 16" O.C., MAX. SUPPORT WALLS w/  
CONT. TRACK, T&B. ALIGN JOIST DIRECTLY OVER STUDS.

12. SEE MECH. DRAWINGS FOR CONCRETE CURBS AROUND FLOOR  
PENETRATIONS. SEE NOTES ON S1.0 FOR REINFORCING. SEE  
MECH. DRAWINGS WHERE CONCRETE CURBS OR PADS OCCUR  
UNDER UNITS. PROVIDE SAME REINFORCING AS FOR CURBS @  
PENETRATIONS PLUS #4 @ 12" O.C. E.W. @ HOUSEKEEPING  
PADS LARGER THAN 24"x24"

SCALE: 1/8" = 1'-0"  
(FIN. FLR. EL. = +28'-0")



LEGEND:

- C=X DENOTES UPWARD CAMBER @ CENTER OF BEAM
- (X) DENOTES NUMBER OF ¾"Ø HD STUDS. SEE NOTES  
ON S1.0. STUDS TO BE 4½" LONG AFTER WELDING.
- C1 DENOTES HSS4x4x¾" STUB COLUMN w/ ½" BASE  
PLATE & (4) ¾"Ø BOLTS
- C2 DENOTES HSS4x4x¼" STUB COLUMN w/ ½" BASE  
PLATE & (4) ¾"Ø BOLTS
- C3 DENOTES HSS5x5x¾" STUB COLUMN w/ ½" BASE  
PLATE & (4) ¾"Ø BOLTS
- C4 DENOTES HSS5x5x¾" STUB COLUMN w/ ½" BASE  
PLATE & (4) ¾"Ø BOLTS
- BF-X DENOTES BRACED FRAME TYPE. SEE FRAMING  
ELEVATIONS ON S7.0.



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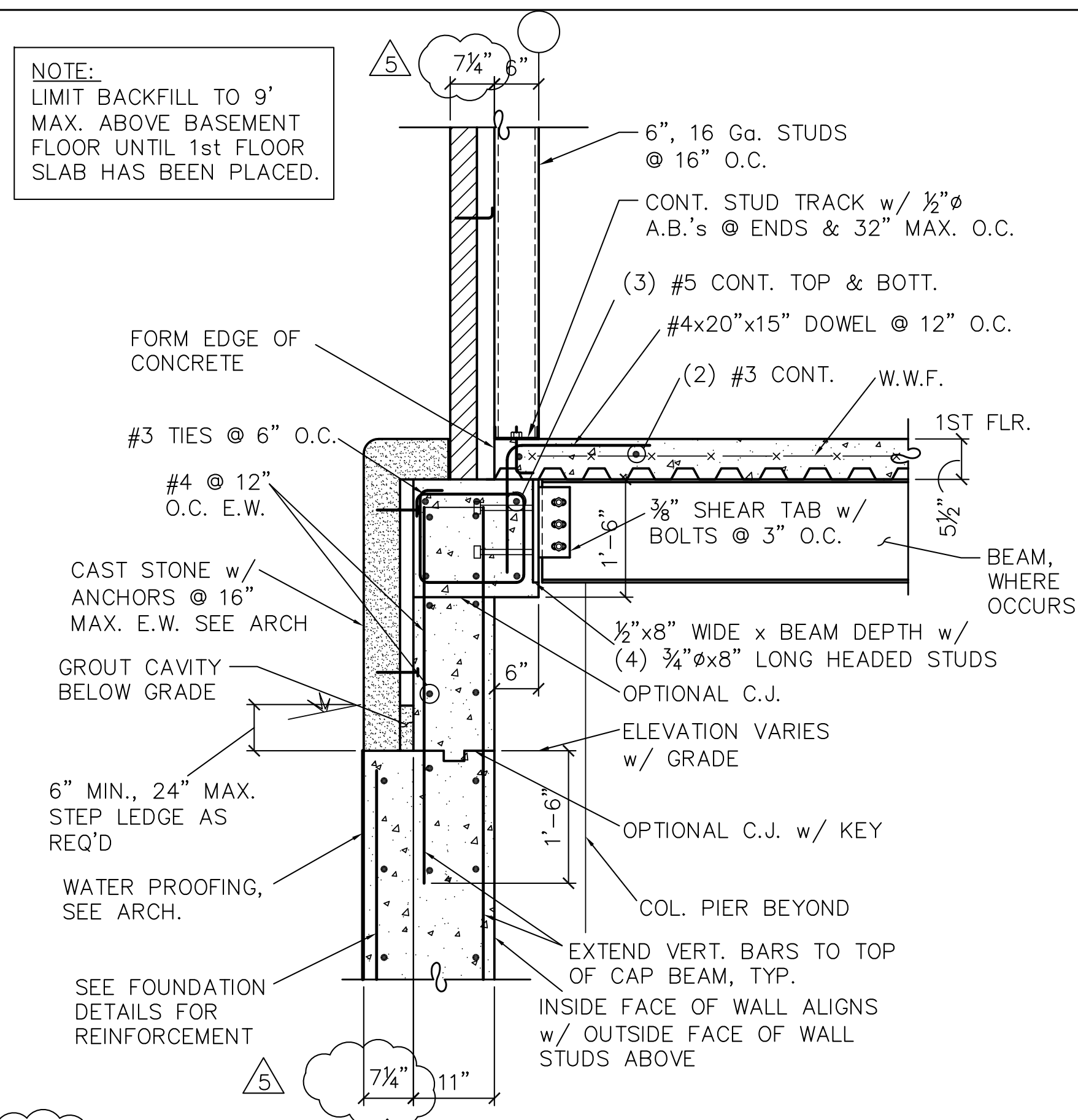


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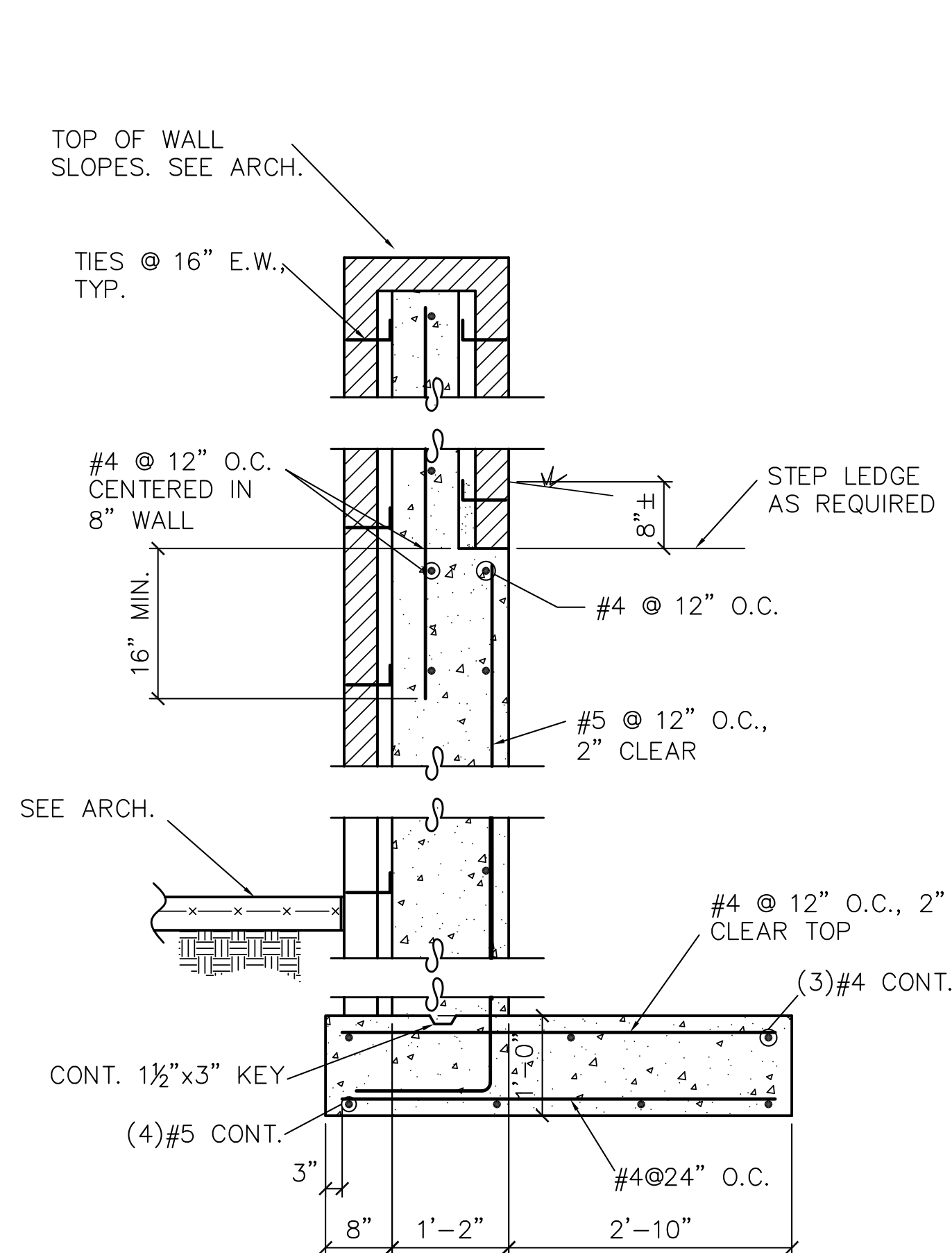




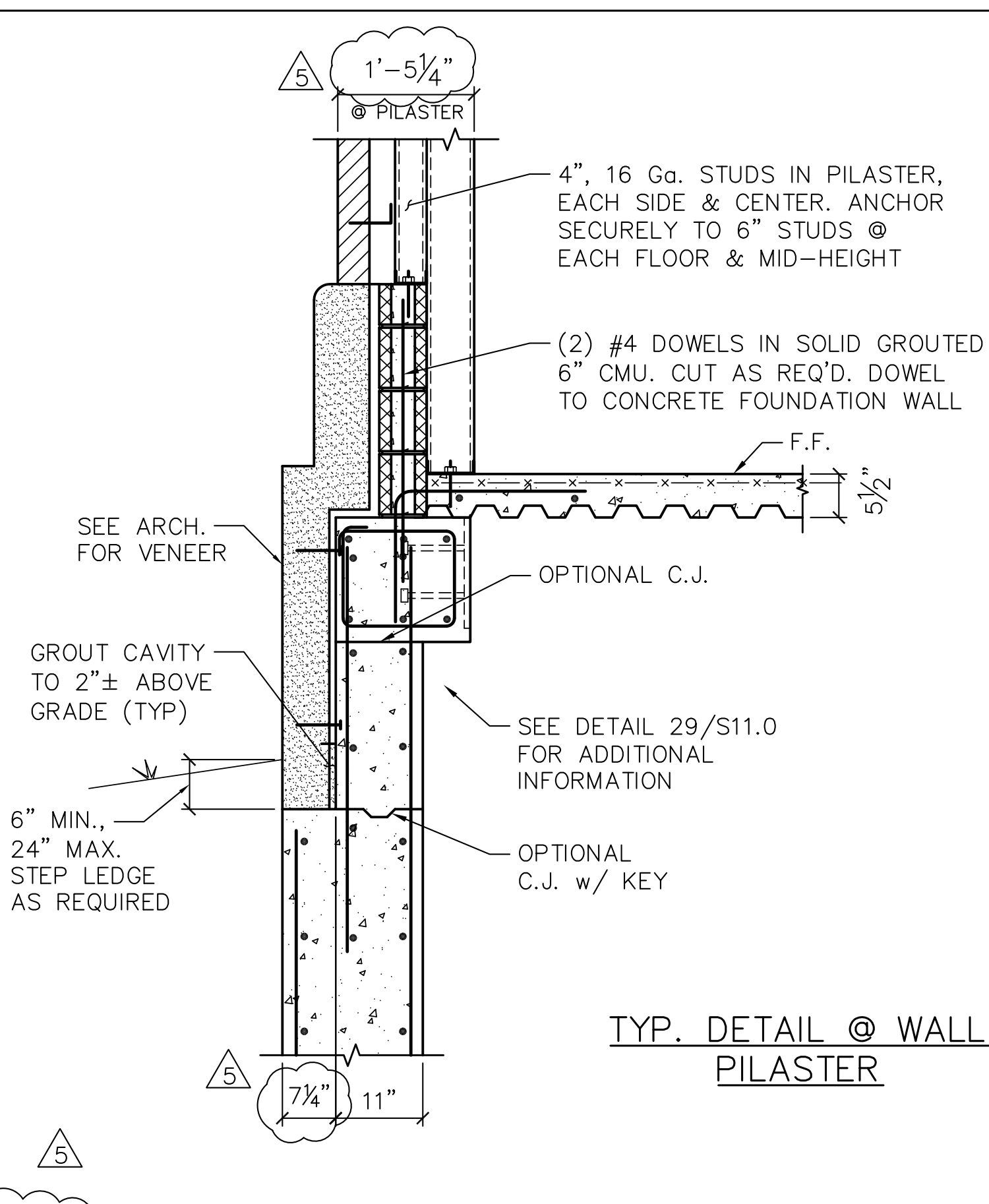




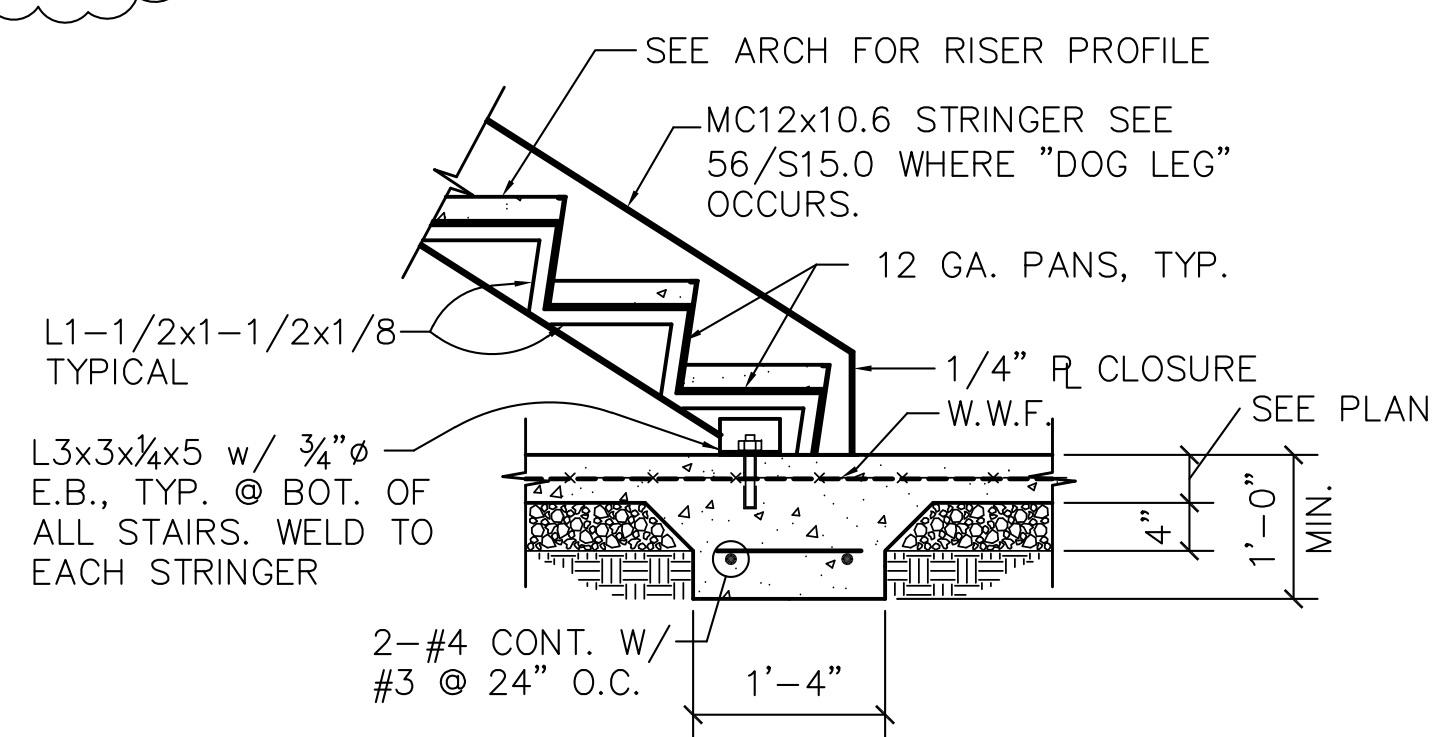
DETAIL 29



DETAIL 32

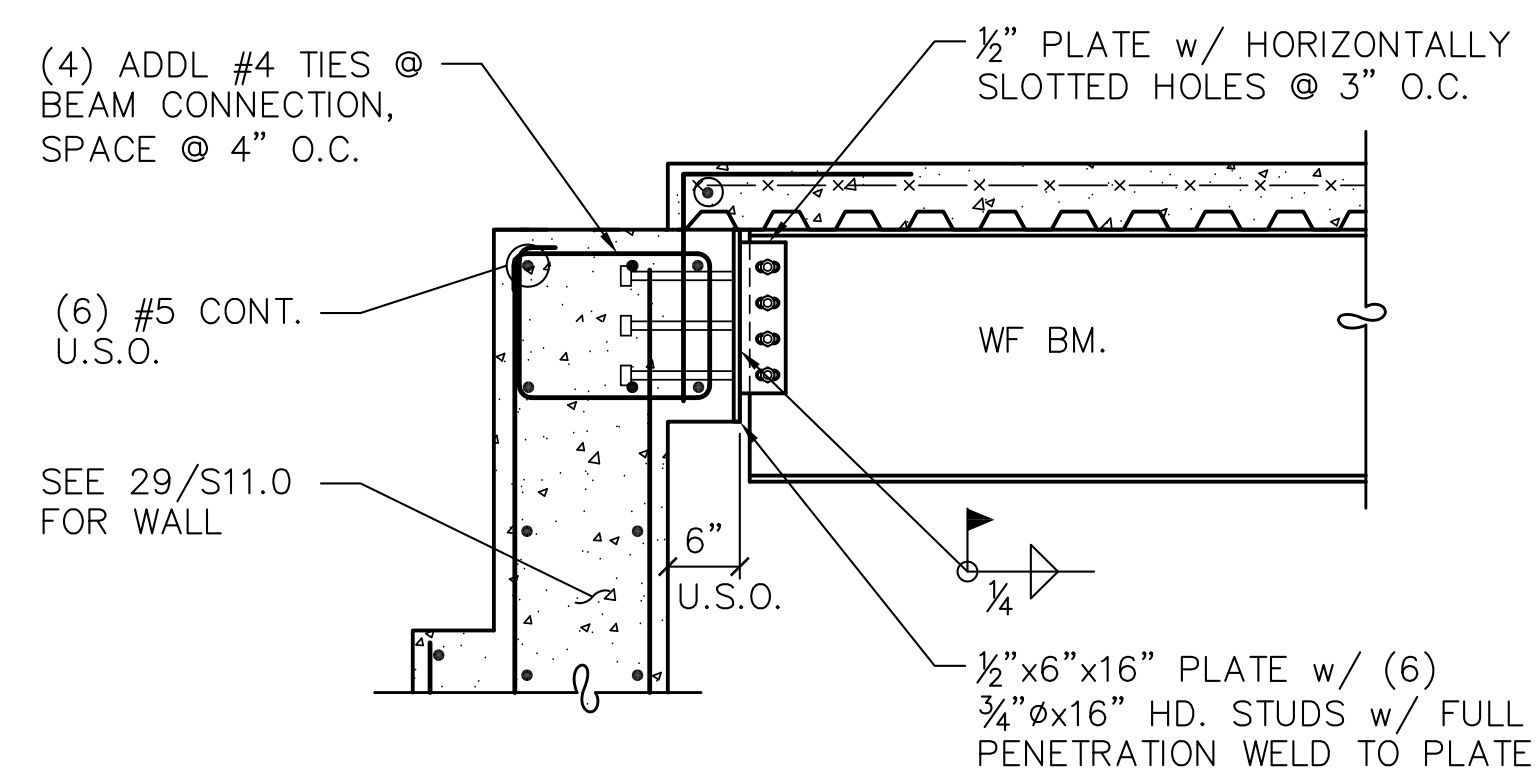


DETAIL 30



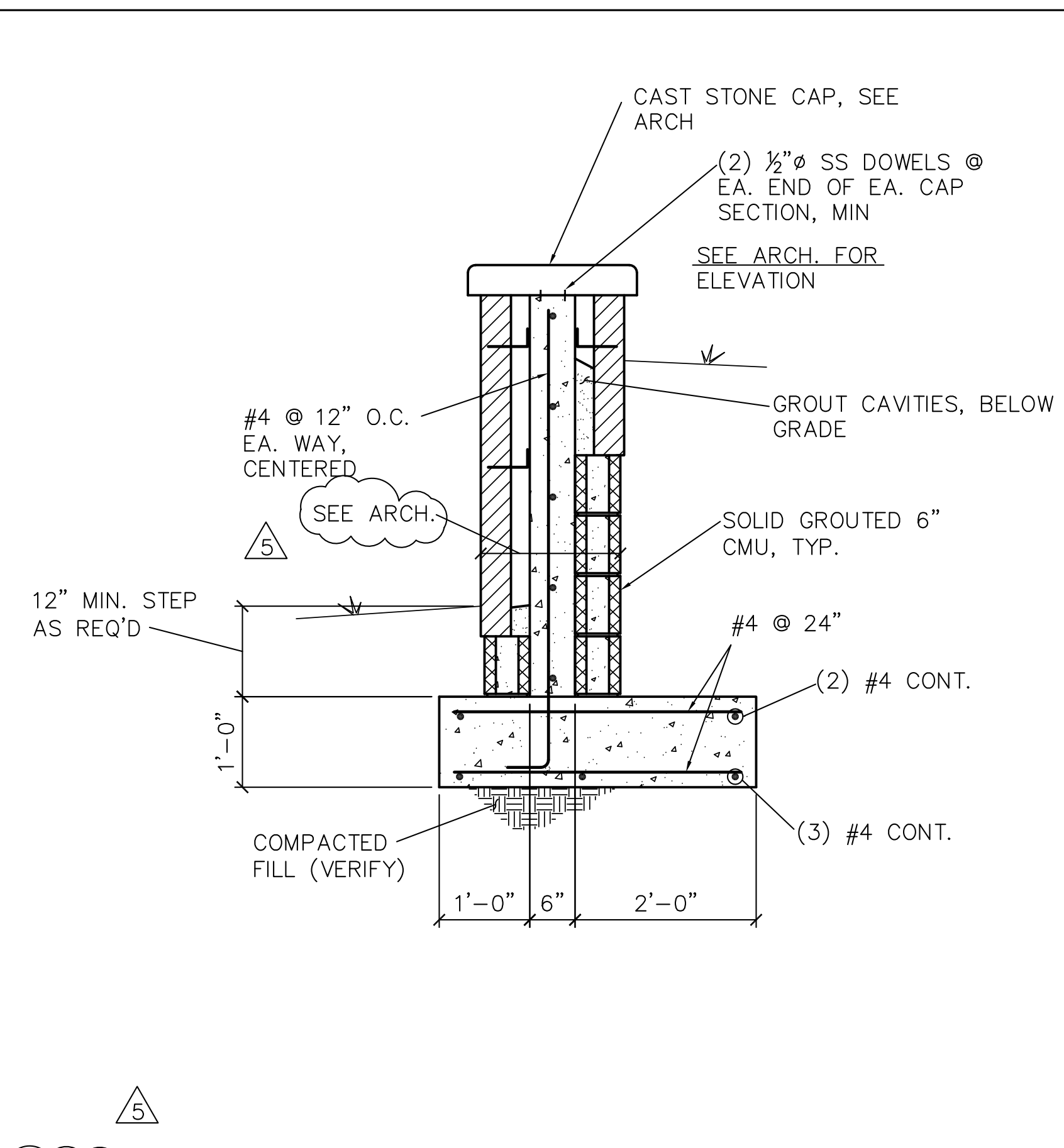
TYPICAL DETAIL @ BOTTOM OF STAIRS

DETAIL 33

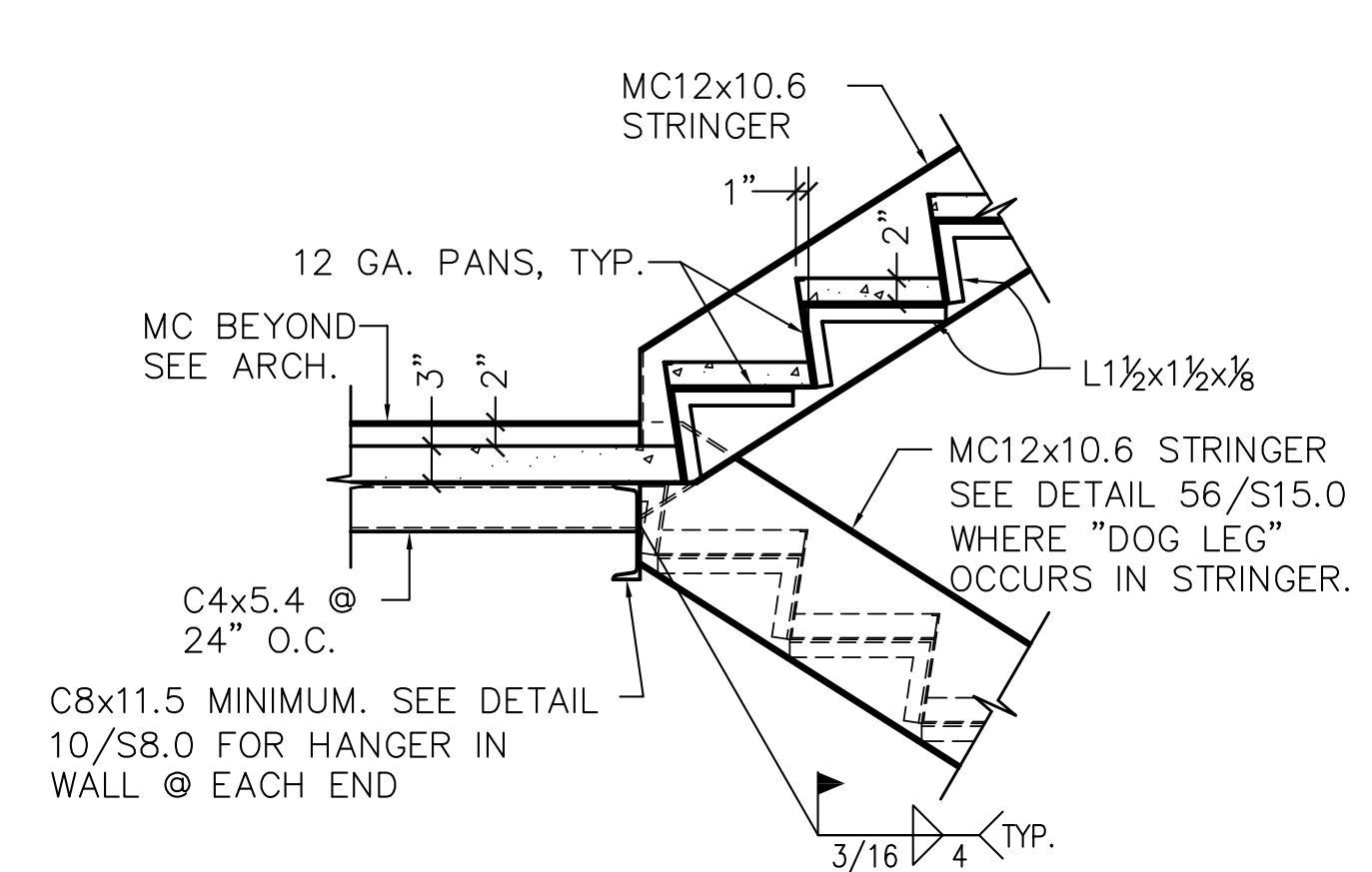


### TYPICAL BEAM CONNECTION TO BASEMENT WALL

DETAIL 34
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DETAIL 31



TYPICAL STAIR DETAIL @ LANDING

DETAIL 35



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432 Herron Street  
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Phone 334-265-4631  
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[illegible]

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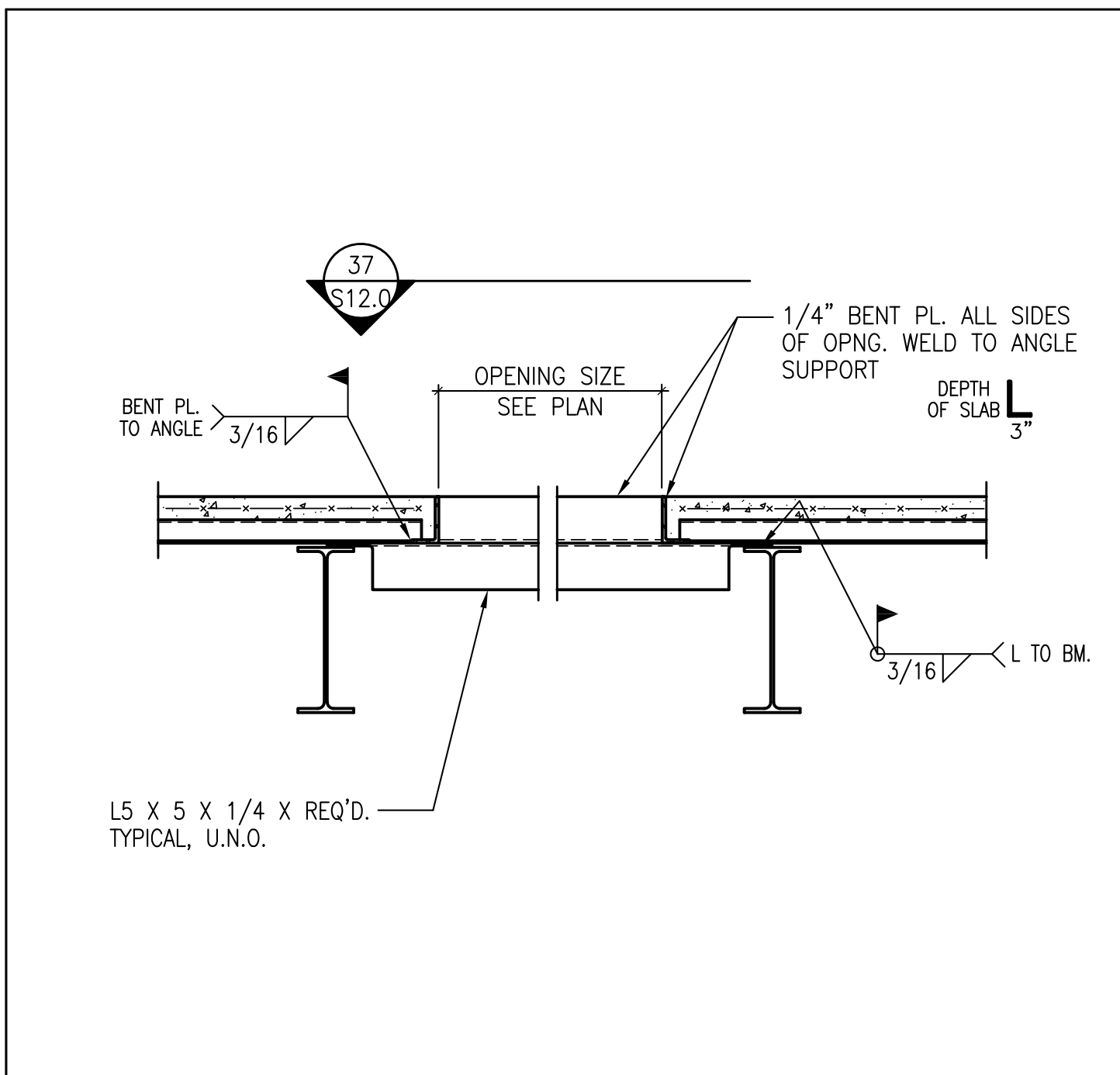
Sheet Title

## STRUCTURAL DETAILS

Sheet Number

S11.0





12 Ga. x 6" x 6' CONT.  
BENT PLATE w/ SCREW  
TO EACH RAFTER

SEE 39/S12.0  
FOR ADD'L  
DETAILS

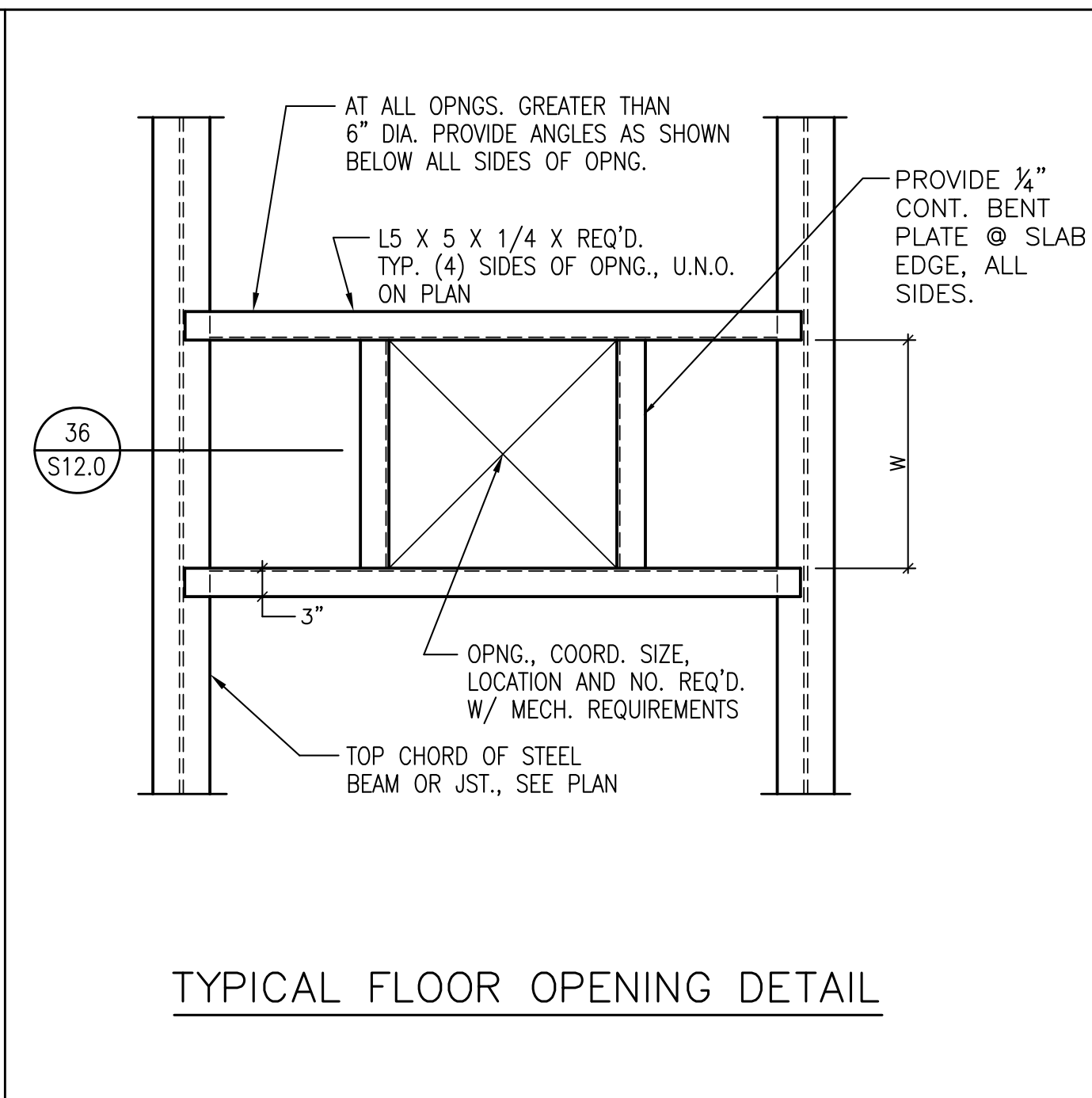
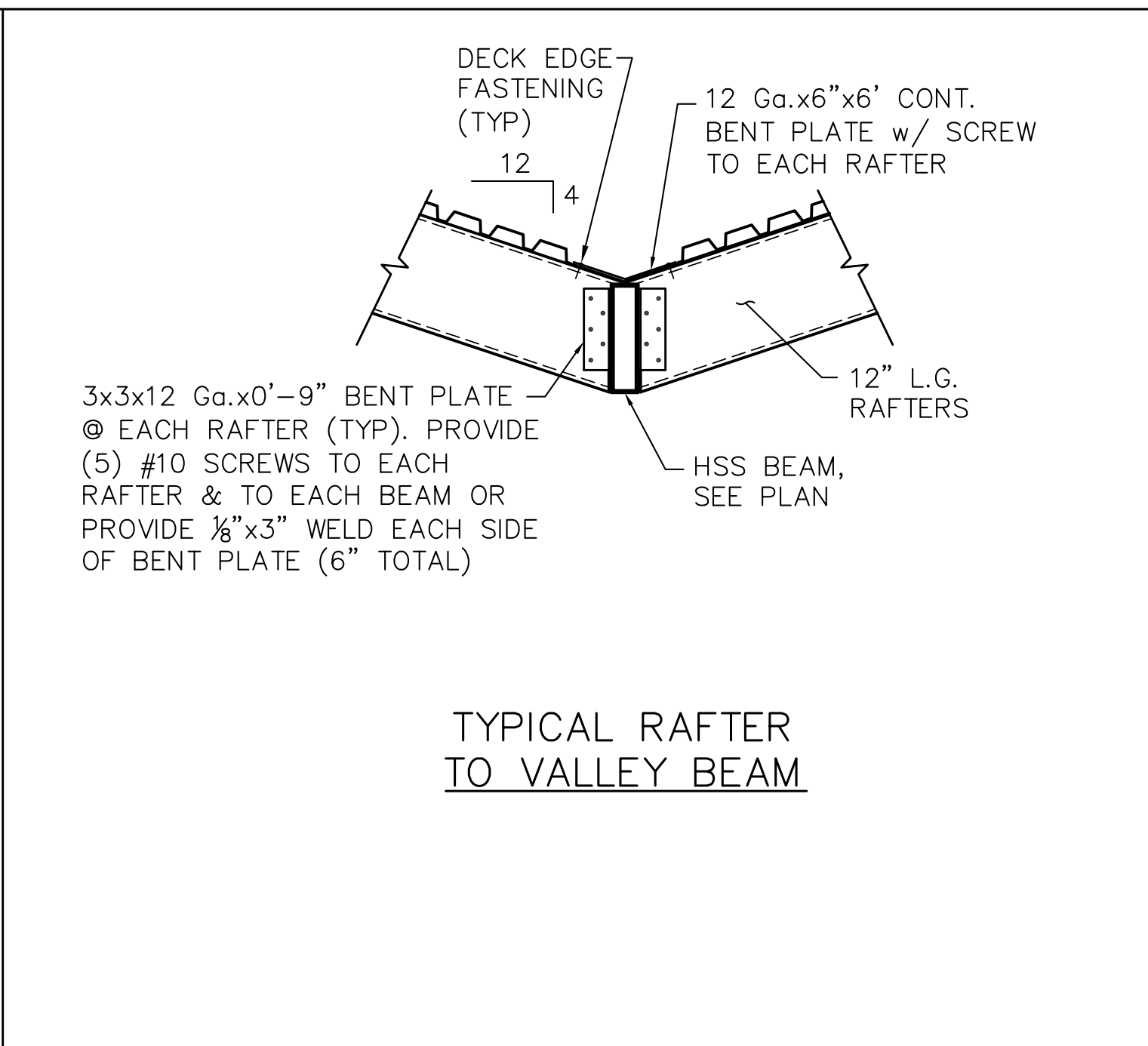
12

6

12" L.G.  
RAFTERS

HSS BEAM,  
SEE PLAN

TYPICAL RAFTER TO BEAM

[illegible]

$\frac{1}{2}$ " CAP PLATE  
 $\frac{3}{16}$ " TYP.  
 $\frac{3}{8}$ " SHEAR TAB  
 w/  $\frac{3}{4}$ "  $\phi$  BOLTS  
 @ 3" O.C.  
 STEEL BEAM,  
 SEE PLAN  
 STEEL COLUMN,  
 SEE PLAN

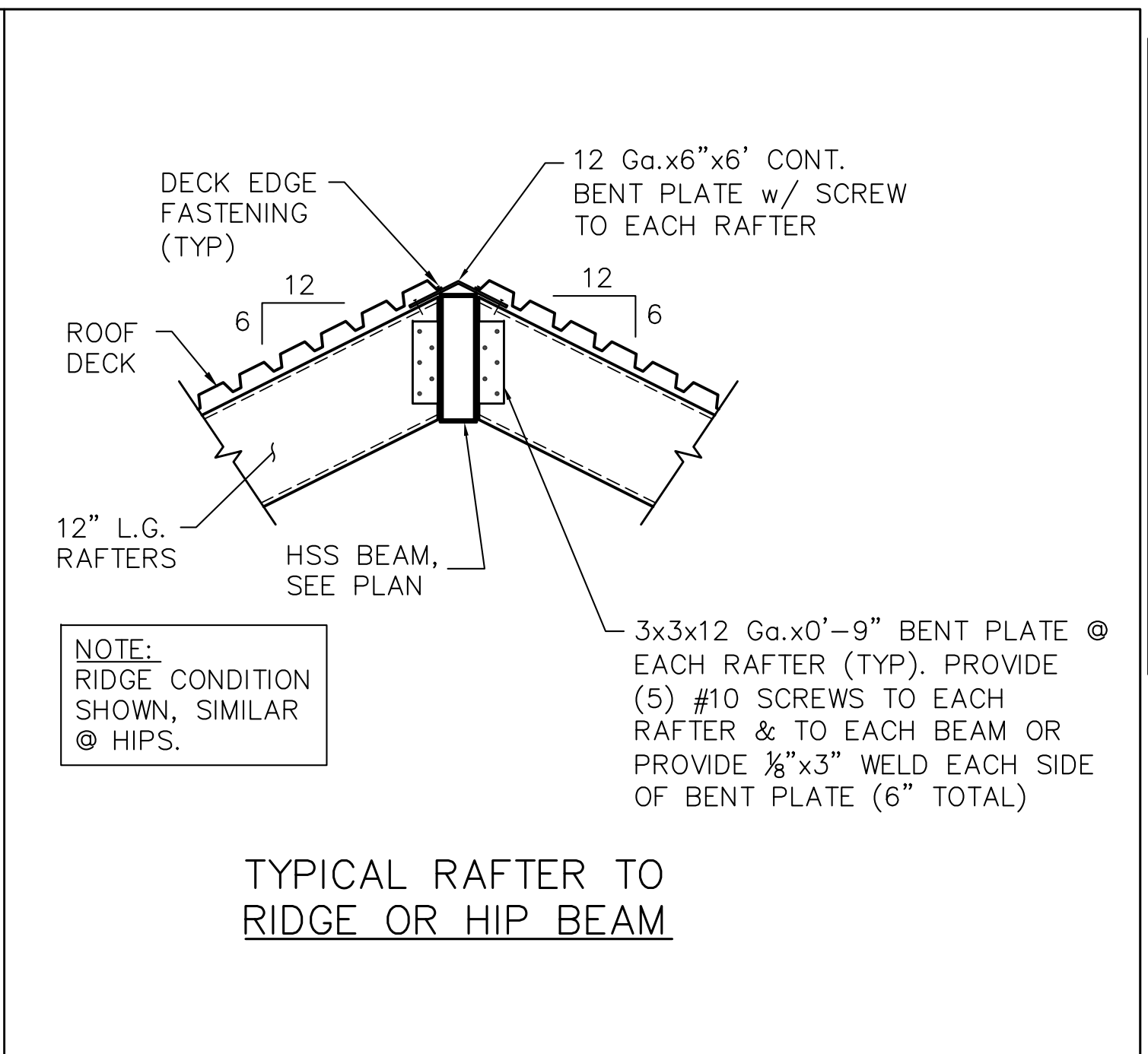
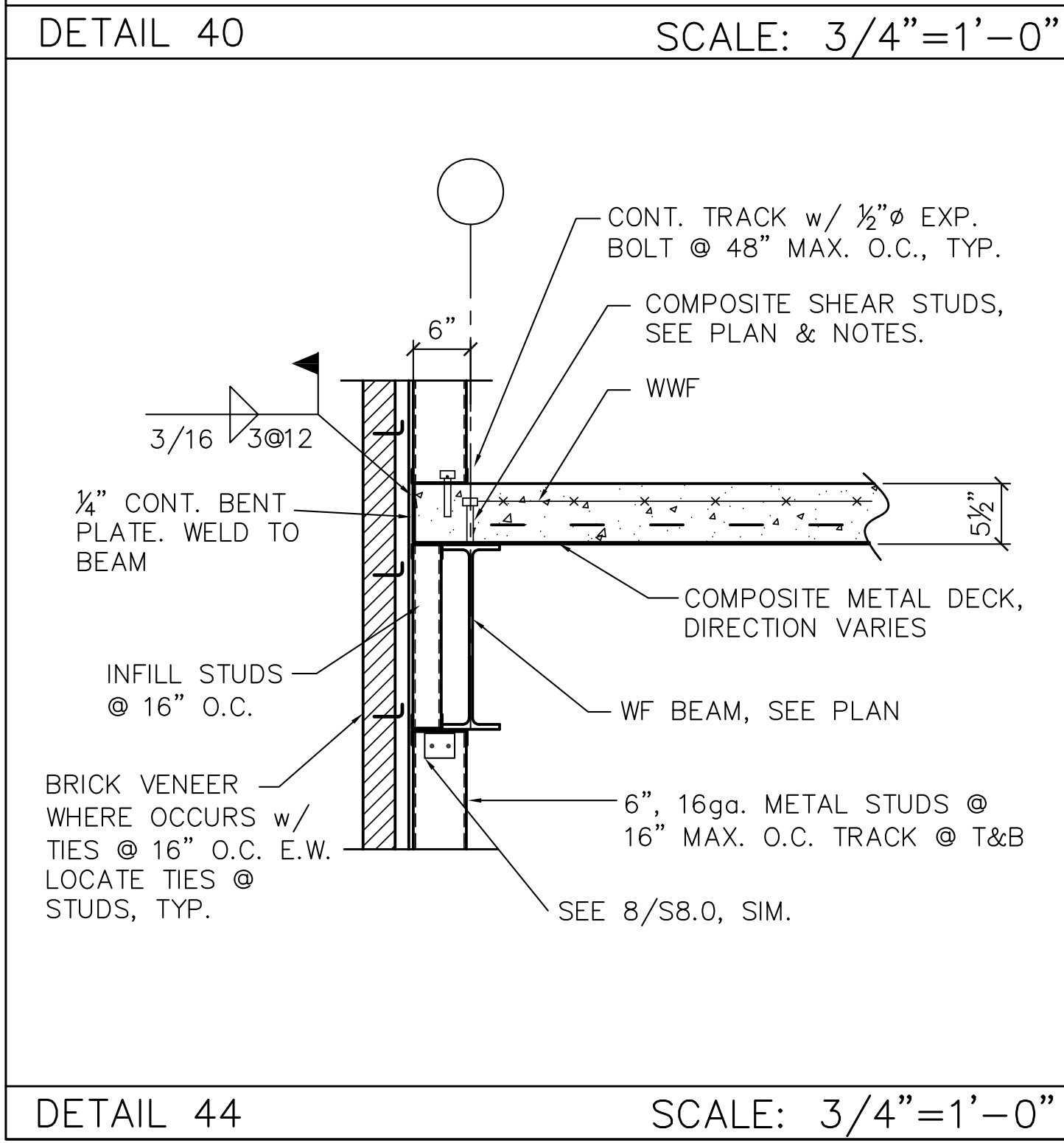
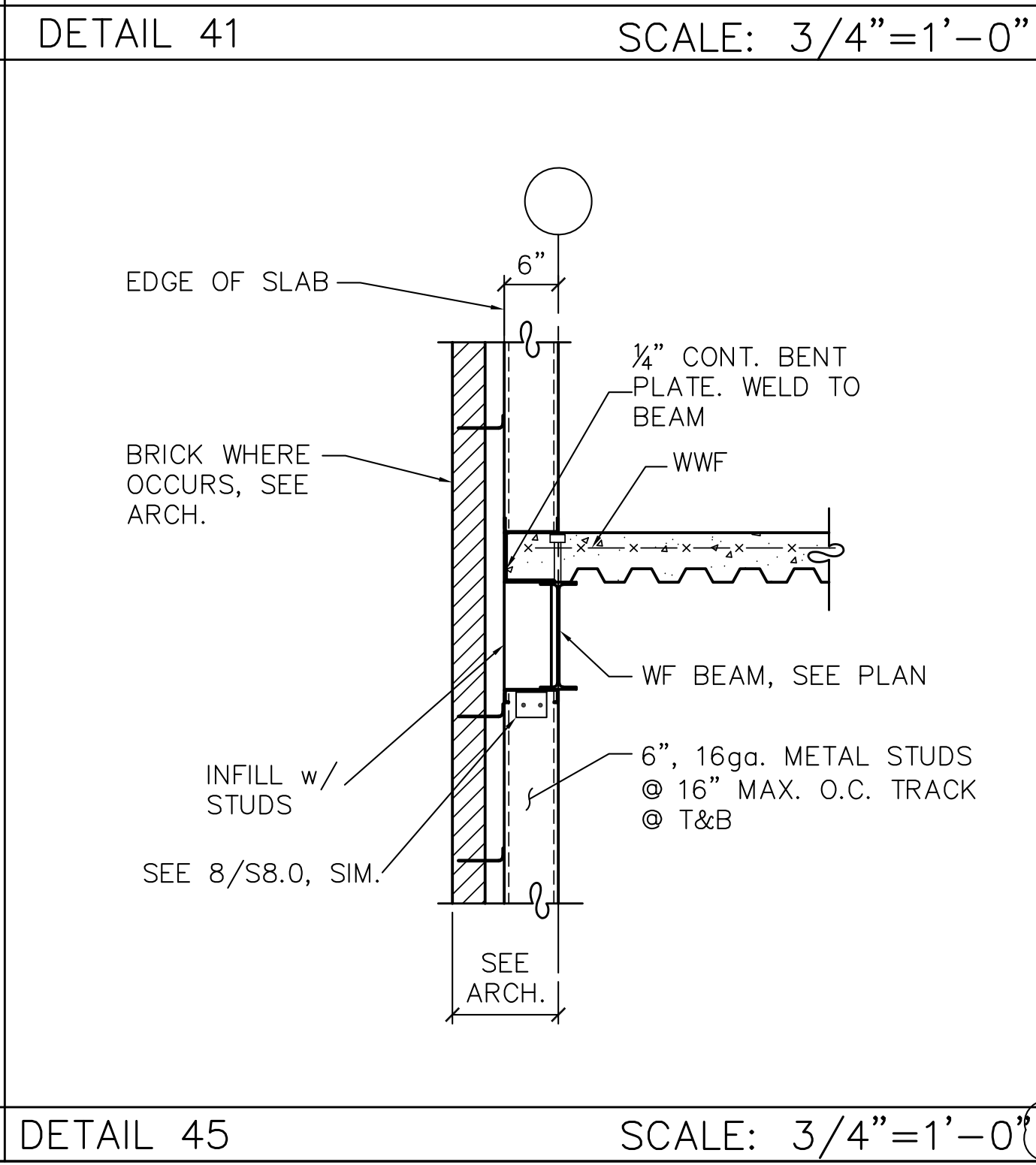


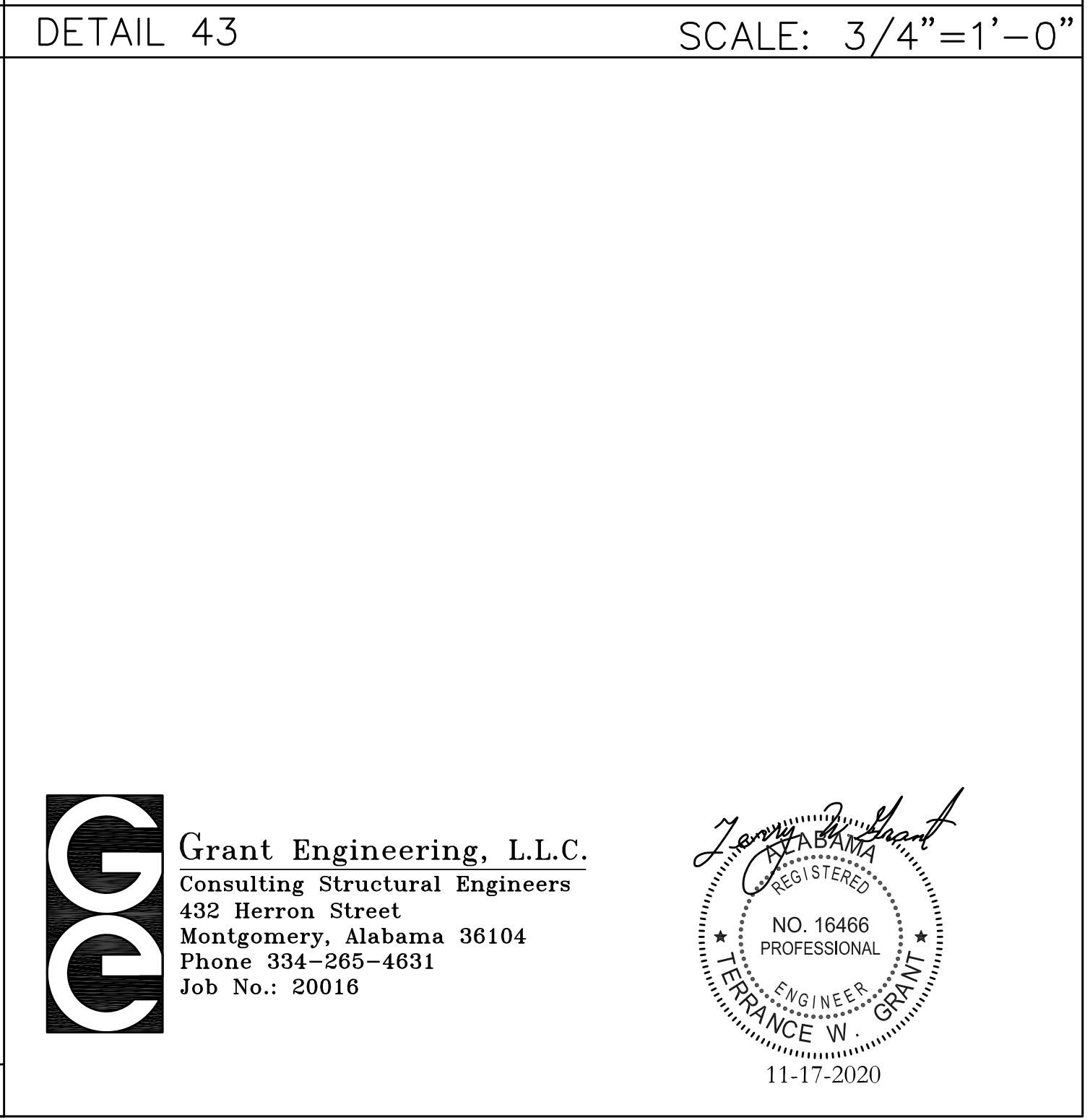
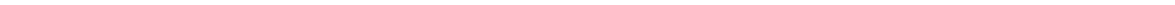
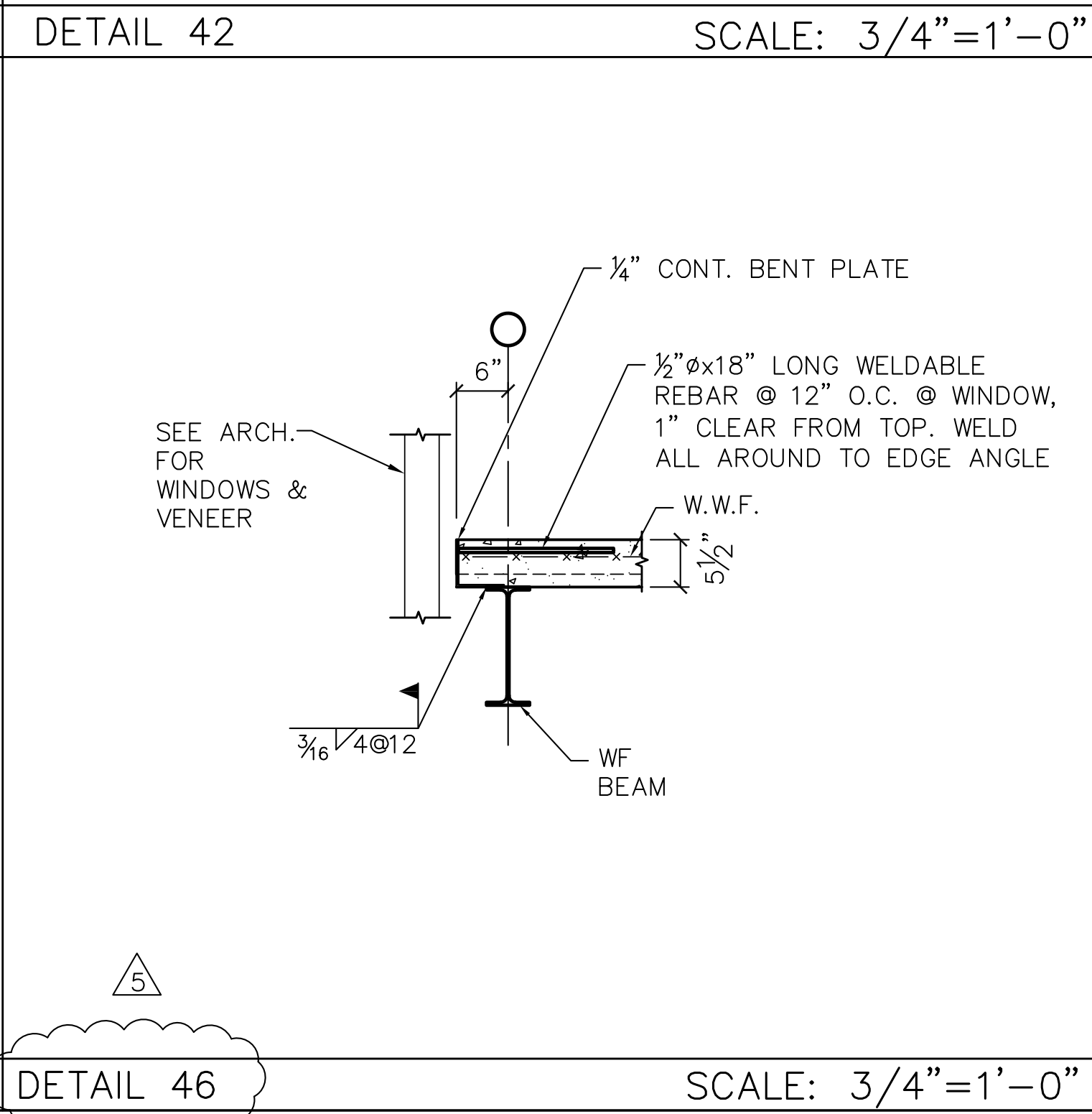
Diagram illustrating the connection between a roof support column and the floor deck & slab. The column is shown as a vertical member with a cross-section of a square or rectangular shape. The floor deck & slab is shown as a horizontal member. The connection is detailed with a 5/8" plate with 4 bolts on the column face, a 3/8" stiffener on each side of the column, and an attic floor composite beam. Labels indicate: 5/8" PLATE w/ (4) BOLTS, ROOF SUPPORT COL., SEE PLAN, FLOOR DECK & SLAB NOT SHOWN, 3/8" STIFFNER EA. SIDE, and ATTIC FLOOR COMPOSITE BEAM.



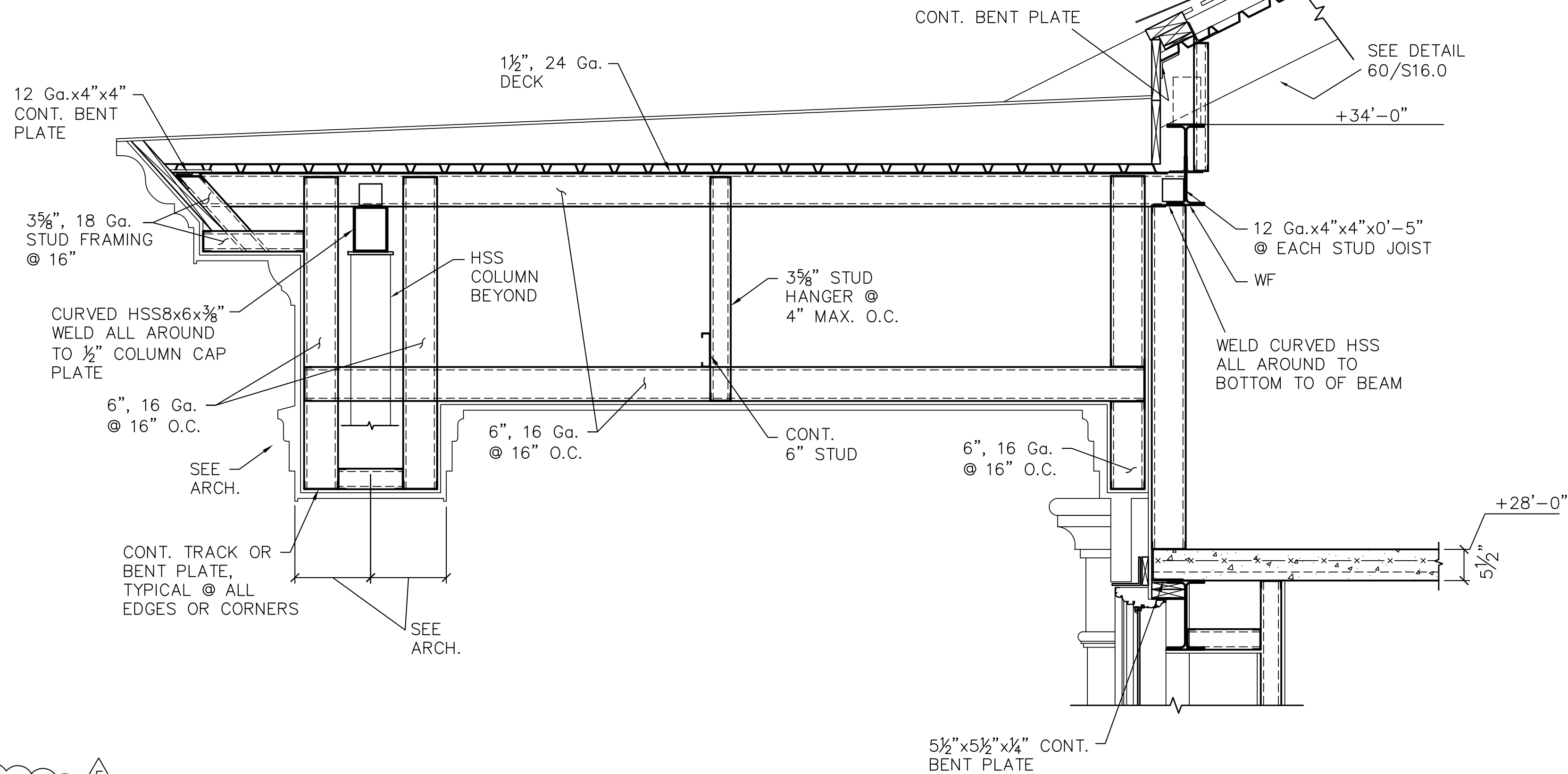
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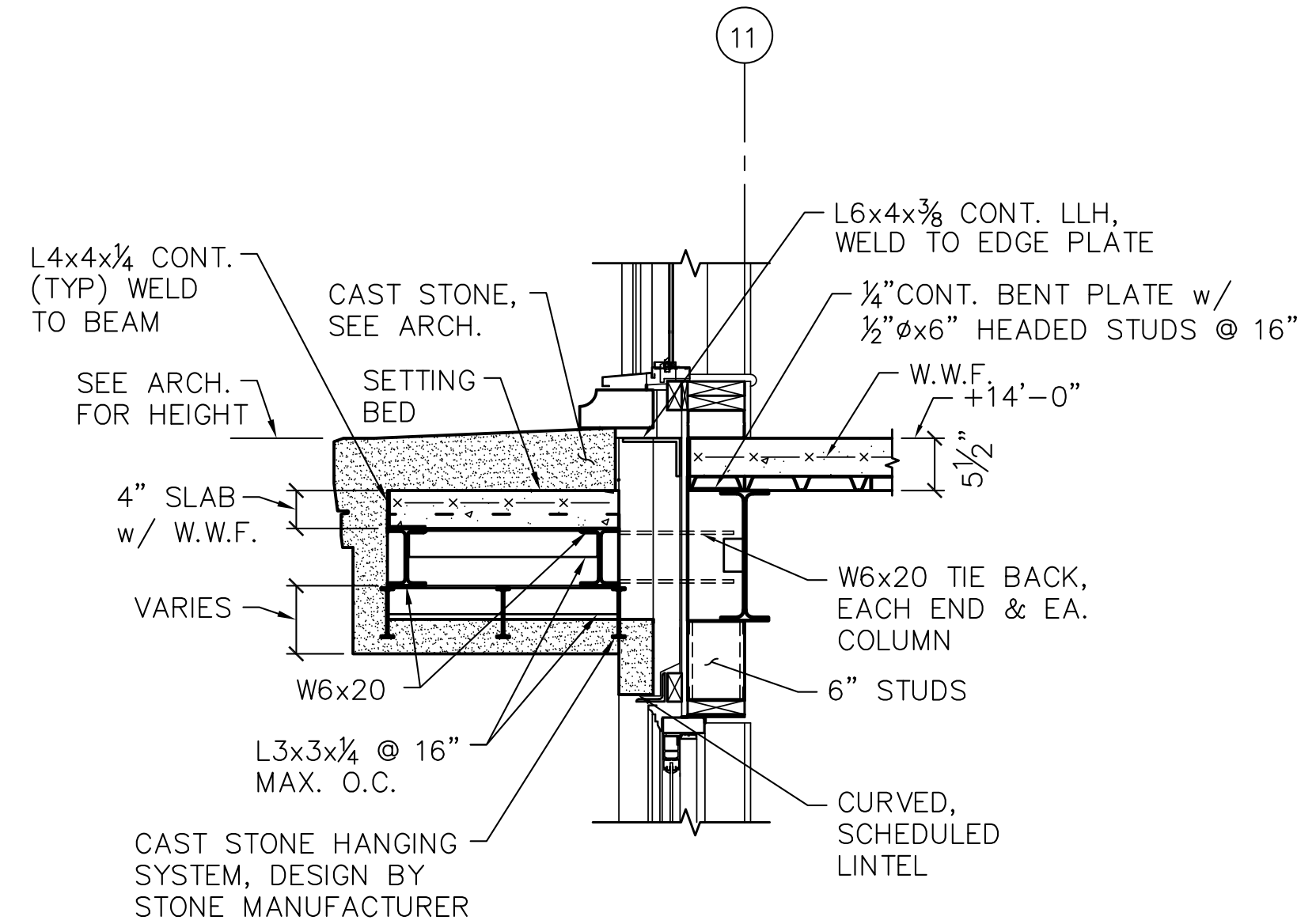






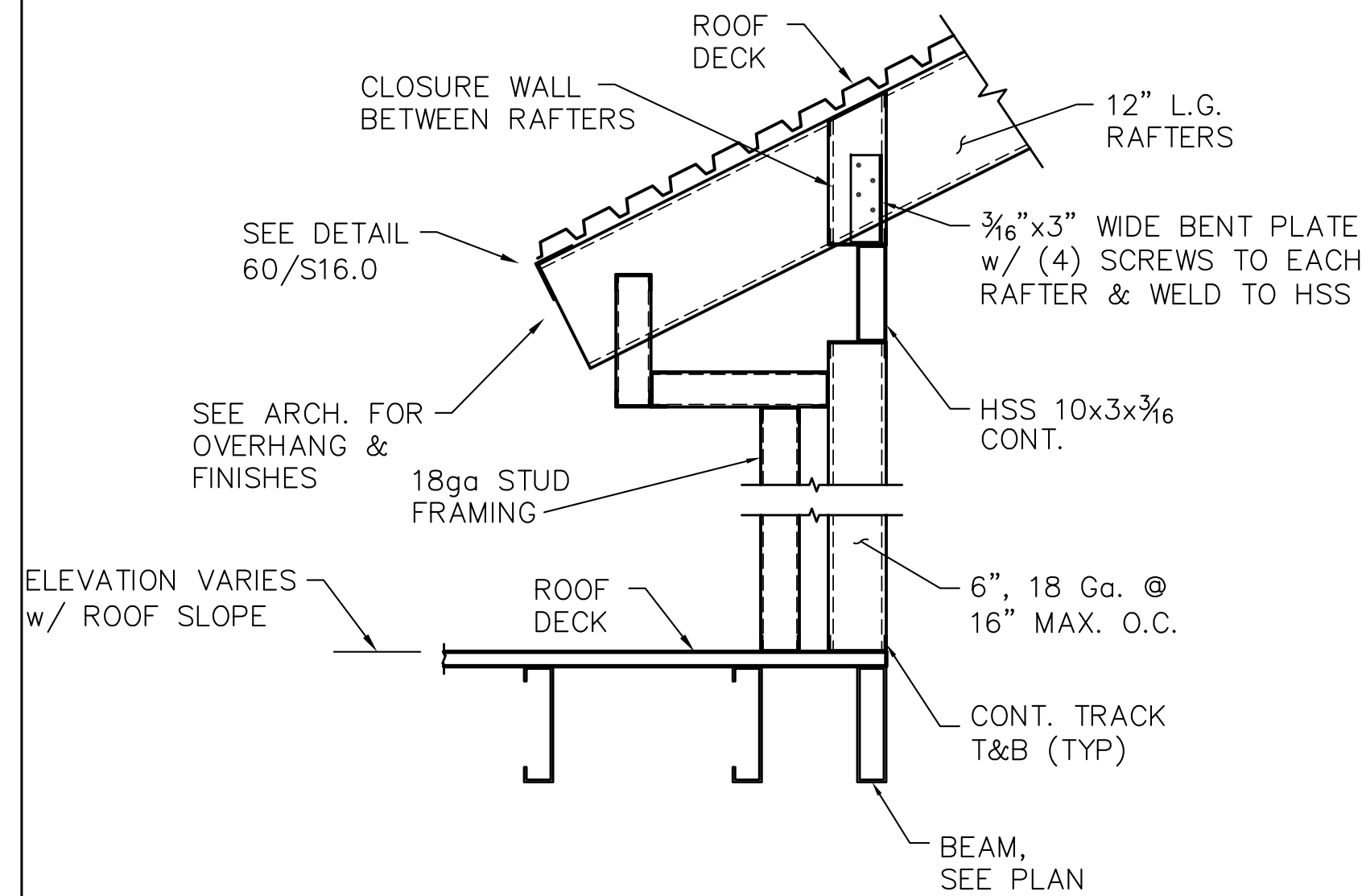
DETAIL 47

SCALE: 3/4"=1'-0"



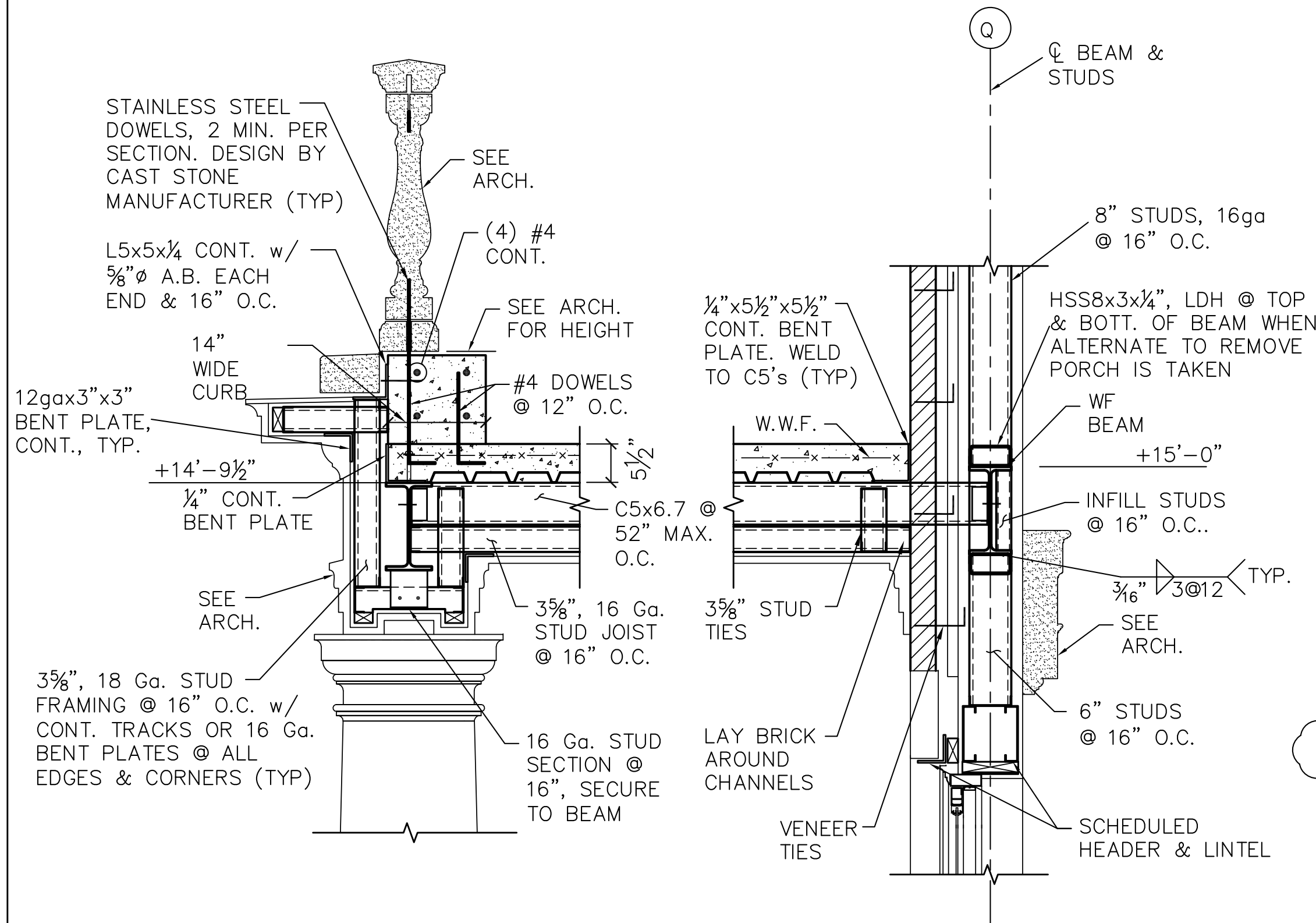
DETAIL 48

SCALE: 3/4"=1'-0"



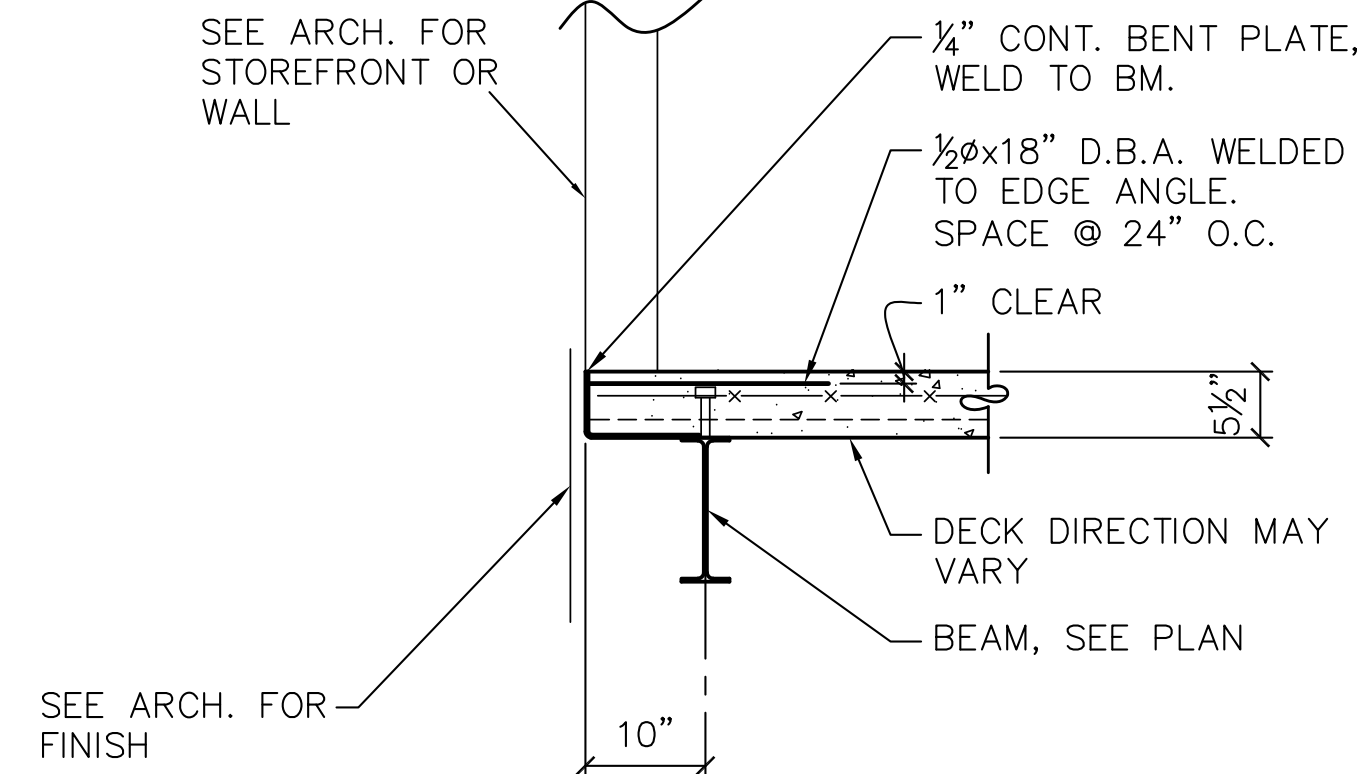
DETAIL 49

SCALE: 3/4"=1'-0"



DETAIL 50

SCALE: 3/4"=1'-0"

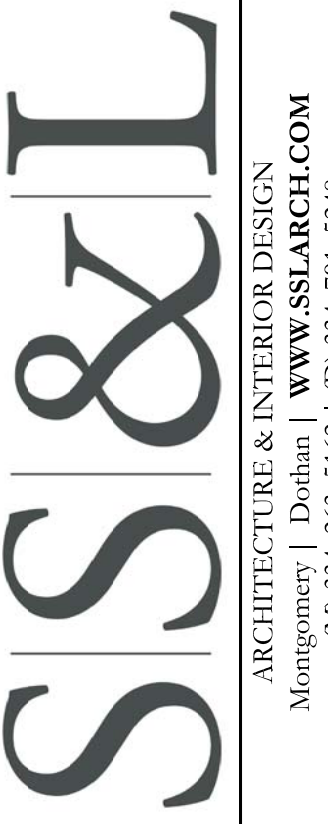
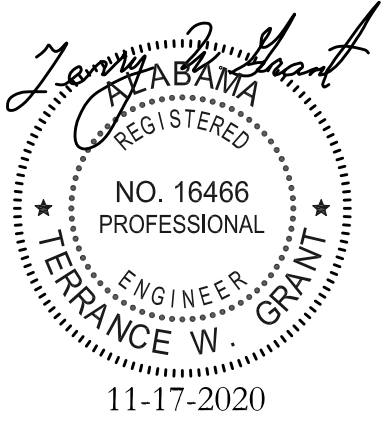


DETAIL 51

SCALE: 3/4"=1'-0"



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Consulting Structural Engineers  
432 Herron Street  
Montgomery, Alabama 36104  
Phone 334-265-4631  
Job No.: 20016



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Job Number 18144

Date 1/17/2020

Drawn By jrm

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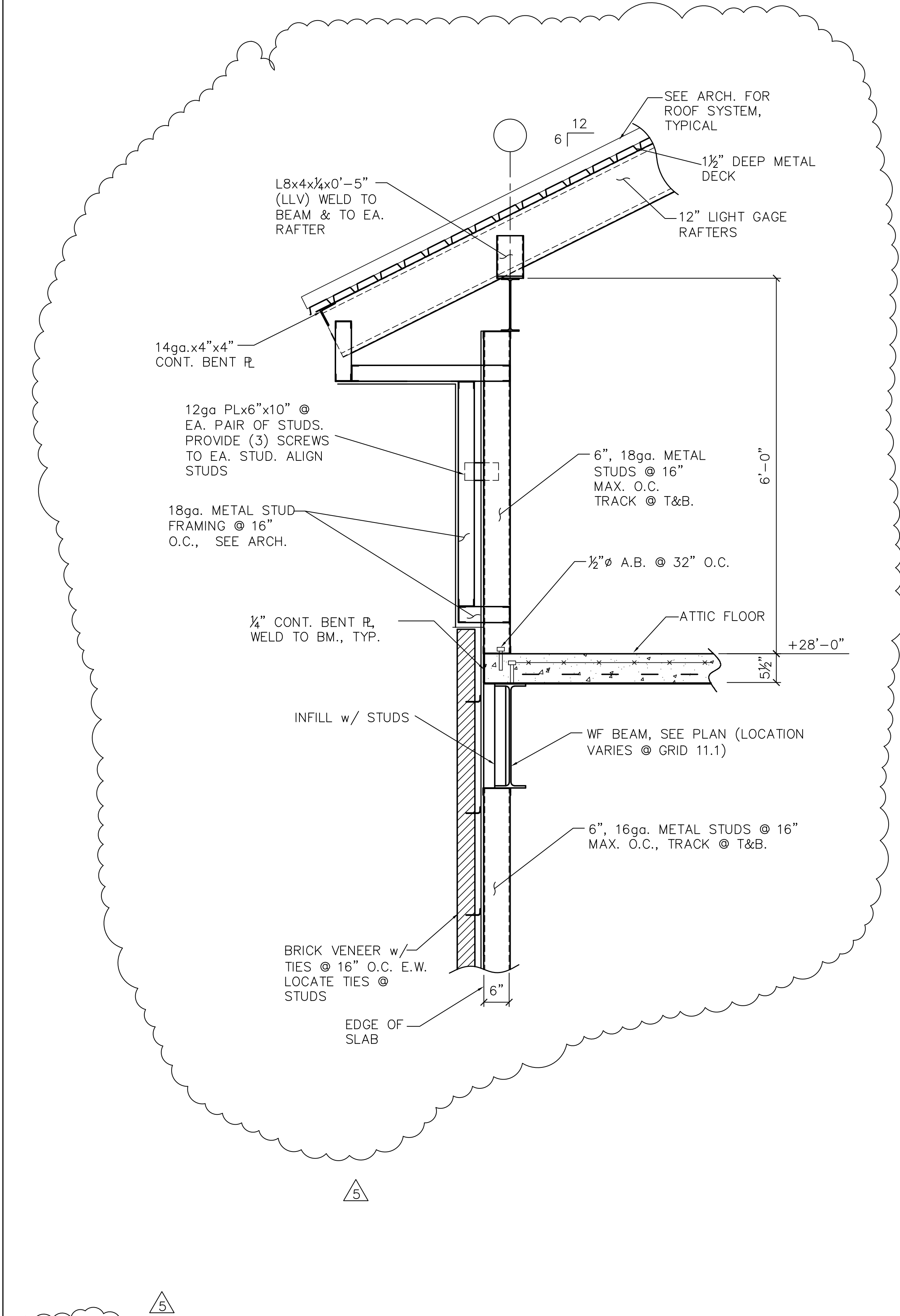
STRUCTURAL  
DETAILS

Sheet Number

S13.0



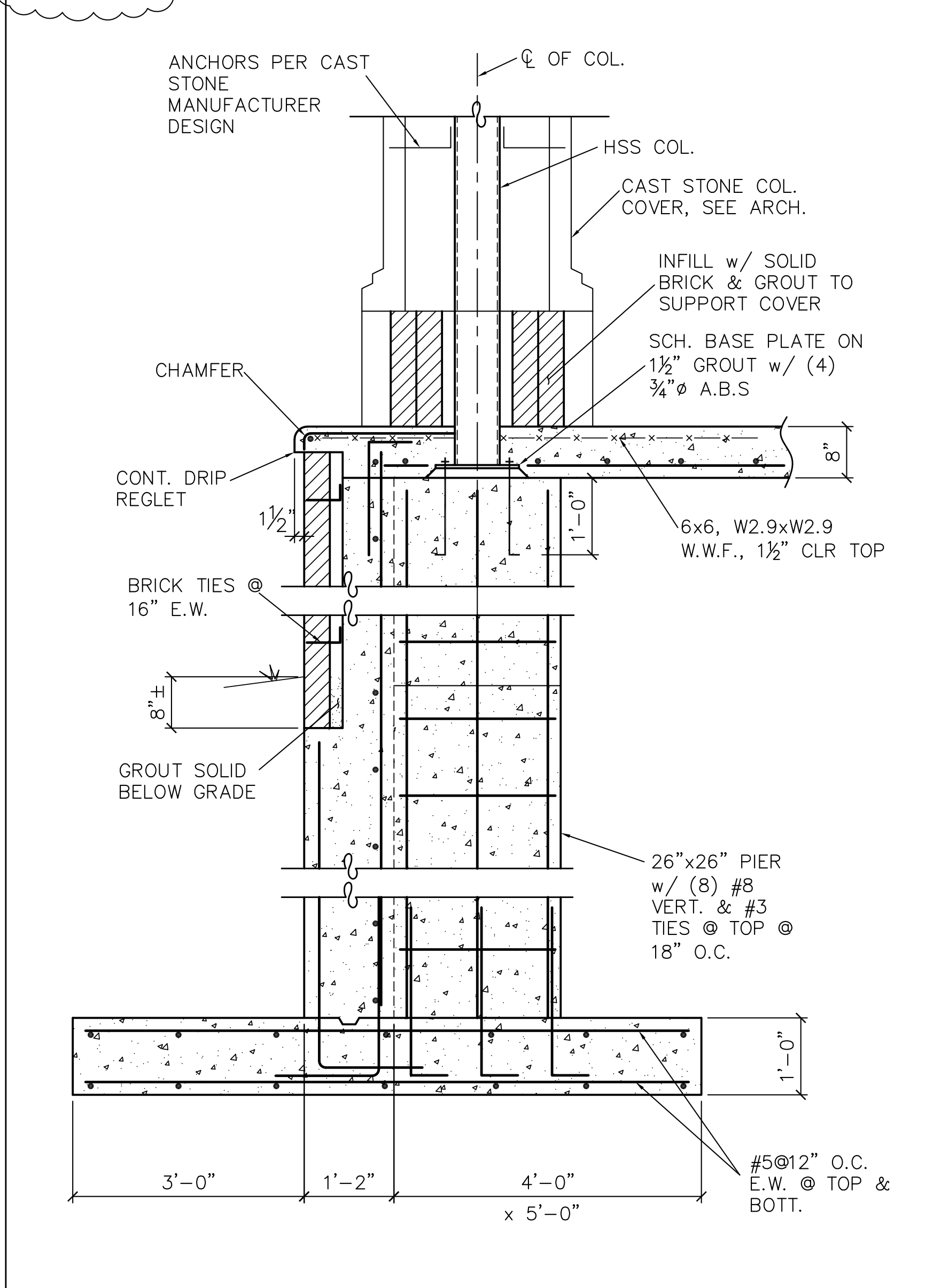




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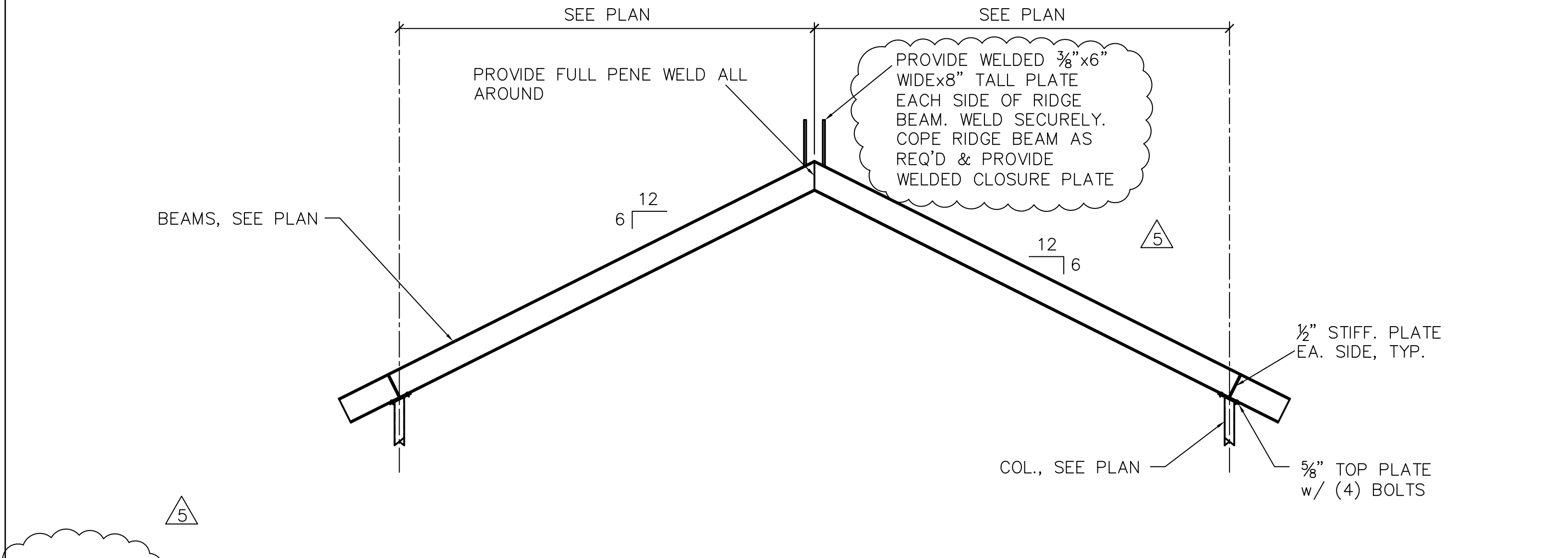
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DETAIL 61



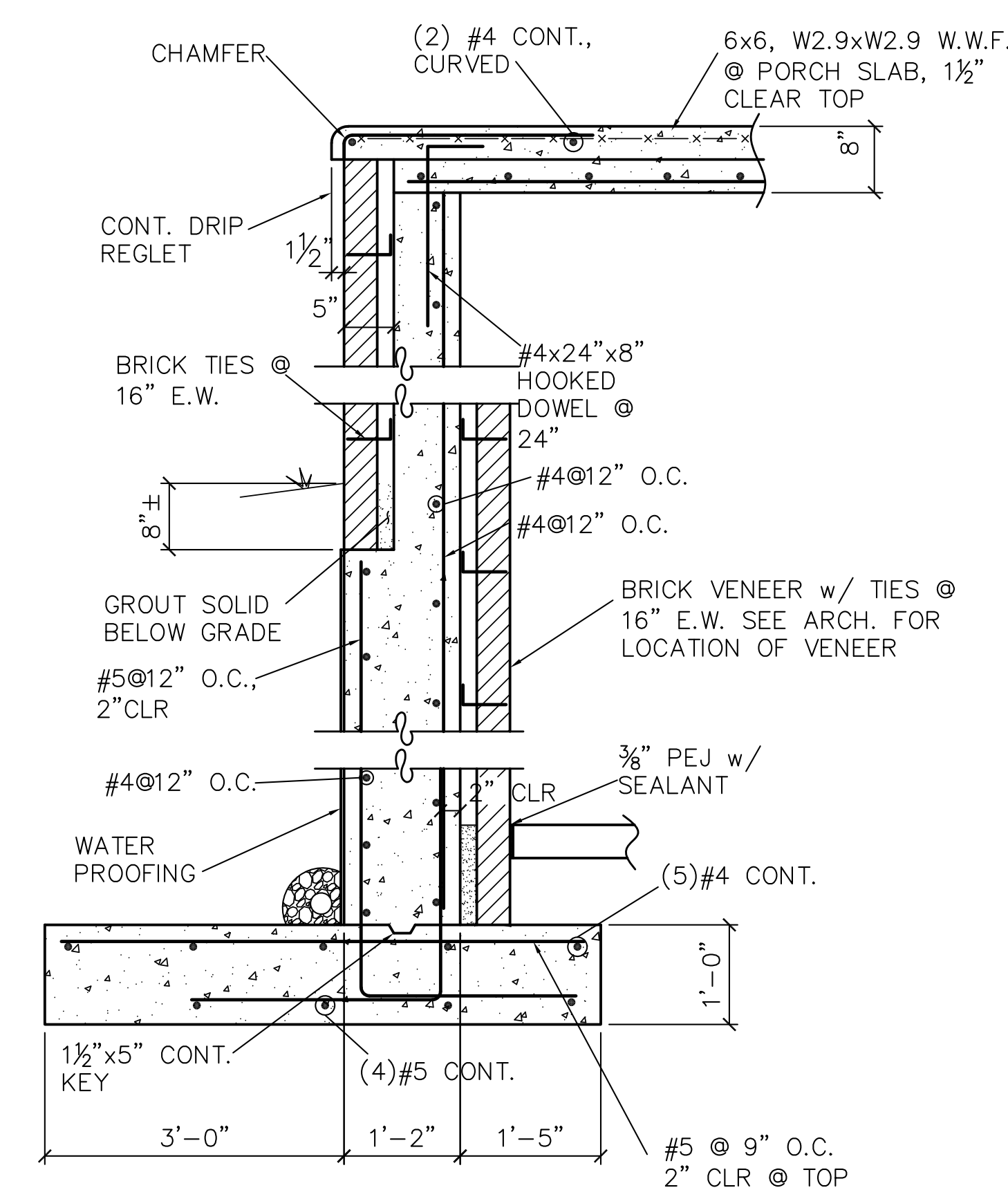
DETAIL 62

SCALE: 3/4"=1'-0"



DETAIL 61

SCALE: 3/4"=1'-0"

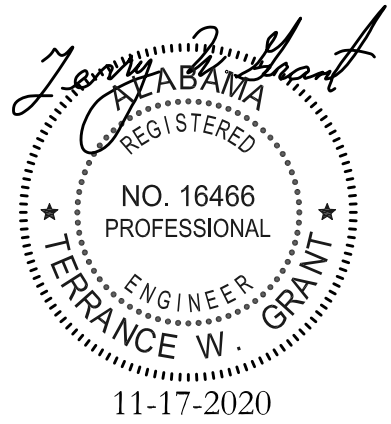


DETAIL 63

SCALE: 3/4"=1'-0"



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Job Number	18144
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Drawn By	jrm
Checked By	TWG

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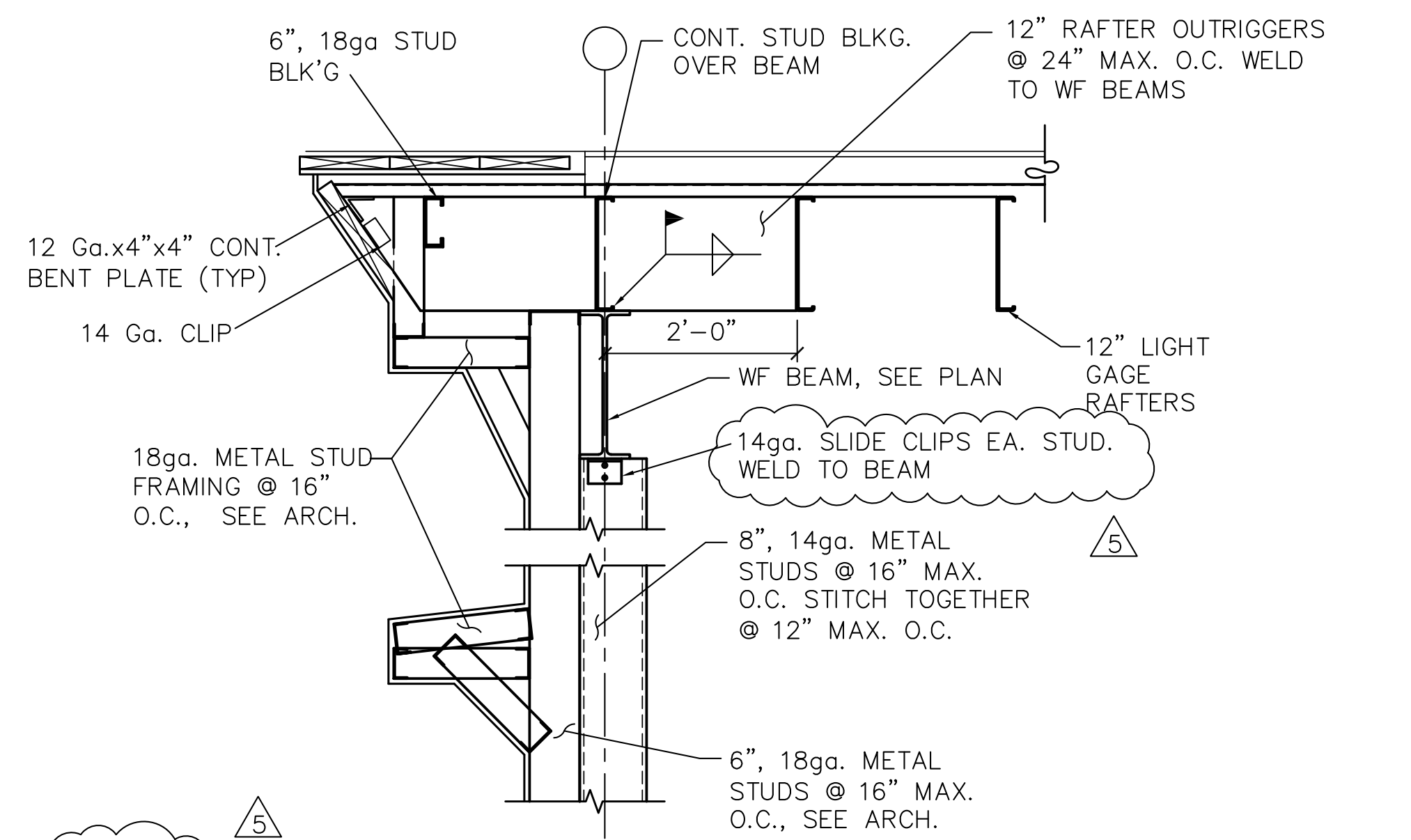
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**STRUCTURAL DETAILS**

Sheet Number  
**S16.0**



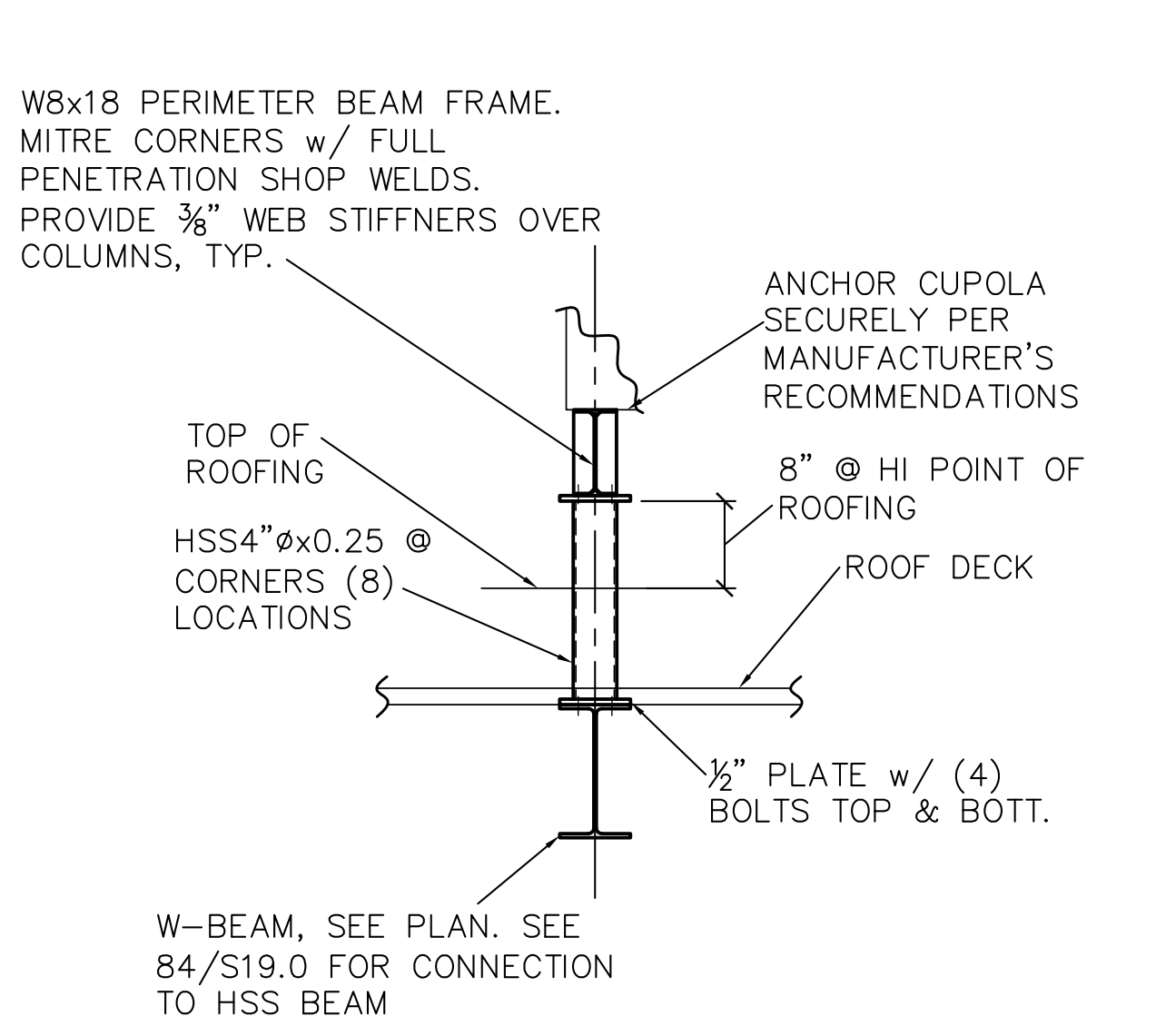






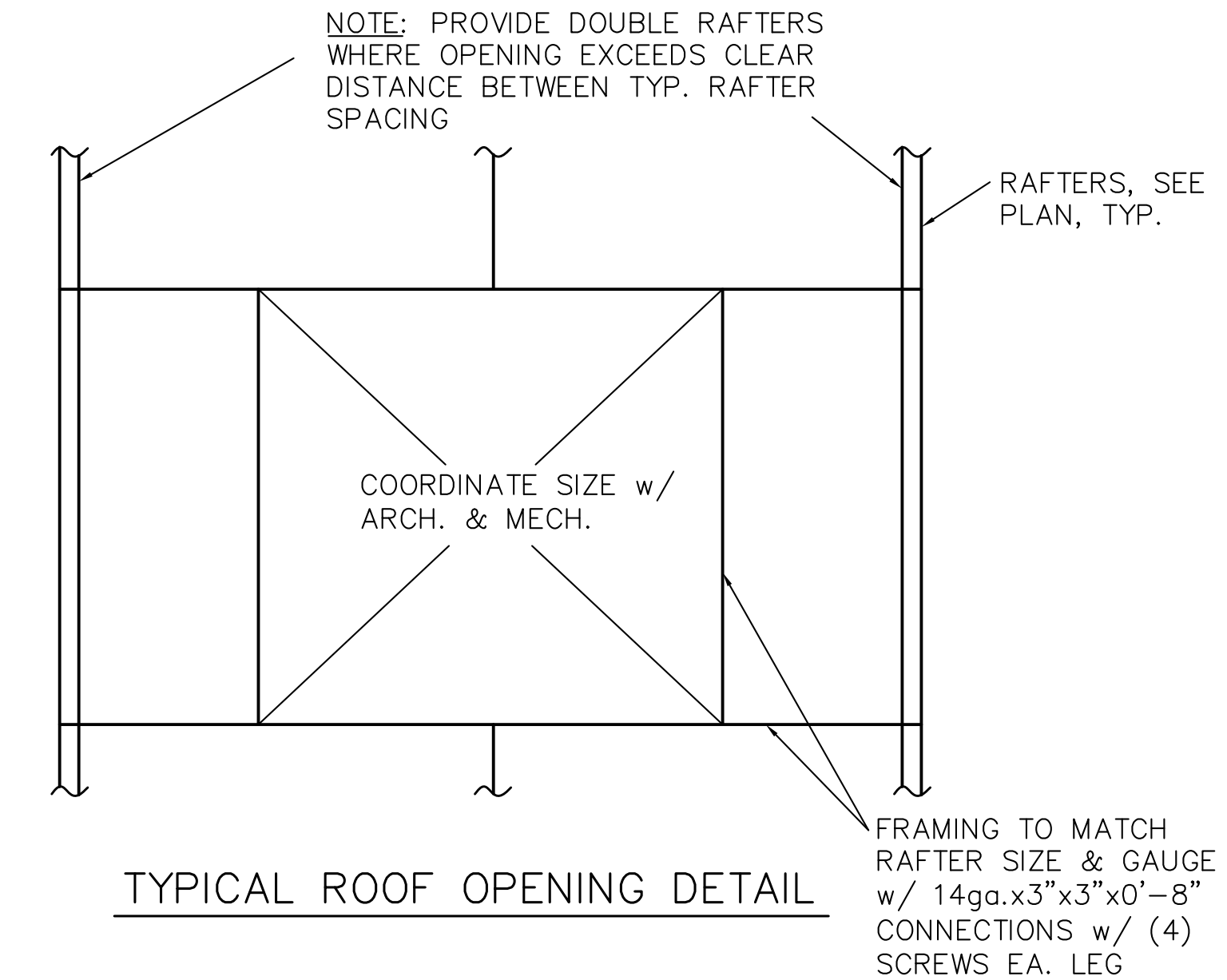
DETAIL 81

SCALE:  $3/4"=1'-0"$



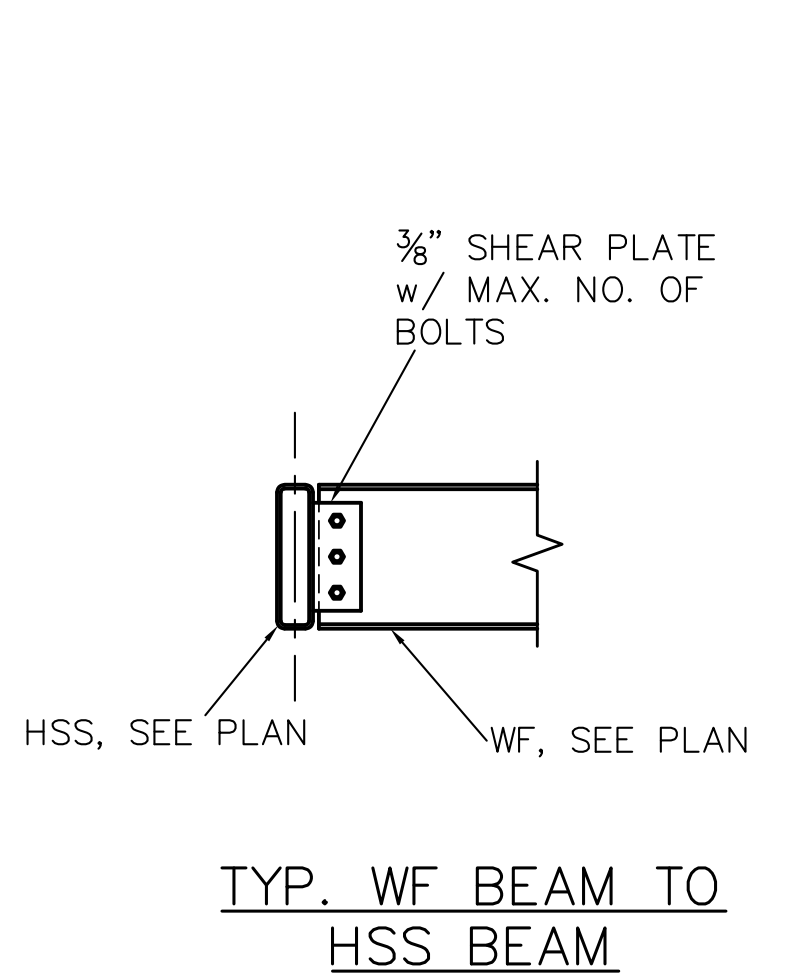
DETAIL 82

SCALE:  $3/4"=1'-0"$



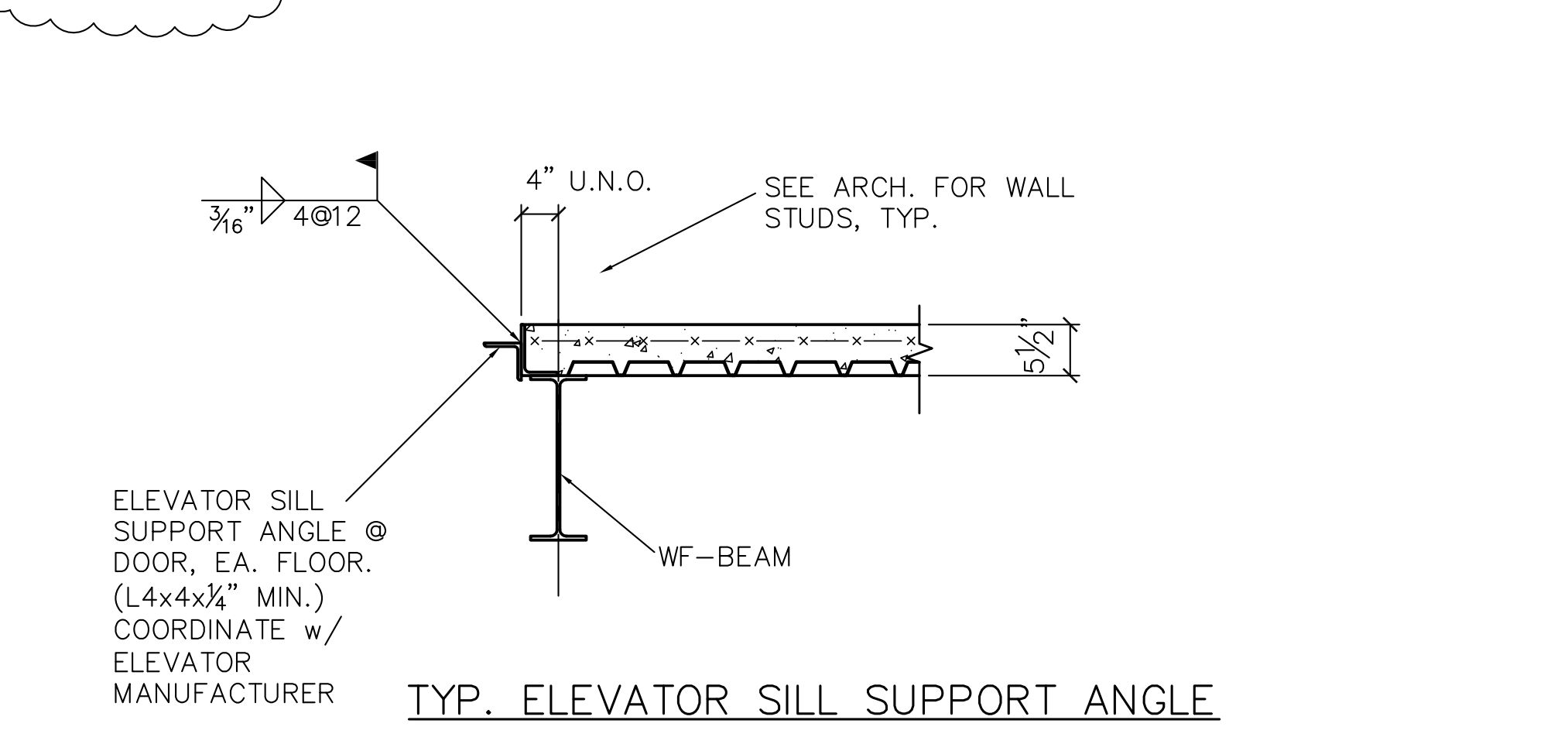
DETAIL 83

NO SCALE



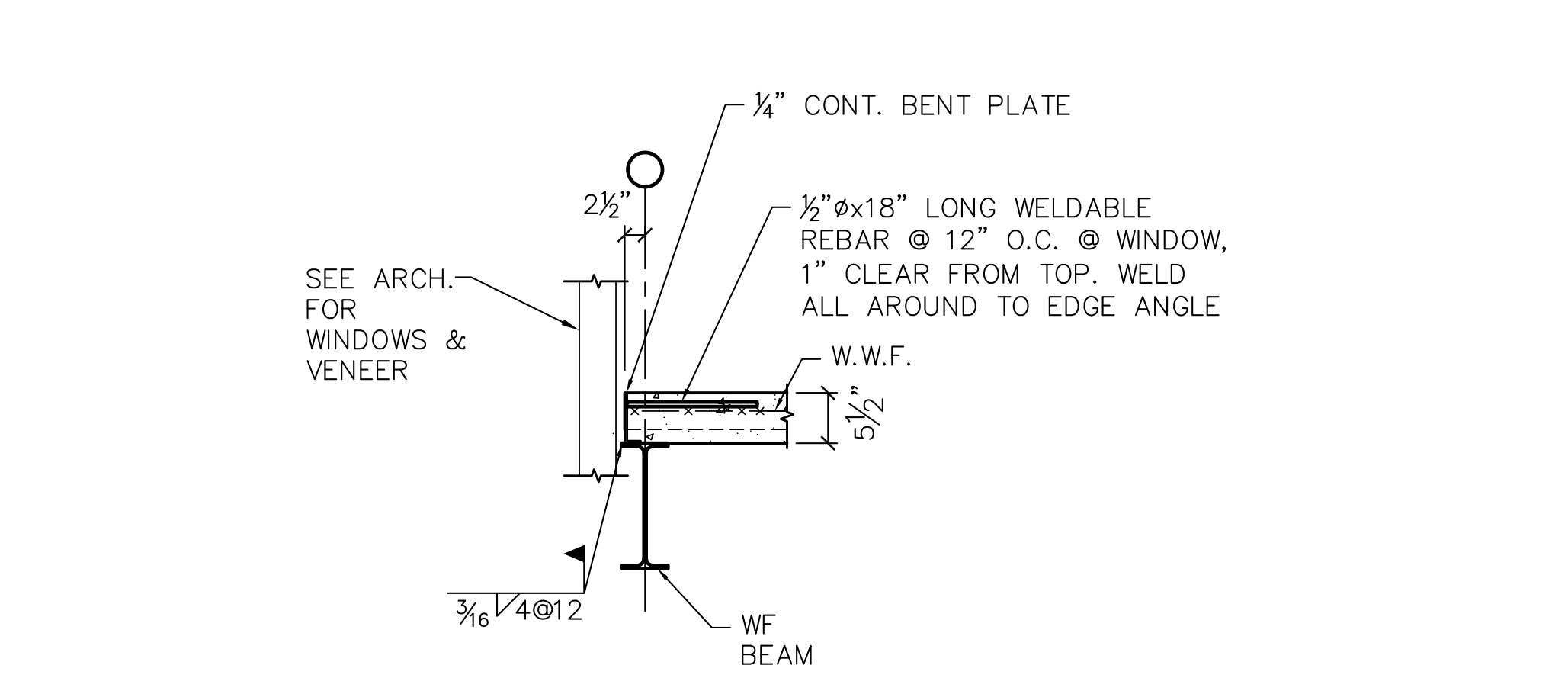
DETAIL 84 SCALE: 3/4"=1'-0"

SCALE:  $3/4"=1'-0"$



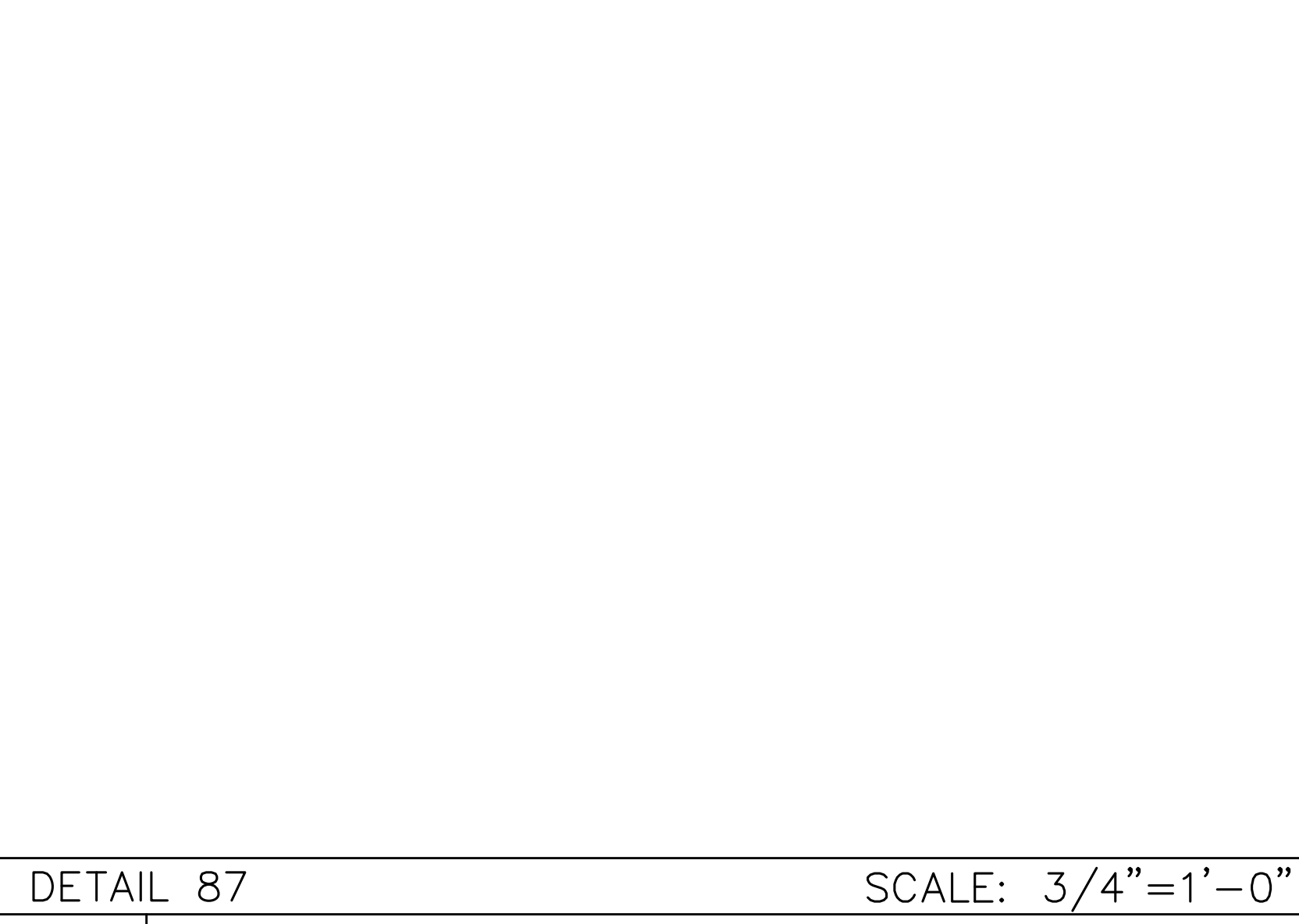
DETAIL 85

SCALE:  $3/4"=1'-0"$



DETAIL 86

SCALE:  $3/4"=1'-0"$



DETAIL 87

SCALE:  $3/4"=1'-0"$

DETAIL 88


SCALE:  $3/4"=1'-0"$


DETAIL 89

SCALE:  $3/4"=1'-0"$

DETAIL 90

SCALE:  $3/4"=1'-0"$

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LEGEND

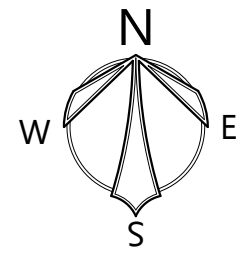
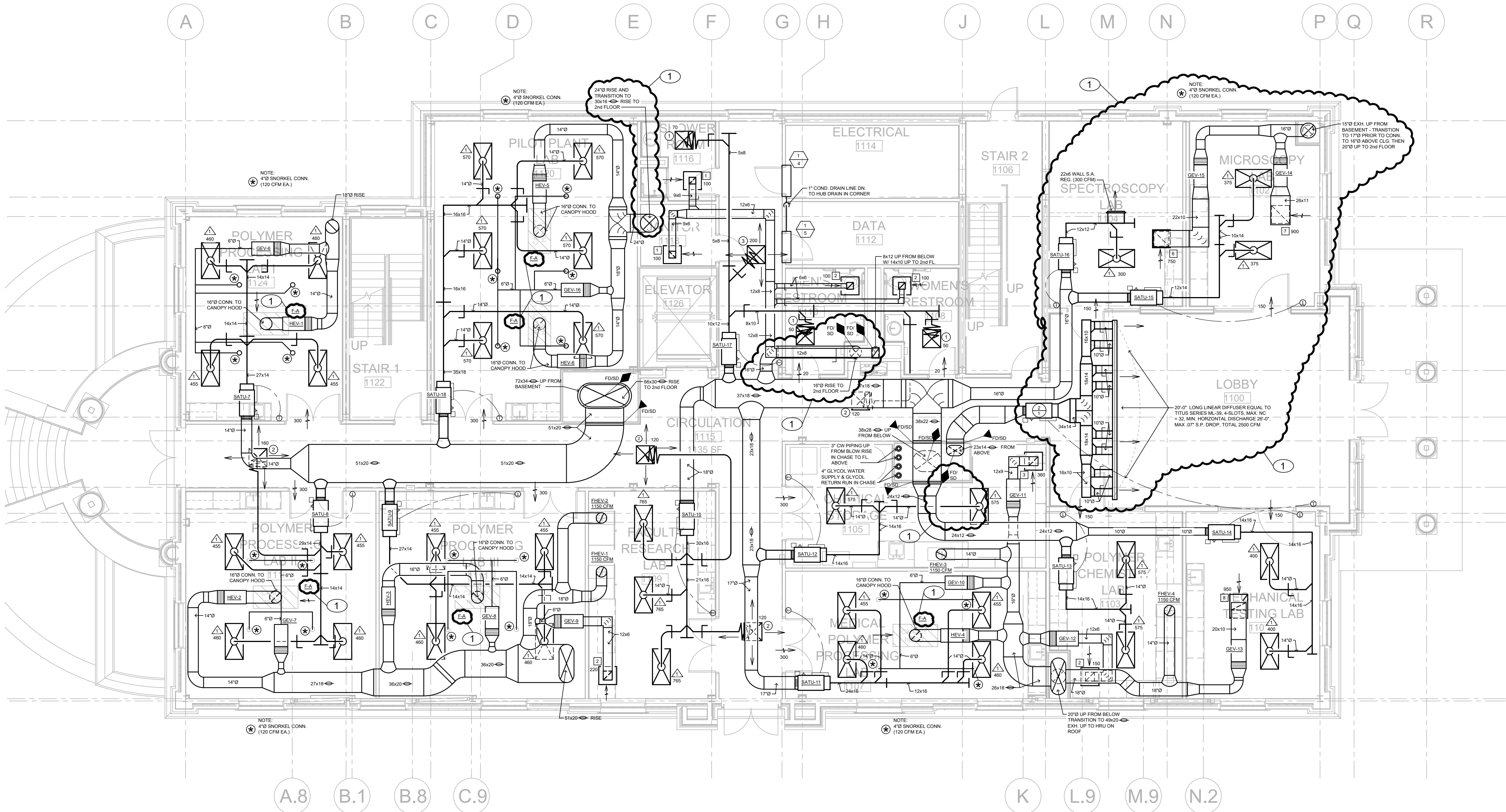
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	CWR	CHILLED WATER RETURN		RETURN AIR GRILLE/REGISTER
	HWS	HOT WATER SUPPLY		EXHAUST AIR GRILLE/REGISTER
	HWR	HOT WATER RETURN		VAV TERMINAL UNIT DESIGNATOR AIR HANDLING UNIT SERVED BY TERMINAL UNIT NUMBER
		AUTOMATIC CHANGEOVER VALVE		DUCT W/ RECTANGULAR SIZE
		ISOLATION / GATE VALVE		DUCT W/ FLAT OVAL SIZE
		SQUARE HEAD BALANCING VALVE		RECTANGULAR SUPPLY DUCT TURNING UP
		COMBINATION BALANCING VALVE AND FLOW METER		RECTANGULAR SUPPLY AIR DUCT TURNING DOWN
		BALL VALVE		RECTANGULAR RETURN AIR OR EXHAUST DUCT TURNING UP
		BUTTERFLY VALVE		RECTANGULAR RETURN AIR OR EXHAUST DUCT TURNING DOWN
		CHECK / SWING GATE		RECTANGULAR SUPPLY AIR DUCT FLOOR OR ROOF PENETRATION
		FACTORY FABRICATED AND INSULATED DOUBLE WALL FLAT OVAL DUCT		RECTANGULAR RETURN OR EXHAUST AIR DUCT FLOOR OR ROOF PENETRATION
		MOTORIZED R.A. DAMPER		R.A. TEMPERATURE SENSOR
		MANUAL VOLUME DAMPER (MVD)		AIR TRANSFER DUCT
		MOTORIZED DAMPER (MD)		AUXILIARY DRAIN
		SMOKE DETECTOR		THERMOSTAT
		SMOKE DAMPER		REMOTE TEMPERATURE SENSOR
		DUCT MOUNTED CO2 SENSOR		HUMIDISTAT
		DENOTES LOCATION OF VERTICAL ACTION FIRE DAMPER		ABOVE FINISH FLOOR
		DENOTES LOCATION OF HORIZONTAL ACTION FIRE DAMPER		CEILING DIFFUSER
		DENOTES LOCATION OF VERTICAL ACTION COMBINATION FIRE AND SMOKE DAMPER		CEILING OR COOLING CONNECT OR CONNECTION
		DENOTES LOCATION OF HORIZONTAL ACTION COMBINATION FIRE AND SMOKE DAMPER		FIRE DAMPER
		CEILING DIFFUSER		GENERAL CONTRACTOR
		RETURN AIR GRILLE/REGISTER		OUTSIDE AIR
		EXHAUST AIR GRILLE/REGISTER		RETURN AIR
				SUPPLY AIR

GENERAL VAV NOTES (AHU-2 SYSTEM):

- 1.) ALL ROUND AND FLAT OVAL DUCTWORK FROM AIR HANDLING UNITS TO THE VAV TERMINAL UNITS SHALL BE FACTORY FABRICATED SPIRAL DUCTS AND FITTINGS RATED FOR 4" STATIC PRESSURE (W.C.).
- 2.) ALL BRANCH TAKE-OFF FITTINGS SHALL BE CONICAL TYPE AS SHOWN ON THE PLANS.
- 3.) ALL DUCTWORK DOWNSTREAM OF THE VAV TERMINAL UNITS SHALL BE LOW PRESSURE TYPE RATED FOR .5" STATIC PRESSURE (W.C.)
- 4.) MAXIMUM LENGTH OF FLEXIBLE ROUND DUCTS TO DIFFUSERS SHALL BE 6'-0" FOR LOW PRESSURE DUCTWORK AND 12" FOR MED/HIGH PRESSURE SUPPLY AIR DUCTS TO VAV TERMINAL UNITS.
- 5.) ALL RECTANGULAR/SQUARE DUCTWORK DOWNSTREAM OF THE VAV TERMINAL UNITS SHALL BE INTERNALLY INSULATED WITH 2" THICK ACOUSTICAL DUCT LINER. SEE SPECS FOR INSULATION TYPE.
- 6.) COORDINATE FINAL LOCATION OF ALL CEILING DIFFUSERS, CEILING REGISTERS, ETC., WITH THE ARCHITECTURAL REFLECTED CEILING PLANS.
- 7.) EXTENT OF FACTORY FABRICATED AND INSULATED DOUBLE WALL DUCT IS INDICATED ON THE DUCTWORK WITH SLASHES.
- 8.) FINAL LOCATION OF ALL VAV TERMINAL UNITS SHALL ALLOW FOR COMPLETE AND EASY MAINTENANCE TO HEATING COILS, FILTERS, CONTROLS, POWER SWITCHES, ETC.
- 9.) ALL AIR TRANSFER DUCTS (ATD) AND COLLARS SHALL BE LINED WITH 2" THICK ACOUSTICAL DUCT LINER/INSULATION.
- 10.) COMBUSTIBLE MATERIALS ARE NOT ALLOWED IN AREAS OR SPACES USED AS A RETURN AIR PLENUM. THE GENERAL CONTRACTOR SHALL PROVIDE AN AIRTIGHT SEAL AT ALL JOINTS OF THE R.A. PLENUM SPACE, INCLUDING INTERIOR PARTITIONS BETWEEN SPACES USED AS A RETURN AIR PLENUM AND SPACES NOT USED AS A RETURN AIR PLENUM. CONTRACTOR SHALL PAY PARTICULAR ATTENTION TO PERIMETER JOINTS OF THE BUILDING TO ENSURE NO AMBIENT AIR ENTERS THE RETURN AIR PLENUM.
- 11.) NO BARE EXPOSED FIBERGLASS INSULATION, INCLUDING BATT TYPE FIBERGLASS INSULATION, IS ALLOWED IN THE RETURN AIR PLENUM. ALL INSULATION SHALL HAVE NON-COMBUSTIBLE FACING WITH 25 RATING FOR FLAME SPREAD AND 50 FOR FUEL CONTRIBUTED AND SMOKE DEVELOPED AS DETERMINED BY ASTM E84.
- 12.) ALL EXPOSED EDGES OF INSULATION THAT OCCURS ON ENDS OF DUCTWORK WITH EXPOSED INSULATION SHALL BE PROVIDED WITH DUCT NOSINGS AS SHOWN ON THE PLAN DETAILS. ALL OTHER SHALL BE PAINTED WITH DUCT SEALER RATED AND IN COMPLIANCE WITH ASTM E84 FOR 25/50 SMOKE AND FLAME SPREAD.

NOTE:

THE SPACE/PLENUM ABOVE THE CEILING IS UTILIZED AS A RETURN AIR PLENUM. THE GENERAL CONTRACTOR SHALL SEAL THE PLENUM AIR TIGHT. ALL PENETRATIONS OF THE R.A. PLENUM SHALL BE SEALED AIR TIGHT. NO COMBUSTIBLES ARE ALLOWED IN THE R.A. PLENUM SPACE.



OVERALL FIRST FLOOR HVAC PLAN

SCALE: 1/8" = 1'-0"

NOTE: OVERALL PLAN IS PROVIDED FOR COORDINATION PURPOSES ONLY - SEE OTHER PLANS FOR DETAILS

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Rev.	Description	Date
1	ADD #5	01.15.21

Job Number	18144
Date	11/17/2020
Drawn By	CW
Checked By	TZ

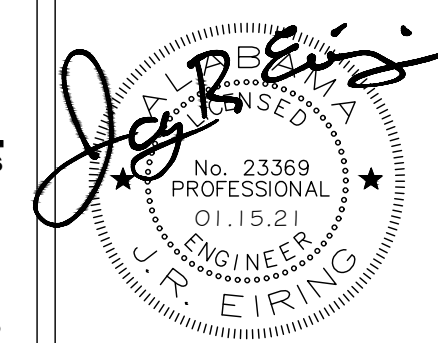
Project Title

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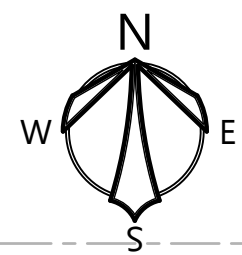
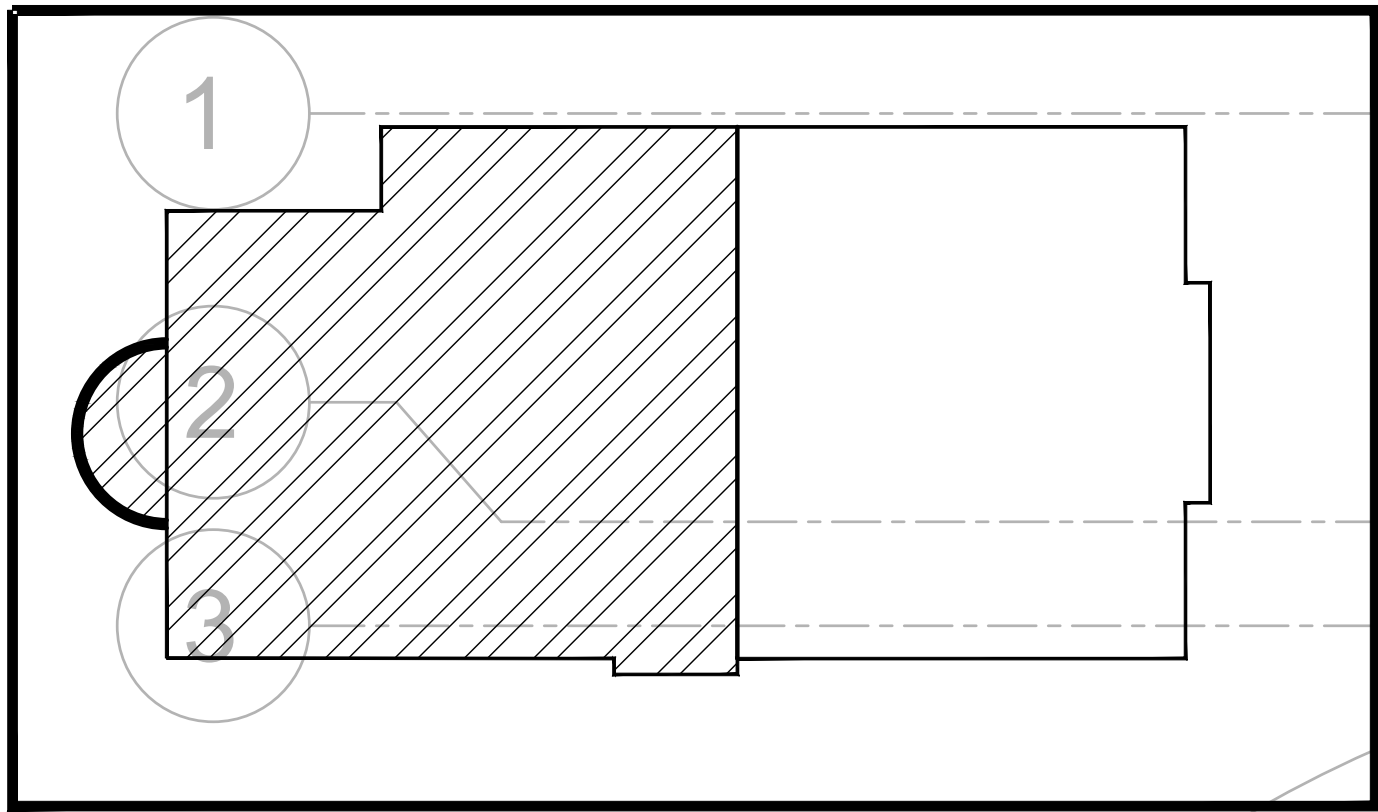
Sheet Title  
OVERALL FIRST  
FLOOR HVAC PLAN

Sheet Number

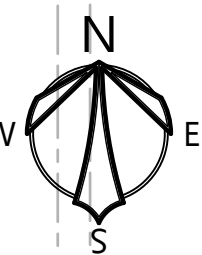
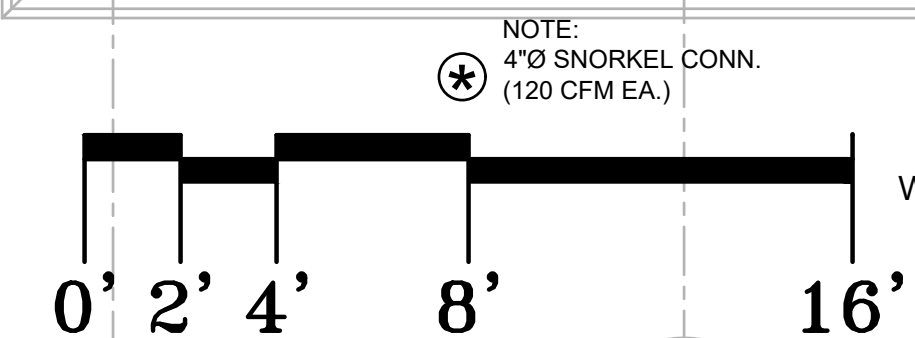
M1.3







**KEY PLAN**  
NOT TO SCALE



**PARTIAL FIRST FLOOR HVAC PLAN**  
SCALE: 1/4" = 1'-0"

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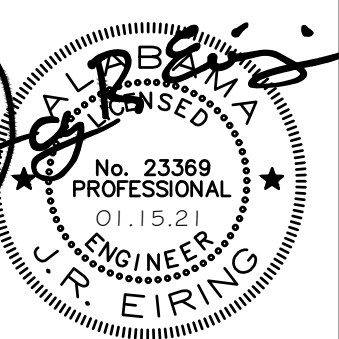
Job Number	18144
Date	11/17/2020
Drawn By	CW
Checked By	TZ

Project Title  
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Sheet Title  
**PARTIAL FIRST FLOOR HVAC PLAN**

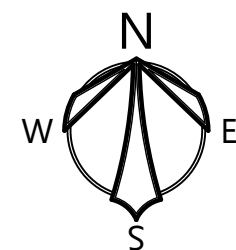
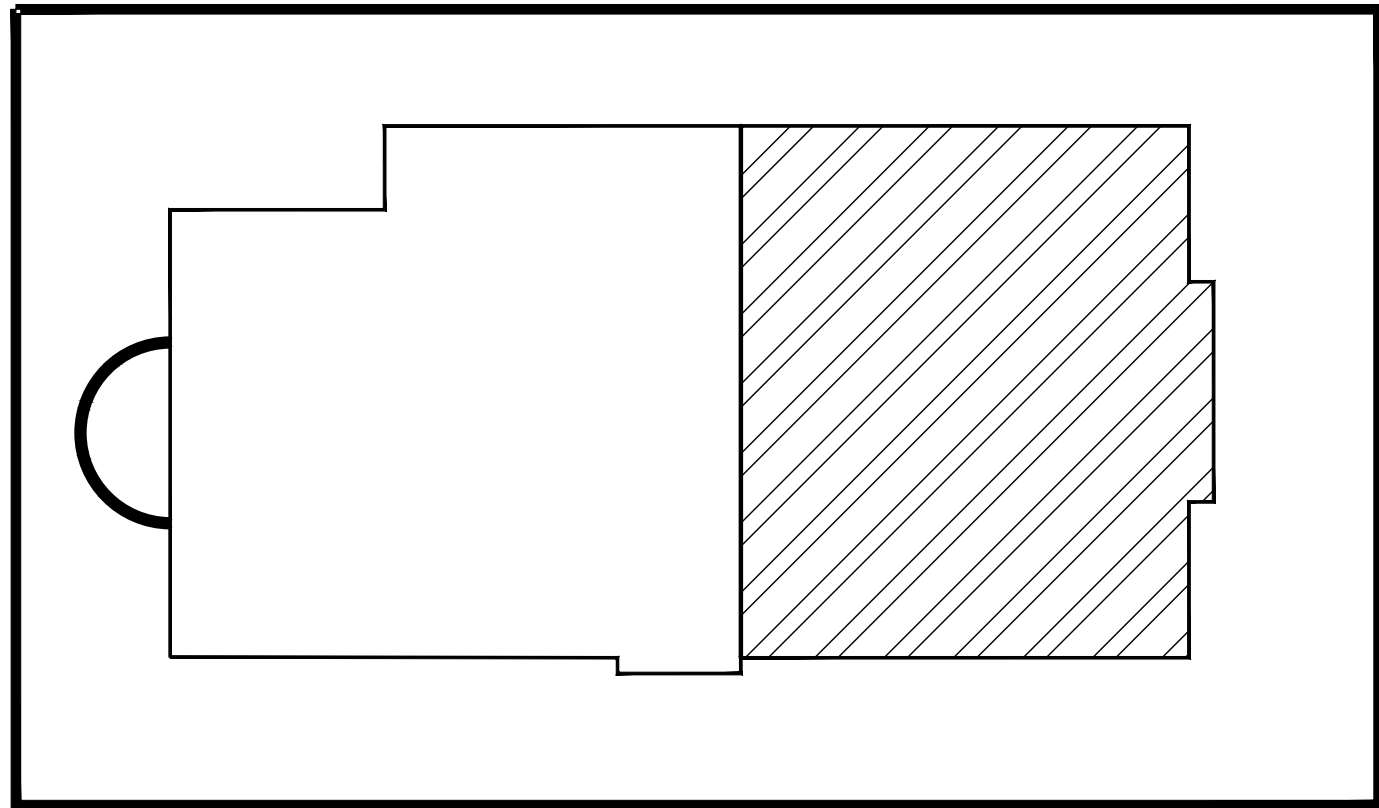
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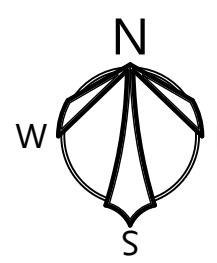
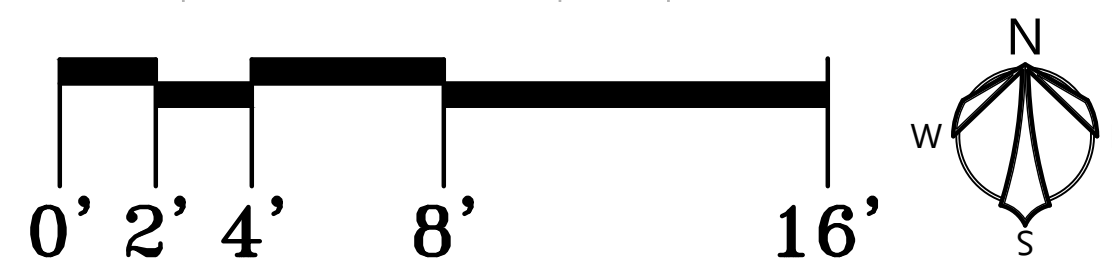
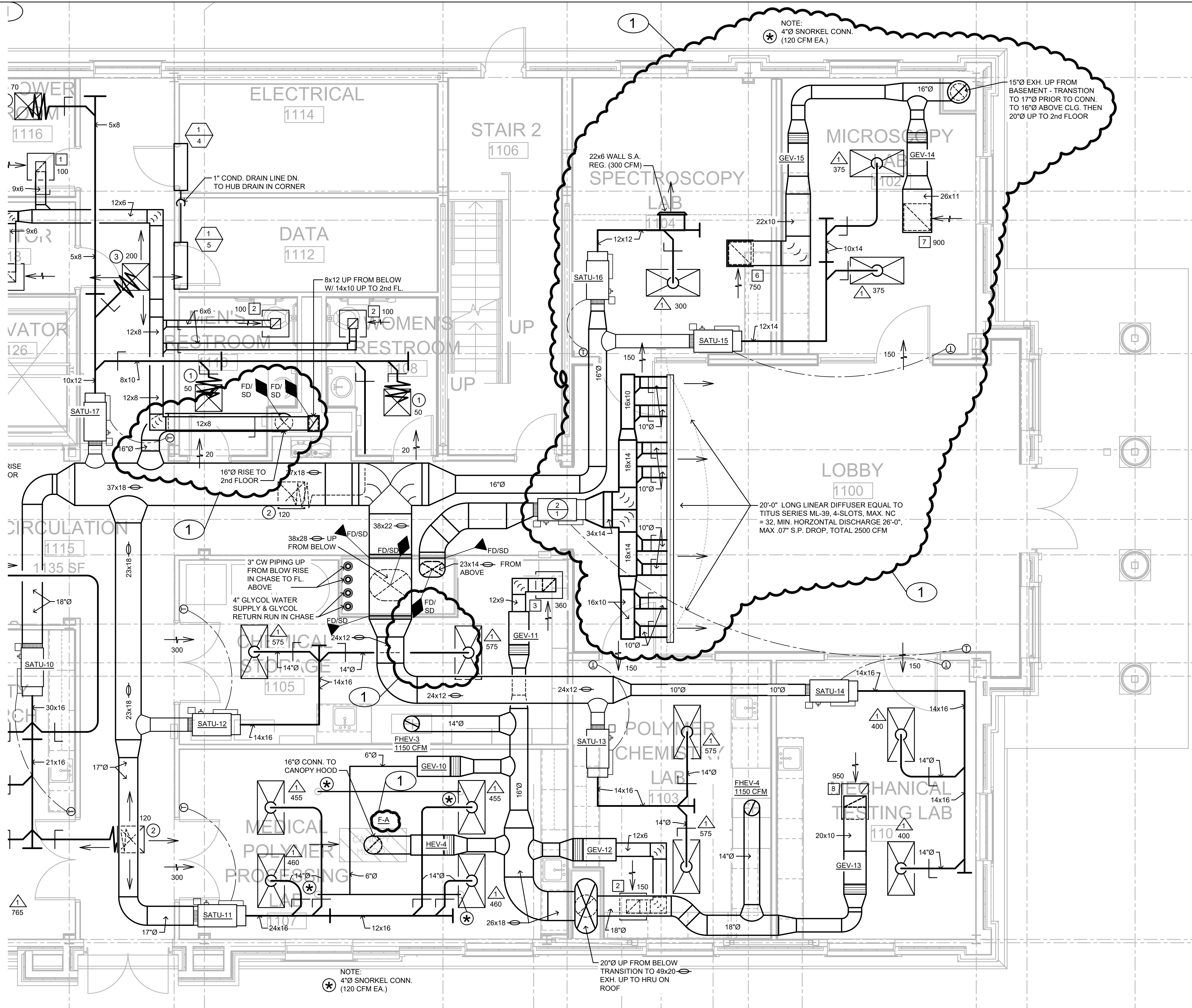


**ZGOUVAS, EIRING & ASSOCIATES**  
CONSULTING ENGINEERS  
800 S. McDONOUGH STREET  
MONTGOMERY, AL 36104  
334.263.4406  
ZEA PROJECT NUMBER 20-171





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**PARTIAL FIRST FLOOR HVAC PLAN**

SCALE: 1/4" = 1'-0"

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Rev.	Description	Date
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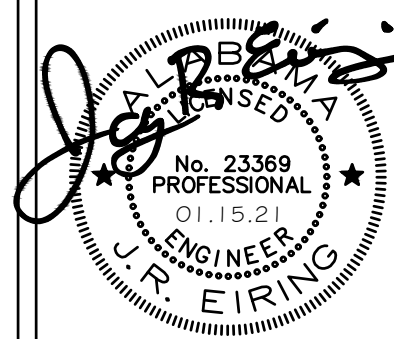
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Date	11/17/2020
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**PARTIAL FIRST FLOOR HVAC PLAN**

Sheet Number

**M1.5**





SCALE: 1/8" = 1'-0"

Rev.	Description	Date
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Job Number

Date \_\_\_\_\_

Drawn By CWA

TZ

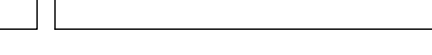
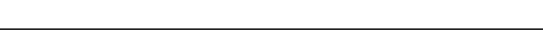
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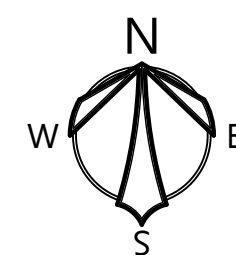
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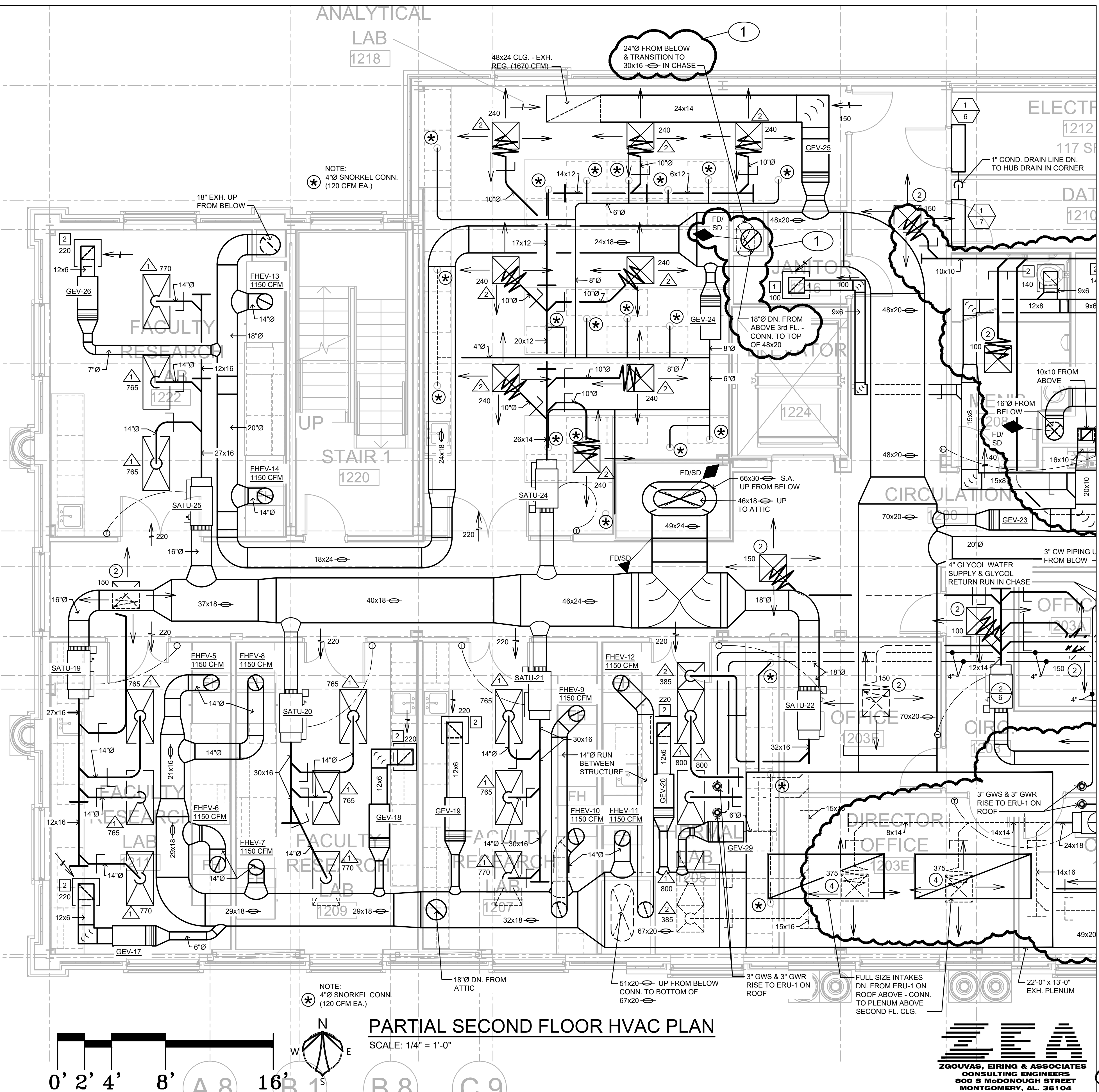
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**KEY PLAN**  
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1844

11/17/2020

Drawn By GW

Checked By \_\_\_\_\_ T7

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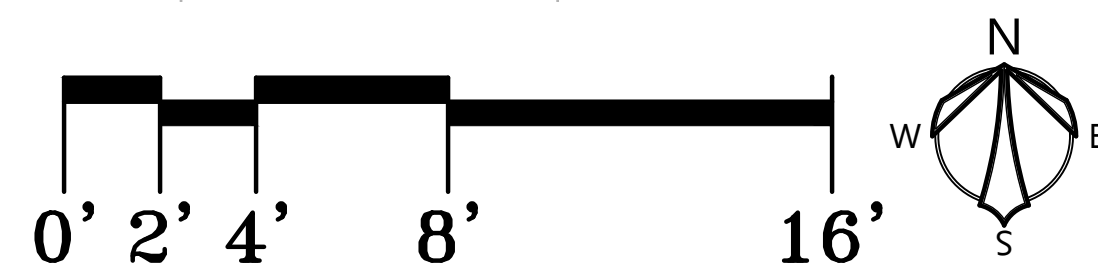
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FLOOR HVAC PLAN

Sheet Number

## M1.7

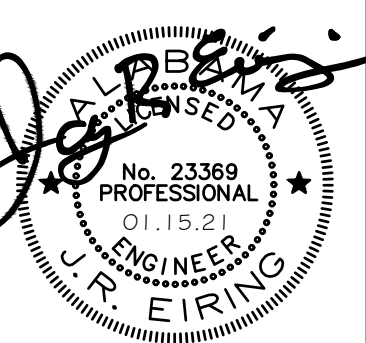






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Date 11/17/2020

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PARTIAL SECOND  
FLOOR HVAC PLAN

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# M1.8

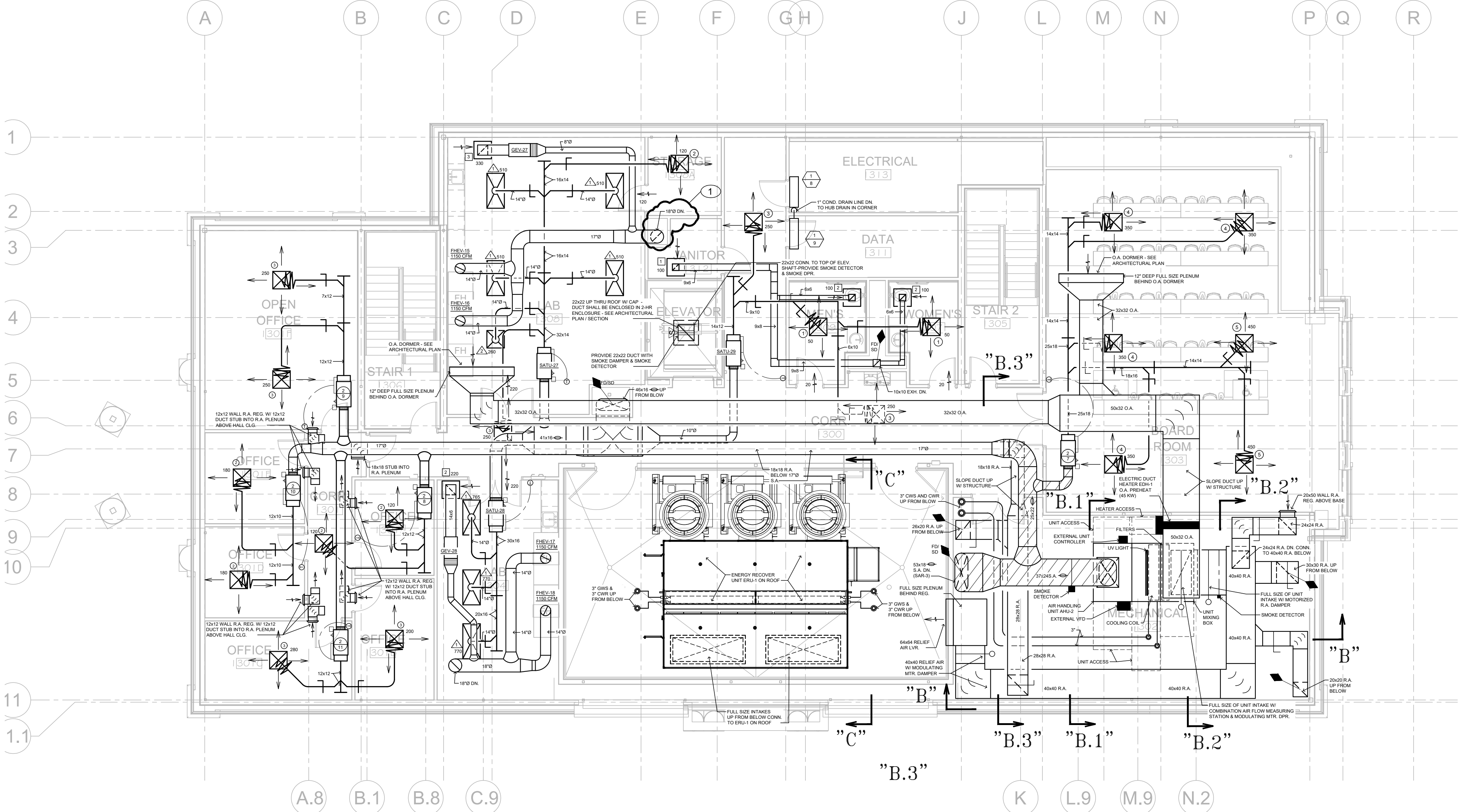


LEGEND

	CWS	CHILLED WATER SUPPLY		CEILING DIFFUSER DESIGNATOR
	CWR	CHILLED WATER RETURN		RETURN AIR GRILLE/REGISTER
	HWS	HOT WATER SUPPLY		EXHAUST AIR GRILLE/REGISTER
	HWR	HOT WATER RETURN		VAV TERMINAL UNIT DESIGNATOR AIR HANDLING UNIT SERVED BY TERMINAL UNIT NUMBER
		AUTOMATIC CHANGEOVER VALVE		
		ISOLATION / GATE VALVE		
		SQUARE HEAD BALANCING VALVE		DUCT W/ RECTANGULAR SIZE
		COMBINATION BALANCING VALVE AND FLOW METER		DUCT W/ FLAT OVAL SIZE
		BALL VALVE		
		BUTTERFLY VALVE		RECTANGULAR SUPPLY DUCT TURNING UP
		CHECK / SWING GATE		RECTANGULAR SUPPLY AIR DUCT TURNING DOWN
		FACTORY FABRICATED AND INSULATED DOUBLE WALL FLAT OVAL DUCT		RECTANGULAR RETURN AIR OR EXHAUST DUCT TURNING UP
		MOTORIZED R.A. DAMPER		RECTANGULAR RETURN AIR OR EXHAUST DUCT TURNING DOWN
		MANUAL VOLUME DAMPER (MVD)		RECTANGULAR SUPPLY AIR DUCT FLOOR OR ROOF PENETRATION
		MOTORIZED DAMPER (MD)		RECTANGULAR RETURN OR EXHAUST AIR DUCT FLOOR OR ROOF PENETRATION
		SMOKE DETECTOR		R.A. TEMPERATURE SENSOR
		SMOKE DAMPER		AIR TRANSFER DUCT
		DUCT MOUNTED CO2 SENSOR		AUXILIARY DRAIN
		DENOTES LOCATION OF VERTICAL ACTION FIRE DAMPER		THERMOSTAT
		DENOTES LOCATION OF HORIZONTAL ACTION FIRE DAMPER		REMOTE TEMPERATURE SENSOR
		DENOTES LOCATION OF VERTICAL ACTION COMBINATION FIRE AND SMOKE DAMPER		HUMIDISTAT
		DENOTES LOCATION OF HORIZONTAL ACTION COMBINATION FIRE AND SMOKE DAMPER		CO2 SENSOR
		CEILING DIFFUSER		ABOVE FINISH FLOOR
		RETURN AIR GRILLE/REGISTER		CEILING DIFFUSER
		EXHAUST AIR GRILLE/REGISTER		CEILING OR COOLING CONNECT OR CONNECTION
				FIRE DAMPER
				GENERAL CONTRACTOR
				OUTSIDE AIR
				RETURN AIR
				SUPPLY AIR

GENERAL VAV NOTES (AHU-2 SYSTEM):

- 1.) ALL ROUND AND FLAT OVAL DUCTWORK FROM AIR HANDLING UNITS TO THE VAV TERMINAL UNITS SHALL BE FACTORY FABRICATED SPIRAL DUCTS AND FITTINGS RATED FOR 4" STATIC PRESSURE (W.C.).
- 2.) ALL BRANCH TAKE-OFF FITTINGS SHALL BE CONICAL TYPE AS SHOWN ON THE PLANS.
- 3.) ALL DUCTWORK DOWNSTREAM OF THE VAV TERMINAL UNITS SHALL BE LOW PRESSURE TYPE RATED FOR .5" STATIC PRESSURE (W.C.)
- 4.) MAXIMUM LENGTH OF FLEXIBLE ROUND DUCTS TO DIFFUSERS SHALL BE 6'-0" FOR LOW PRESSURE DUCTWORK AND 12" FOR MED/HIGH PRESSURE SUPPLY AIR DUCTS TO VAV TERMINAL UNITS.
- 5.) ALL RECTANGULAR/SQUARE DUCTWORK DOWNSTREAM OF THE VAV TERMINAL UNITS SHALL BE INTERNALLY INSULATED WITH 2" THICK ACOUSTICAL DUCT LINER. SEE SPECS FOR INSULATION TYPE.
- 6.) COORDINATE FINAL LOCATION OF ALL CEILING DIFFUSERS, CEILING REGISTERS, ETC., WITH THE ARCHITECTURAL REFLECTED CEILING PLANS.
- 7.) EXTENT OF FACTORY FABRICATED AND INSULATED DOUBLE WALL DUCT IS INDICATED ON THE DUCTWORK WITH SLASHES.
- 8.) FINAL LOCATION OF ALL VAV TERMINAL UNITS SHALL ALLOW FOR COMPLETE AND EASY MAINTENANCE TO HEATING COILS, FILTERS, CONTROLS, POWER SWITCHES, ETC.
- 9.) ALL AIR TRANSFER DUCTS (ATD) AND COLLARS SHALL BE LINED WITH 2" THICK ACOUSTICAL DUCT LINER/INSULATION.
- 10.) COMBUSTIBLE MATERIALS ARE NOT ALLOWED IN AREAS OR SPACES USED AS A RETURN AIR PLENUM. THE GENERAL CONTRACTOR SHALL PROVIDE AN AIRTIGHT SEAL AT ALL JOINTS OF THE R.A. PLENUM SPACE, INCLUDING INTERIOR PARTITIONS BETWEEN SPACES USED AS A RETURN AIR PLENUM AND SPACES NOT USED AS A RETURN AIR PLENUM. CONTRACTOR SHALL PAY PARTICULAR ATTENTION TO PERIMETER JOINTS OF THE BUILDING TO ENSURE NO AMBIENT AIR ENTERS THE RETURN AIR PLENUM.
- 11.) NO BARE EXPOSED FIBERGLASS INSULATION, INCLUDING BATT TYPE FIBERGLASS INSULATION, IS ALLOWED IN THE RETURN AIR PLENUM. ALL INSULATION SHALL HAVE NON-COMBUSTIBLE FACING WITH 25 RATING FOR FLAME SPREAD AND 50 FOR FUEL CONTRIBUTED AND SMOKE DEVELOPED AS DETERMINED BY ASTM E84.
- 12.) ALL EXPOSED EDGES OF INSULATION THAT OCCURS ON ENDS OF DUCTWORK WITH EXPOSED INSULATION SHALL BE PROVIDED WITH DUCT NOSINGS AS SHOWN ON THE PLAN DETAILS. ALL OTHER SHALL BE PAINTED WITH DUCT SEALER RATED AND IN COMPLIANCE WITH ASTM E84 FOR 25/50 SMOKE AND FLAME SPREAD.



OVERALL ATTIC HVAC PLAN

SCALE: 1/8" = 1'-0"

NOTE: OVERALL PLAN IS PROVIDED FOR COORDINATION PURPOSES ONLY - SEE OTHER PLANS FOR DETAILS

NOTE:

THE SPACE/PLENUM ABOVE THE CEILING IS UTILIZED AS A RETURN AIR PLENUM. THE GENERAL CONTRACTOR SHALL SEAL THE PLENUM AIR TIGHT. ALL PENETRATIONS OF THE R.A. PLENUM SHALL BE SEALED AIR TIGHT. NO COMBUSTIBLES ARE ALLOWED IN THE R.A. PLENUM SPACE.

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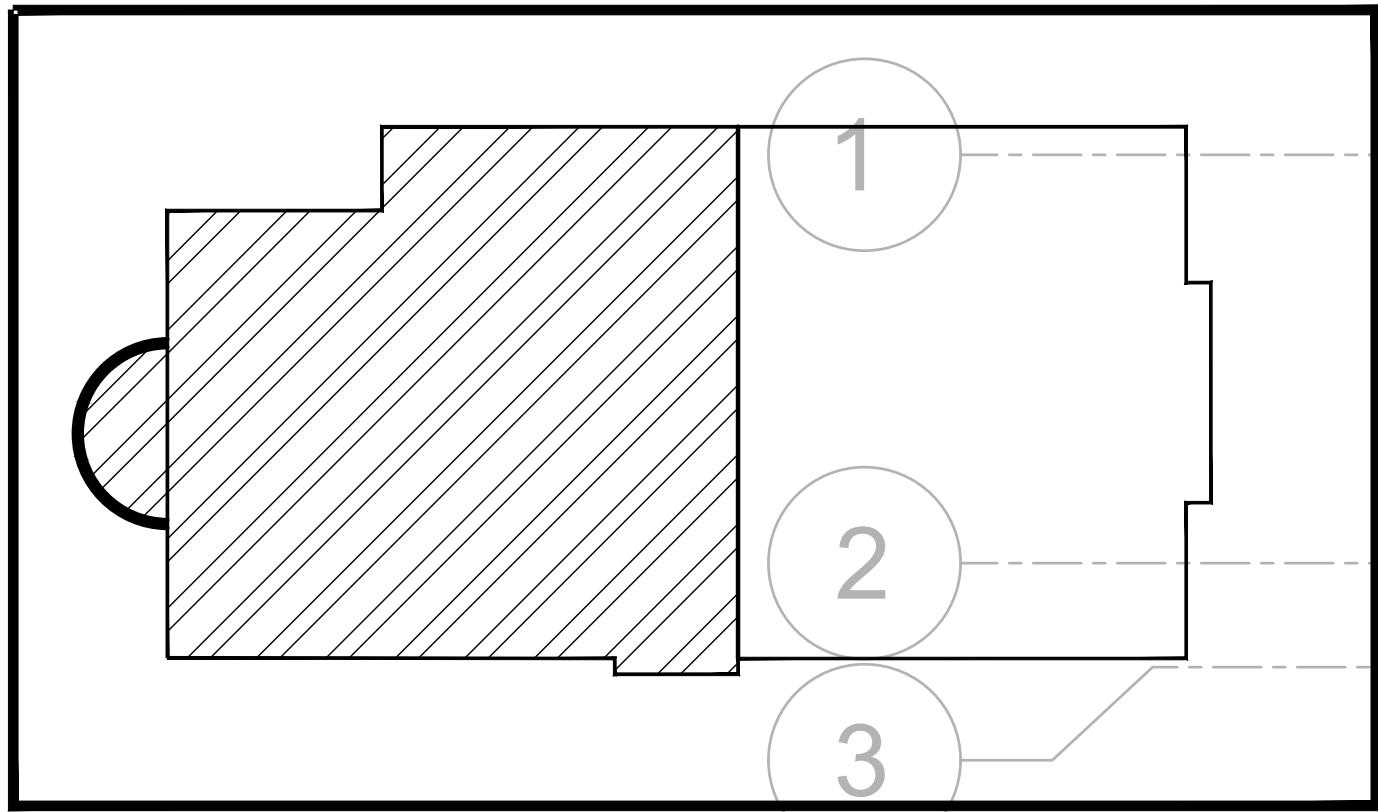
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HVAC PLAN

Sheet Number

M1.9







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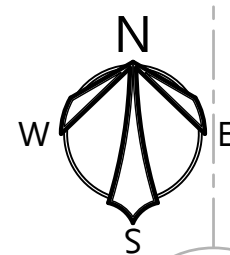
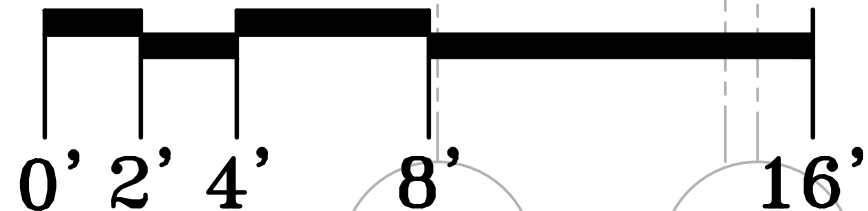
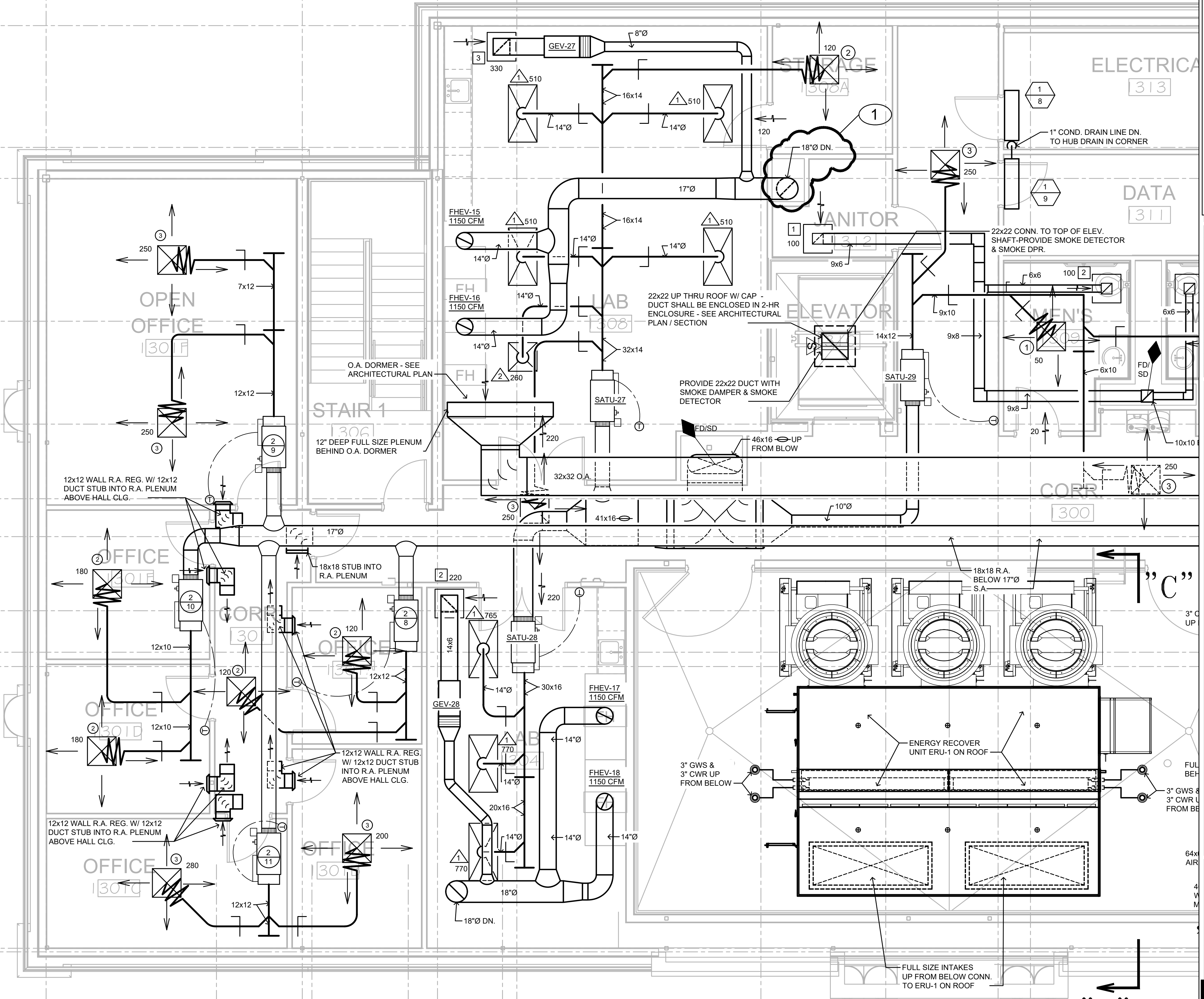
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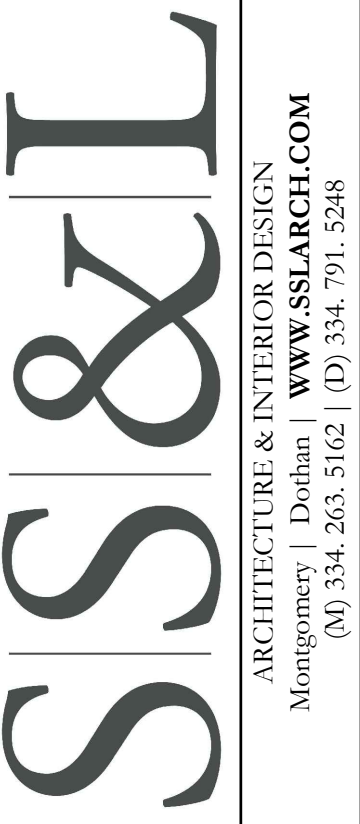
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11.1



PARTIAL ATTIC PLAN  
SCALE: 1/4" = 1'-0"



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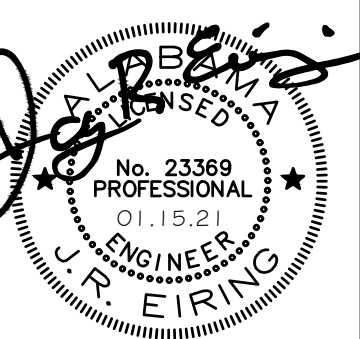
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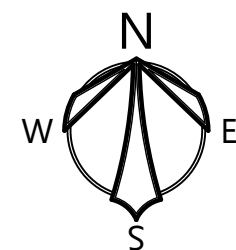
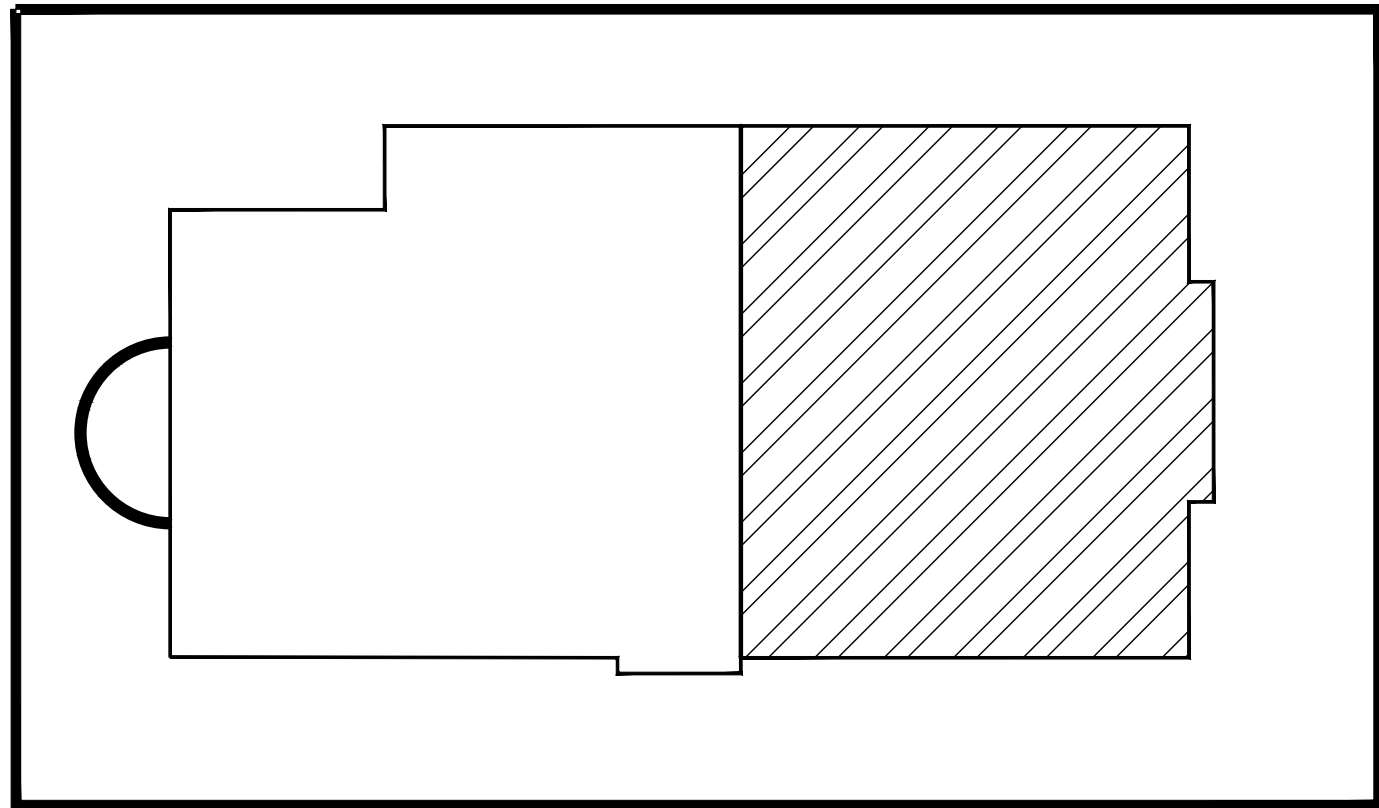
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PARTIAL ATTIC HVAC  
PLAN

Sheet Number

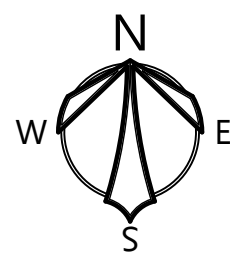
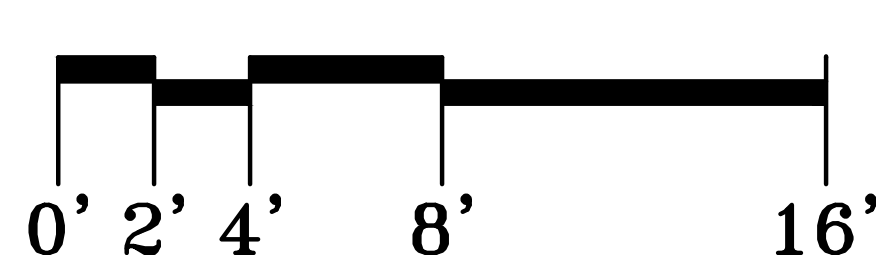
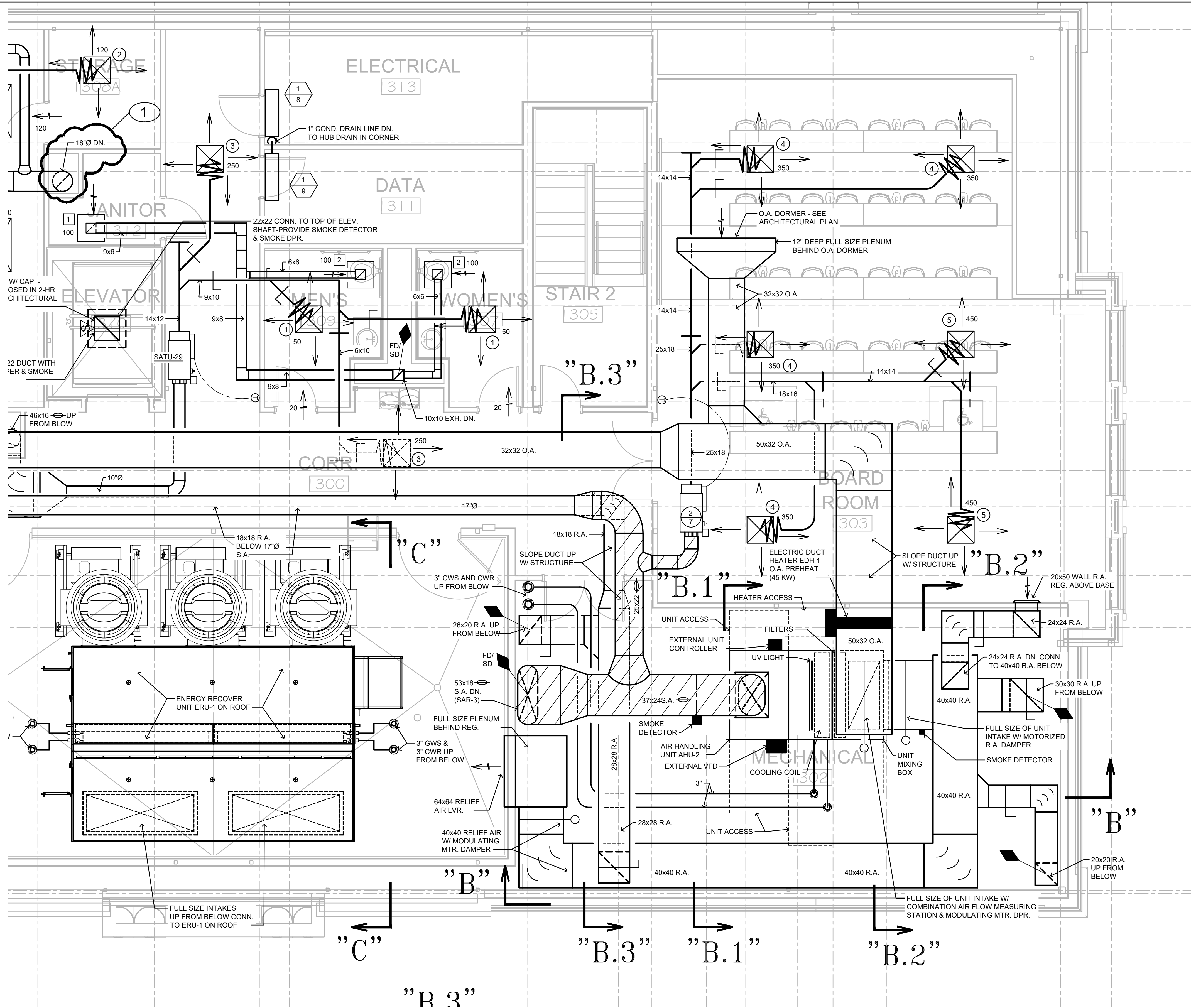
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**KEY PLAN**  
NOT TO SCALE



**PARTIAL ATTIC PLAN**

SCALE: 1/4" = 1'-0"

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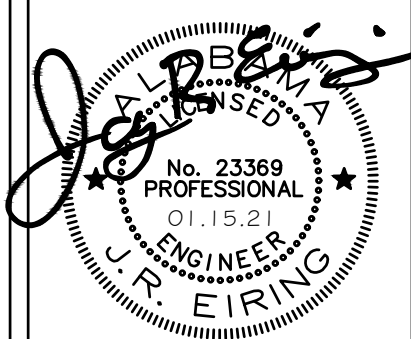
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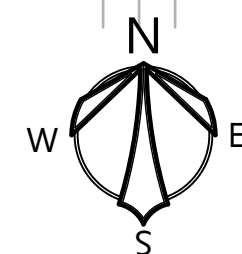
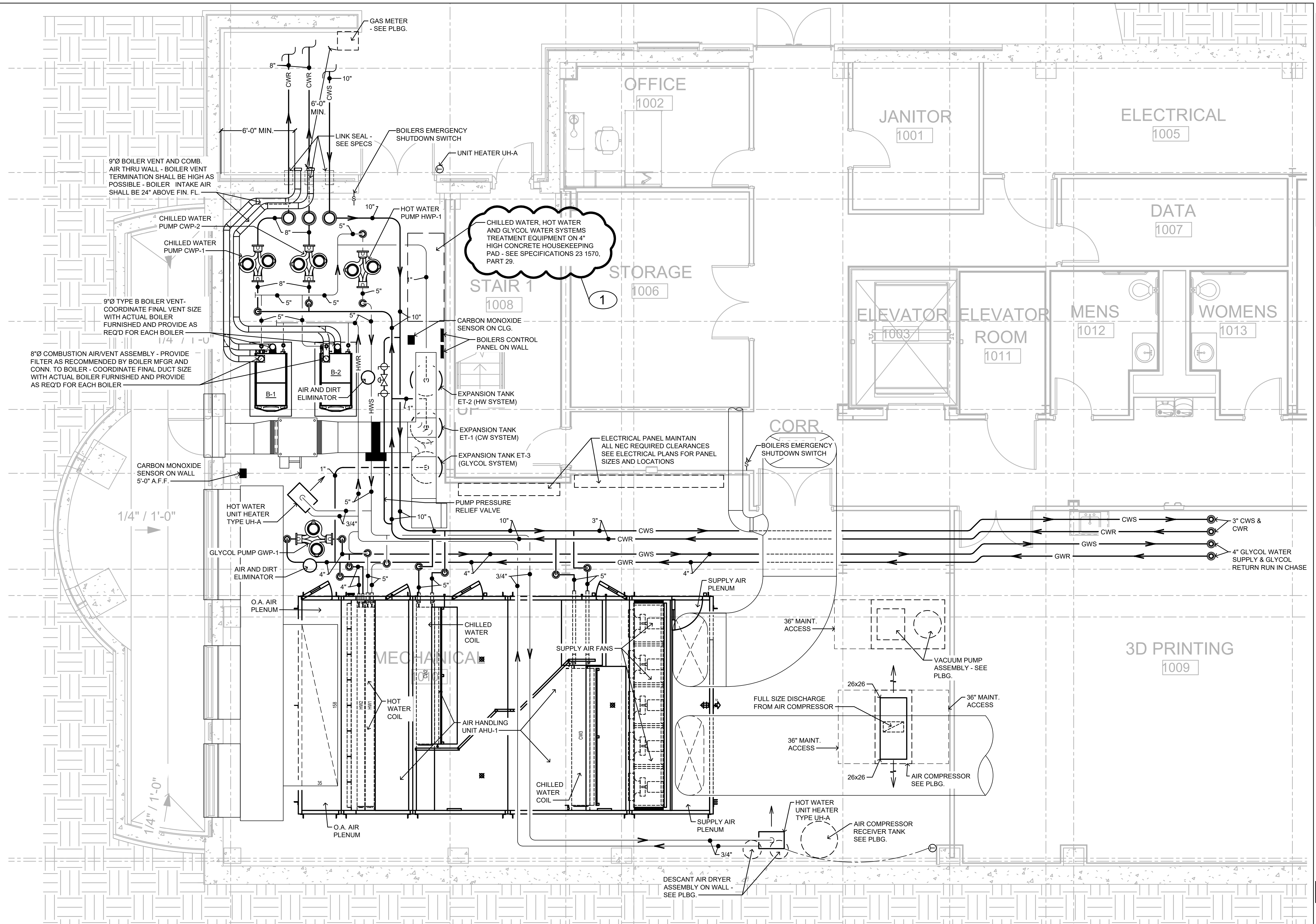
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Sheet Number

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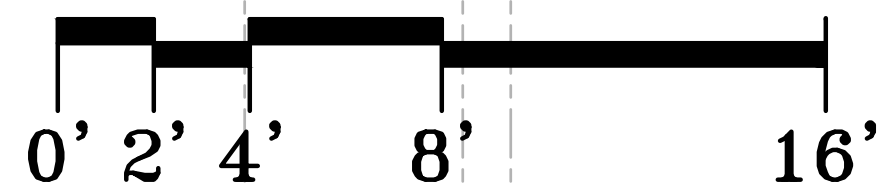






## BASEMENT MECH. PIPING FLOOR PLAN

SCALE: 1/4" = 1'-0"



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ZEA PROJECT NUMBER 20-171

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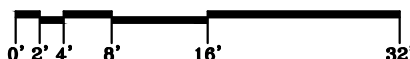
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PIPING PLAN

Sheet Number

M1.12



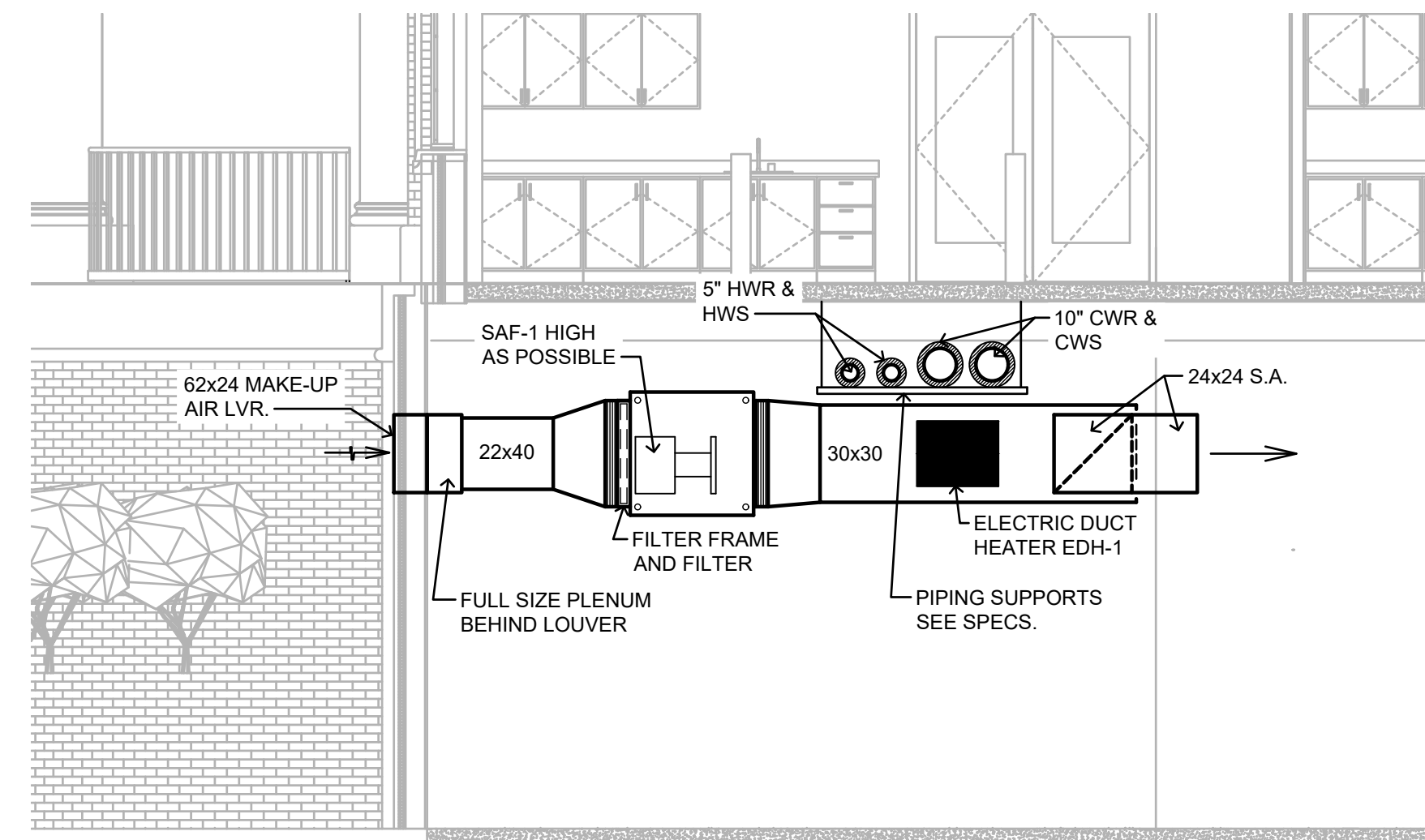
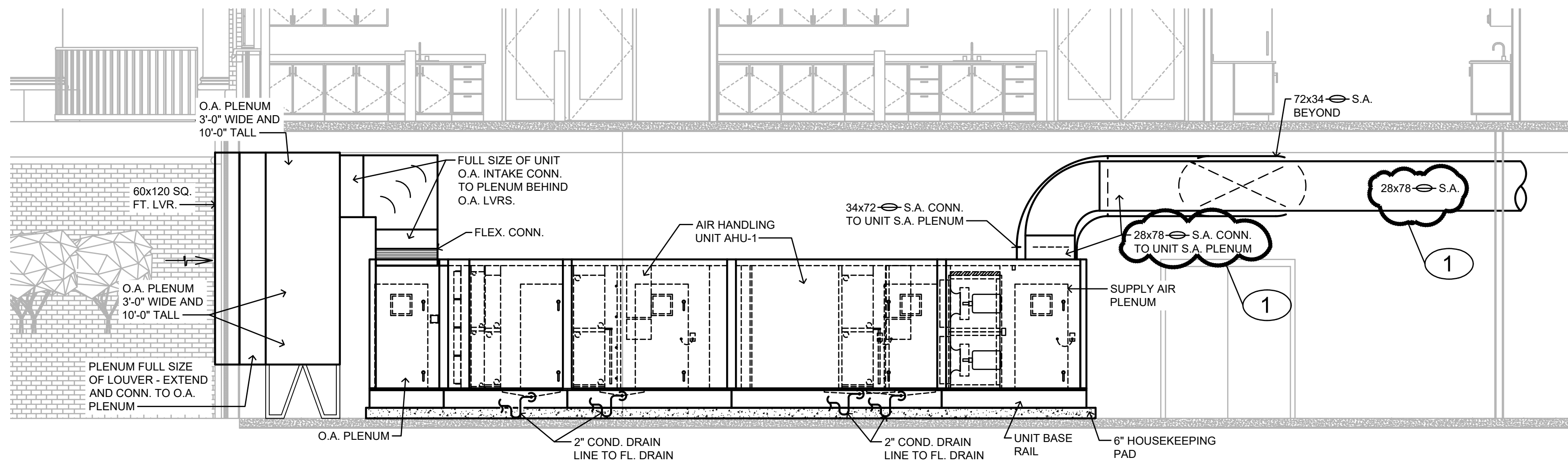




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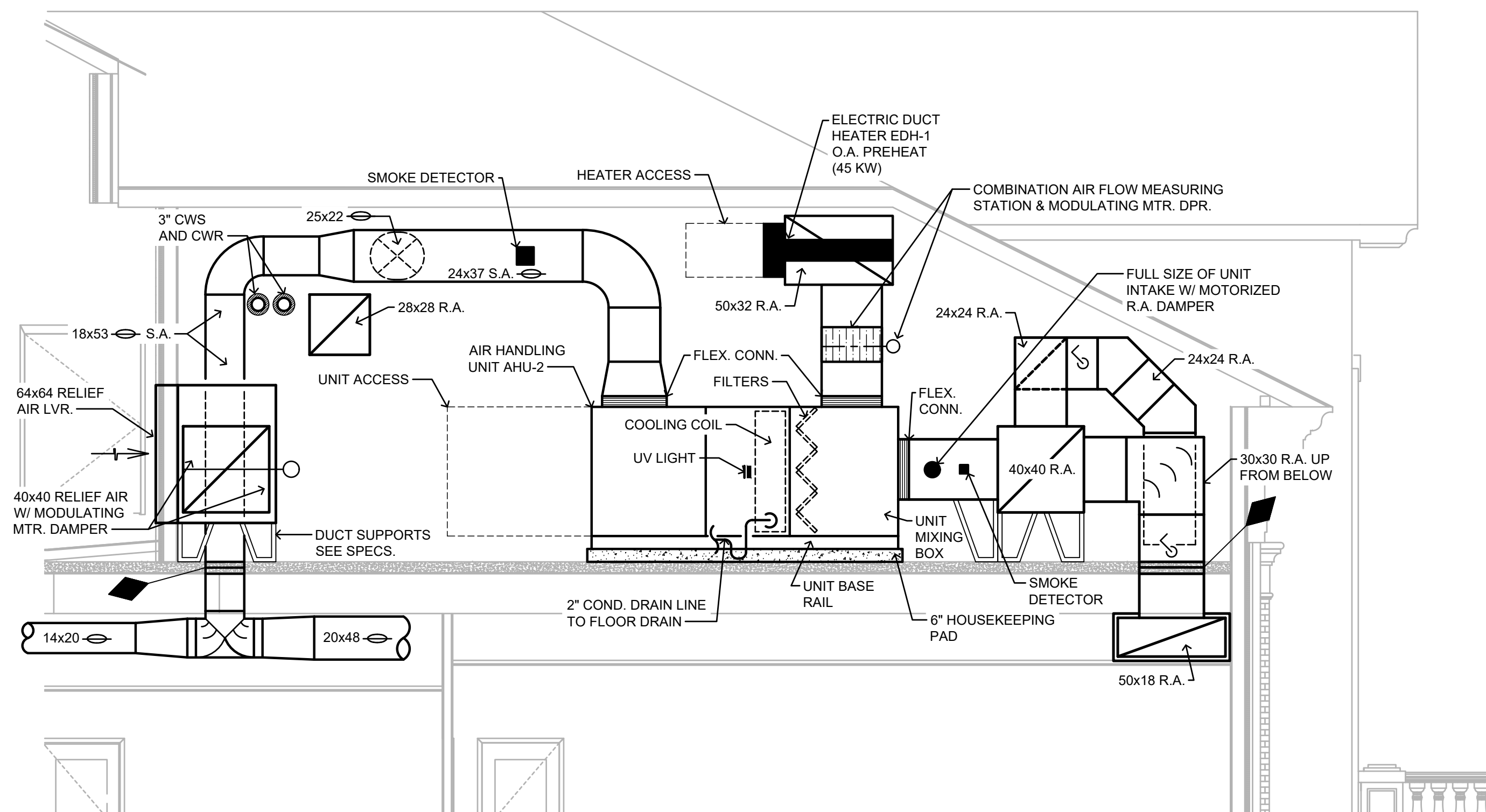
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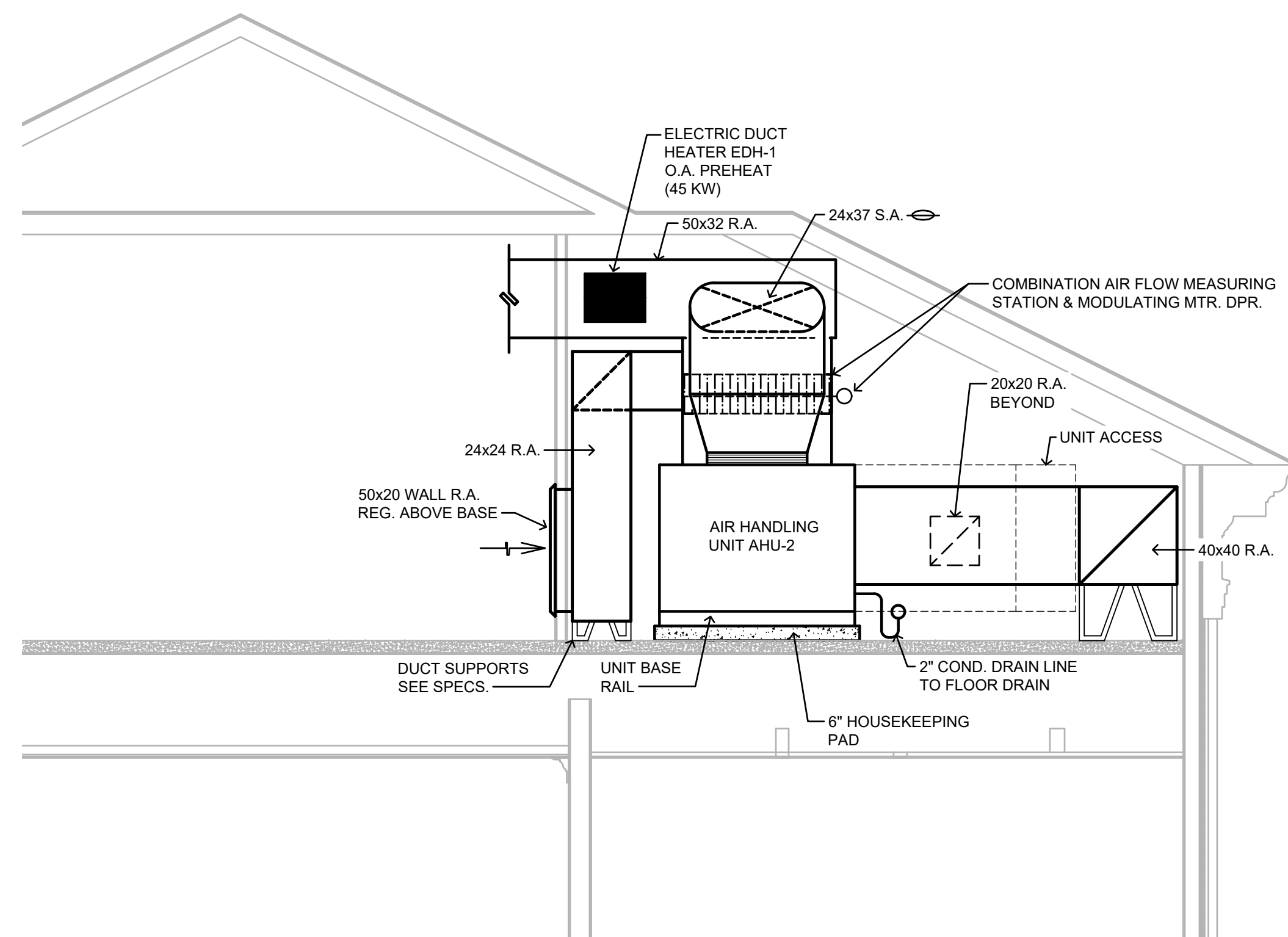
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**SECTION "A.1"**  
SCALE: 1/4" = 1'-0"



## SECTION "B"

SCALE: 1/4" = 1'-0"



**SECTION "B.1"**  
SCALE: 1/4" = 1'-0"

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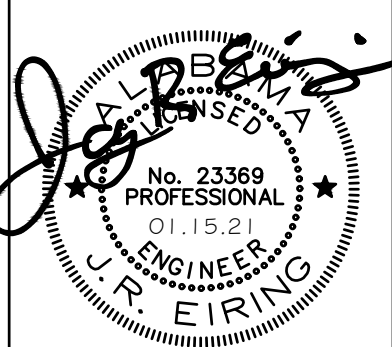
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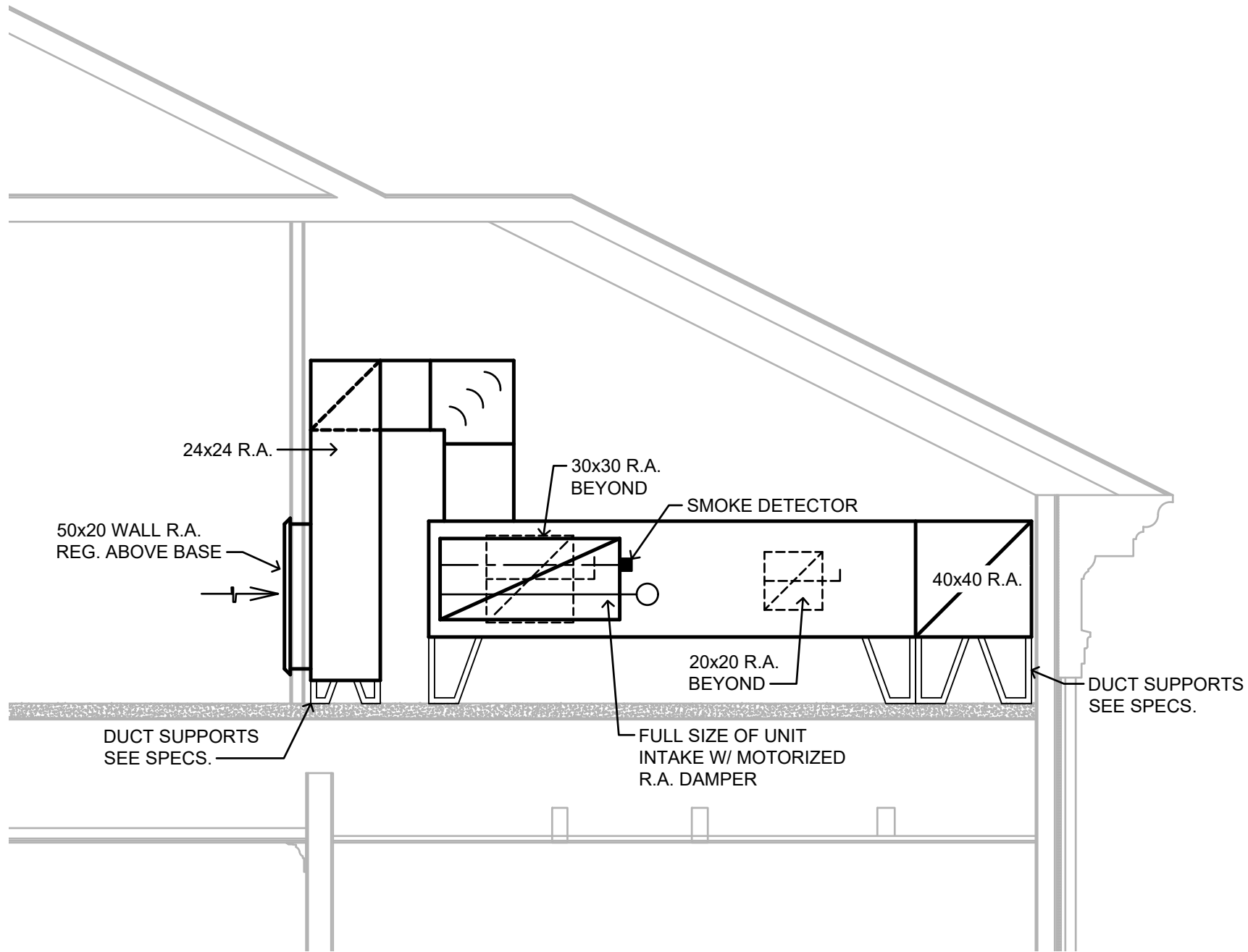
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HVAC SECTIONS

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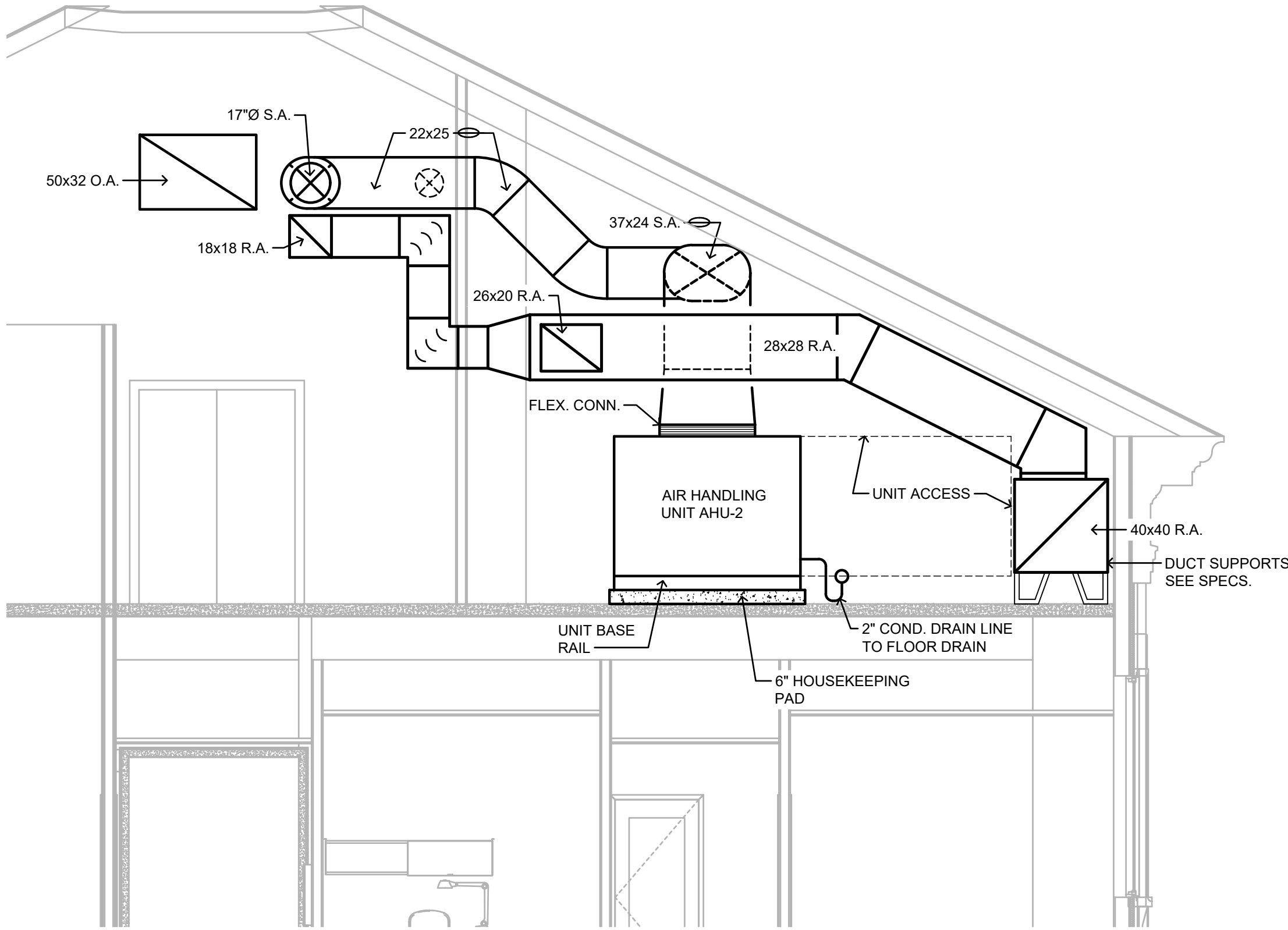
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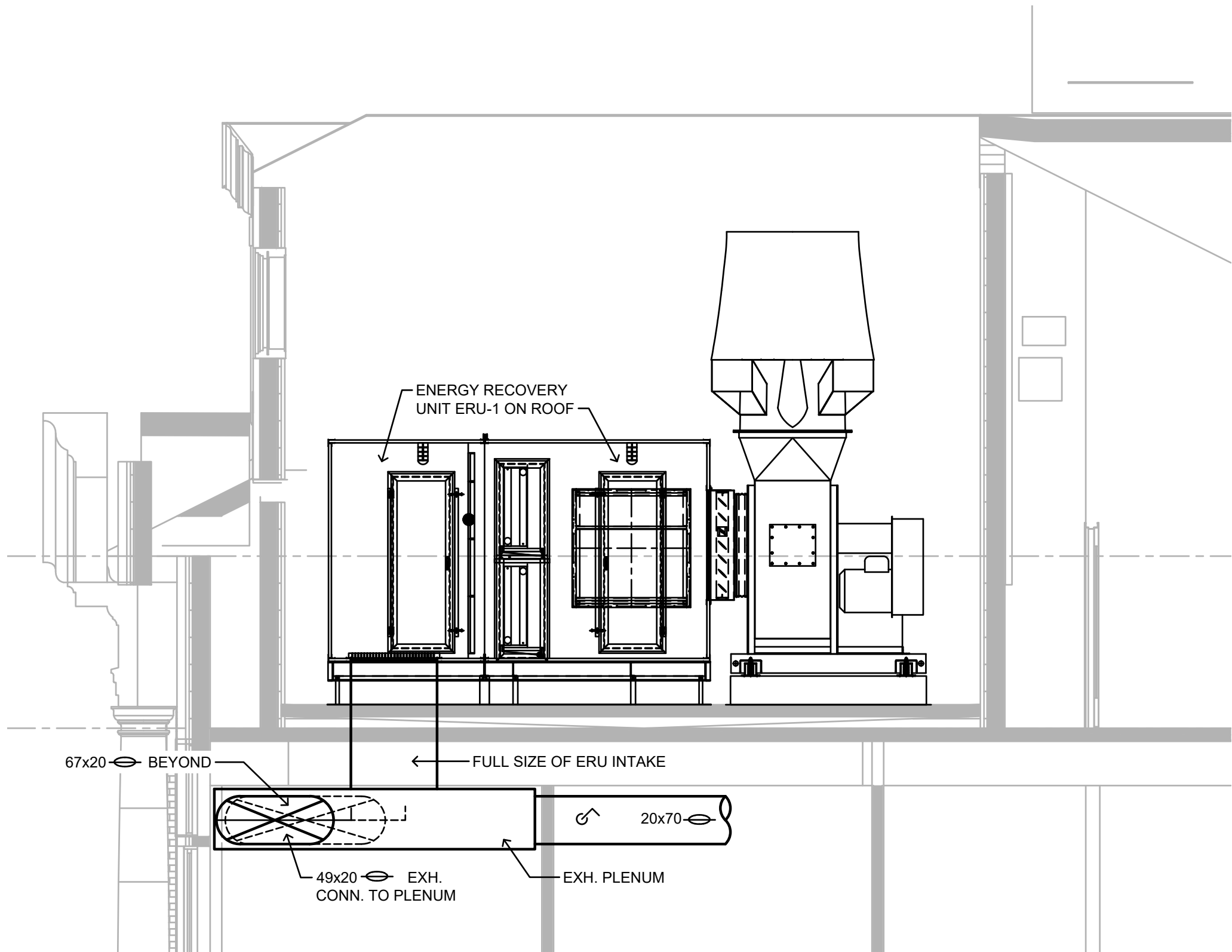
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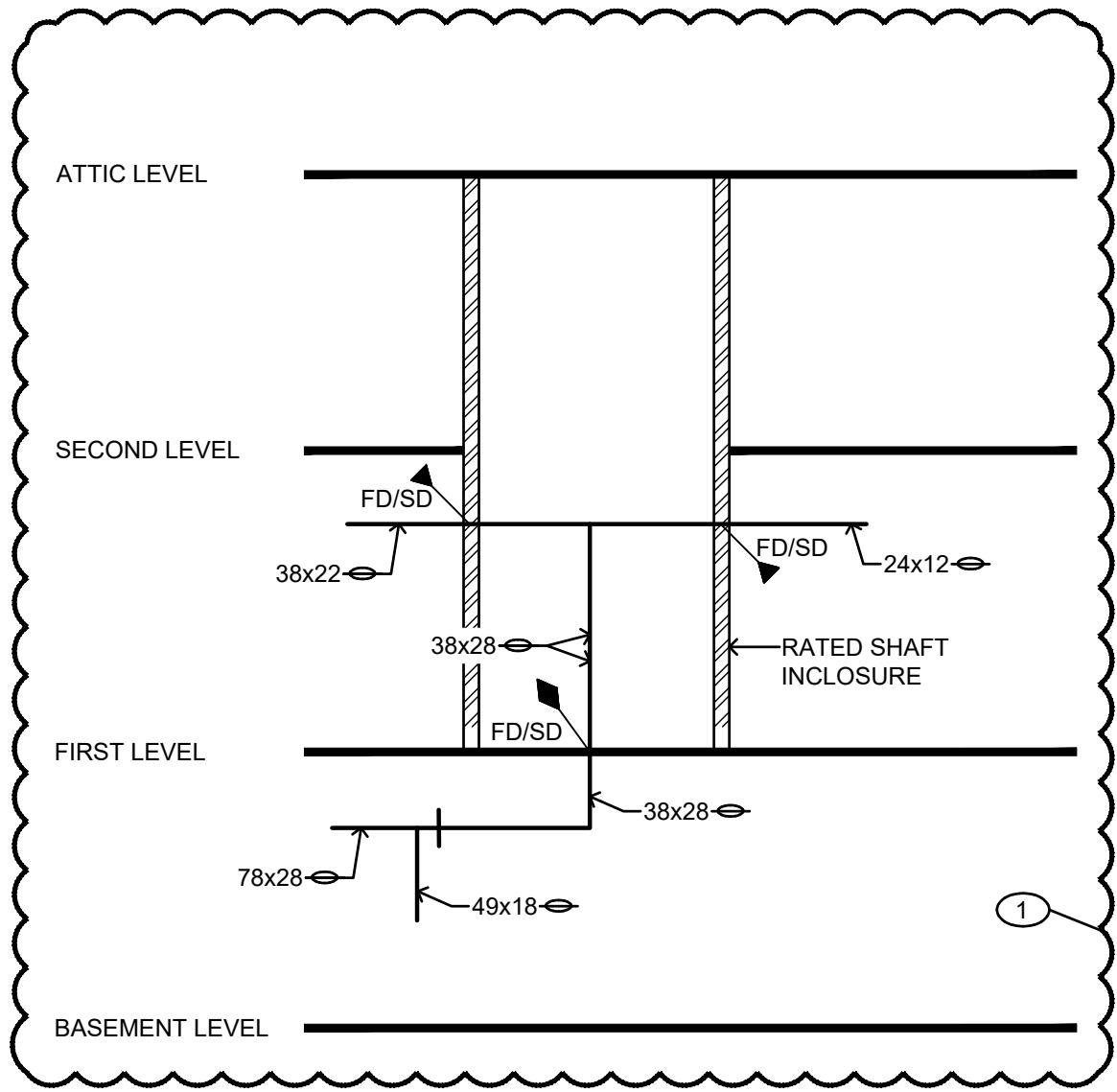
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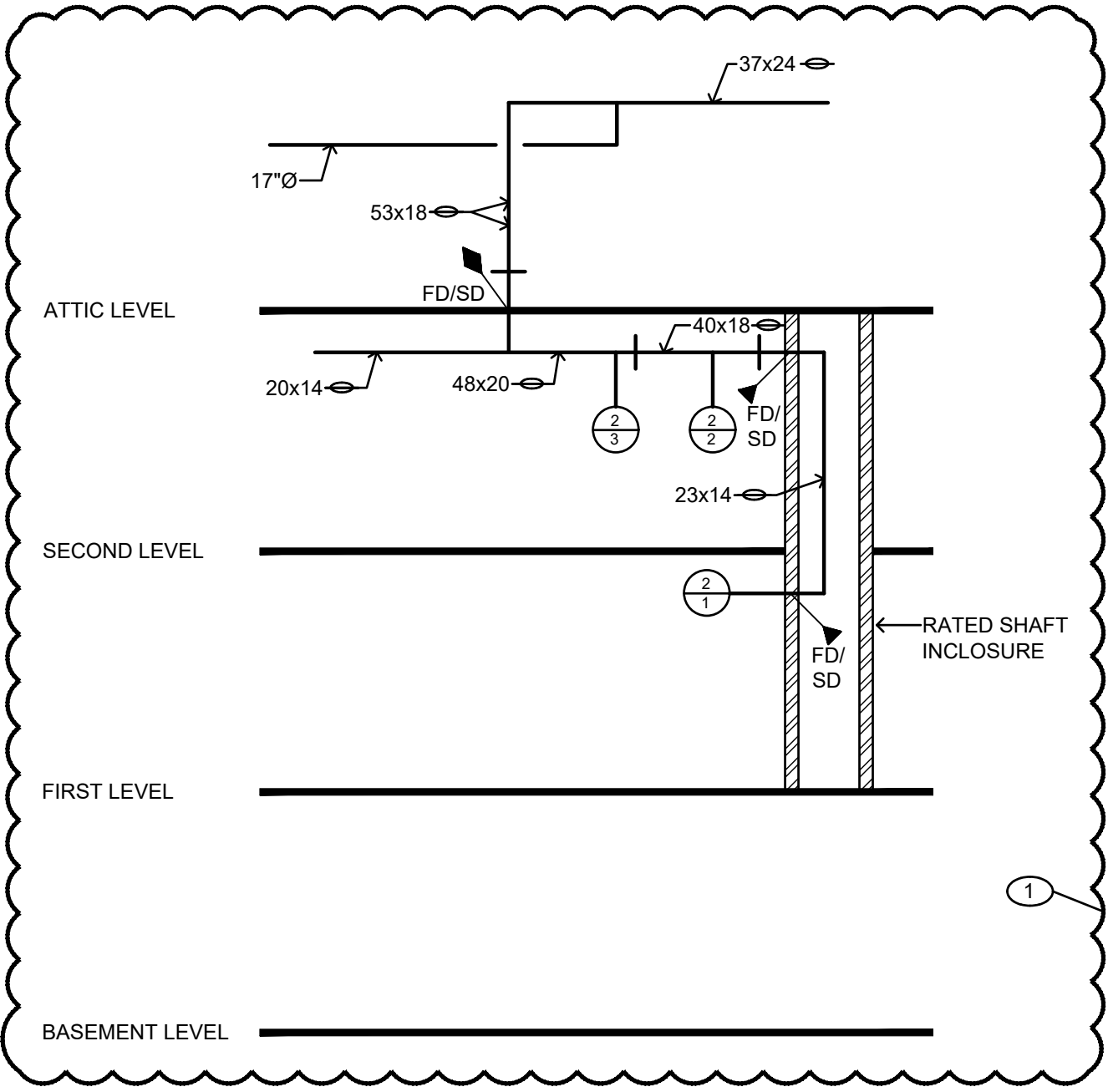
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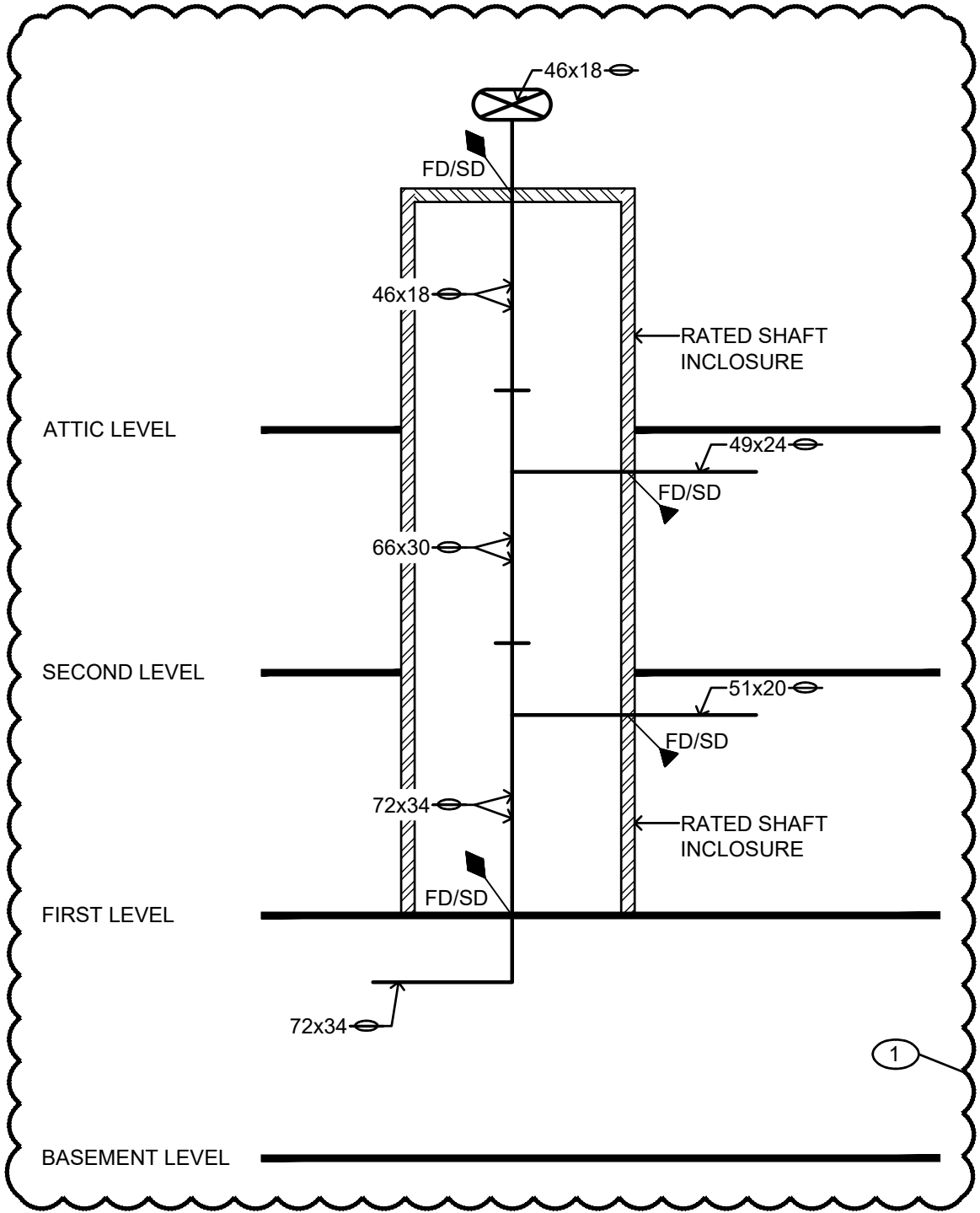
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SUPPLY AIR RISER SAR-2  
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SUPPLY AIR RISER SAR-3  
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SUPPLY AIR RISER SAR-1  
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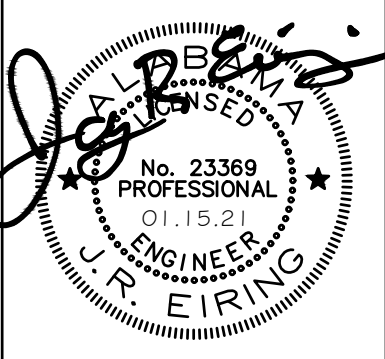
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HVAC SECTIONS

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M3.1



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800 S McDONOUGH STREET  
MONTGOMERY, AL 36104  
334.263.4406  
ZEA PROJECT NUMBER 20-171



[illegible]

NOTES: 1.) MAXIMUM A-WEIGHTED SOUND PRESSURE LEVEL, DBA, REFERENCE 20 MICRO PA WHEN MEASURED AT 30 FT. FROM THE SIDE OF THE CHILLER  
2.) PROVIDE 20% PROPYLENE GLYCOL BY WEIGHT SOLUTION IN SYSTEM

[illegible]

NOTES:

- 1.) COOLING COIL DEPTH SHALL BE MINIMUM 8-ROWS AND 10 FINS/INCH MAXIMUM SPACING.
- 2.) PERFORMANCE DATA SPECIFIED IS BASED ON CIRCULATING FLUID WITH 20% PROPYLENE GLYCOL BY WEIGHT
- 3.) FAN MOTOR HORSEPOWER BASED ON VFD MAXIMUM ALLOWABLE FREQUENCY OUTPUT OF 60 HZ.

PUMP NUMBER	SERVICE	G.P.M.	APPROX. HEAD - FEET OF WATER	MINIMUM EFFICIENCY PERCENT	MAXIMUM R.P.M.	MOTOR CHARACTERISTICS				DESCRIPTION	REMARKS
						MINIMUM H.P.	POWER				
							VOLTS	PH.	HZ		
CWP-1	CHILLED WATER - CHILLER C-1	425.5	125.0	70.0	3,500	25.0	480	3	60	SPLIT COUPLED, VERTICAL IN-LINE	ARMSTRONG 4302 DUAL ARM
CWP-2	CHILLED WATER - CHILLER C-2	425.5	125.0	70.0	3,500	25.0	480	3	60	SPLIT COUPLED, VERTICAL IN-LINE	ARMSTRONG 4302 DUAL ARM
HWP-1	HOT WATER - BOILERS B-1 & B-2	281.0	66.0	67.6	1750	10.0	480	3	60	SPLIT COUPLED, VERTICAL IN-LINE	ARMSTRONG 4302 DUAL ARM
GWP-1	GLYCOL RUNAROUND LOOP ERU-1	125.0	96.0	59.0	3,500	15.0	480	3	60	SPLIT COUPLED, VERTICAL IN-LINE	ARMSTRONG 4302 DUAL ARM

NOTES:

- 1.) CHILLED WATER PUMP SHALL BE SELECTED FOR 20% PROPYLENE GLYCOL BY WEIGHT SOLUTION.
- 2.) GLYCOL RUNAROUND LOOP PUMP AND HOT WATER PUMP SHALL BE SELECTED FOR 30% PROPYLENE GLYCOL BY WEIGHT SOLUTION.
- 3.) PUMP MOTOR HORSEPOWER BASED ON VFD MAXIMUM ALLOWABLE FREQUENCY OUTPUT OF 60 HZ.

EXPANSION TANKS SCHEDULE					
TANK NUMBER	SYSTEM	TYPE / DESCRIPTION	MINIMUM TOTAL VOLUME - GALS.	MINIMUM ACCEPTANCE VOLUME - GALLONS	REMARKS
ET-1	CHILLED WATER	FLOOR MTD., DIAPHRAGM TYPE	130	FULL	BUTYL RUBBER
ET-2	HOT WATER	FLOOR MTD., DIAPHRAGM TYPE	75	FULL	BUTYL RUBBER
ET-3	RUN AROUND GLYCOL	FLOOR MTD., DIAPHRAGM TYPE	50	FULL	BUTYL RUBBER

CW HYDRONIC SYSTEM CONTAINS 20% BY WEIGHT PROPYLENE GLYCOL. RUNAROUND AND HW SYSTEM CONTAINS 30% PROPYLENE GLYCOL BY WEIGHT

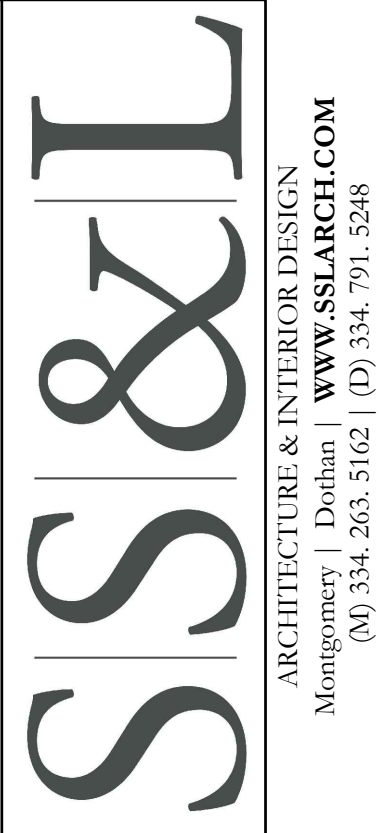
NATURAL GAS FIRED BOILER SCHEDULE									
BOILER NUMBER	FIRING RATE-C.F.H.	MINIMUM OUTPUT-M.B.H. GROSS	MINIMUM TURNDOWN	POWER	PH.	HERTZ	GAS PRESSURE	COMBUSTION AIR / VENT SIZE	BASIS OF DESIGN
B-1	2,500.0	2,400.0	20 : 1	120	1	60	2 PSI	8" / 9"	LOCHINVAR FBN 2501
B-2	2,500.0	2,400.0	20 : 1	120	1	60	2 PSI	8" / 9"	LOCHINVAR FBN 2501

COMBUSTION AIR / VENT SIZE SHALL BE AS REQUIRED BY THE BOILER MFGR FOR THE BOILERS AS INSTALLED.

ELECTRIC DUCT HEATERS SCHEDULE							
HEATER NUMBER	AIR QUANTITY- CFM	MINIMUM CAPACITY- KW	POWER			HEATER CONTROL	REMARKS
			VOLTS	PHASE	HERTZ		
EDH-1	4,000	45.0	480	3	60	SCR	AHU-2 OUTSIDE AIR DUCT
EDH-2	5,000	50.0	480	3	60	SCR	SAF-1 SUPPLY AIR DUCT

LAB ISLAND CANOPY FUME HOODS SCHEDULE					
HOOD TYPE	HOOD DIMENSIONS	NUMBER OF LED LIGHT FIXTURES	MAXIMUM PRESSURE DROP AT HOOD COLLAR - IN. WTR.	HOOD COLLAR DIAMETER DROP AT HOOD COLLAR - IN. WTR.	BASIS OF DESIGN
H-A	6'-0"L x 2'-6"W	TWO	0.40	SAME AS CONNECTING DUCT	HEMCO 23160 WITH LED LAMPS

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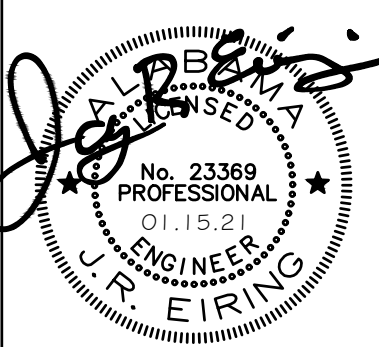
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HVAC SCHEDULES

Sheet Number

# M4.0





EXHAUST AIR VALVE SCHEDULE (GEV and FHEV)

TERMINAL NUMBER	CAP. CFM MIN. SETTING (UNOCCUPIED)	CAP. CFM MAX. SETTING (OCCUPIED)	VALVE INLET SIZE - INCHES	MAX. VALVE. PRESS. DROP AT MAXIMUM CFM - IN. WC.	MAX. N.C. RATING AT 2" NEG. PRESS
GEV-1	350	1900	14	.60	35
GEV-2	755	1375	12	.60	35
GEV-3	755	1375	12	.60	35
GEV-4	760	1375	12	.60	35
GEV-5	760	1375	12	.60	35
HEV-1	520	1650	14	.60	35
GEV-6	0	480	6	.60	35
HEV-2	600	1650	14	.60	35
GEV-7	0	480	6	.60	35
HEV-3	640	1650	14	.60	35
GEV-8	0	480	6	.60	35
FHEV-1	720	1150	12	.60	35
FHEV-2	720	1150	12	.60	35
GEV-9	110	220	6	.60	35
HEV-4	530	1650	14	.60	35
GEV-10	0	480	6	.60	35
FHEV-3	720	1150	12	.60	35
GEV-11	150	300	10	.60	35
FHEV-4	720	1150	12	.60	35
GEV-12	150	150	8	.60	35
GEV-13	430	950	12	.60	35
GEV-14	350	900	12	.60	35
GEV-15	390	900	12	.60	35
HEV-5	405	1500	12	.60	35

EXHAUST AIR VALVE SCHEDULE (GEV AND FHEV)

TERMINAL NUMBER	CAP. CFM MIN. SETTING (UNOCCUPIED)	CAP. CFM MAX. SETTING (OCCUPIED)	VALVE INLET SIZE - INCHES	MAX. VALVE. PRESS. DROP AT MAXIMUM CFM - IN. WC.	MAX. N.C. RATING AT 2" NEG. PRESS
HEV-6	405	1500	12	.60	35
GEV-16	0	720	8	.60	35
FHEV-5	720	1150	12	.60	35
FHEV-6	720	1150	12	.60	35
GEV-17	110	220	9	.60	35
GEV-18	110	220	9	.60	35
FHEV-7	720	1150	12	.60	35
FHEV-8	720	1150	12	.60	35
FHEV-9	720	1150	12	.60	35
FHEV-10	720	1150	12	.60	35
GEV-19	110	220	6	.60	35
FHEV-11	720	1150	12	.60	35
FHEV-12	720	1150	12	.60	35
GEV-20	110	220	6	.60	35
GEV-21	0	960	12	.60	35
GEV-22	660	1210	12	.60	35
GEV-23	1200	1200	12	.60	35
GEV-24	0	1920	14	.60	35
GEV-25	370	1670	14	.60	35
FHEV-13	720	1150	12	.60	35
FHEV-14	720	1150	12	.60	35
GEV-26	110	220	6	.60	35
GEV-27	230	330	8	.60	35
FHEV-15	720	1150	12	.60	35

EXHAUST AIR VALVE SCHEDULE (GEV AND FHEV)

TERMINAL NUMBER	CAP. CFM MIN. SETTING (UNOCCUPIED)	CAP. CFM MAX. SETTING (OCCUPIED)	VALVE INLET SIZE - INCHES	MAX. VALVE. PRESS. DROP AT MAXIMUM CFM - IN. WC.	MAX. N.C. RATING AT 2" NEG. PRESS
FHEV-16	720	1150	12	.60	35
FHEV-17	720	1150	12	.60	35
FHEV-18	720	1150	12	.60	35
GEV-28	110	220	6	.60	35
GEV-29	0	720	12	.60	35

- NOTES:  
1. ALL PERFORMANCE BASED IN ACCORDANCE WITH ASHRAE 130-2008 AND AHRI 880-2011  
2. ALL NC LEVELS SHALL BE BASED IN ACCORDANCE WITH AHRI 885-2008 APPENDIX E  
3. BASIS OF DESIGN IS TITUS DECV

VARIABLE AIR VOLUME TERMINAL UNITS SCHEDULE

TERMINAL NUMBER	COOLING CFM		MIN. INLET DUCT SIZE - INCHES ROUND	MAXIMUM PRESSURE DROP WITH OPEN DAMPER - INCHES OF WATER COLUMN	APPROXIMATE EXTERNAL STATIC PRESSURE - INCHES OF WATER COLUMN	HEATING COIL CHARACTERISTICS					MAX. NC RATING AT 2.0" STATIC PRESS.
	MIN. SET POINT	MAX.				HEATING CFM	MINIMUM HEATING CAPACITY- KW	VOLTS	PH.	HZ	
$\frac{2}{1}$	1980	2500	24x16	.20	.40	2500	32.0	480	3	60	32
$\frac{2}{2}$	1980	2500	24x16	.20	.40	2500	32.0	480	3	60	32
$\frac{2}{3}$	600	1650	12	.20	.40	1400	16.0	480	3	60	32
$\frac{2}{4}$	600	1850	12	.20	.40	1400	16.0	480	3	60	32
$\frac{2}{5}$	OMITTED					OMITTED					
$\frac{2}{6}$	150	690	10	.20	.42	450	5.0	277	1	60	32
$\frac{2}{7}$	600	2300	14	.20	.51	1700	20.0	480	3	60	32
$\frac{2}{8}$	100	240	8	.20	.38	240	3.0	277	1	60	32
$\frac{2}{9}$	150	500	8	.20	.40	400	5.0	277	1	60	32
$\frac{2}{10}$	100	360	6	.20	.40	360	4.0	277	1	60	32
$\frac{2}{11}$	100	480	8	.20	.40	350	4.0	277	1	60	32

- NOTES:  
1. ALL PERFORMANCE BASED IN ACCORDANCE WITH ASHRAE 130-2008 AND AHRI 880-2011  
2. ALL NC LEVELS SHALL BE BASED IN ACCORDANCE WITH AHRI 885-2008 APPENDIX E  
3. ALL HEATERS SHALL BE SCR  
4. BASIS OF DESIGN IS TITUS DESV



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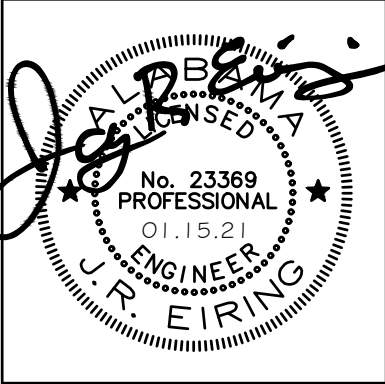
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Sheet Title  
HVAC SCHEDULES

Sheet Number

M4.2



100% OUTSIDE AIR HEATING AND AIR CONDITIONING UNIT (AHU-1)

UNIT NO.	MAXIMUM AIR SIDE PRESSURE	FAN MOTOR						COOLING COIL												HEATING COIL								
		APPROX. EXTERNAL STATIC PRESS. IN. OF WATER	APPROX. TOTAL STATIC PRESS. IN. OF WATER	FANS / TOTAL H.P.	POWER			MAX. COIL FACE VELOCITY F.P.M.	MAXIMUM AIR SIDE PRESSURE DROP - IN. WATER	MINIMUM TOTAL COOLING CAPACITY MBTU/HR	MINIMUM SENSIBLE COOLING CAPACITY MBTU/HR	AIR TEMPERATURES				CHILLED WATER			MAXIMUM WATER PRESS. DROP - FT. WTR.	MAX. COIL FACE VEL. FPM	MAXIMUM AIR SIDE PRESSURE DROP - IN. WATER	MINIMUM TOTAL HEATING CAPACITY- BTU/HR	AIR TEMPS. °F		HOT WATER			MAXIMUM WATER PRESS. DROP - FT. WTR.
					VOLTS	PHASE	HERTZ					ENTERING		LEAVING		GPM	TEMPERATURES						ENT.	LVG.	GPM	TEMPERATURES		
												D.B. °F	W.B. °F	D.B. °F	W.B. °F		E.W.T. °F	L.W.T. °F								ENT. °F	LVG. °F	
AHU-1	50,000	4.16	7.60	TEN - 110 TOTAL	480	3	60	500	0.80	4,421.8	2,349.0	88.3	76.1	49.6	49.4	761.2	45	57	28.0	600	0.30	3,931.0	10.0	75.8	274.7	160	130	14.0

100% OUTSIDE AIR HEATING AND AIR CONDITIONING UNIT (AHU-1) CONTINUED

UNIT NO.	ENERGY RECOVERY (PRECOOL)									ENERGY RECOVERY COIL (PREHEAT)									FLA	MCA
	MAX. COIL FACE VEL. FPM	MAXIMUM AIR SIDE PRESSURE DROP - IN. WATER	MINIMUM TOTAL COOLING CAPACITY- BTU/HR	AIR TEMPERATURES		GLYCOL WATER			MAXIMUM WATER PRESS. DROP - FT. WTR.	MAX. COIL FACE VEL. FPM	MAXIMUM AIR SIDE PRESSURE DROP - IN. WATER	MINIMUM TOTAL HEATING CAPACITY- BTU/HR	AIR TEMPS. °F		GLYCOL WATER			MAXIMUM WATER PRESS. DROP - FT. WTR.		
				ENTERING °F DB/ °F WB	LEAVING °F DB/ °F WB	GPM	TEMPERATURES	ENT. °F					LVG. °F	ENT. °F	LVG. °F					
AHU-1	600	0.40	395,000	96.0 / 78.0	88.3 / 76.1	125.0	79.4	86.1	18.0	600	0.40	969,000	10.0	26.3	125.0	55.1	38.7	18.0	131.0	134.0

NOTES:

1. COOLING COIL DEPTH SHALL BE MINIMUM 6 ROWS WITH MAXIMUM 12 FINS/INCH SPACING
2. HEATING COIL DEPTH SHALL BE MINIMUM 3 ROWS WITH MAXIMUM 6 FINS/INCH SPACING
3. ENERGY RECOVERY COIL DEPTH SHALL BE MINIMUM 4 ROWS WITH MAXIMUM 6 FINS/INCH SPACING
4. COOLING COILS SCHEDULED CAPACITY IS NET AFTER THE ADDITION OF 20% PROPYLENE GLYCOL
5. HEATING COILS SCHEDULED CAPACITY IS NET AFTER THE ADDITION OF 30% PROPYLENE GLYCOL
6. ENERGY RECOVERY COIL SCHEDULED CAPACITY IS NET AFTER THE ADDITION OF 30% PROPYLENE GLYCOL
7. ALL COILS SCHEDULED FLOW RATES ARE ADJUSTED FOR SPECIFIED PROPYLENE GLYCOL SOLUTIONS
8. UNIT SHALL BE PROVIDED WITH FACTORY INSTALLED VFD'S. NOTE THAT MINIMUM OF TWO VFD'S ARE REQUIRED DUE TO N+1 REQUIRED CONFIGURATION
9. EACH CHILLED WATER COIL BANK SHALL BE PROVIDED WITH UV-C LIGHTS AS REQUIRED TO COVER ENTIRE COIL BANK. MINIMUM OF 4-ROW OF 2 LONGITUDINAL LAMPS PER COIL SECTION
10. MINIMUM FAN MOTOR HORSEPOWER SAFETY FACTOR SHALL BE 10% WITH 1.15 SERVICE FACTOR
11. SHAFT GROUNDING SHALL BE WITH CERAMIC BEARINGS
12. FANS SHALL BE PROVIDED WITH OPTIMIZATION CONTROL AS A FACTORY INSTALLED OPTION
13. SUPPLY FAN DISCHARGE PLENUM SHALL BE RATED FOR 10.0" STATIC PRESSURE.
14. BASIS OF DESIGN IS TEMTROL/NORTEK MODEL ITF

ENERGY RECOVERY UNIT (RUN AROUND COIL) SCHEDULE (ERU-1)

UNIT NO.	TOTAL EXHAUST AIR - CFM	FAN MOTOR								MINIMUM EFFECTIVE PLUME HEIGHT W/ 10MPH WIND	ENERGY RECOVERY COIL CHARACTERISTICS (COOLING)									ENERGY RECOVERY COIL CHARACTERISTICS (HEATING)								
		APPROX. EXTERNAL STATIC PRESS. - IN. OF WATER	APPROX. TOTAL STATIC PRESS. IN. OF WATER	MIN. FAN DIA. - INCHES	MAX. FAN MOTOR RPM AT SPECIFIED CFM	FANS / TOTAL H.P.	POWER				MAX. COIL FACE VEL. FPM	MAXIMUM AIR SIDE PRESSURE DROP - IN. WATER	MINIMUM TOTAL COOLING CAPACITY- BTU/HR	AIR TEMPS. °F		GLYCOL WATER		MAXIMUM WATER PRESS. DROP - FT. WTR.	MAX. COIL FACE VEL. FPM	MAXIMUM AIR SIDE PRESSURE DROP - IN. WATER	MINIMUM TOTAL HEATING CAPACITY- BTU/HR	AIR TEMPS. °F		GLYCOL WATER		MAXIMUM WATER PRESS. DROP - FT. WTR.		
							VOLTS	PHASE	HERTZ					ENT.	LVG.	GPM	TEMPERATURES					ENT.	LVG.	GPM	TEMPERATURES			
																	°F								°F		°F	°F
ERU-1	52,000	4.51	7.40	40.25	1,800	(3) - 40 HP EACH	480	3	60	55 FT.	500	0.82	400,000	75.0	82.3	125.0	86.0	79.4	18.0	500	0.80	966,000	70.0	57.0	125.0	38.7	55.1	18.0

NOTES:

1. ENERGY RECOVERY COIL DEPTH SHALL BE MINIMUM 6 ROWS WITH MAXIMUM 10 FINS/INCH SPACING
2. REFER TO AHU-1 SCHEDULE ABOVE FOR ENERGY RECOVERY COIL CHARACTERISTICS AND REQUIREMENTS
3. MINIMUM TOTAL COIL FACE AREA FOR ENERGY RECOVERY COIL SHALL BE 104 SQ. FT.
6. ENERGY RECOVERY COILS SCHEDULED CAPACITY IS NET AFTER THE ADDITION OF 30% PROPYLENE GLYCOL
7. ALL COILS SCHEDULED FLOW RATES ARE ADJUSTED FOR SPECIFIED PROPYLENE GLYCOL SOLUTIONS
8. EACH FAN SHALL BE PROVIDED WITH FACTORY INSTALLED VFD
9. FANS SHALL BE AS REQUIRED FOR N+1 ARRANGEMENT
10. IF FRP CONSTRUCTION IS NOT AVAILABLE, PROVIDE ACID RESISTANT COATED 304 STAINLESS STEEL
11. PROVIDE 304 STAINLESS STEEL DRAIN PAN UNDER COIL
12. COIL CASING SHALL BE CONSTRUCTED OF 16 GA. 304 STAINLESS STEEL
13. PROVIDE LED MARINE LIGHTS WIRED TO ONE LIGHT SWITCH ON EXTERIOR UNIT CABINET
14. FANS ARE CONNECTED TO ENERGY RECOVERY PLENUM TO RECOVER EXHAUST AIR ENERGY. PLENUM SHALL BE K-KORE ENERGY RECOVERY PLENUM OR EQUIVALENT.
15. PROVIDE FACTORY FABRICATED DILUTION PLENUM WITH MODULATING DILUTION DAMPER TO MAINTAIN 2,750 FPM WIND BAND VELOCITY DURING VAV TURNDOWN.
16. PROVIDE FOR EACH FAN, GRAPHITE LINER WITH WEATHER COVER, DRAIN WITH PLUG, ISOLATION AND BYPASS DAMPERS WITH CONTROL.
17. CONTRACTOR TO VERIFY ALL MFGR. REQUIRED EQUIPMENT MAINTENANCE CLEARANCES. UNITS SHALL HAVE PROPER ACCESS WITHIN THE SPACE ALLOWED. DO NOT ORDER EQUIPMENT PRIOR TO COORDINATING
18. MOTOR SERVICE FACTOR SHALL BE MINIMUM 1.15 WITH MINIMUM OF 10% SAFETY FACTOR
19. FANS BASIS OF DESIGN IS MK PLASTICS MODEL AXIJET-FSW

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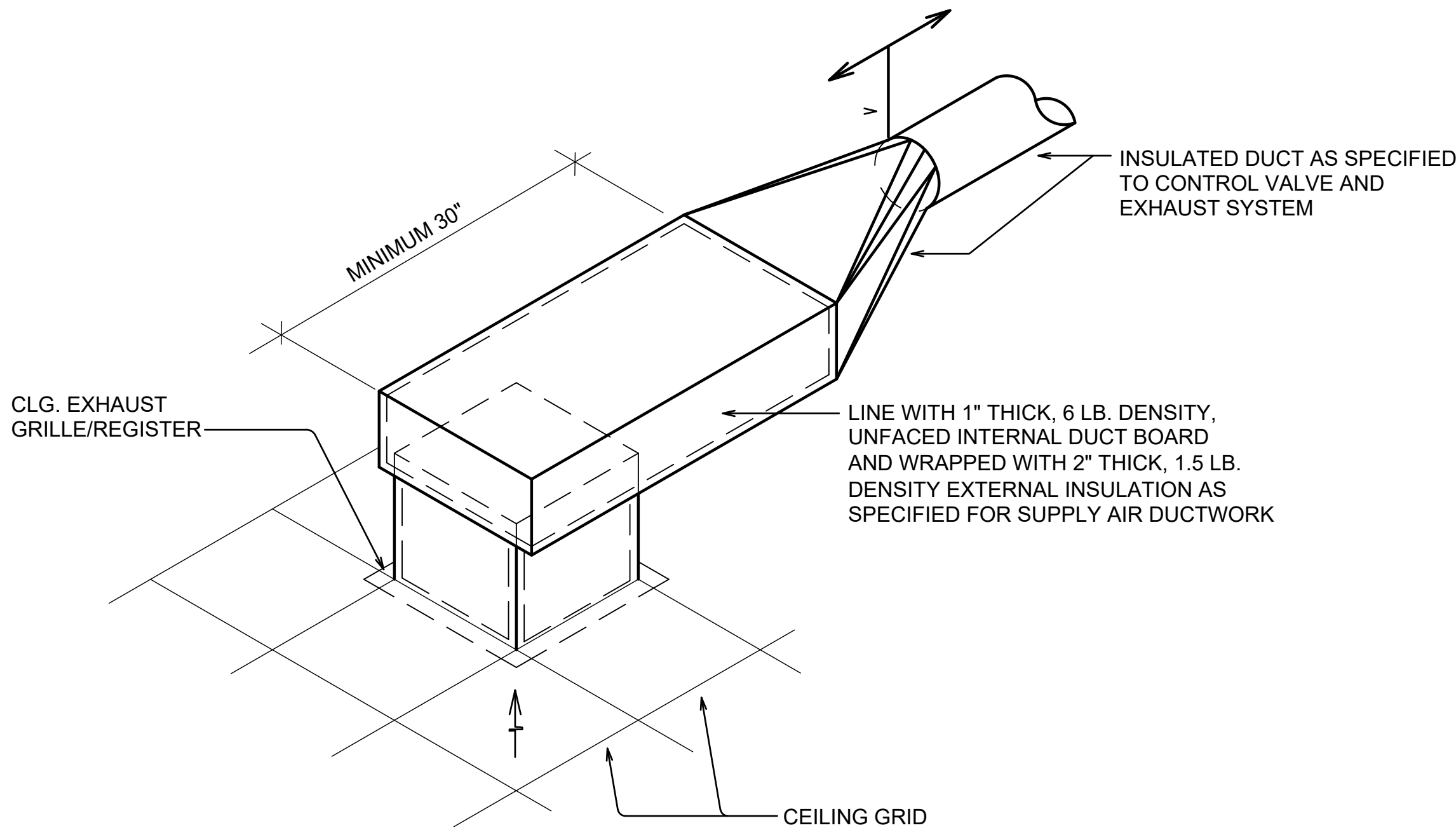
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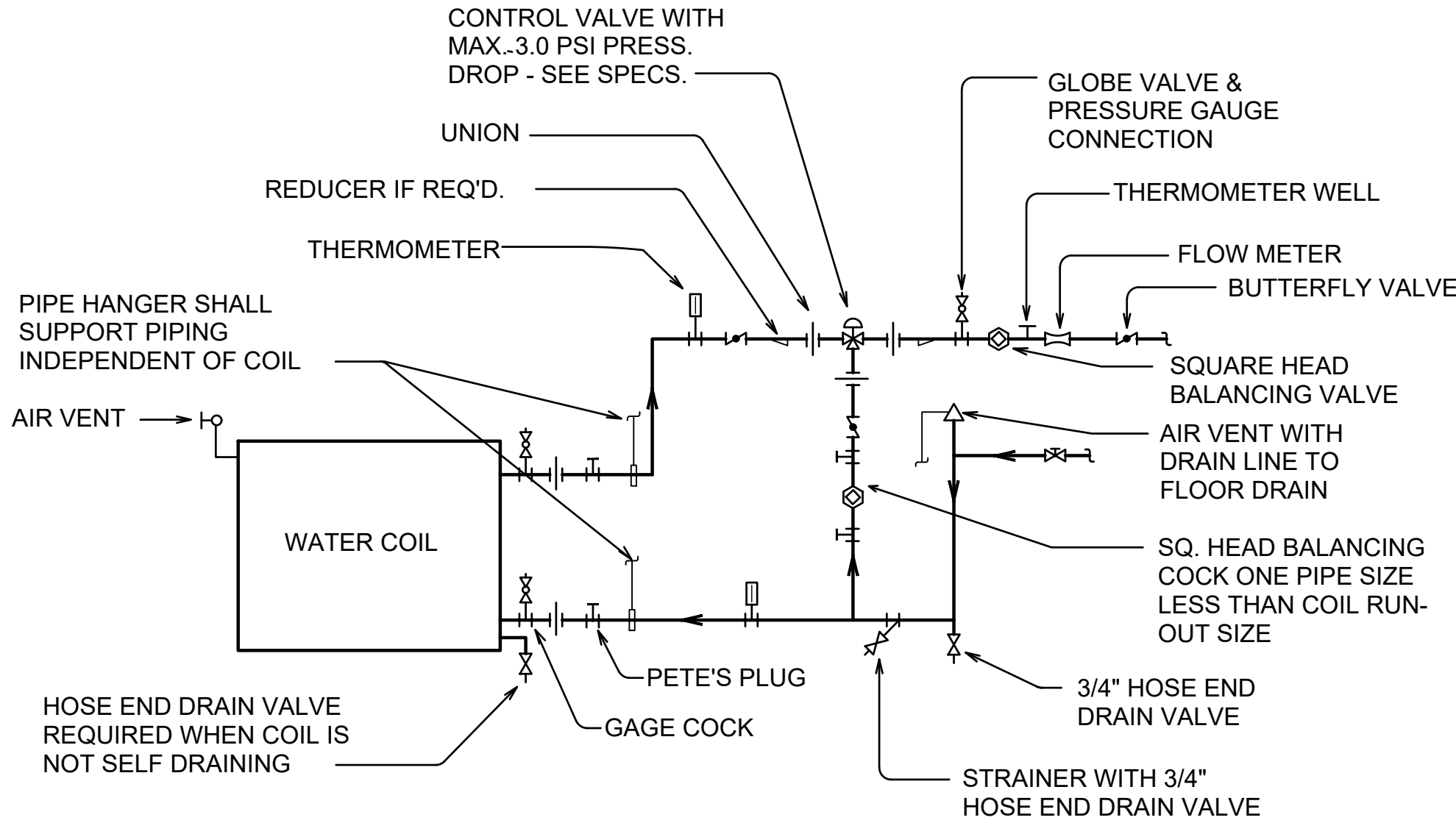






### GENERAL LAB EXHAUST REGISTER / PLENUM CONN. DETAIL

NOT TO SCALE



### ENERGY RECOVERY UNIT ERU-1 GLYCOL COIL CONNECTION DETAIL

NOT TO SCALE

#### NOTES:

- 1) RUNOUTS PIPING FOR COIL CONNECTIONS SHALL BE INSTALLED WITH SWING JOINTS TO ALLOW FOR VIBRATION
- 2) PIPING SHALL BE INSTALLED IN SUCH A MANNER SO AS NOT TO BLOCK THE SWING OR USE OF ACCESS DOORS, PANELS, FILTERS, VALVES OR OTHER APPURTENANCES
- 3) PROVIDE ISOLATION VALVES IN SUPPLY AND RETURN LINES. LOCATE ISOLATION VALVES OUTSIDE THE COIL PULL LINE TO ALLOW COIL REMOVAL WITHOUT DISRUPTION OF HYDRONIC SERVICE TO OTHER EQUIPMENT AND TO KEEP PIPING DISASSEMBLY TO A MINIMUM



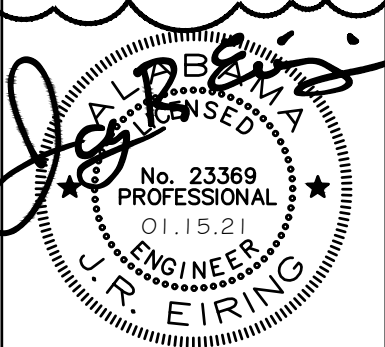
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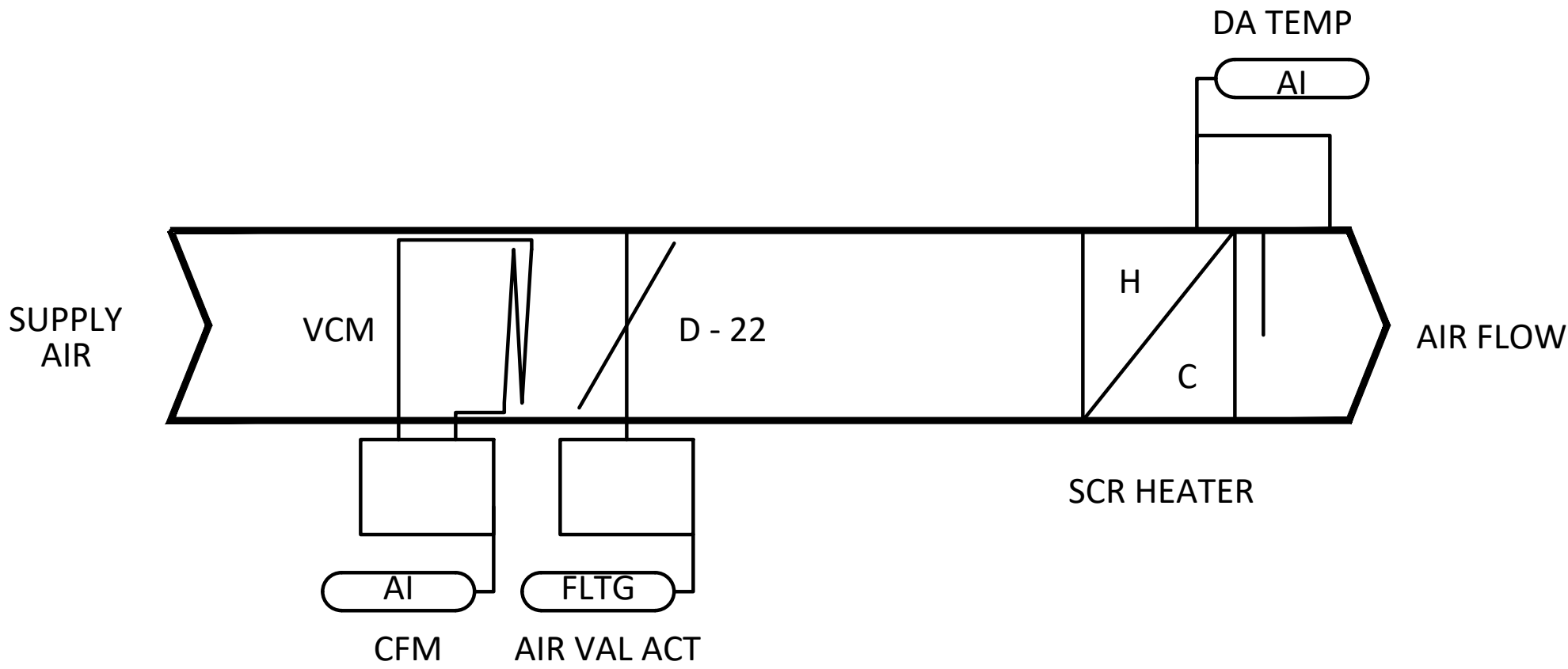
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Sheet Title	HVAC DETAILS
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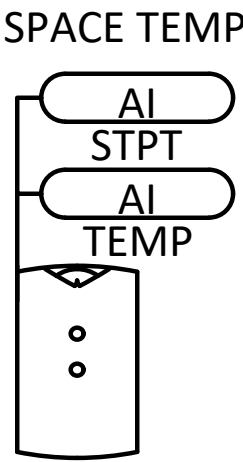
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SPACE TEMPERATURE SENSOR



VAV Terminal Units with Elec. Reheat (AHU-2 ONLY)

VAV Terminal units with Electric Reheat (AHU-2)

Sequence of Operations

Building Automation System Interface:

The Building Automation System (BAS) shall send the controller Occupied and Unoccupied commands. The BAS may also send a Heat/Cool mode, priority shutdown commands, space temperature and/or space temperature setpoint. If communication is lost with the BAS, the VAV controller shall operate using its local setpoints.

Occupancy Mode:

The occupancy mode shall be communicated or hardwired to the controller via a binary input. Valid occupancy modes for the unit shall be:

Occupied:

Normal operating mode for occupied spaces or daytime operation. When the unit is in the occupied mode the VAV shall maintain the space temperature at the active occupied heating or cooling setpoint. Applicable ventilation and airflow setpoints shall be enforced. The occupied mode shall be the default mode of the VAV.

Unoccupied:

Normal operating mode for unoccupied spaces or nighttime operation. When the unit is in unoccupied mode the VAV controller shall maintain the space temperature at the stored unoccupied heating or cooling setpoint regardless of the presence of a hardwired or communicated setpoint. When the space temperature exceeds the active unoccupied setpoint the VAV shall modulate fully closed.

Occupied Bypass:

Mode used to temporarily place the unit into the occupied operation. Tenants shall be able to override the unoccupied mode from the space sensor. The tenants shall be able to cancel the override from the space sensor at any time. During the override the unit shall operate in occupied mode.

Heat/Cool Mode:

The Heat/Cool mode shall be set by a communicated value or automatically by the VAV. In standalone or auto mode the VAV shall compare the primary air temperature with the configured auto changeover setpoint to determine if the air is "hot" or "cold". Heating mode it implies the primary air temperature is hot. Cooling mode it implies the primary air temperature is cold.

Heat/Cool Setpoint:

The space temperature setpoint shall be determined either by a local setpoint, the VAV default setpoint or a communicated value. The VAV shall use the locally stored default setpoints when neither a local setpoint nor communicated setpoint is present. If both a local setpoint and communicated setpoint exist, the VAV shall use the communicated value.

Cooling Mode:

When the unit is in cooling mode, the VAV controller shall maintain the space temperature at the active cooling setpoint by modulating the airflow between the active cooling minimum airflow setpoint to the maximum cooling airflow setpoint. The VAV shall use the measured space temperature and the active cooling setpoint to determine the requested cooling capacity of the unit. The outputs will be controlled based on the unit configuration and the requested cooling capacity.

Heating Mode:

When the unit is in heating mode, the VAV controller shall maintain the space temperature at the active heating setpoint by modulating the airflow between the active heating minimum airflow setpoint to the maximum heating airflow setpoint. The VAV controller shall use the measured space temperature and the active heating setpoint to determine the requested heating capacity of the unit. The outputs will be controlled based on the unit configuration and the requested heating capacity.

Reheat Control:

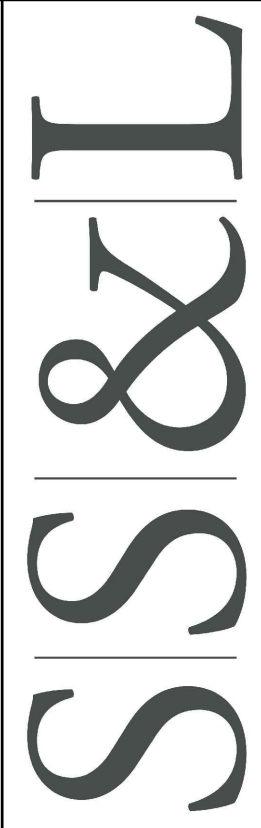
Reheat will only be allowed when the primary air temperature is 5.0 deg. F below the configured reheat enable setpoint. The reheat shall be enabled when the space temperature drops below the active heating setpoint and the minimum airflow requirements are met. During reheat the VAV shall operate at its minimum heating airflow setpoint and energize the heat as follows:

Proportional Electric Reheat:

If the space temperature is below the heating setpoint the SCR electric heater shall modulate as required to maintain the active heating setpoint and humidity setpoint.

Space Sensor Failure:

If there is a fault with the operation of the zone sensor an alarm shall be annunciated at the BAS. Space sensor failure shall cause the VAV to drive the damper to minimum air flow if the VAV is in the occupied mode, or drive it closed if the VAV is in the unoccupied mode.



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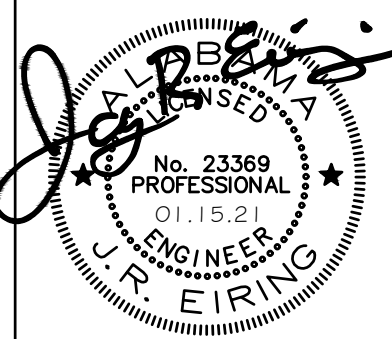
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PLUMBING LEGEND

————	SOIL OR WASTE LINE
- - - - -	VENT LINE
— ACID —	ACID WASTER LINE
- - ACID - -	ACID VENT LINE
— S —	STORM LINE
— - - - -	COLD WATER LINE
— - - - -	HOT WATER LINE
- - - - -	HOT WATER RETURN LINE
— A —	AIR LINE
— V —	VACUUM LINE
— VE —	VACUUM EXHAUST LINE
— G —	GAS LINE
— ? —	NON-POTABLE COLD WATER LINE
↓	GAS COCK
●	BALL VALVE
↗	SWING CHECK VALVE
⊕	GAS PRESSURE REGULATOR
⊕	UNION
○	PIPE TURNING UP
⊖	PIPE TURNING DOWN
⊥	P TRAP
⊙	FD FLOOR DRAIN
⊙	MFD MECHANICAL FLOOR DRAIN
⊙	SD SHOWER DRAIN
⊙	RD ROOF DRAIN
⊙	OFRD OVERFLOW ROOF DRAIN
↔ A	LABORATORY AIR OUTLET
↔ V	LABORATORY VACUUM OUTLET
↔ G	LABORATORY GAS OUTLET
↔ CW	LABORATORY COLD WATER OUTLET
↔ HW	LABORATORY HOT WATER OUTLET
P-#	PLUMBING FIXTURE NUMBER
△ #	RISER DIAGRAM NUMBER
L-#	LABORATORY EQUIPMENT NUMBER
TMV-1	THERMOSTATIC MIXING VALVE #1
TMV-2	THERMOSTATIC MIXING VALVE #2
TMV-3	THERMOSTATIC MIXING VALVE #3
AFF	ABOVE FINISH FLOOR
CO	CLEAN OUT
WS	WASTE STACK
WSV	WASTE STACK VENT
AWS	ACID WASTE STACK
VS	VENT STACK
AVS	ACID VENT STACK
AWSV	ACID WASTE STACK VENT
VSTR	VENT STACK THRU ROOF
AVSTR	ACID VENT STACK THRU ROOF
RL	RAIN LEADER
OFRL	OVERFLOW RAIN LEADER
CW	COLD WATER
HW	HOT WATER
HWR	HOT WATER RETURN
UR	URINAL
WC	WATER CLOSET
LAV	LAVATORY
EWC	ELECTRIC WATER COOLER
EXIST.	EXISTING
HB	HOSE BIBB
WH	WALL HYDRANT
NPCW	NON-POTABLE COLD WATER
RPZBP	REDUCED PRESSURE ZONE BACKFLOW PREVENTER
INV	INVERT
NC	NORMALLY CLOSED

PLUMBING FIXTURE CONNECTION SCHEDULE

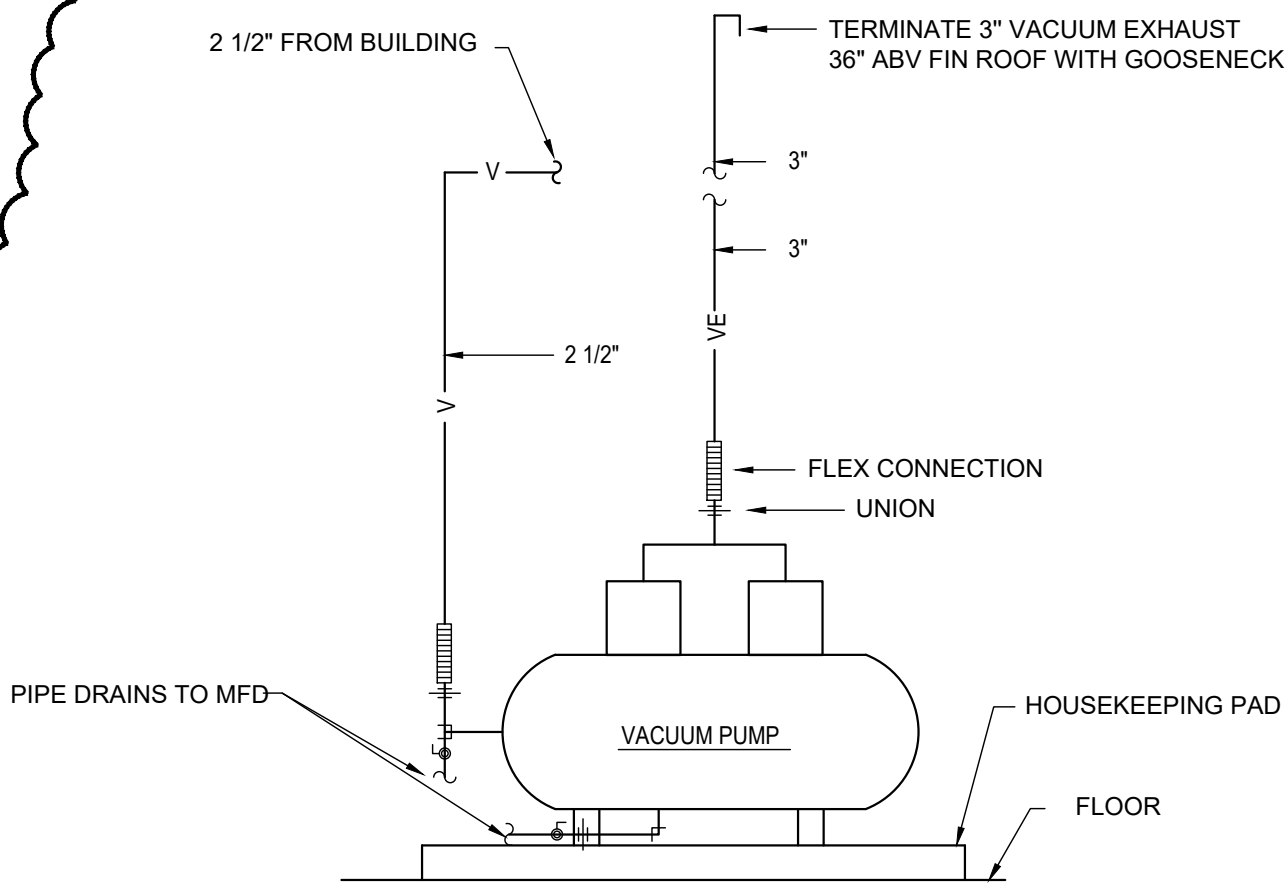
MARK	FIXTURE	WASTE	CW	HW	REMARKS
P-1	WATER CLOSET	4"	1"	-	FLOOR MOUNTED, STANDARD MOUNTING HEIGHT
P-2	WATER CLOSET	4"	1"	-	FLOOR MOUNTED, ADA COMPLIANT, PULL HANDLE LEFT SIDE OF FIXTURE
P-3	WATER CLOSET	4"	1"	-	FLOOR MOUNTED, ADA COMPLIANT, PULL HANDLE RIGHT SIDE OF FIXTURE
P-4	URINAL	2"	3/4"	-	WALL HUNG, ADA COMPLIANT LIP 17" A.F.F.
P-5	LAVATORY	1 1/4"	1/2"	1/2"	COUNTERTOP, ADA COMPLIANT
P-6	ELEC WATER COOLER	1 1/4"	1/2"	-	WALL HUNG, ADA COMPLIANT, LOWER SPOUT OUTLET 36" A.F.F.
P-7	JANITOR'S RECEPTOR	3"	1/2"	1/2"	-
P-8	SHOWER	2"	1/2"	1/2"	-

GENERAL PLUMBING NOTES

- ROUGH WATER CLOSET AND URINAL FLUSH VALVE SO THAT THE FLUSH TUBE IS VERTICALLY STRAIGHT.
- PROVIDE A CAST IRON DEEP SEAL P-TRAP AND A TRAP SEAL FOR EACH FLOOR DRAIN AND HUB DRAIN.
- PROVIDE A VACUUM BREAKER FOR EACH WALL HYDRANT/HOSE BIBB.
- ROUTE ALL OVERHEAD WATER PIPING AND WATER PIPING WITHIN NON-MASONRY WALLS WITHIN THE BUILDING INSULATION ENVELOPE.
- ALL WATER PIPING WITHIN MASONRY WALLS SHALL BE INSULATED AS SPECIFIED.
- ALL WATER PIPING INSTALLED IN EXTERIOR WALLS SHALL BE LOCATED ON THE INTERIOR SIDE OF THE BUILDING EXTERIOR WALL INSULATION
- COORDINATE ALL PIPING RUNS WITH THE ELECTRICAL PLANS AN ELECTRICAL CONTRACTOR. DO NOT ROUTE ANY PIPING OVER ELECTRICAL PANELS, TRANSFORMERS, SWITCHGEAR, ETC. MAINTAIN CLEARANCES AS REQUIRED BY RESPECTIVE CODES.
- ALL PIPING AND FITTINGS ROUTED IN/THROUGH RETURN AIR PLENUMS, RETURN AIR PLATFORMS OR FIRE RATED PARTITIONS OR ENCLOSURES SHALL BE CAST IRON OR PVDF. SEE SPECS.
- PLUMBING VENTS SHALL TERMINATE A MINIMUM OF 10'-0" DISTANCE FROM ALL HVAC OUTSIDE AIR INTAKES.
- ADA FIXTURES AND INSTALLATION SHALL COMPLY WITH CURRENT ADA STANDARDS FOR ACCESSIBLE DESIGN.
- FLUSH VALVE HANDLE FOR ALL MANUAL FLUSH WATER CLOSETS SHALL BE LOCATED ON THE WIDE SIDE OF THE TOILET STALL AS REQUIRED BY CURRENT ADA STANDARDS FOR ACCESSIBLE DESIGN.
- ROUGH-IN ADA WATER CLOSETS 18" FROM FINISHED WALL TO CENTERLINE OF THE WATER CLOSET. MEASURE FROM FACE OF SHORT SIDE OF THE STALL TO THE FINISHED WALL.
- PROVIDE A READILY ACCESSIBLE CLEANOUT AT OR NEAR THE BASE OF EACH WASTE AND VENT STACK PER INTERNATIONAL PLUMBING CODE AND THE SPECIFICATIONS. LOCATE TO THE SIDE OF THE WATER CLOSETS WITH A MINIMUM CLEARANCE OF 6" FROM THE ROUGH-IN OF THE WATER CLOSETS. PREFERRED LOCATION IS IN ADA STALL TO ALLOW FOR ADDITIONAL ACCESS.
- WATER SUPPLY SYSTEM IS DESIGNED FOR A STATIC PRESSURE OF 50 TO 75 PSI. GAUGE WATER SUPPLY PRESSURE AND VERIFY PRESSURE IS WITHIN THE SPECIFIED LIMITS. PROVIDE WATER PRESSURE REDUCING VALVE AS REQUIRED TO MAINTAIN WATER PRESSURE WITHIN DESIGN LIMITS.
- PROVIDE A BALL VALVE ON EACH SIDE OF EVERY DIELECTRIC UNION TO FACILITATE ITS REMOVAL.
- ALL OUTSIDE CLEANOUTS SHALL BE BROUGHT TO GRADE AND FINISHED FLUSH IN 12x12x12 CONCRETE PAD.
- ALL INTERIOR AND EXTERIOR WALL HYDRANTS AND HOSE BIBBS SHALL BE LOCATED 24" A.F.F.
- WATER HAMMER ARRESTORS SHALL BE INSTALLED AT ALL SOLENOID, REMOTE OPERATED OR QUICK CLOSING VALVES AND AT EACH PLUMBING FIXTURE OR BATTERY OF PLUMBING FIXTURES. SEE SPECS FOR ADDITIONAL REQUIREMENTS.
- ALL HUB DRAINS THAT RISE THROUGH RETURN AIR PLATFORMS SHALL BE INSULATED CAST IRON AND TERMINATED TO 6" ABOVE THE RETURN AIR PLATFORM AND SEALED AIR TIGHT. COORDINATE REQUIREMENT WITH MECHANICAL CONTRACTOR.

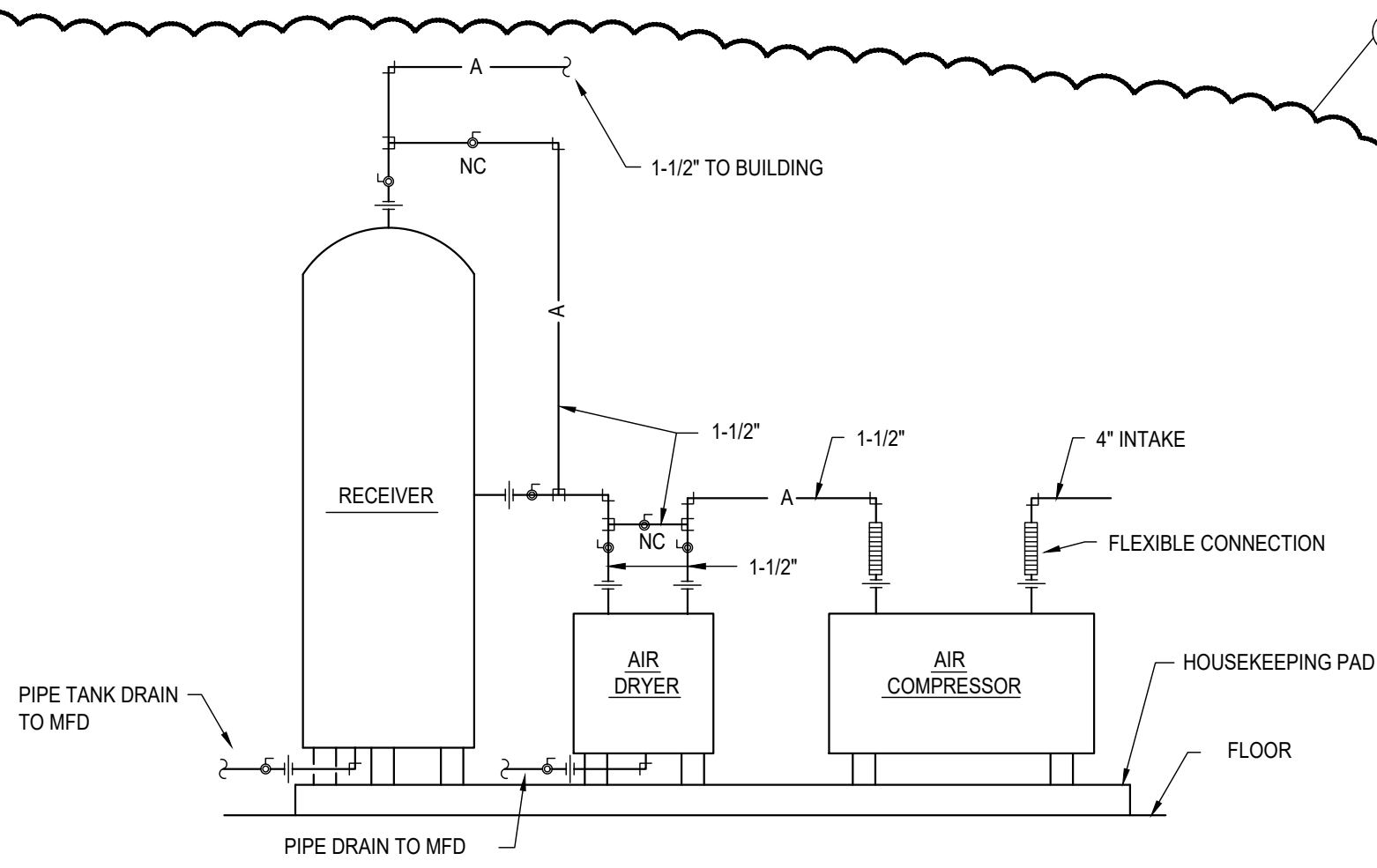
LABORATORY EQUIPMENT CONNECTION SCHEDULE

MARK	FIXTURE	WASTE	CW	HW	AIR	VACUUM	GAS	REMARKS
L-1	LAB SINK	1 1/2"	1/2"	1/2"	-	-	-	ROUGH & CONNECT
L-2	FUME HOOD	1 1/2"	1/2"	-	(2) 1/2"	(2) 1/2"	(2) 1/2"	ROUGH & CONNECT
L-3	SAFETY SHOWER/EYE WASH	-	1"	1"	-	-	-	ROUGH & CONNECT. PROVIDE TMV-1 ABOVE CEILING
L-4	EMERGENCY SHUT OFF	-	-	-	-	-	-	LOCATE ON GAS LINE ABV CEILING AND BUTTON ON WALL ADJACENT TO EXIT DOOR
L-5	ISIMET GAS DETECTOR	-	-	-	-	-	-	LOCATE WHERE SHOWN ON PLANS
L-6	DEIONIZED FAUCET	-	1/2"	-	-	-	-	ROUGH & CONNECT
L-7	COUNTERTOP EYE WASH	-	1/2"	1/2"	-	-	-	ROUGH & CONNECT. PROVIDE TMV-2 ABOVE CEILING



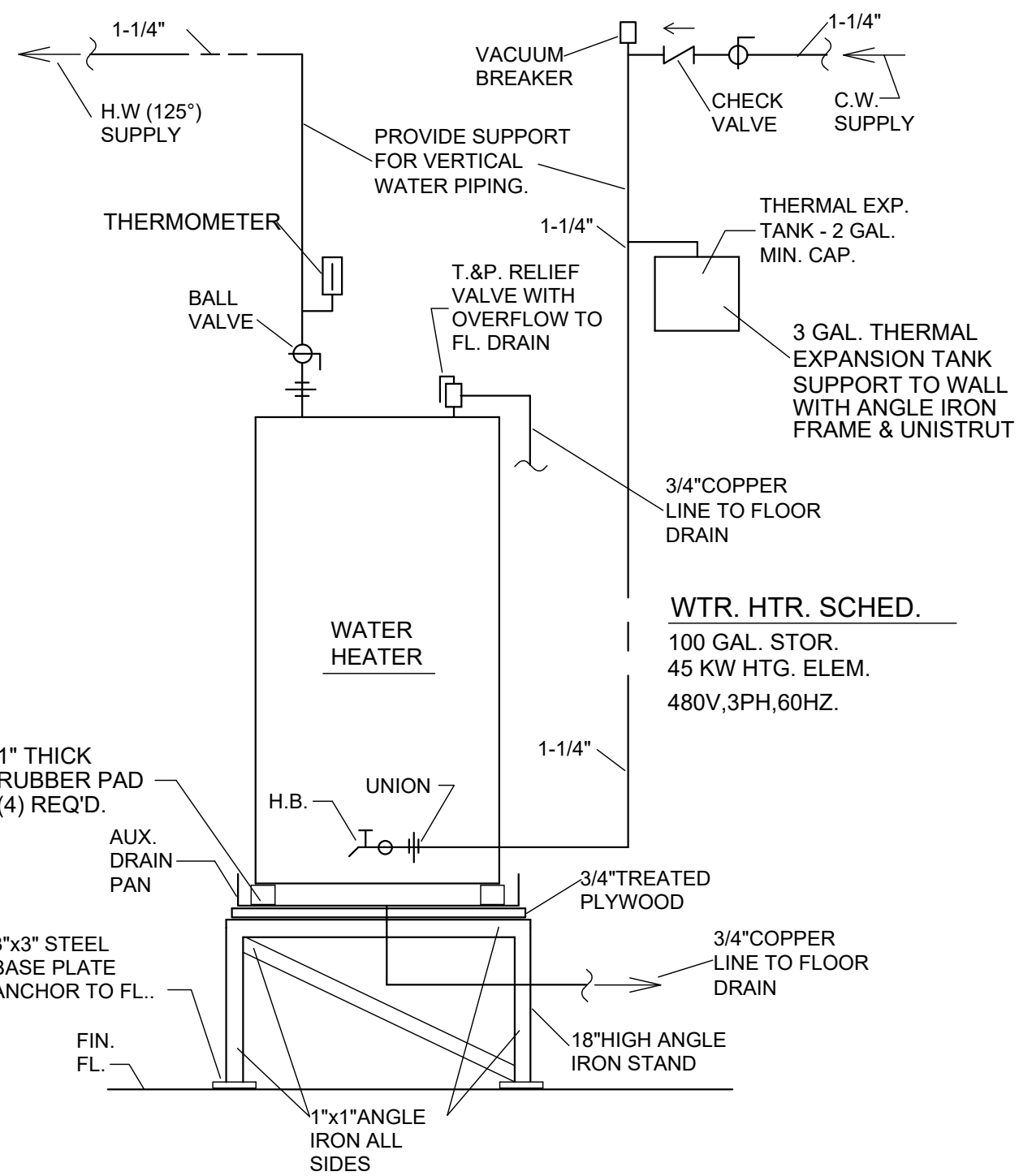
DETAIL OF PIPING AT VACUUM PUMP  
NO SCALE

VACUUM PUMP CAPACITY:  
120 ACFM AT 25" HgV  
7.5 HP MIN. 87% EFFICIENT MOTOR - 480V/3PH/60HZ  
VOLUMETRIC EFFICIENCY=96.1%  
MAX. MOTOR RPM = 1,800  
MOTORS SHALL BE PREMIUM EFFICIENCY

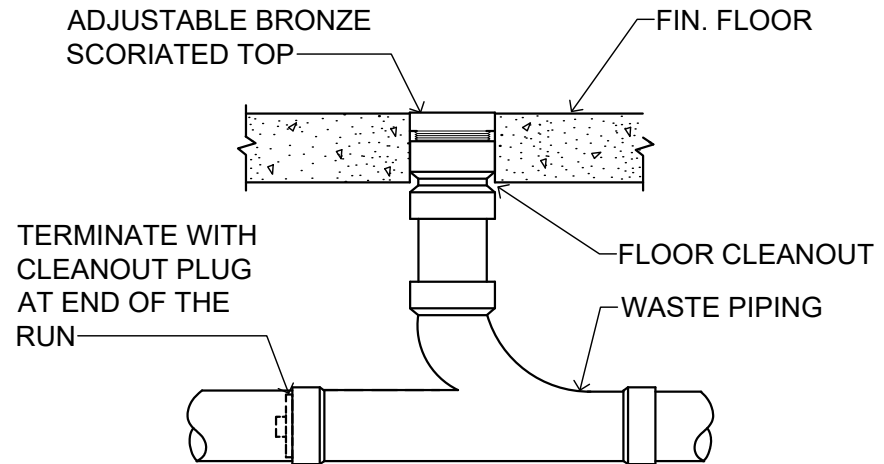


DETAIL OF PIPING AT AIR COMPRESSOR  
NO SCALE

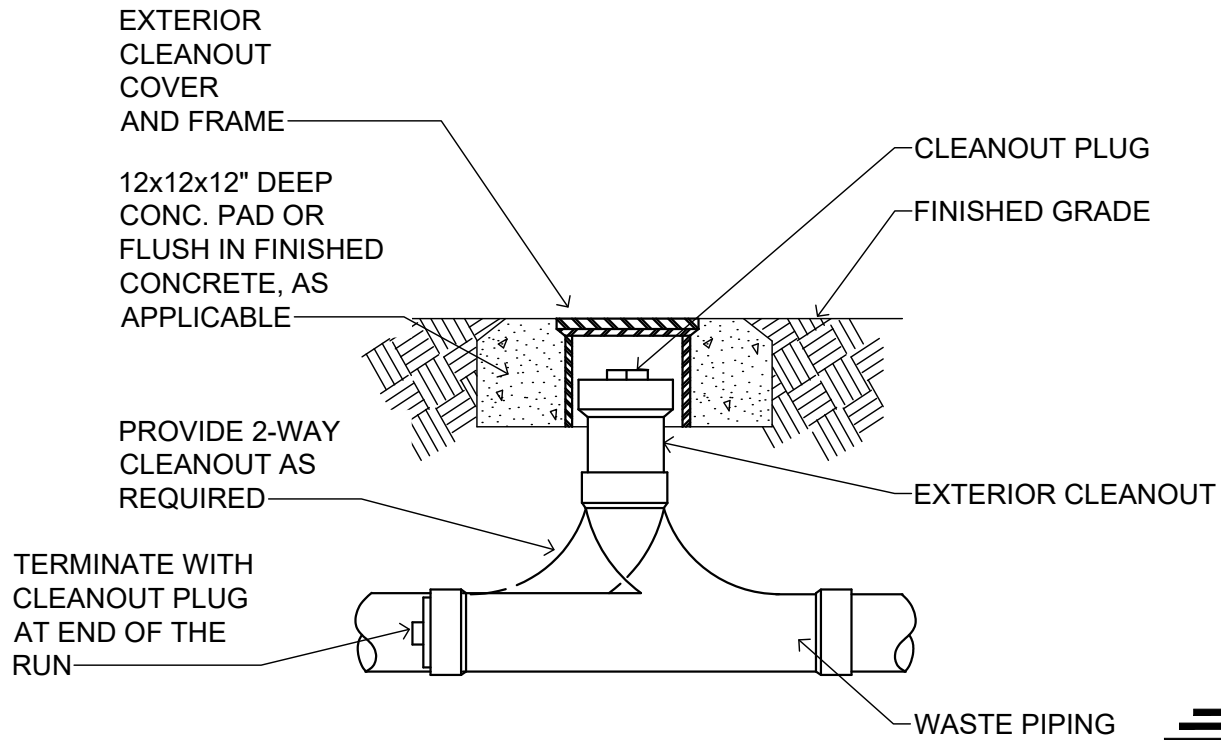
AIR COMPRESSOR CAPACITY:  
63 ACFM AT 150 PSI  
15 HP - 480V/3PH/60HZ  
MAX. 3,800 RPM  
RECEIVER TANK: 240 GALLONS AT 200 PSI  
MOTORS SHALL BE PREMIUM EFFICIENCY



WATER HEATER DETAIL  
NO SCALE



TYP. FLOOR CLEANOUT DETAIL  
NO SCALE



TYP. EXTERIOR CLEANOUT DETAIL  
NO SCALE

Rev.	Description	Date
1	ADD #5	01.15.21

Job Number	18144
Date	11/17/2020
Drawn By	CW
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Project Title	CENTER FOR MATERIALS AND MANUFACTURING SCIENCES TROY UNIVERSITY   TROY, AL
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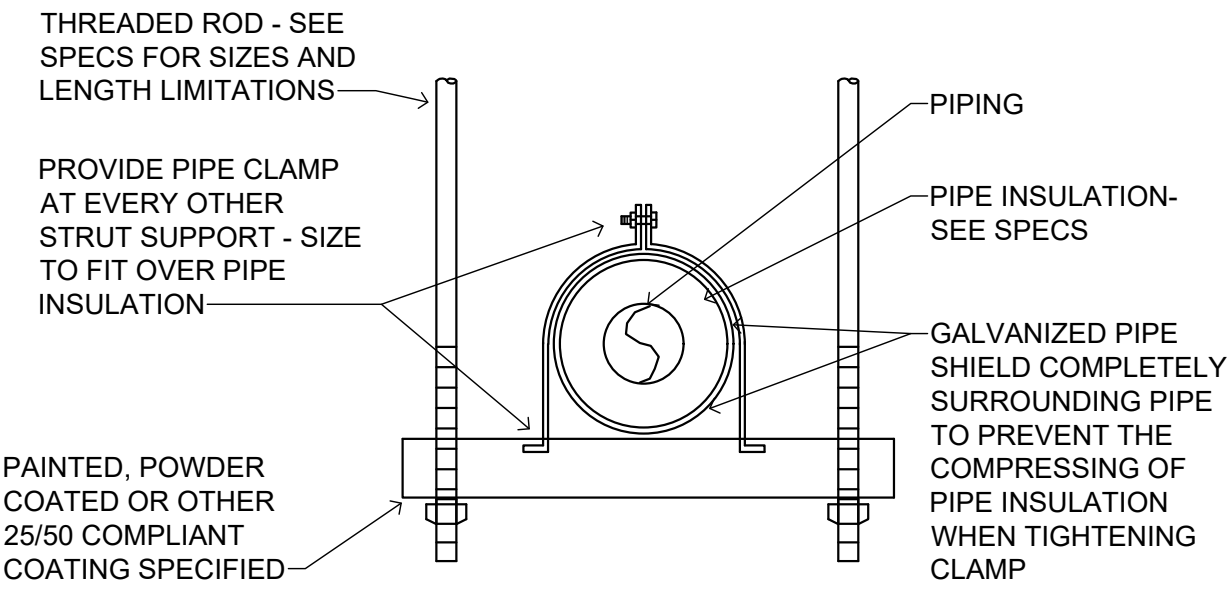
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PLBG. SCHEDULES  
DETAILS

Sheet Number

P1.0

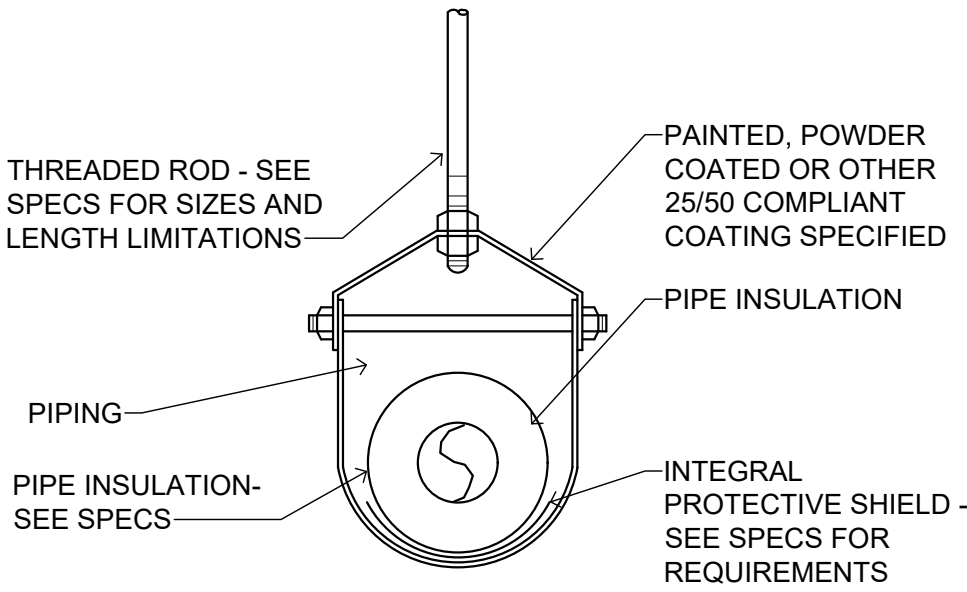
**ZGOUVAS, EIRING & ASSOCIATES**  
CONSULTING ENGINEERS  
800 S McDONOUGH STREET  
MONTGOMERY, AL 36104  
334.263.4406  
ZEA PROJECT NUMBER 20-171





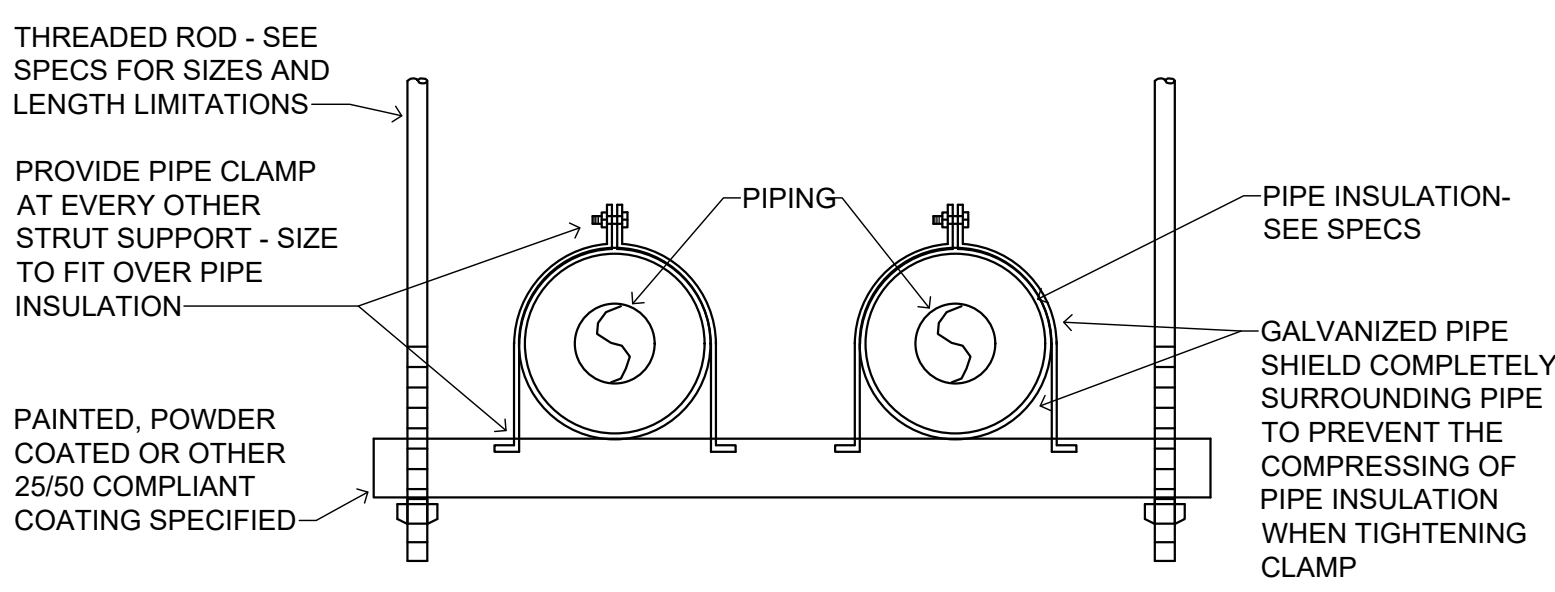
Typical Pipe Hanger Detail

NO SCALE  
NOTE: HANGER SPACING TO BE AS SPECIFIED



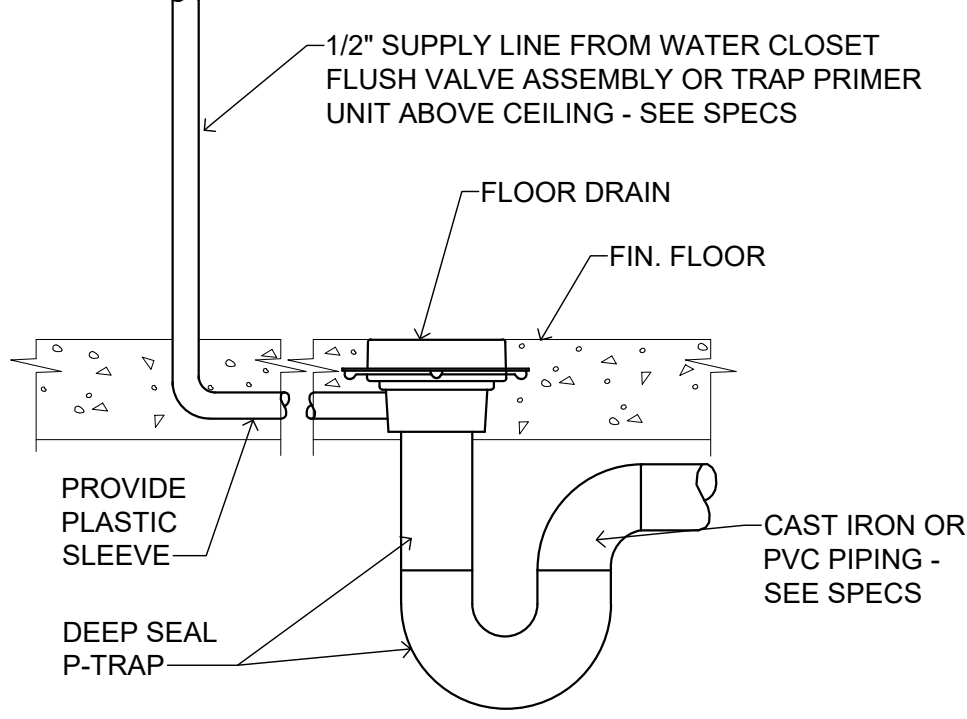
Typical Pipe Hanger Detail

NO SCALE  
NOTE: HANGER SPACING TO BE AS SPECIFIED



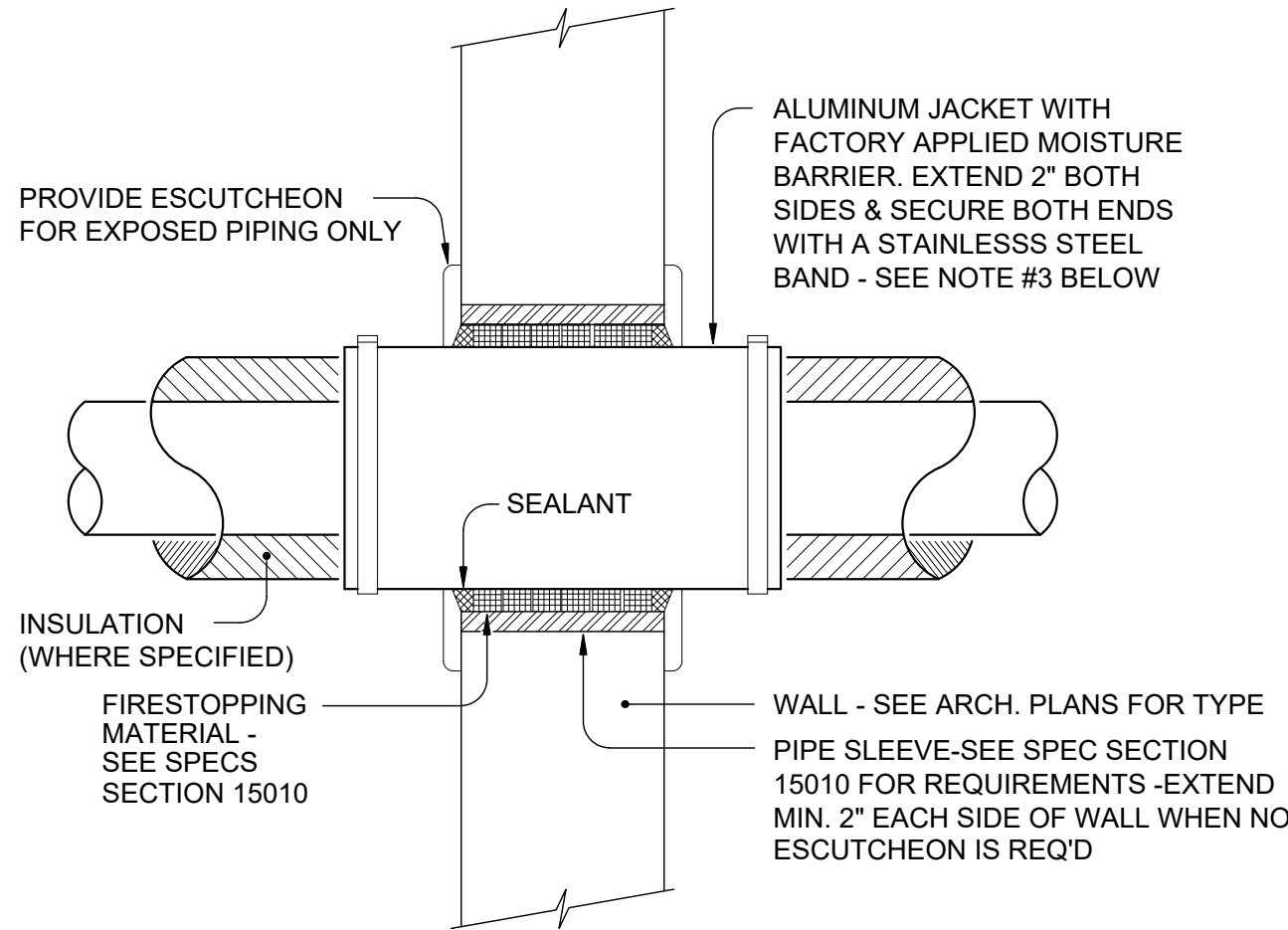
Typical Multiple Pipes Hanger Detail

NO SCALE



Trap Primer Detail

NO SCALE

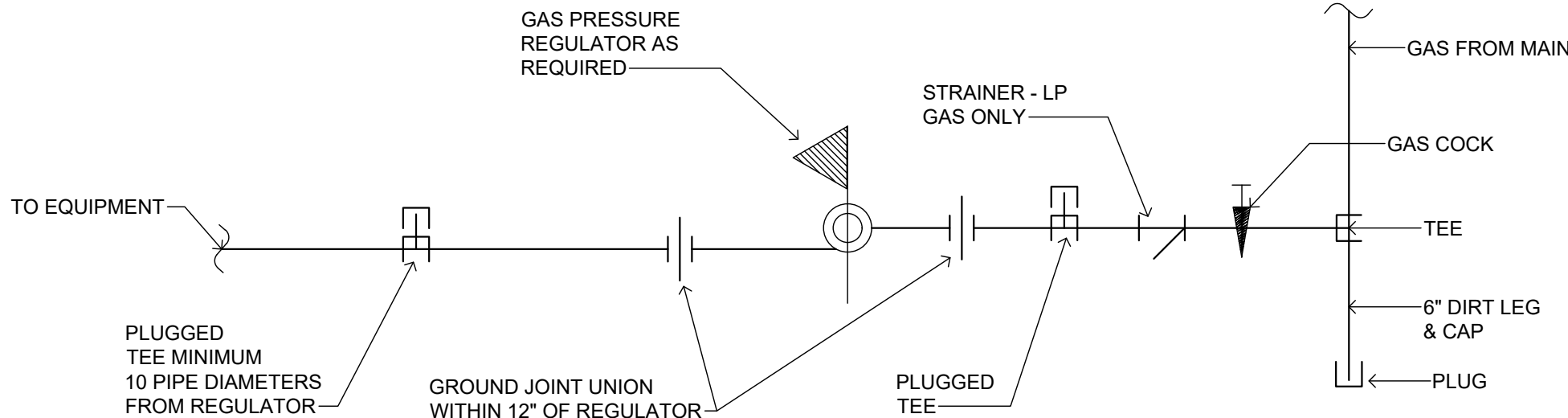


Interior Wall Pipe Penetration Detail

NOT TO SCALE

NOTES:

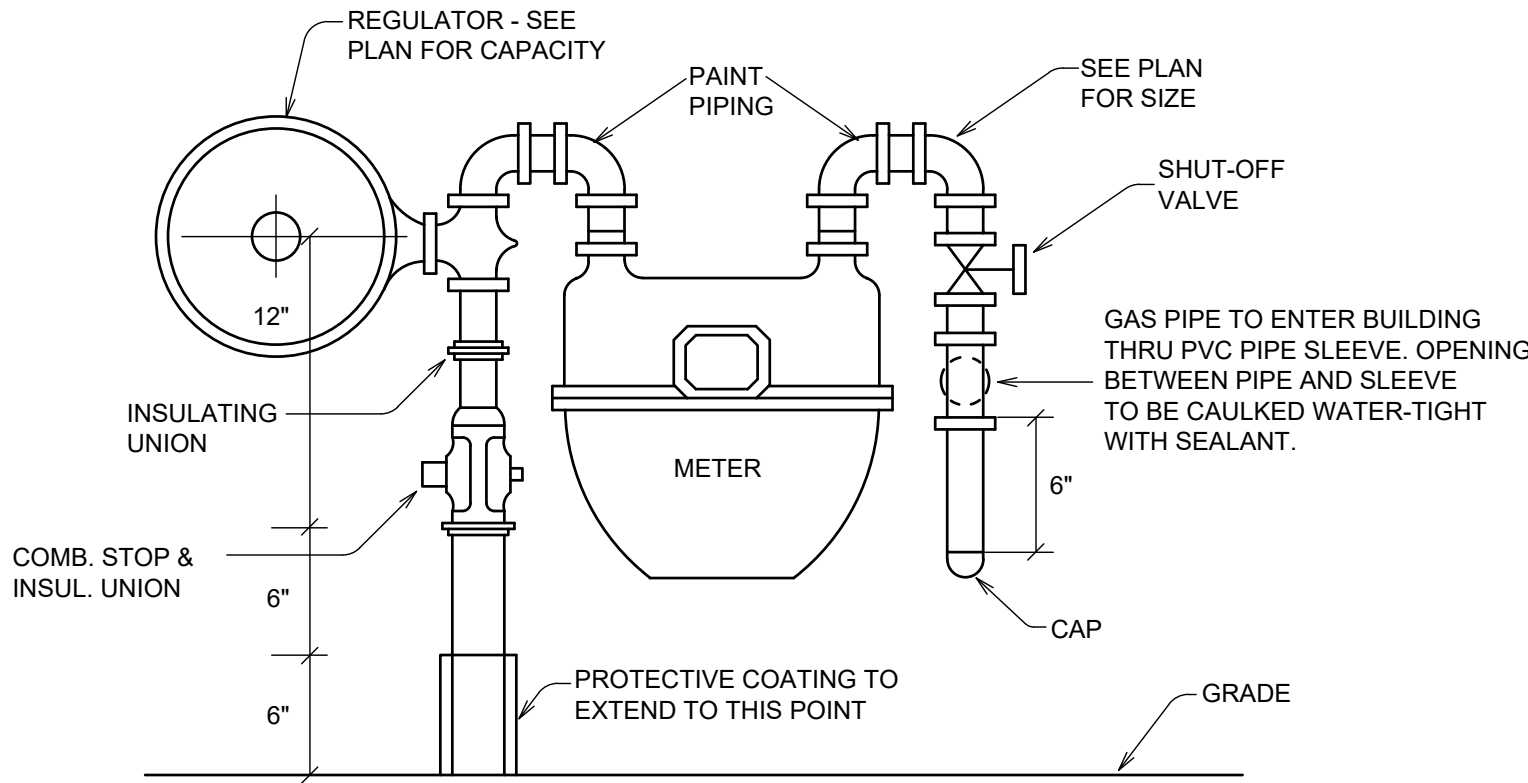
1. DETAIL APPLIES TO ALL PIPING ABOVE AND BELOW THE CEILING.
2. AT GYPSUM BOARD WALLS, PROVIDE MINIMUM 16 GA. GALVANIZED STEEL SLEEVE WITH LOCKING TYPE LONGITUDINAL SEAM
3. OMIT ALUMINUM JACKET IF PIPING IS UNINSULATED.
4. ONLY ONE PIPE PER SLEEVE ALLOWED



Typical Gas Piping Conn. Detail

NOT TO SCALE

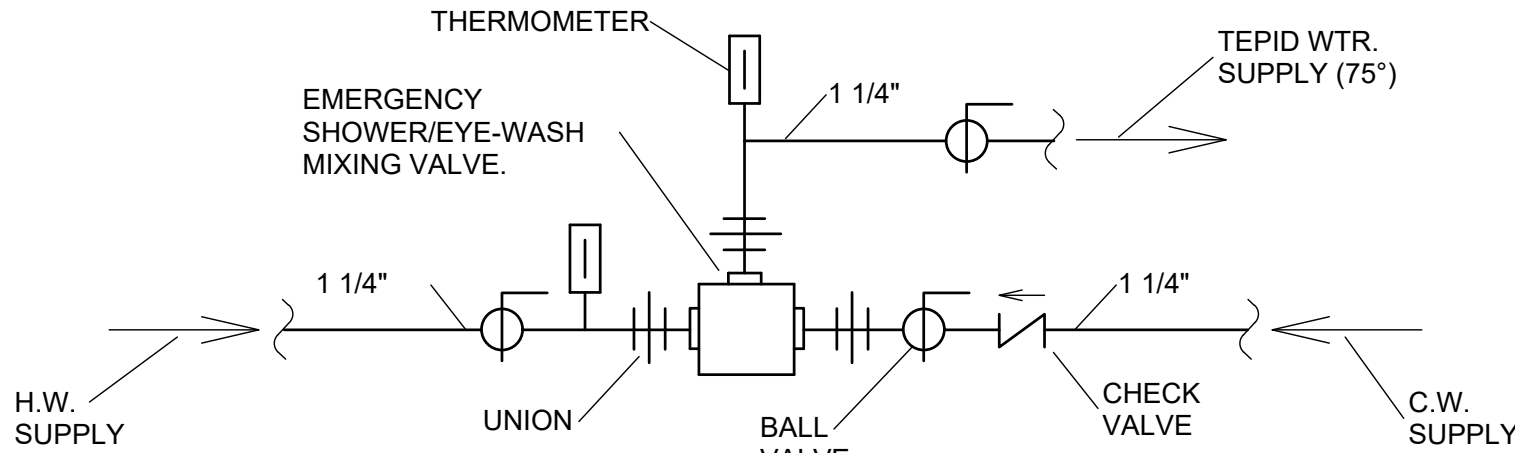
GAS PIPING SIZED FOR 2PSI - PROVIDE ASSEMBLY AT EACH PIECE OF GAS FIRED EQUIPMENT/APPLIANCE



Typical Gas Meter Piping Detail

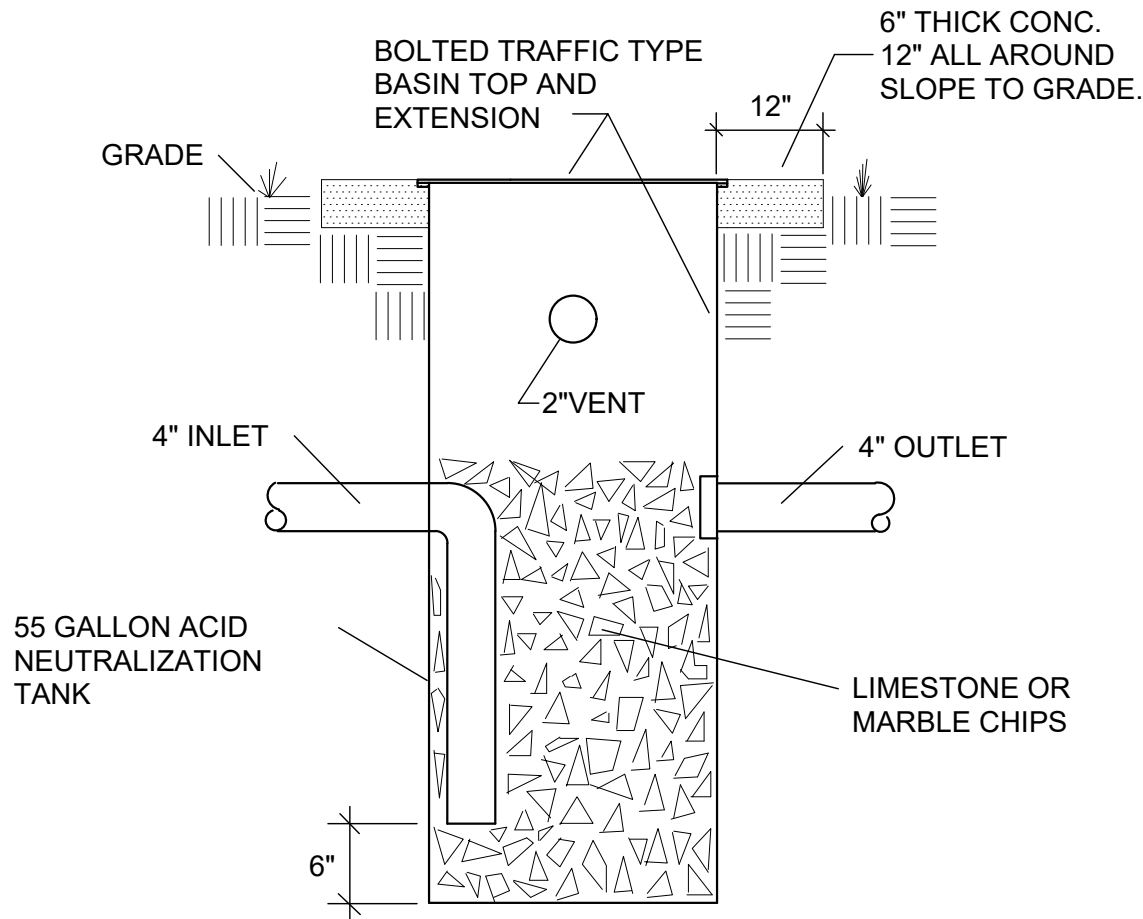
NO SCALE

1. GAS METER AND REGULATOR ASSEMBLY AND UPSTREAM PIPING BY LOCAL GAS CO. COORDINATE AND PAY ANY AND ALL COST ASSOCIATED WITH SERVICE AND INSTALLATION.
2. PROVIDE GROUNDING OF THE NATURAL GAS SYSTEM - SEE SPECS.



Emergency Shower/Eye-Wash Mixing Valve Piping Connection

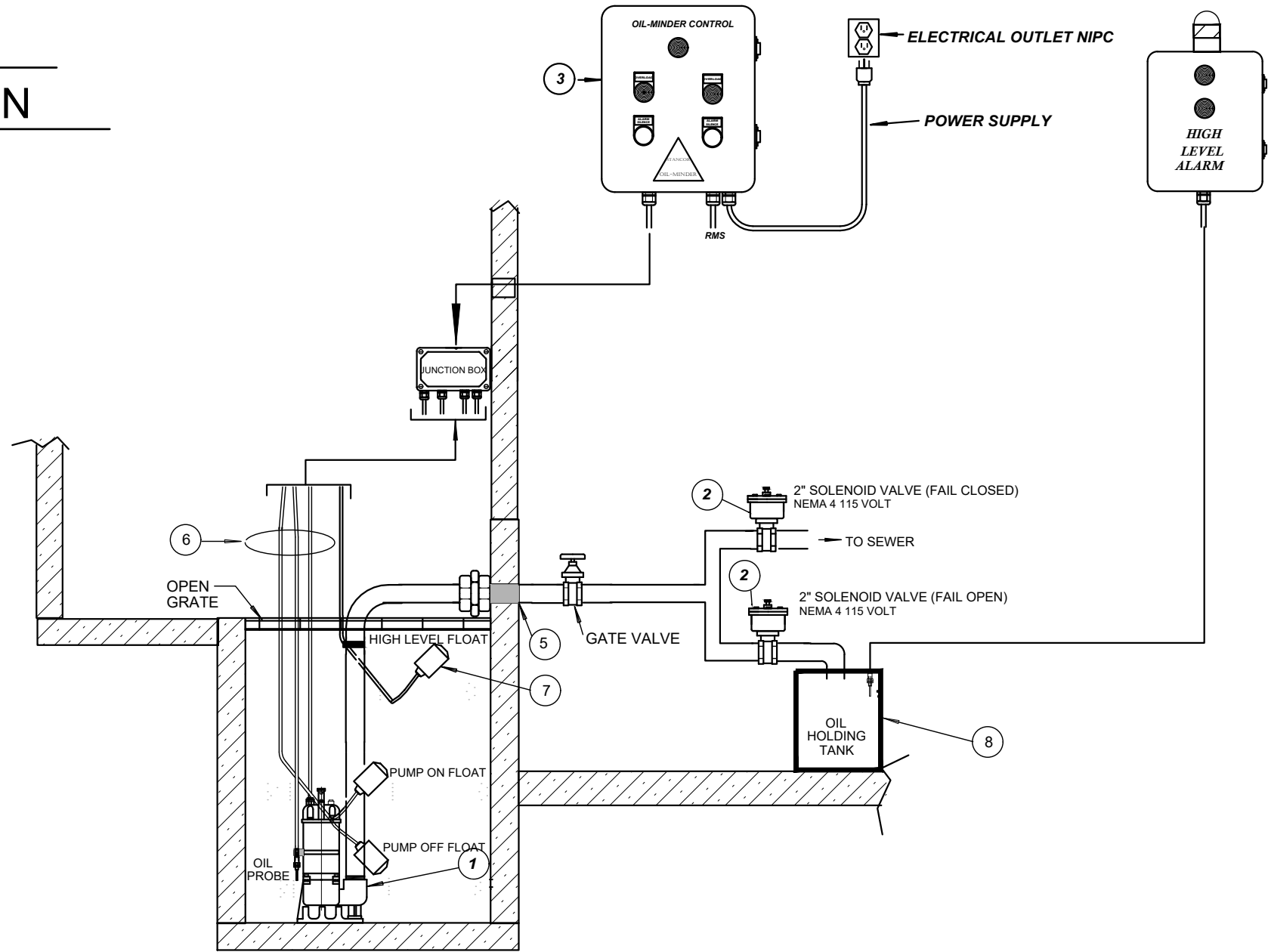
MIXING VALVE SHALL BE EQUAL TO LAWLER MODEL #911E.



Acid Neutralization Tank Detail

NO SCALE

- 1 STANCOR MODEL SE-50 SUBMERSIBLE EFFLUENT PUMP, 50 GPM, 1/2 HP, 115V, 1PH, 60HZ., 3500 RPM, 2" DISCHARGE CONNECTION.
  - 2 TWO NEMA 4 SOLENOID VALVES WITH 115 VOLT ACTUATORS, ONE SECOND ACTUATION TIME.
  - 3 STANCOR SIMPLEX OIL MINDER 115V, 1PH, CONTROL SYSTEM WITH OPTIONAL BUILT-IN AUDIBLE AND VISUAL ALARM WHEN PUMP DOES RUN DUE TO OIL IN PIT OR HIGH LIQUID ALARM. PROVIDE SILENCING BUTTON FOR AUDIBLE ALARM BUILT INTO PANEL. PANEL SHALL HAVE ADDITIONAL CONTACT FOR A REMOTE ALARM LOCATION. OPTIONAL JUNCTION BOX CAN BE PROVIDED WITH DIN RAIL MOUNTED TERMINALS FOR FIELD HARD WIRING.
  - 5 ALL BURIED PUMP PRESSURE DISCHARGE PIPING SHALL BE PROTECTED WITH TAPECOAT CT CORROSION PROTECTION TAPE.
  - 6 OIL MINDER POWER CABLE, PROBE CABLE AND HIGH LIQUID ALARM CABLE.
  - 7 HIGH LIQUID ALARM FLOAT WITH CLAMP DEVICE TO MOUNT TO PUMP DISCHARGE PIPING.
  - 8 OIL HOLDING TANK SHALL BE A VERTICAL FIBERGLASS TANK WITH A 55 GALLON CAPACITY. APPROX. 20" DIA. x 54" TALL.
- ITEMS 1, 2, 3, 6 AND 7 PROVIDED BY STANCOR.
- EQUAL PRODUCT BY LIBERTY PUMPS.



Elevator Sump Pump/Oil Tank Piping Diagram

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ZEA PROJECT NUMBER 20-171

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1	ADD #5	01.15.21

Job Number	18144
Date	11/17/2020
Drawn By	CW
Checked By	TZ

Project Title

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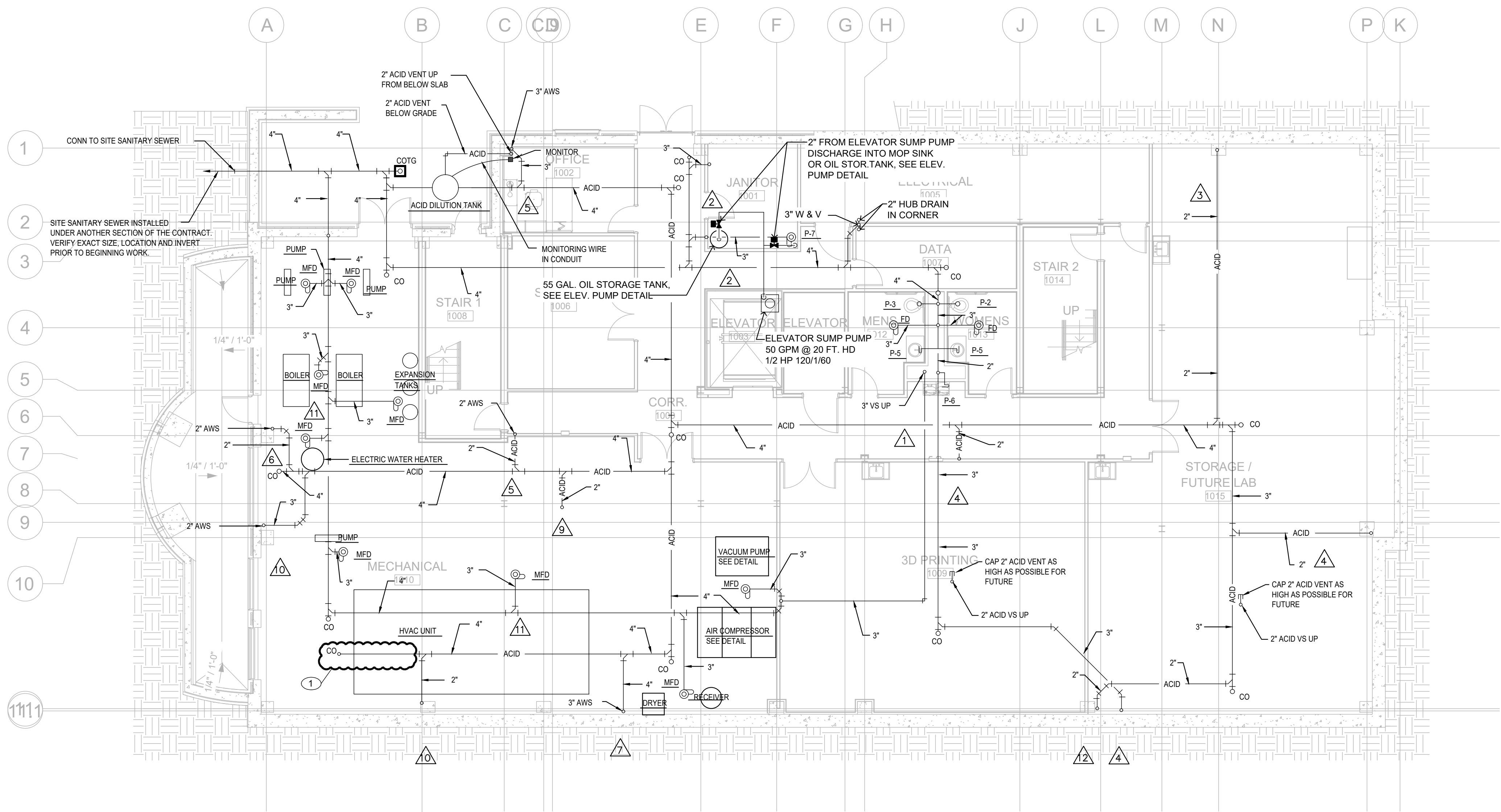
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Sheet Title  
PLBG. DETAILS

Sheet Number

P1.3

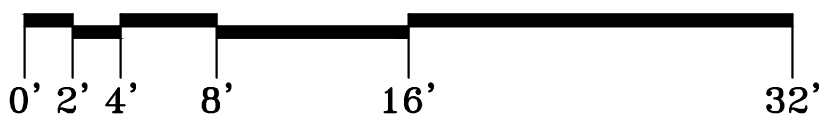
*Professional Engineer*  
No. 23369  
PROFESSIONAL  
01.15.21  
ENGINEER  
Z. EIRING



**BASEMENT FLOOR PLAN - NON-PRESSURE PIPING**

SCALE: 1/8"=1'-0"

FINISH FLOOR ELEVATION: 525.42 FT



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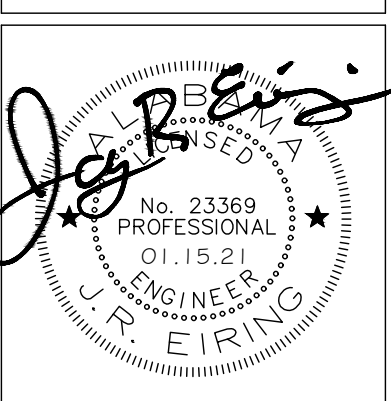
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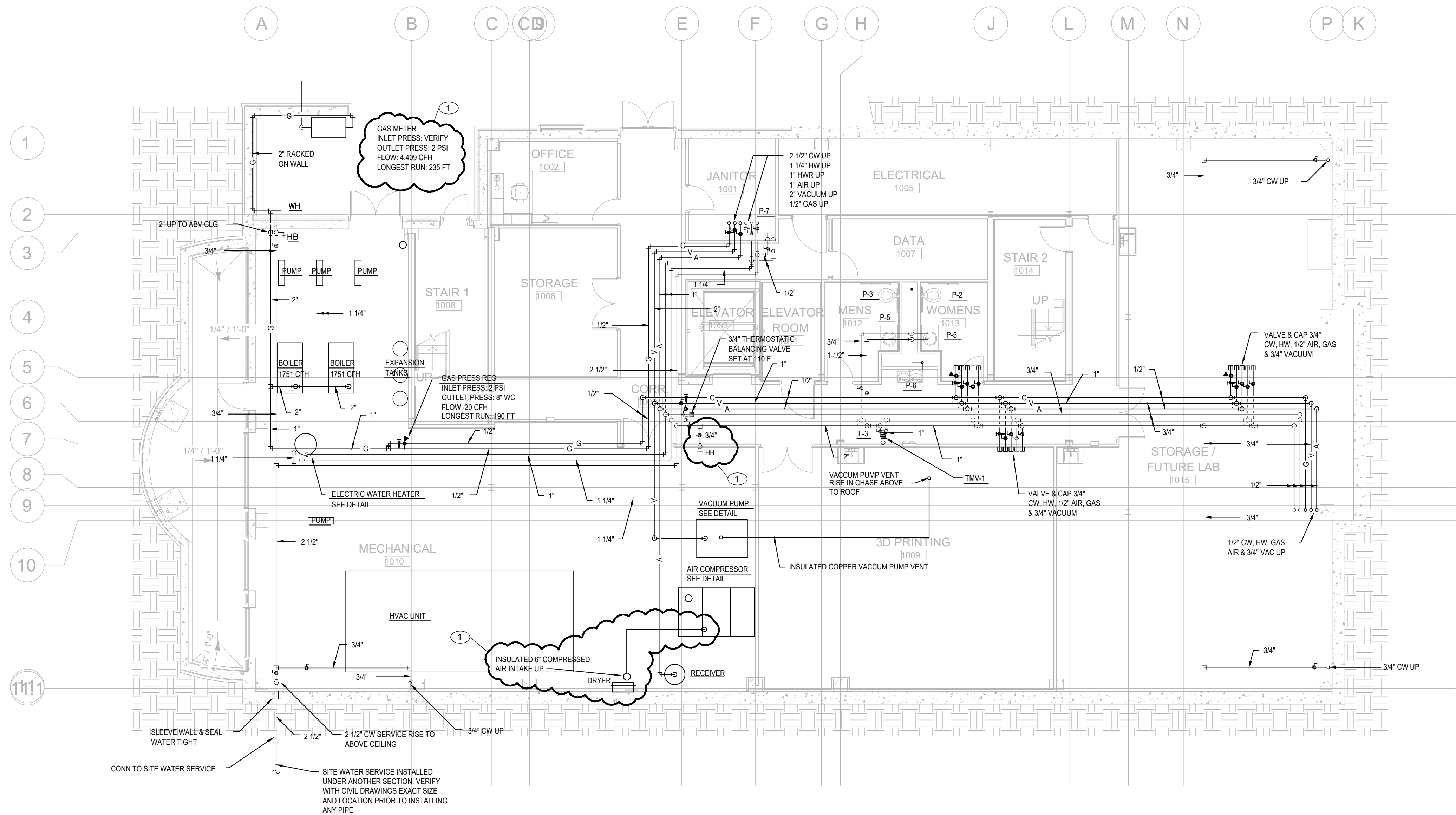
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PLAN -  
NON-PRESSURE  
PIPING

Sheet Number

P2.0

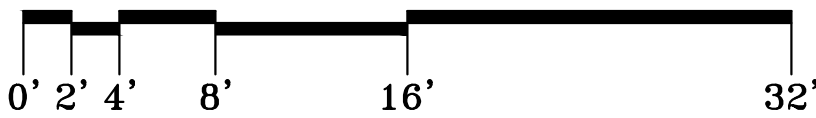




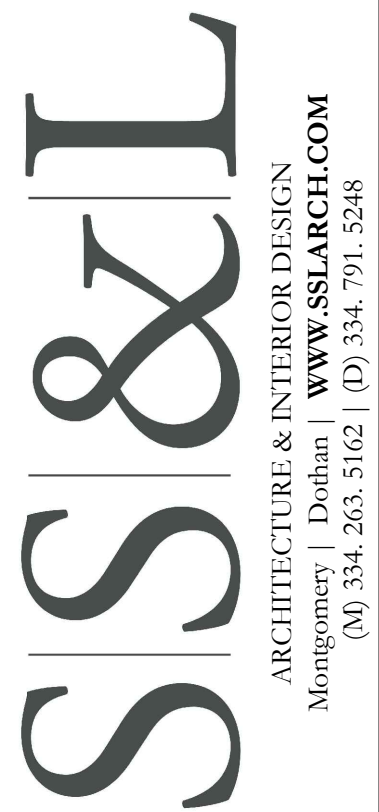


**BASEMENT FLOOR PLAN - PRESSURE PIPING**

SCALE: 1/8"=1'-0"



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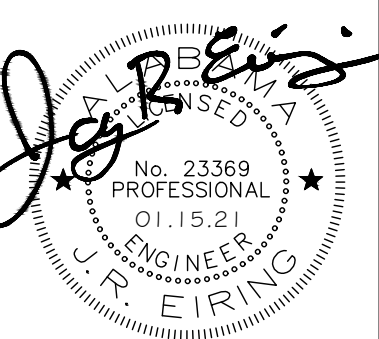
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Date	11/17/2020
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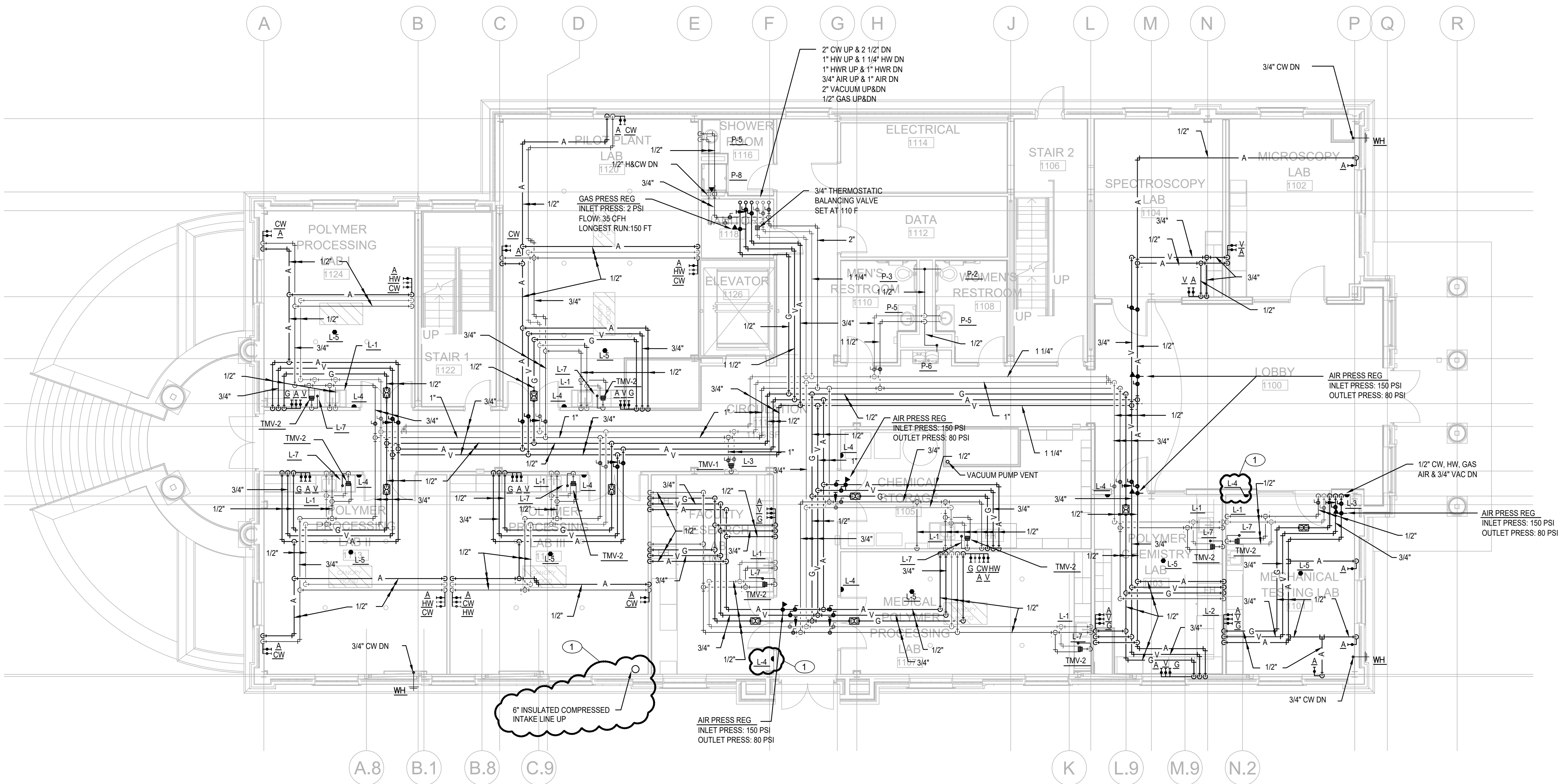
Project Title	CENTER FOR MATERIALS AND MANUFACTURING SCIENCES TROY UNIVERSITY   TROY, AL
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Sheet Title  
BASEMENT PLBG.  
PLAN - PRESSURE  
PIPING

Sheet Number

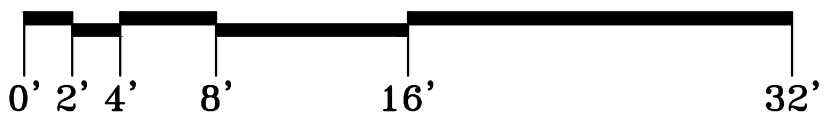
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**FIRST FLOOR PLAN - PRESSURE PIPING**

SCALE: 1/8"=1'-0"



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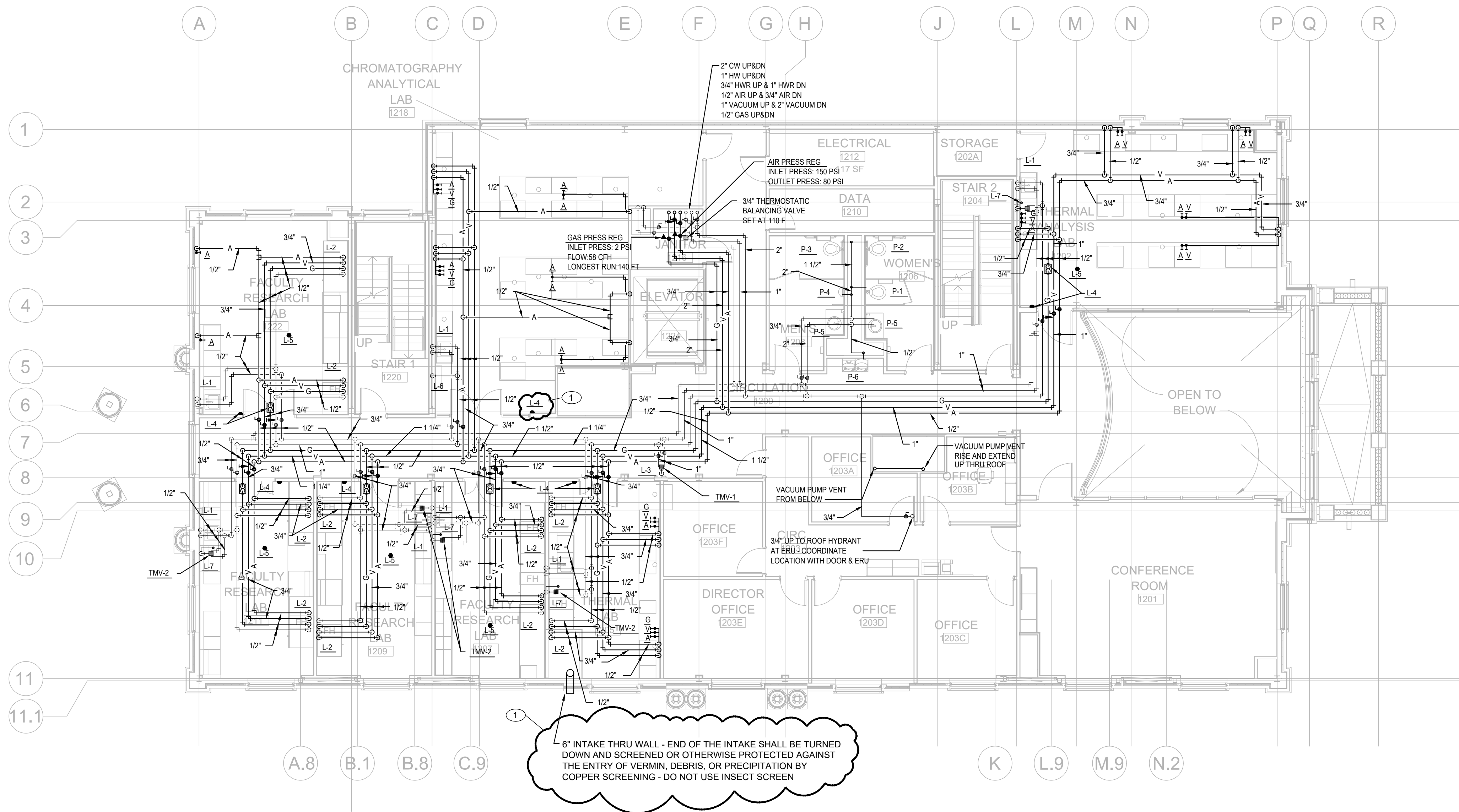
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Sheet Title  
FIRST FL. PLBG. PLAN  
- PRESSURE PIPING

Sheet Number

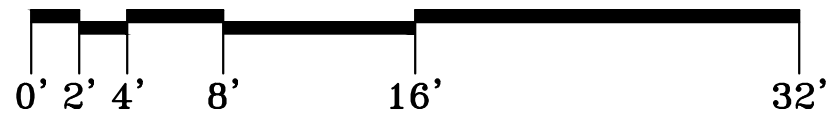
**P3.1**





**SECOND FLOOR PLAN - PRESSURE PIPING**

SCALE: 1/8"=1'-0"



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Sheet Title  
SECOND FL. PLBG.  
PLAN - PRESSURE  
PIPING

Sheet Number

P3.2

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11/17/2020

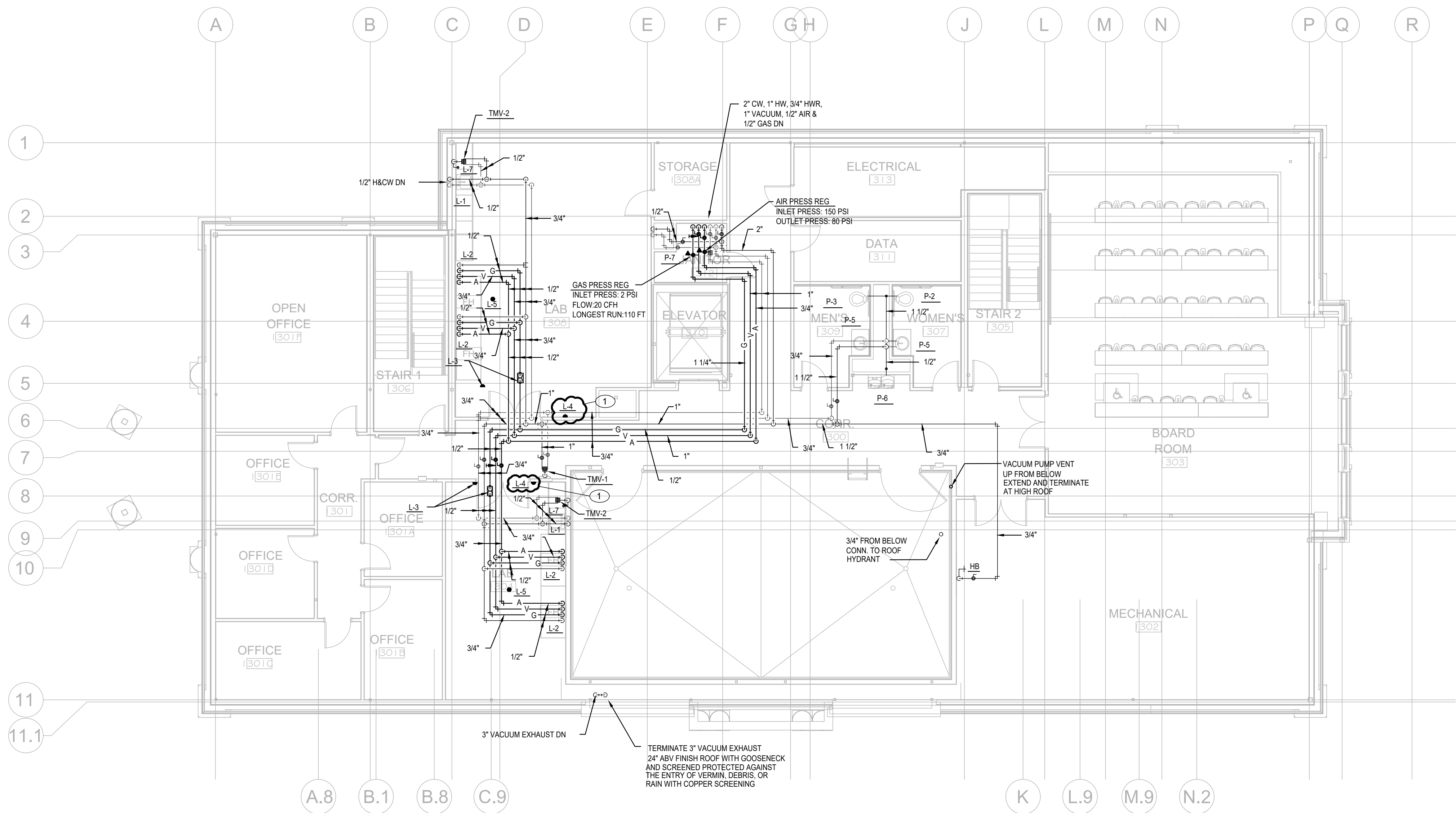
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PROFESSIONAL

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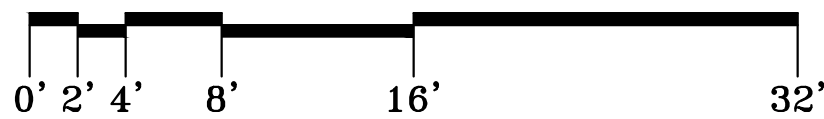
ENGINEER

Z. EIRING



**ATTIC FLOOR PLAN - PRESSURE PIPING**

SCALE: 1/8"=1'-0"



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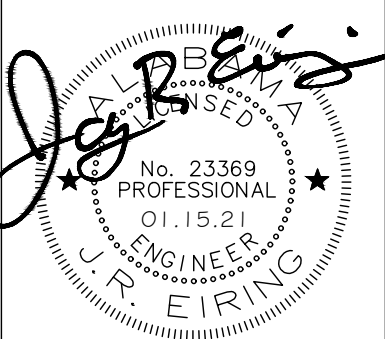
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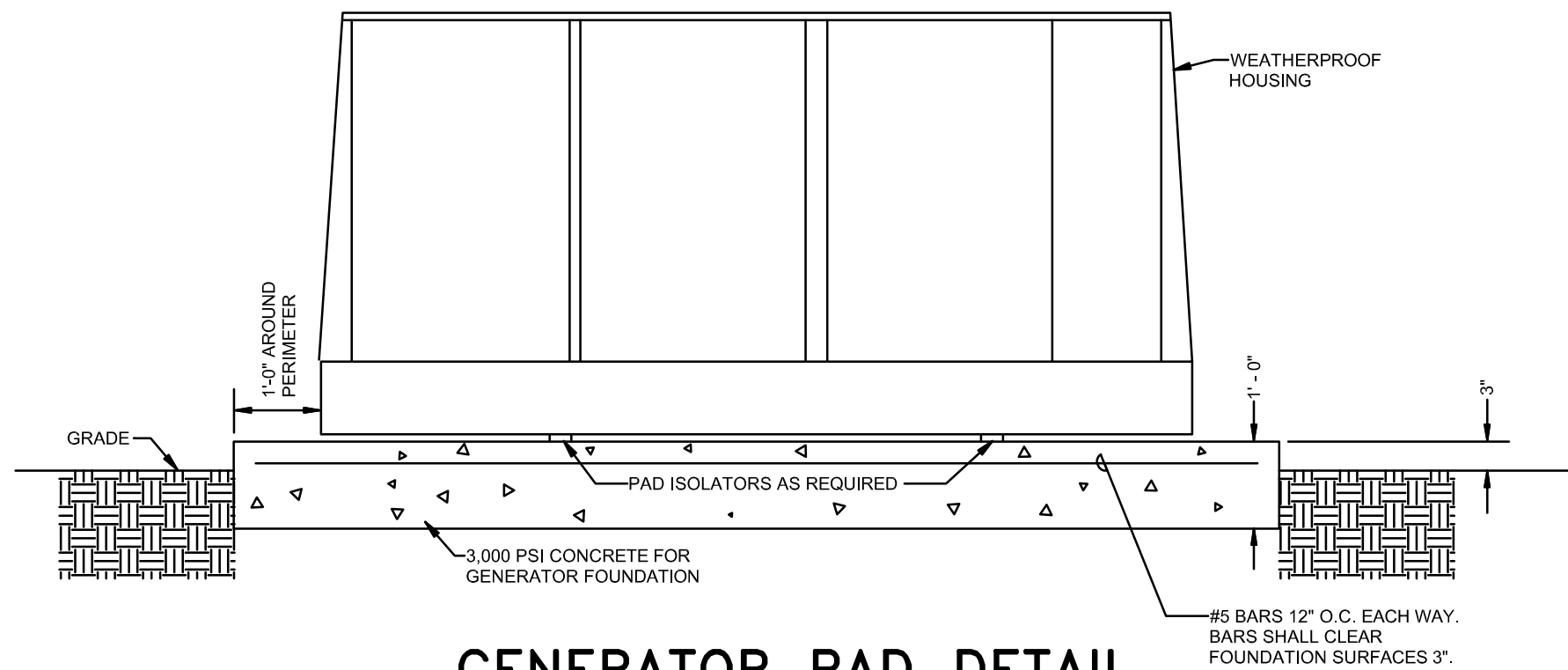
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ATTIC FL. PLBG.  
PLAN - PRESSURE  
PIPING

Sheet Number

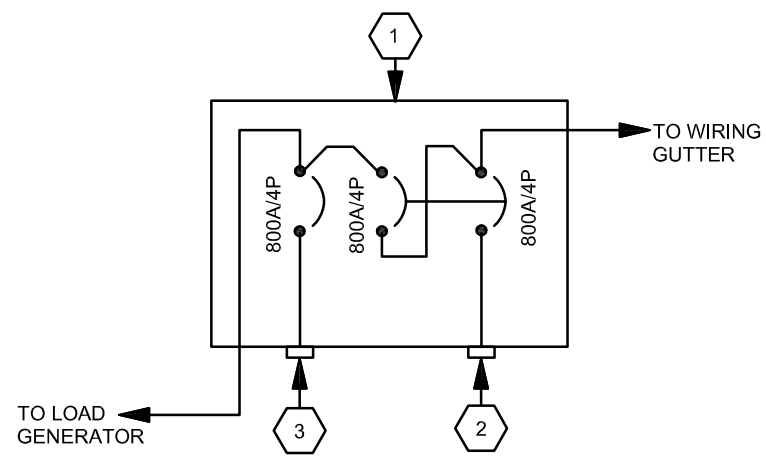
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GENERATOR PAD DETAIL  
SCALE: NOT TO SCALE

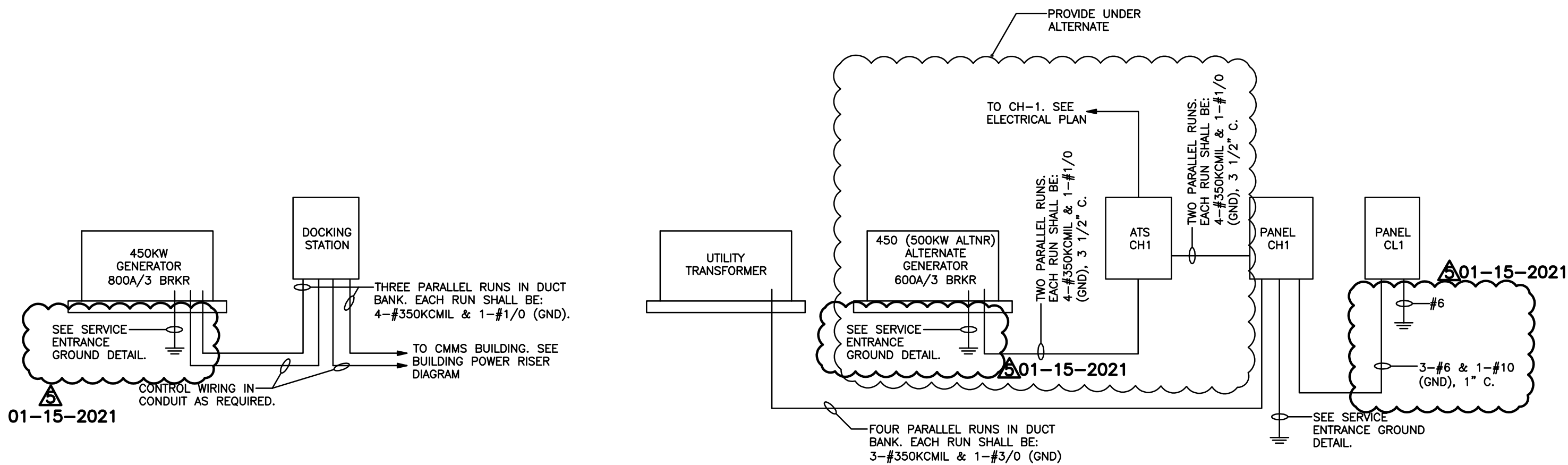
- KEYED NOTES:
- 1 800A, 277/480V, 3Ø, 4W TRIPLE SWITCH DOCKING STATION IN A NEMA 3R SS ENCLOSURE MOUNTED ON WALL. NEUTRAL SHALL BE SWITCHED (4 POLE) DOCKING STATION SHALL HAVE MECHANICAL INTERLOCKS TO PREVENT PERMANENT AND TEMPORARY GENERATORS FROM BEING CONNECTED AT THE SAME TIME. DOCKING STATION SHALL ALSO HAVE A TERMINAL BLOCK FOR TEMPORARY GENERATOR START/STOP CONTROL CONDUCTORS.
  - 2 CONNECTION FOR FUTURE PORTABLE GENERATOR, MALE CAMLOCK CONNECTION WITH WEATHERPROOF COVER.
  - 3 TO LOAD BANK, FEMALE CAMLOCK CONNECTION WITH WEATHERPROOF COVER.



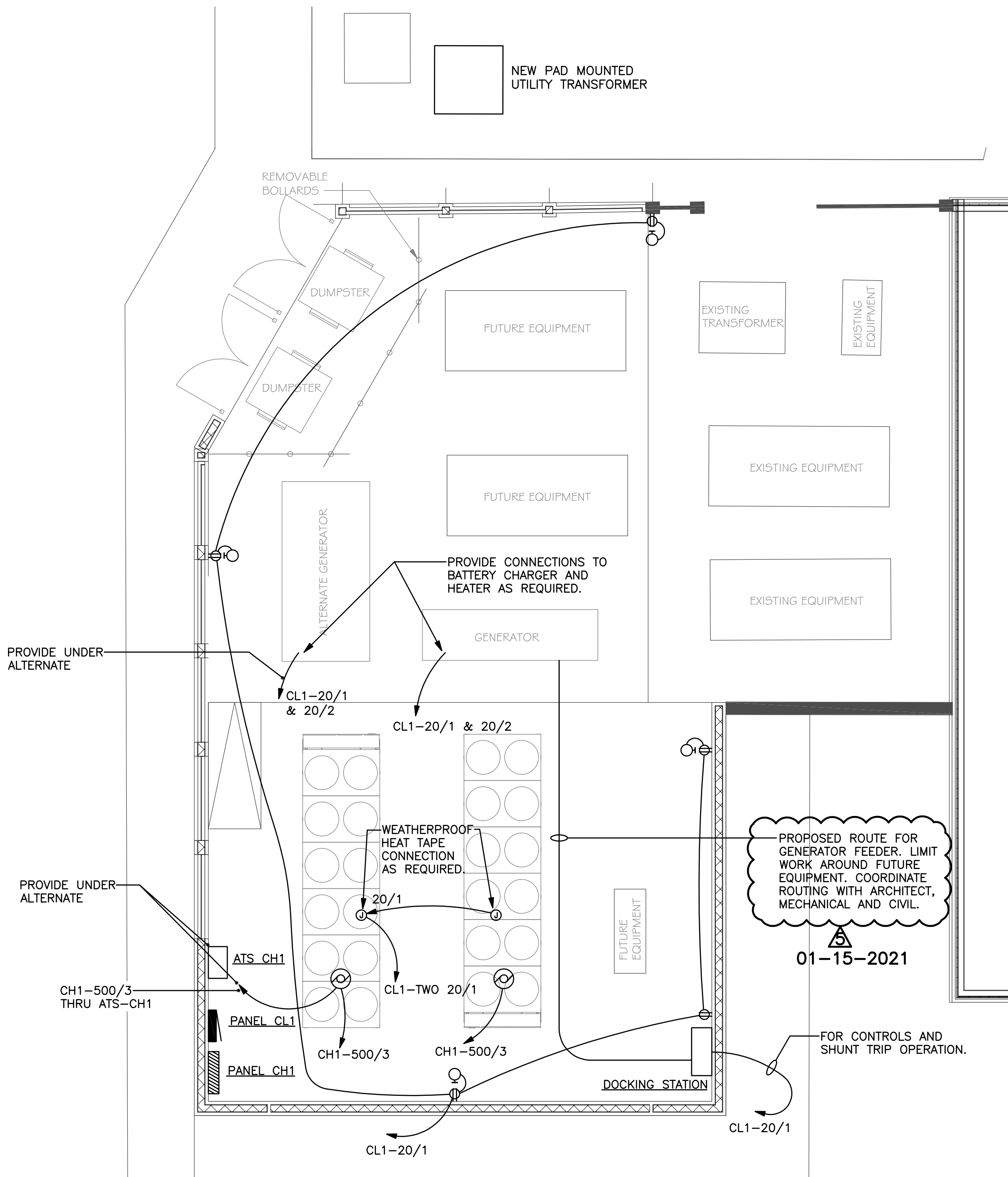
DOCKING STATION DETAIL  
SCALE: NOT TO SCALE

LEGEND (THIS SHEET ONLY):

- BRANCH CIRCUIT WIRING IN UNDERGROUND PVC CONDUIT, #12 CONDUCTORS IN 1" CONDUIT BELOW GRADE UNLESS NOTED.
- SAFETY SWITCH, SIZE AND TYPE AS NOTED. FUSE PER NAMEPLATE.
- MOTOR OR EQUIPMENT JUNCTION BOX.
- DUPLEX RECEPTACLE, GFI WP TYPE, 18" A.F.F. UNLESS NOTED OTHERWISE. MOUNTED FLUSH IN WALL.
- PANELBOARD.
- 17"x8" LED WALL BRACKET WITH ALUMINUM HOUSING. FLAT RECTANGULAR DESIGN, 3000 LUMEN OUTPUT, WIDE THROW MEDIUM LIGHT DISTRIBUTION, INTEGRAL MOTION/PHOTO SENSOR, INTERNAL BATTERY BACKUP AND 120-277V INTERNAL DRIVER. LITHONIA #WSTLED-P2-40K-VW-MVOLT-PIR-E20WH OR APPROVED EQUAL.



MECHANICAL YARD  
POWER RISER DIAGRAM  
SCALE: NOT TO SCALE



- NOTES:
- 1. ALL RECEPTACLES SHOWN ON THIS SHEET SHALL BE WEATHER-PROOF GFCI TYPE.
  - 2. CHILLER BREAKERS IN PANEL CH SHALL BE COORDINATED WITH MOP RATINGS OF EQUIPMENT PRIOR TO ORDERING.

ENLARGED MECHANICAL YARD ELECTRICAL PLAN  
SCALE: 1/8" = 1'

**MCE** MILLS-CONOLY  
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Revised 01/15/2021  
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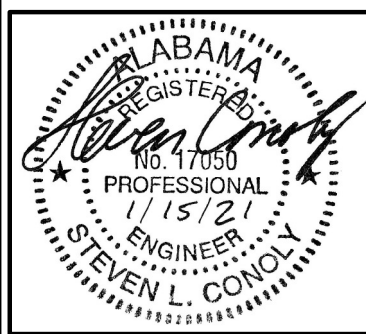
Center for Materials and  
Manufacturing Sciences  
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Sheet Title

Mechanical Yard Electrical  
Site Plan




























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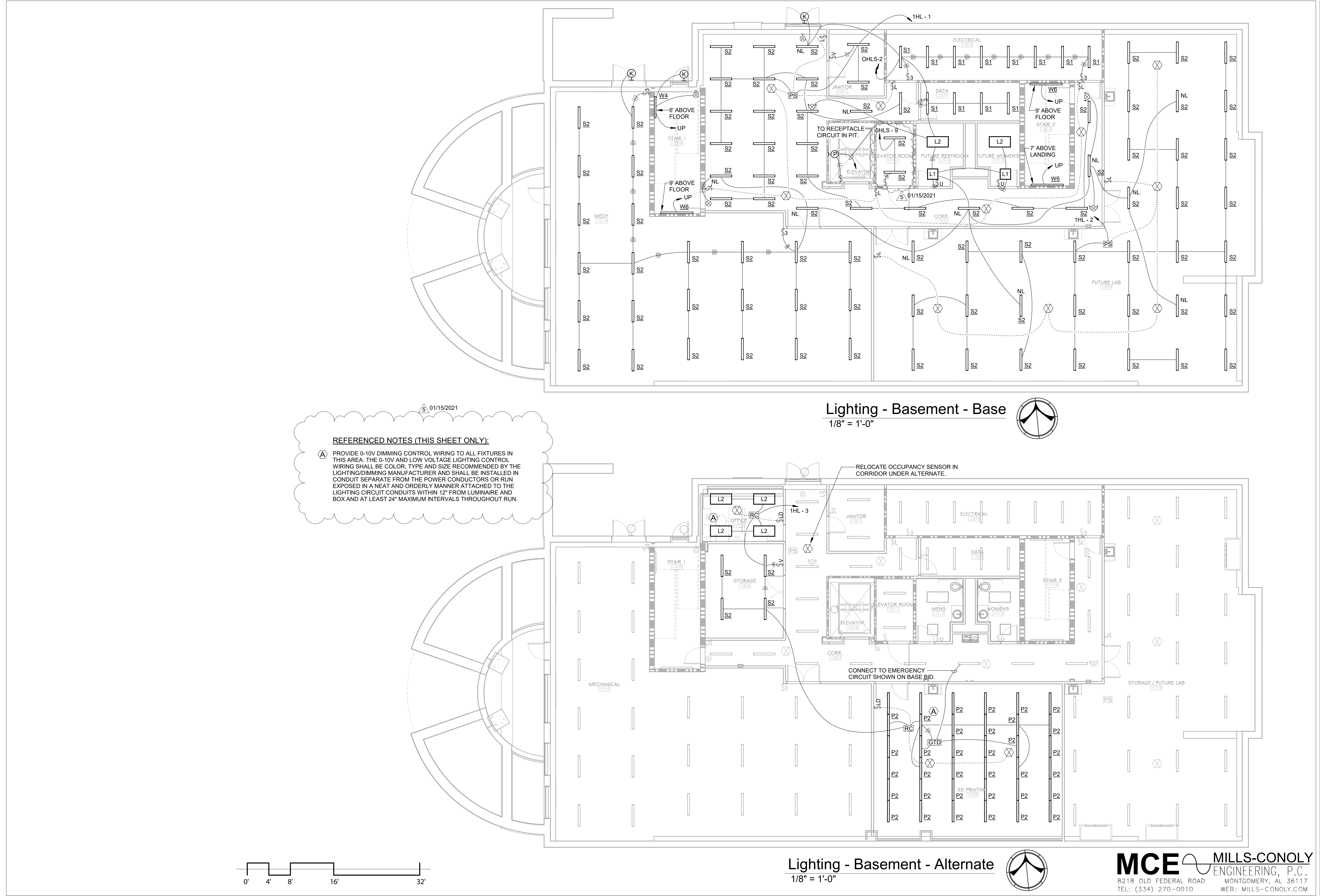


### LEGEND (CONTINUED)

	DIGITAL LIGHTING CONTROLS, WALL SWITCH.
	DIGITAL LIGHTING CONTROLS, WALL DIMMER SWITCH.
	DIGITAL LIGHTING CONTROLS, ONE ZONE POWER SUPPLY.
	DIGITAL LIGHTING CONTROLS, ONE ZONE DIMMING ROOM CONTROLLER.
	DIGITAL LIGHTING CONTROLS, TWO ZONE DIMMING ROOM CONTROLLER.
	DIGITAL LIGHTING CONTROLS, ONE ZONE ROOM CONTROLLER WITH TIME AND SCHEDULING CONTROL.
	DIGITAL LIGHTING CONTROLS, PLUG LOAD CONTROLLER. CONNECT TO OCCUPANCY SENSOR/ROOM CONTROLLER PER INSTALLATION INSTRUCTIONS.
	DIGITAL LIGHTING CONTROLS, OCCUPANCY SENSOR, 360°, DUAL TECHNOLOGY. FLUSH IN CEILING. IF NO CEILING OCCURS, SUSPEND TO LEVEL OF LIGHT FIXTURES.
	DIGITAL LIGHTING CONTROLS, OCCUPANCY SENSOR, WALL MOUNTED, DUAL TECHNOLOGY.
	UL 924 EMERGENCY GENERATOR TRANSFER DEVICE WITH DIMMING CONTROL BYPASS. CONNECT 0-10V WIRING TO DEVICE AND FIXTURE PER INSTALLATION INSTRUCTIONS. HUBBELL #ALCR1277 OR APPROVED EQUAL.
	FIRE ALARM SYSTEM, ANNUNCIATOR.
	FIRE ALARM SYSTEM, CONTROL PANEL.
	FIRE ALARM SYSTEM, MONITOR MODULE AND TAMPER SWITCH CONNECTION.
	FIRE ALARM SYSTEM, MONITOR MODULE AND FLOW VALVE CONNECTION.
	FIRE ALARM SYSTEM, SPEAKER AND FLASHING LIGHT.
	FIRE ALARM SYSTEM, FLASHING LIGHT ONLY.
	FIRE ALARM SYSTEM, MANUAL STATION.
	FIRE ALARM SYSTEM, CONTROL MODULE.
	FIRE ALARM SYSTEM, MONITOR MODULE.
	FIRE ALARM SYSTEM, HEAT DETECTOR, CEILING MOUNTED.
	FIRE ALARM SYSTEM, CARBON MONOXIDE DETECTOR, CEILING/WALL MOUNTED.
	FIRE ALARM SYSTEM, SMOKE DETECTOR, CEILING MOUNTED.
	FIRE ALARM SYSTEM, SMOKE DETECTOR, DUCT MOUNTED. COORDINATE LOCATION WITH MECHANICAL CONTRACTOR.
	ADJACENT TO DEVICE INDICATES GFI TYPE.
	ADJACENT TO DEVICE INDICATES WEATHERPROOF TYPE.
	ADJACENT TO DEVICE INDICATES FUSE PER NAMEPLATE.
	ADJACENT TO FIXTURE INDICATES FIXTURE TO BE CONSTANTLY ON (NIGHT LIGHT).

1. NO MULTI-WIRE BUNDLE CIRCUITS SHALL BE RUN ON THIS PROJECT. PROVIDE A NEUTRAL CONDUCTOR FOR EACH PHASE CONDUCTOR. THE NEUTRAL CONDUCTOR SHALL HAVE A CONTINUOUS STRIPE OF SAME COLOR AS THE PHASE CONDUCTOR IN BRANCH CIRCUIT. GROUP BRANCH CIRCUIT CONDUCTORS WHEN SAME COLOR IS USED IN COMMON CONDUIT. NO MORE THAN THREE CIRCUITS SHALL BE RUN IN A CONDUIT.
2. PROVIDE GREEN INSULATED GROUND CONDUCTOR IN ALL RUNS IN ADDITION TO THOSE SHOWN. WHEN NO CONDUCTORS ARE SHOWN, THEN PROVIDE A PHASE, NEUTRAL AND GROUND CONDUCTOR.
3. PLEASE CONTACT THE ARCHITECT OR ENGINEER IF ANY CONCERNS OR QUESTIONS OCCUR. IT IS BETTER TO DISCUSS THE ITEMS, NO MATTER HOW TRIVIAL, THAN TO ASSUME SOMETHING THAT COULD POSSIBLY BE INCORRECT.
4. FROM EACH DATA WALL OUTLET AND TELEVISION/DATA WALL OUTLET RUN A 3/4" CONDUIT CONCEALED IN WALL AND STUB OUT AT NEAREST CABLE HOOK SYSTEM OR DATA ROOM.
5. REFER TO SPECIFICATIONS FOR LIGHTNING PROTECTION WORK TO BE INCLUDED IN THIS PROJECT.
6. CONTRACTOR SHALL VERIFY ALL ELECTRICAL EQUIPMENT (PANELBOARDS, SWITCHBOARDS, TRANSFORMERS, ATS'S, SAFETY SWITCHES, ETC.) WILL PHYSICALLY FIT IN ROOMS OR SPACES SHOWN WITH OTHER EQUIPMENT BY ELECTRICAL AND OTHER TRADES PRIOR TO BID.
7. THIS PROJECT IS REQUIRED TO COMPLY WITH AN ENERGY CODE (ASHRAE 90.1 2013 EDITION), PROVIDE LIGHTING AND RECEPTACLE CONTROLS TO MEET THIS CODE. PROGRAM LIGHTING AND RECEPTABLES AS DIRECTED BY OWNER, BUT TO STILL MEET ENERGY CODE. PROVIDE ENERGY METERING IN PANELS TO MEET ENERGY CODE.
8. THE ELECTRICAL CONTRACTOR SHALL REFER TO THE MECHANICAL DRAWINGS AND PROVIDE THERMOSTAT BACK BOXES WHERE SHOWN. FROM EACH THERMOSTAT BOX RUN A 1/2" CONDUIT UP WALL AND STUB OUT AT AN ACCESSIBLE SPACE ABOVE THE CEILING. COORDINATE WORK AND BOX SIZES WITH MECHANICAL CONTRACTOR.
9. ALL BRANCH CIRCUIT RUNS SHALL BE OVERHEAD UNLESS SHOWN BELOW SLAB. PROVIDE JUNCTION BOXES ABOVE CEILING OR ON/SUSPENDED FROM STRUCTURE TO FEED LIGHT FIXTURES, RECEPTACLES AND OTHER DEVICES OR ITEMS.
10. AIC RATINGS SHOWN ON PANELBOARD/SWITCHBOARD SCHEDULES ARE ESTIMATED. ACTUAL RATING SHALL BE AS REQUIRED BY ARC FAULT STUDY CALCULATIONS.
11. ALL SURFACE MOUNTED PANELS SHALL HAVE DOOR-IN-DOOR CONSTRUCTION.
12. UNDER ALTERNATE FLOOR PLANS, PROVIDE ALL WORK SHOWN ON BASE BID FLOOR PLAN IN ADDITION TO WORK SHOWN ON ALTERNATE PLAN. SHADED SYMBOLS ON ALTERNATE FLOOR PLANS INDICATE BASE BID ITEMS.
13. PRIOR TO ROUGH-IN OF A NEW OUTLET (RECEPTACLE, DATA, TV, ETC.), VERIFY EXACT LOCATION WITH THE ARCHITECT.
14. THE LOW VOLTAGE LIGHTING CONTROL WIRING SHALL BE COLOR, TYPE AND SIZE RECOMMENDED BY THE LIGHTING/DIMMING MANUFACTURER AND SHALL BE INSTALLED IN CONDUIT SEPARATE FROM THE POWER CONDUCTORS OR RUN EXPOSED IN A NEAT AND ORDERLY MANNER ATTACHED TO THE LIGHTING CIRCUIT CONDUITS WITHIN 12" FROM LUMINAIRE AND BOX AND AT LEAST 24" MAXIMUM INTERVALS THROUGHOUT RUN.
15. AFTER WORK HAS BEEN COMPLETED, CLEAN ALL LIGHT FIXTURES IN THE RENOVATED SPACES. NO DIRT, DEBRIS, FINGER PRINTS, SOAP RESIDUE, ETC. SHALL BE VISIBLE.
16. SUBMIT SUBSTITUTIONS TO LIGHT FIXTURES AND LIGHTING CONTROLS TO THE ENGINEER AT LEAST 10 DAYS PRIOR TO BID FOR REVIEW.
17. COORDINATE ANY POWER OUTAGES WITH UNIVERSITY.
18. THE SPACE ABOVE THE CEILINGS IS AN AIR PLENUM. ALL DEVICES, WIRING, ETC. SHALL BE PLENUM RATED IF LOCATED ABOVE THE CEILING.

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Job Number	18144
Date	11/17/2020
Drawn By	SCC
Checked By	SLO
Revised	01/15/2021
Project Title	
Center for Materials and Manufacturing Sciences TROY UNIVERSITY	
Sheet Title	
Legends, Schedules and Notes	
Sheet Number	E003
	



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11/17/2020

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Project Title

Center for Materials and Manufacturing Sciences

TROY UNIVERSITY

Sheet Title

Basement Lighting Plans

Sheet Number

E004

ALABAMA REGISTERED PROFESSIONAL ENGINEER 11/15/21

STEVEN L. CONOLY

MCE

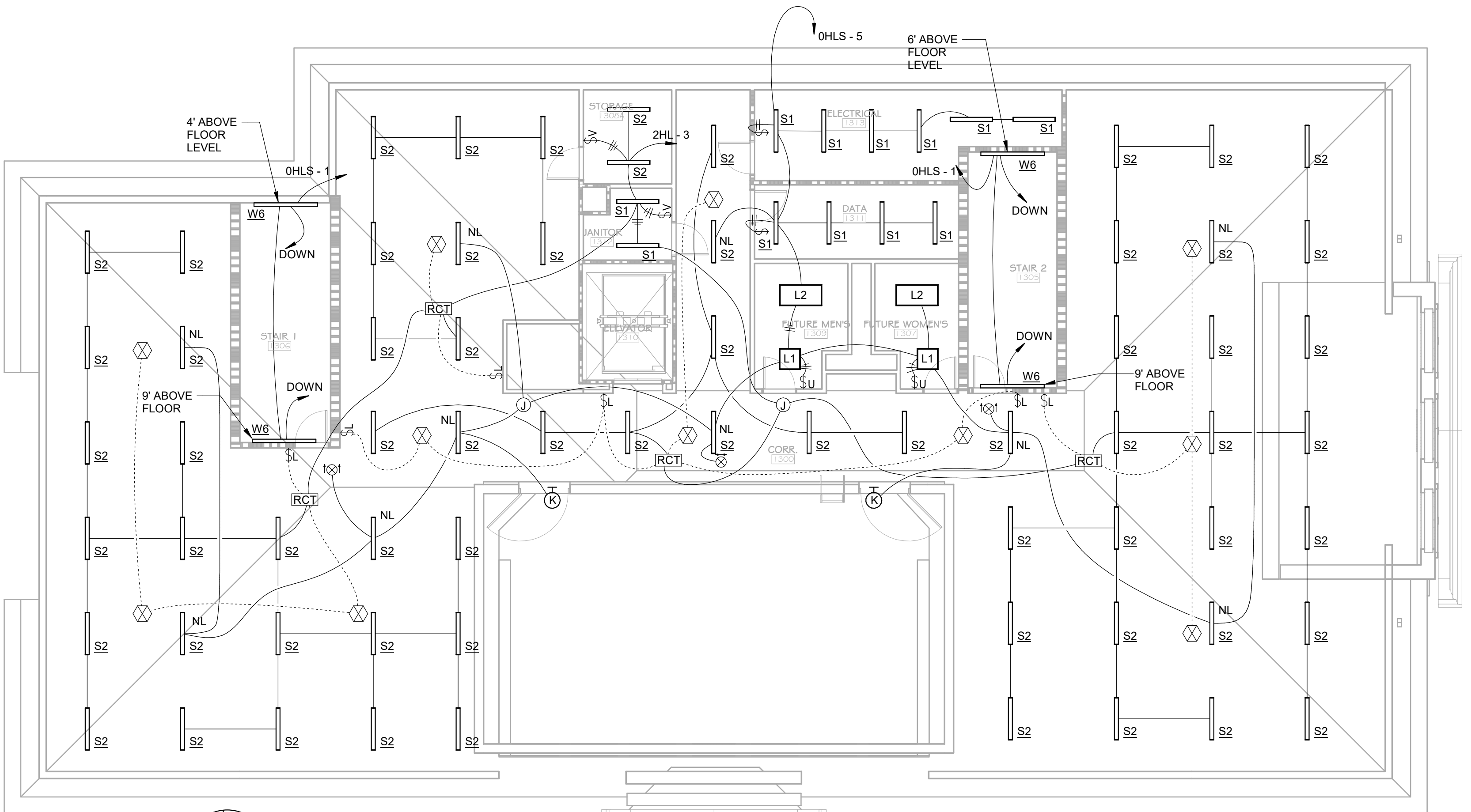
MILLS-CONOLY ENGINEERING, P.C.

8218 OLD FEDERAL ROAD

TEL: (334) 270-0010

MONTGOMERY, AL 36117

WEB: MILLS-CONOLY.COM

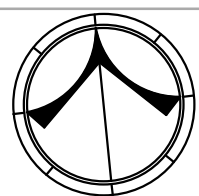
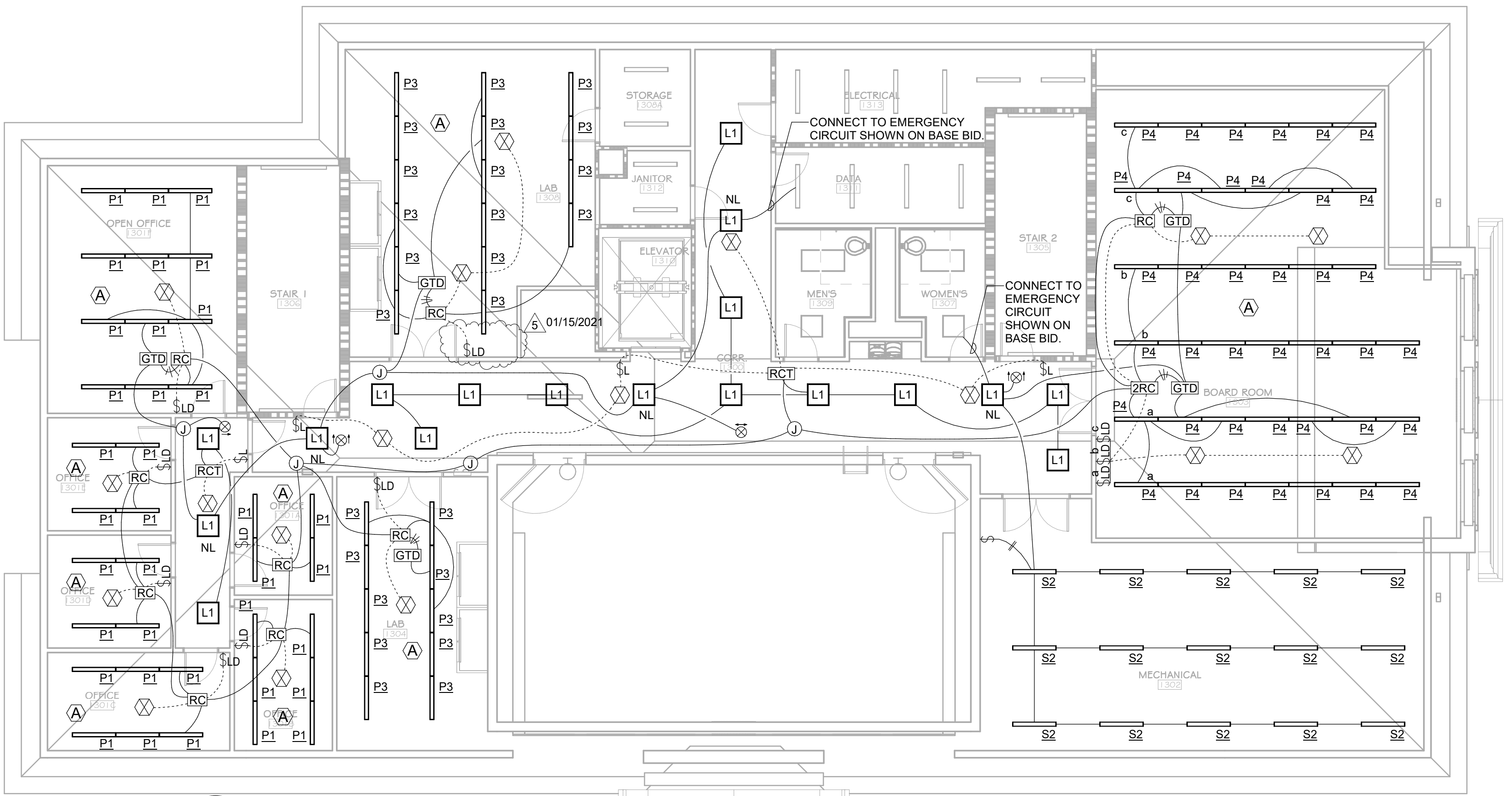


Lighting - Attic - Base

1/8" = 1'-0"

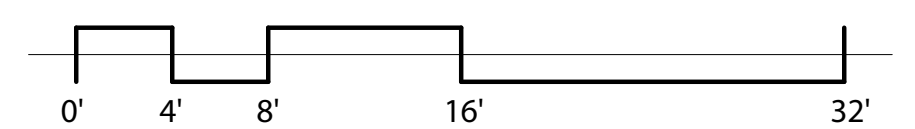
REFERENCED NOTES (THIS SHEET ONLY):

- (A) PROVIDE 0-10V DIMMING CONTROL WIRING TO ALL FIXTURES IN THIS AREA. THE 0-10V AND LOW VOLTAGE LIGHTING CONTROL WIRING SHALL BE COLOR, TYPE AND SIZE RECOMMENDED BY THE LIGHTING/DIMMING MANUFACTURER AND SHALL BE INSTALLED IN CONDUIT SEPARATE FROM THE POWER CONDUCTORS OR RUN EXPOSED IN A NEAT AND ORDERLY MANNER ATTACHED TO THE LIGHTING CIRCUIT CONDUITS WITHIN 12" FROM LUMINAIRE AND BOX AND AT LEAST 24" MAXIMUM INTERVALS THROUGHOUT RUN.

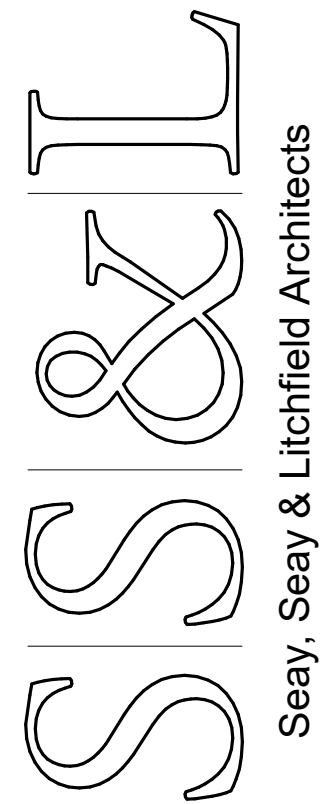


Lighting - Attic - Alternate

1/8" = 1'-0"



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Revised	01/15/2021
Project Title	

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Manufacturing Sciences  
TROY UNIVERSITY

Sheet Title

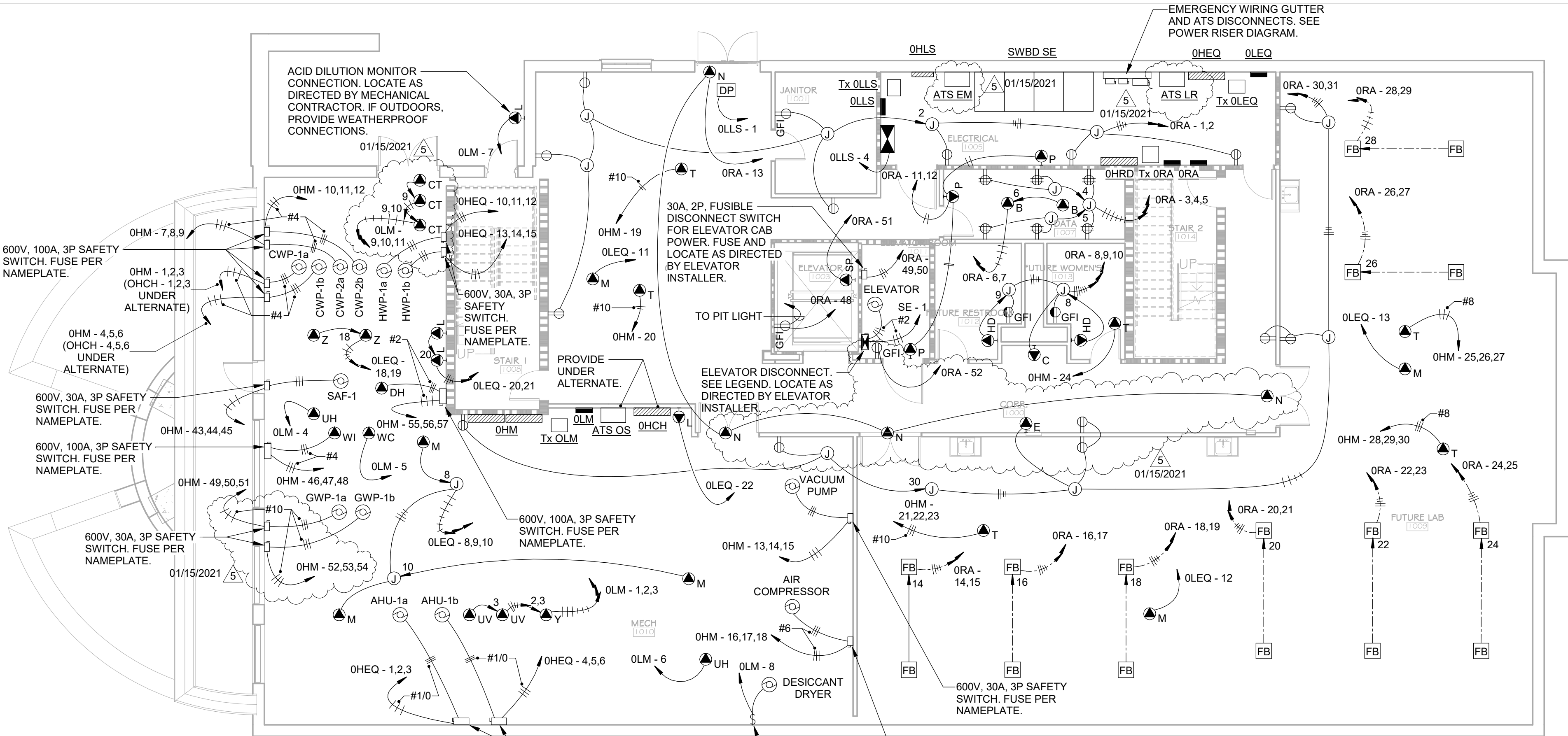
Attic Lighting Plans

Sheet Number

E006



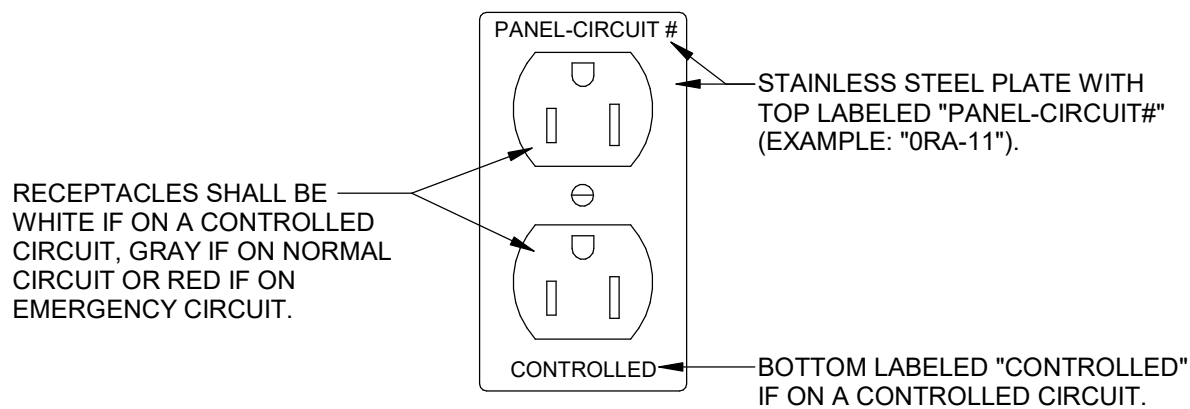
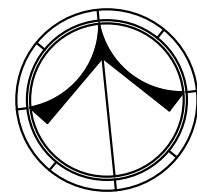




NOTE:  
COORDINATE WITH MECHANICAL  
CONTRACTOR AND LOCATE SAFETY  
SWITCHES TO MEET CLEARANCE  
REQUIREMENTS OF NEC 110-26.

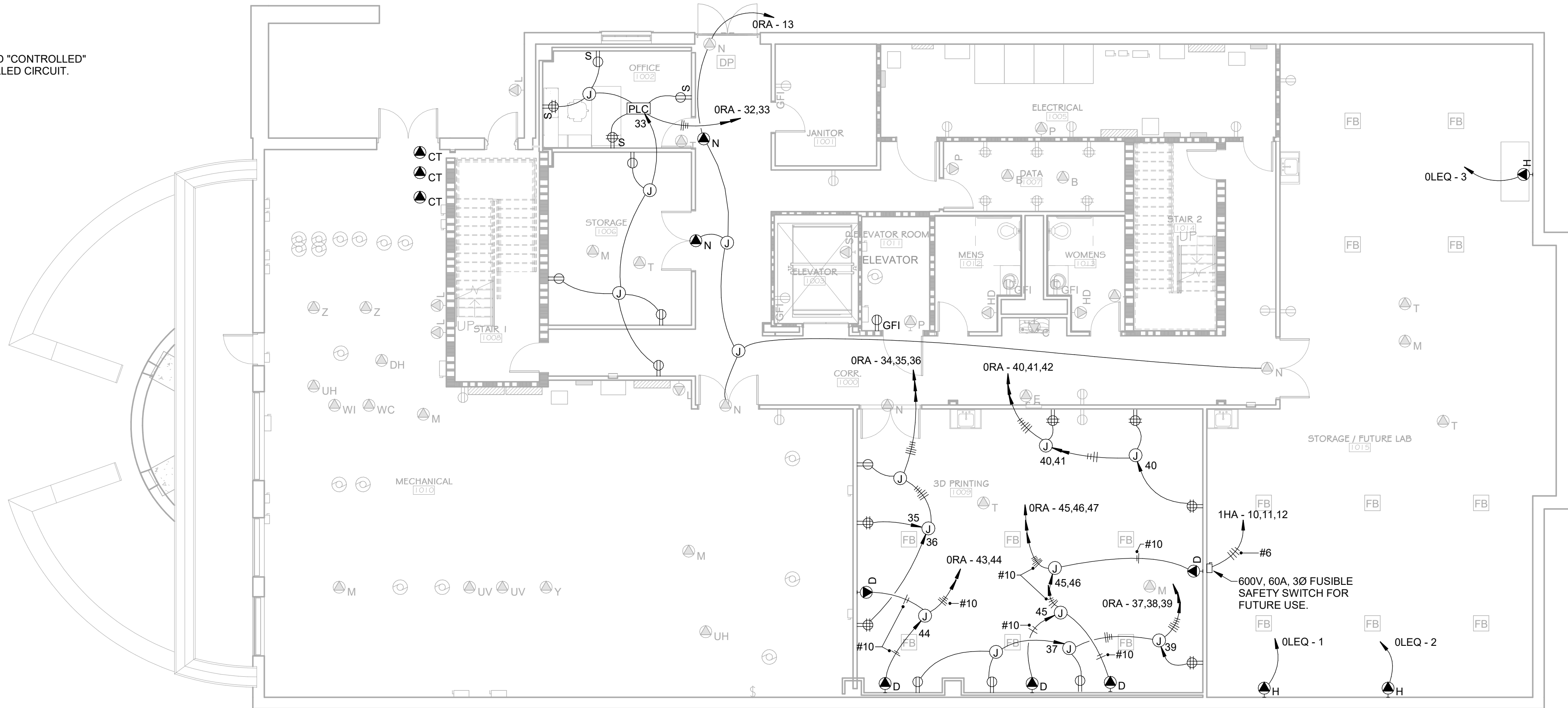
### Power - Basement - Base

1/8" = 1'-0"



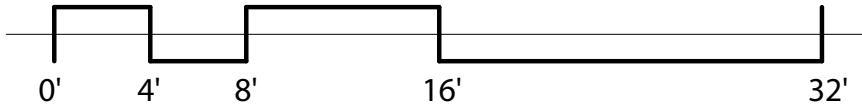
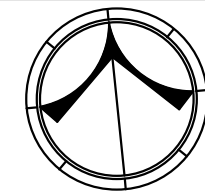
### Receptacle Detail

No Scale



### Power - Basement - Alternate

1/8" = 1'-0"



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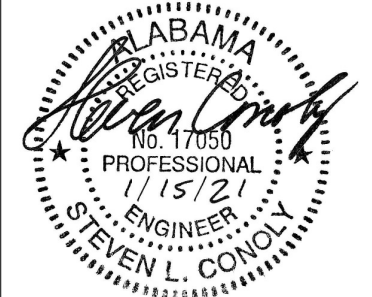
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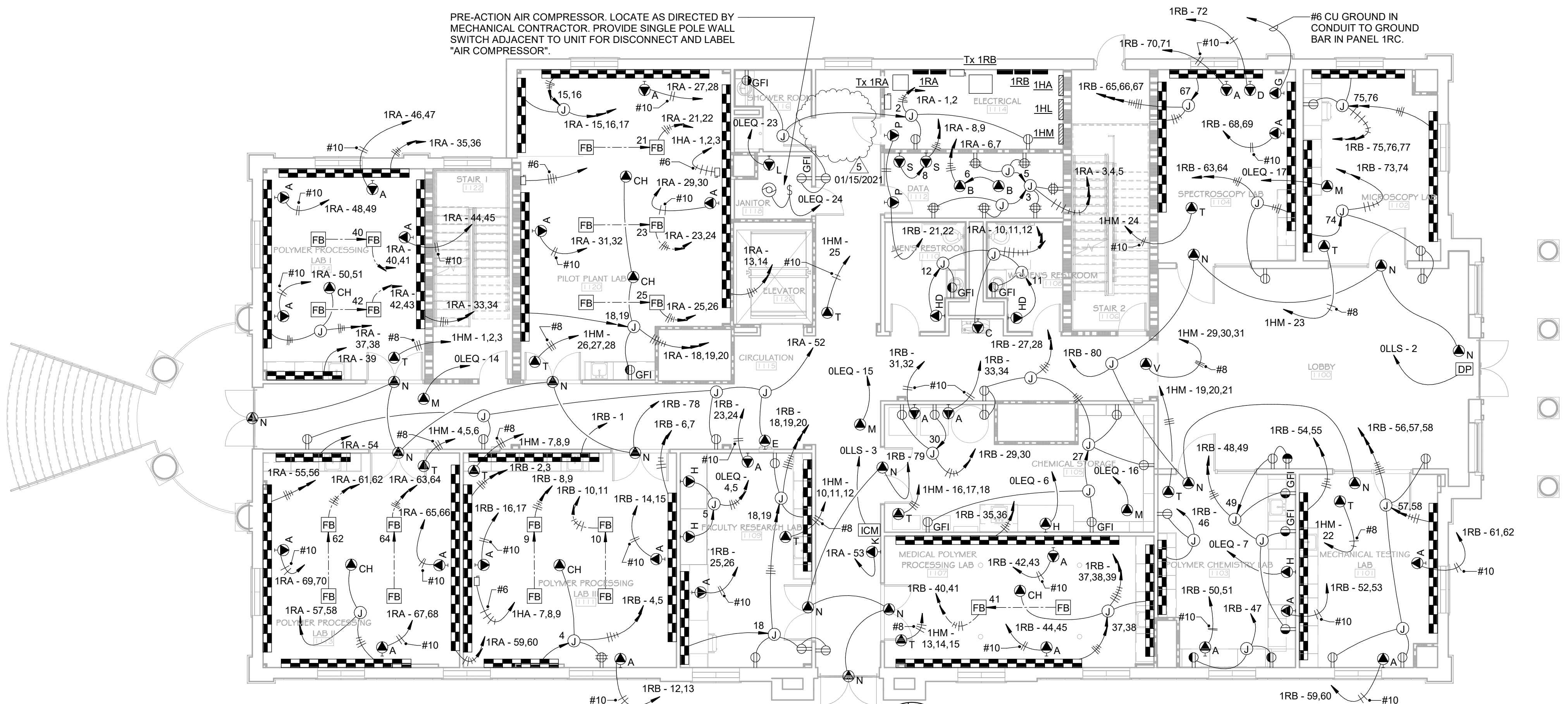
Sheet Title

Basement Power Plans

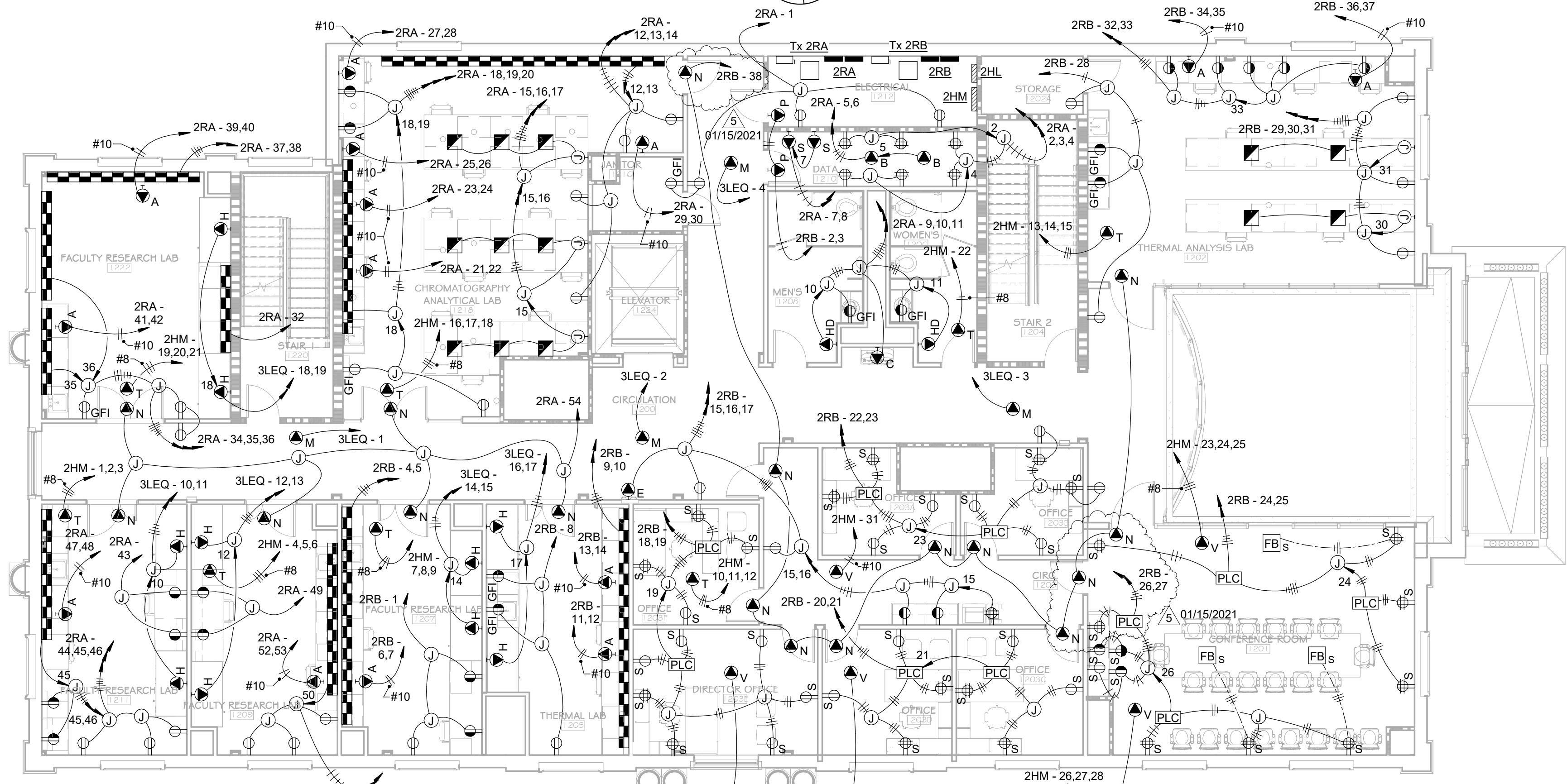
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E007

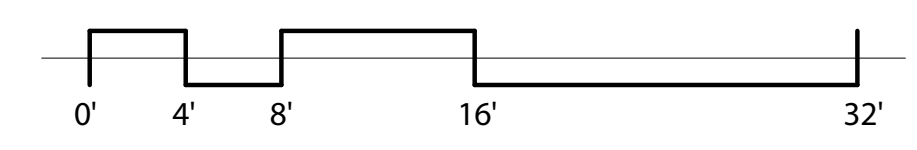




Power - Level 1  
1/8" = 1'-0"

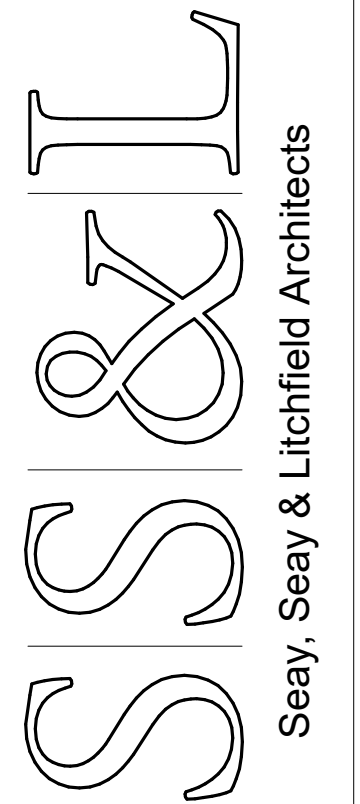


Power - Level 2  
1/8" = 1'-0"



PRE-ACTION AIR COMPRESSOR. LOCATE AS DIRECTED BY MECHANICAL CONTRACTOR. PROVIDE SINGLE POLE WALL SWITCH ADJACENT TO UNIT FOR DISCONNECT AND LABEL "AIR COMPRESSOR".

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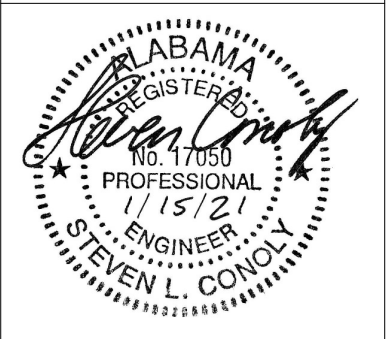
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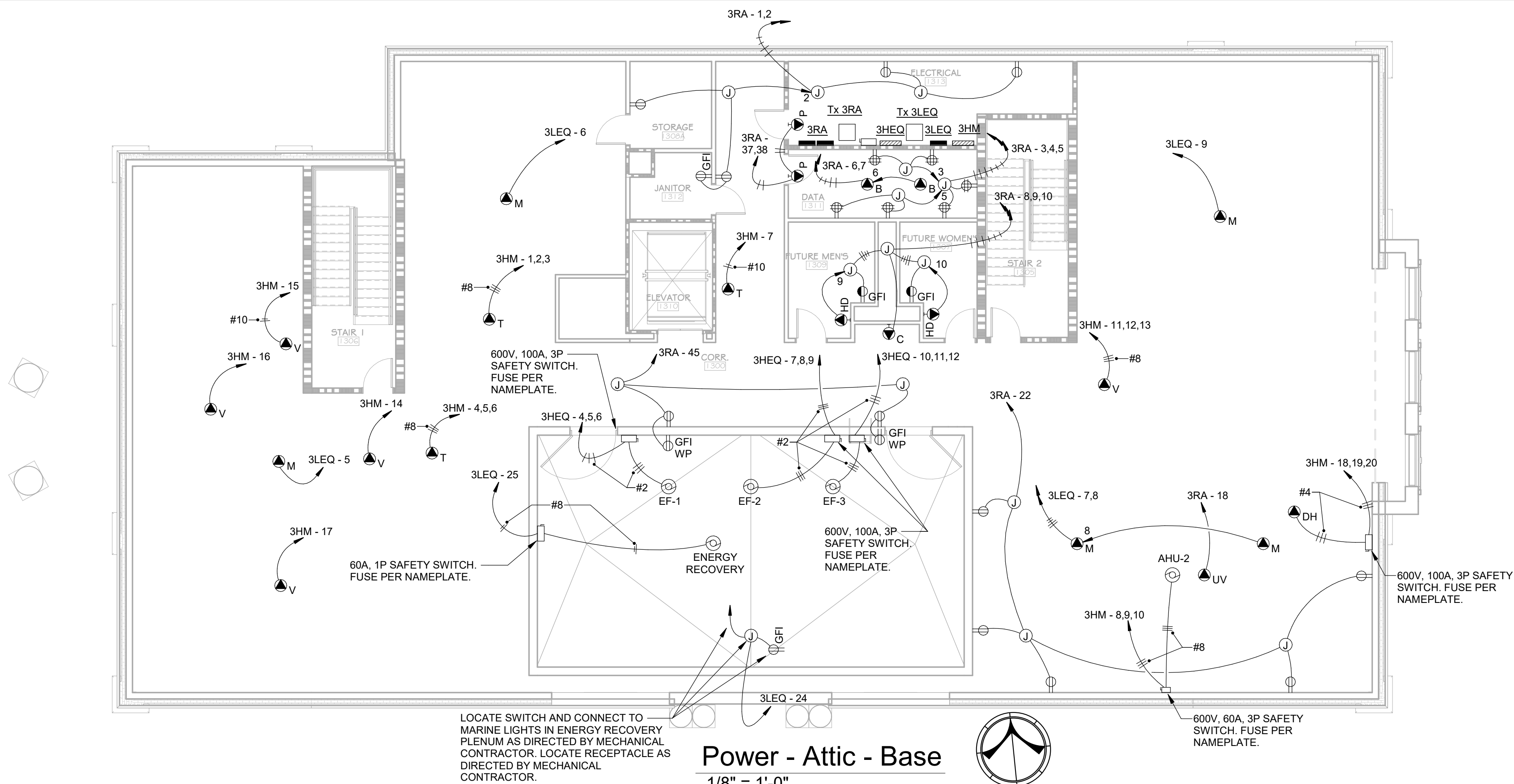
Sheet Title

First and Second Floor  
Power Plans

Sheet Number

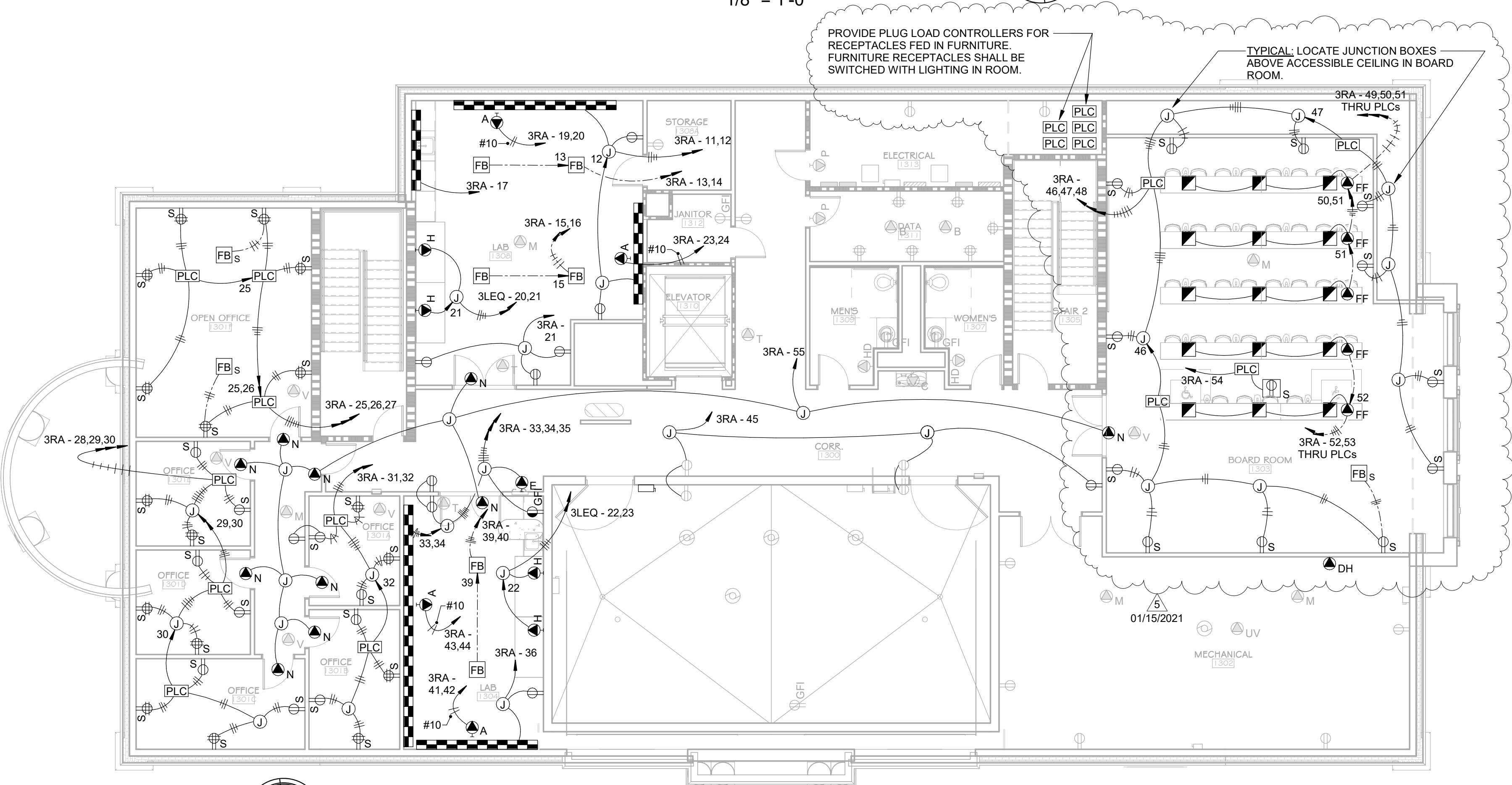
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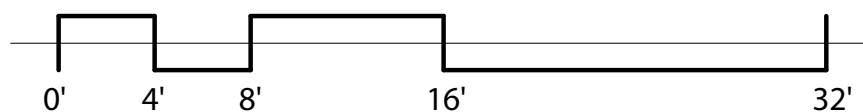
Power - Attic - Base

1/8" = 1'-0"



Power - Attic - Alternate

1/8" = 1'-0"



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Sheet Title

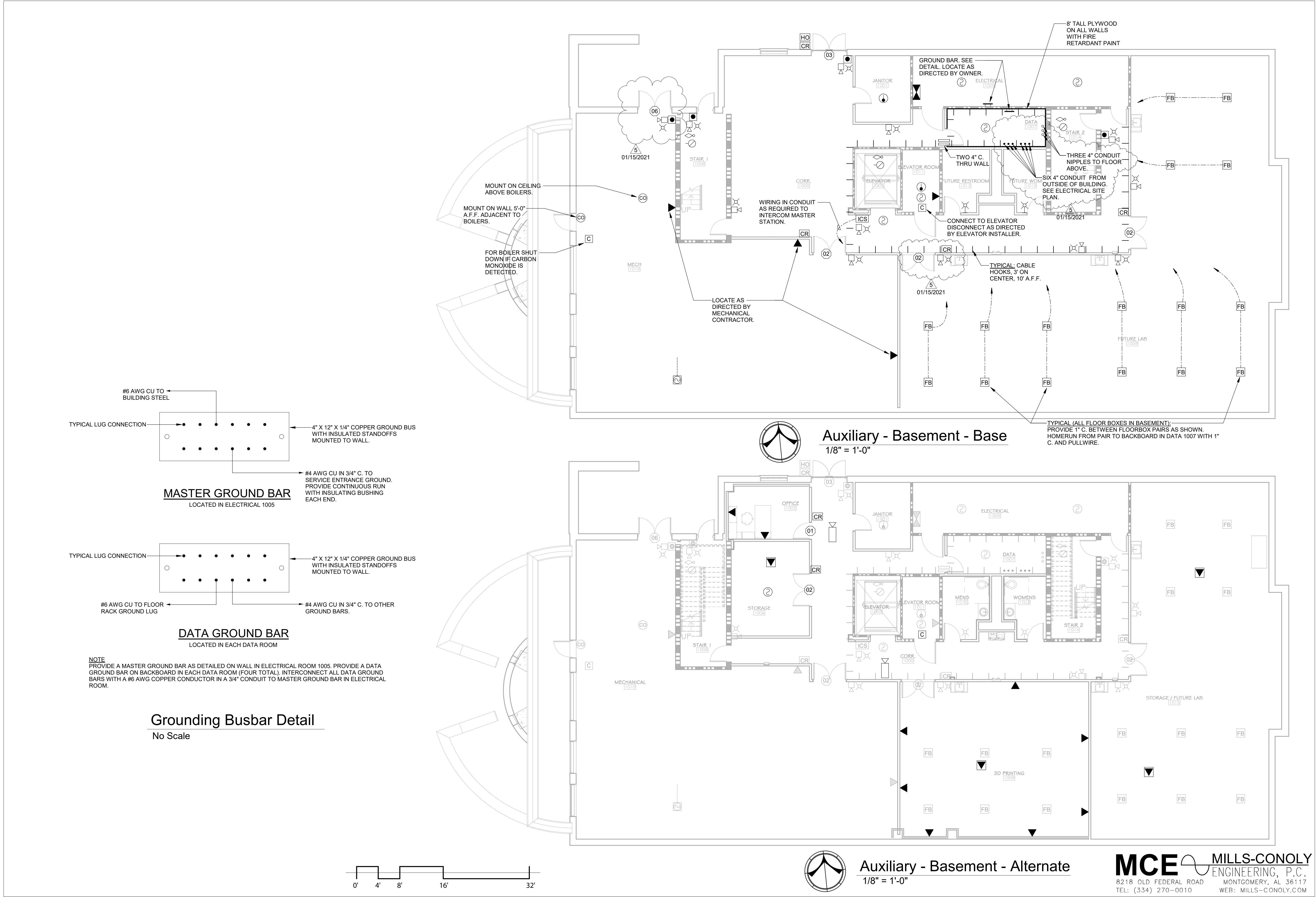
Attic Power Plans

Sheet Number

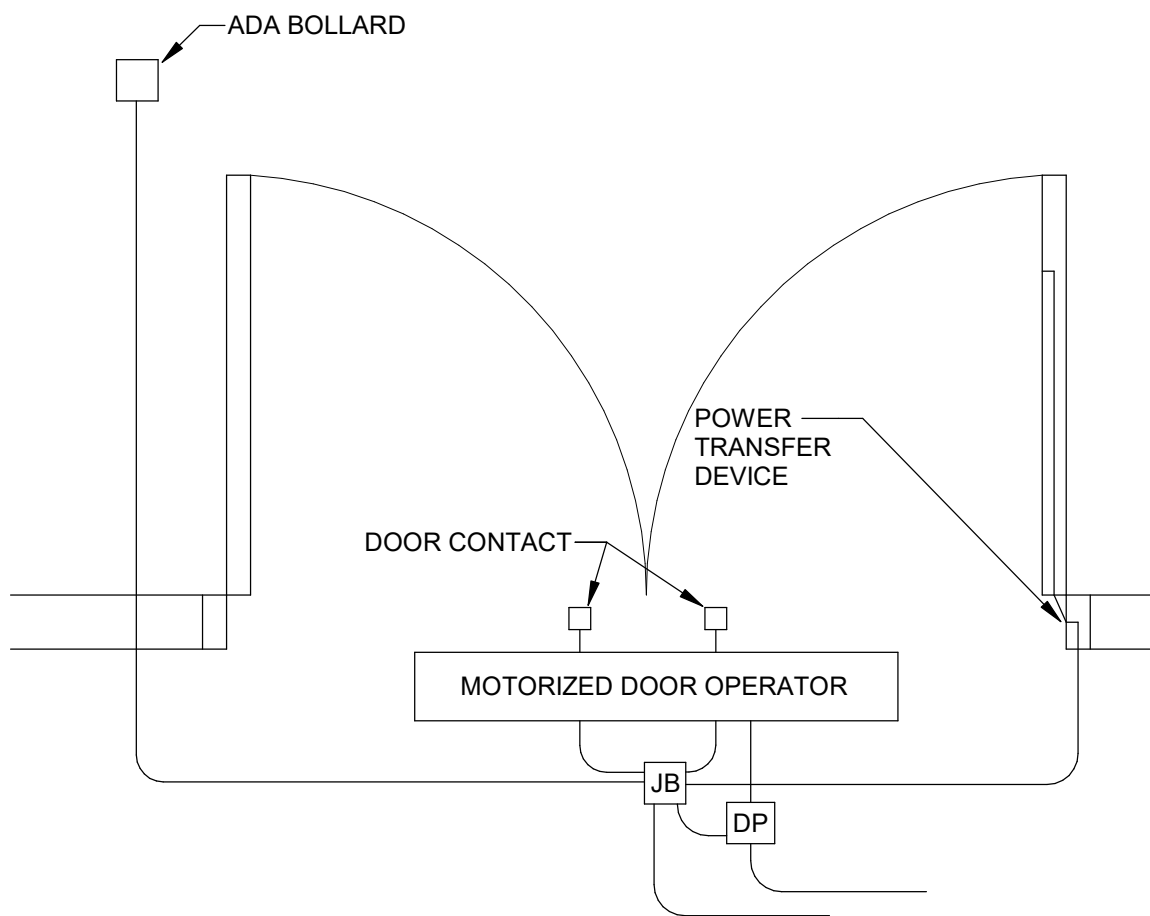
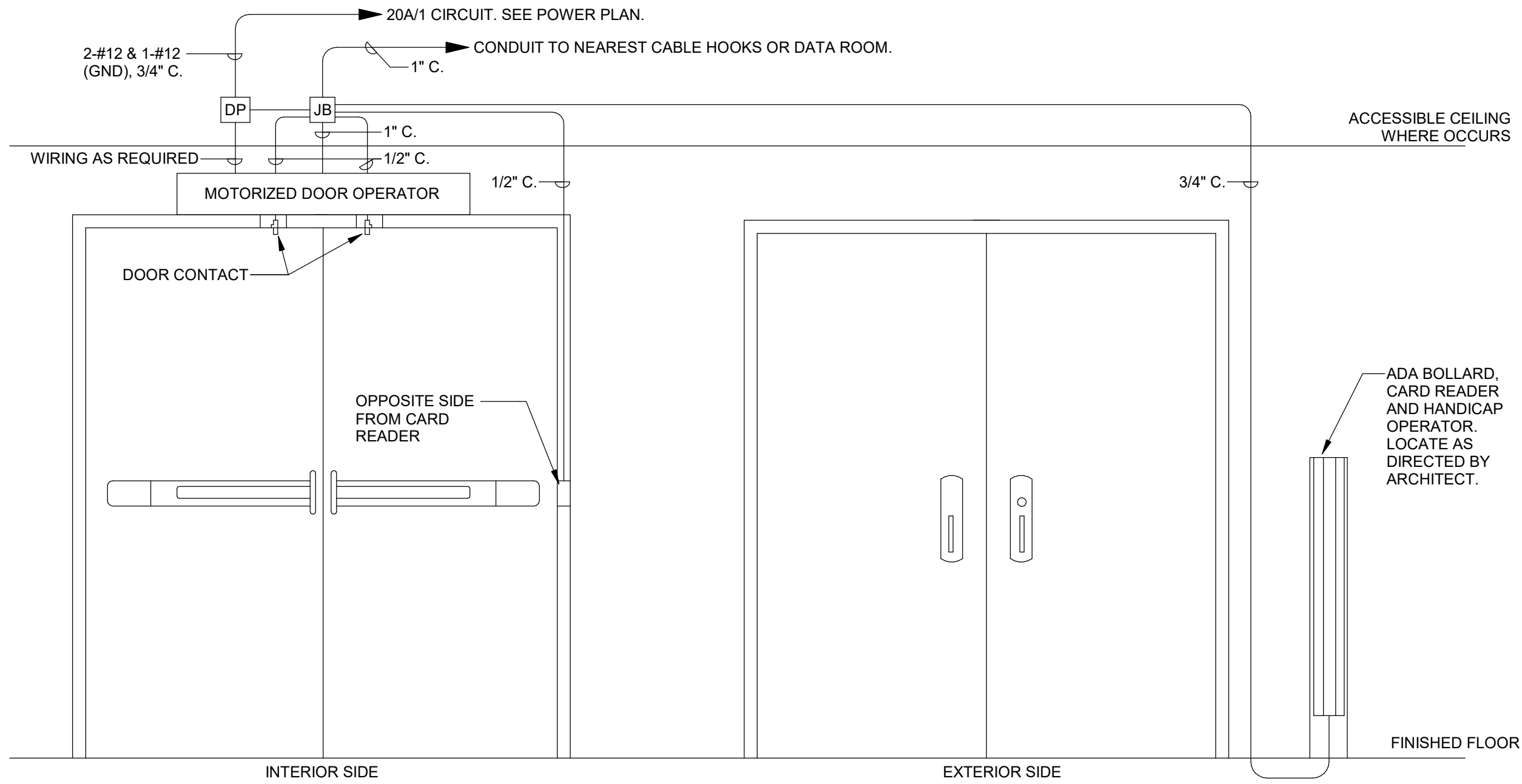
E009











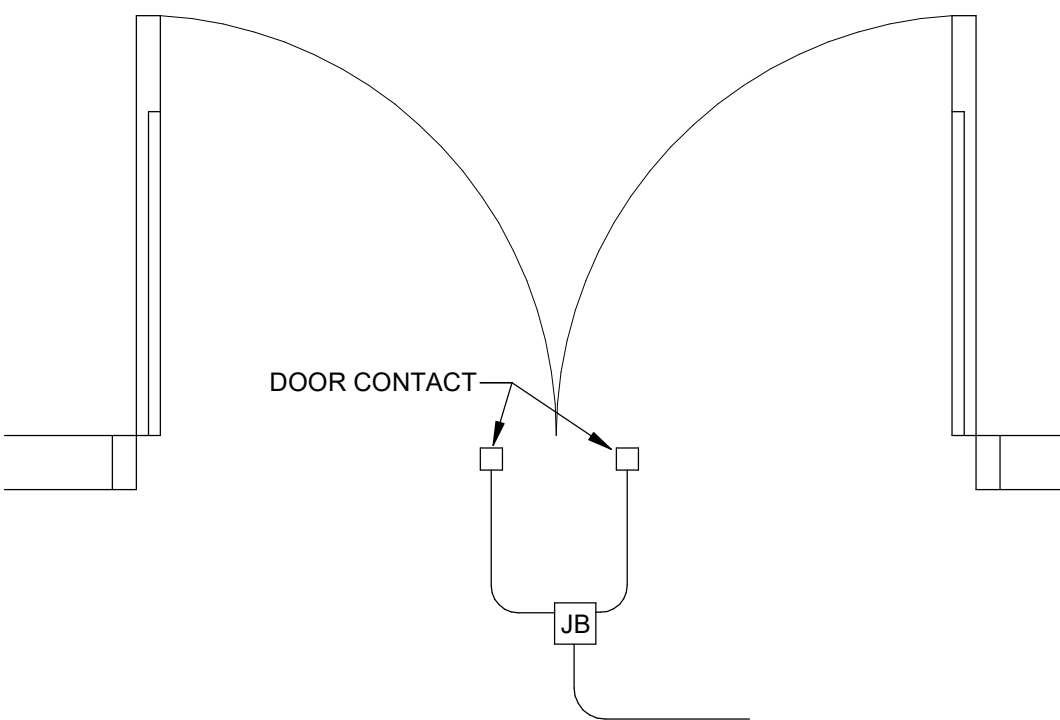
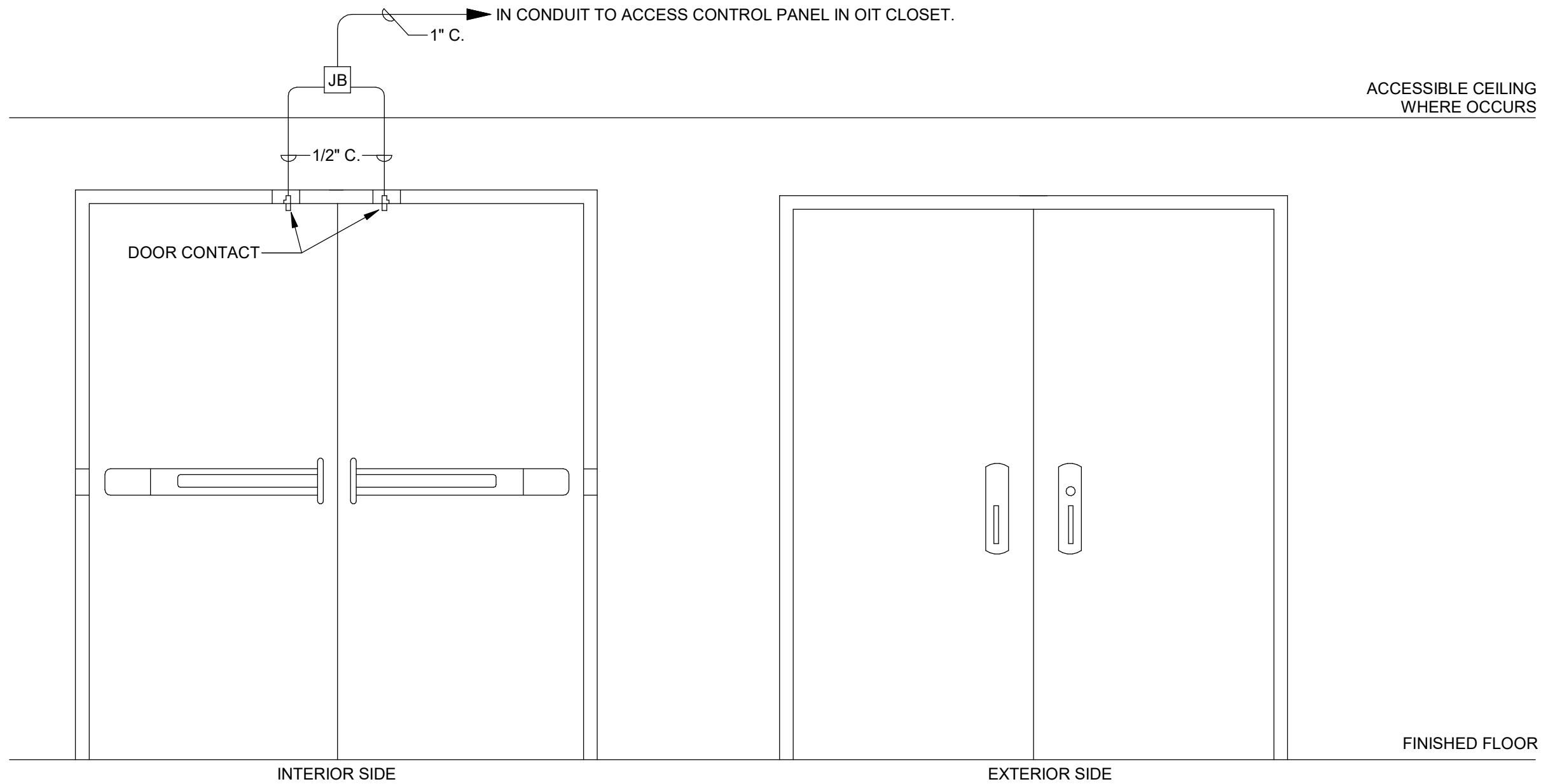
ELEVATION VIEWS

PLAN VIEW

SYMBOL: 05

05 Access Control Detail

No Scale



ELEVATION VIEWS

PLAN VIEW

SYMBOL: 06

06 Access Control Detail

No Scale

5  
01/15/2021

[illegible]

Panel: 1RA															
<b>Location:</b> Electrical 1114 <b>Supply From:</b> Tx 1RA <b>Mounting:</b> Surface Mounted <b>Enclosure:</b> NEMA 1					<b>Volts:</b> 120/208 Wye <b>Phases:</b> 3 <b>Wires:</b> 4 <b>Type:</b> NQOD					<b>A.I.C. Rating:</b> 10kA <b>Mains Type:</b> MCB <b>Mains Rating:</b> 225 A <b>MCB Rating:</b> 225 A					
CKT	Circuit Description	Trip	Poles	Breaker Type	A		B		C		Breaker Type	Poles	Trip	Circuit Description	CKT
1	Receptacles	20 A	1	QOB	360 VA	360 VA					QOB	1	20 A	Other	43
2	Receptacles	20 A	1	QOB			720 VA	750 VA			QOB	2	30 A	L6-30R	44
3	Receptacles	20 A	1	QOB					720 VA	750 VA	--	--	--	--	45
4	Receptacles	20 A	1	QOB	720 VA	750 VA					QOB	2	30 A	L6-30R	46
5	Receptacles	20 A	1	QOB			720 VA	750 VA			--	--	--	--	47
6	Rack Receptacle	20 A	1	QOB					1500 VA	750 VA	QOB	2	30 A	L6-30R	48
7	Rack Receptacle	20 A	1	QOB	1500 VA	750 VA					--	--	--	--	49
8	Shades	20 A	1	QOB			1200 VA	750 VA			QOB	2	30 A	L6-30R	50
9	Shades	20 A	1	QOB					1200 VA	750 VA	--	--	--	--	51
10	Receptacles	20 A	1	QOB	610 VA	665 VA					QOB	1	20 A	Receptacles	52
11	Hand Dryer	20 A	1	QOB			1200 VA	125 VA			QOB	1	20 A	Key Box	53
12	Hand Dryer	20 A	1	QOB					1200 VA	720 VA	QOBGFI	1	20 A	Plug-in Strip	54
13	Plug-in Strip	20 A	1	QOB	1080 VA	1080 VA					QOB	1	20 A	Plug-in Strip	55
14	Plug-in Strip	20 A	1	QOB			1080 VA	720 VA			QOB	1	20 A	Plug-in Strip	56
15	Plug-in Strip	20 A	1	QOB					720 VA	720 VA	QOB	1	20 A	Plug-in Strip	57
16	Plug-in Strip	20 A	1	QOB	1080 VA	870 VA					QOB	1	20 A	Plug-in Strip	58
17	Plug-in Strip	20 A	1	QOB			720 VA	1080 VA			QOB	1	20 A	Plug-in Strip	59
18	Plug-in Strip	20 A	1	QOB					720 VA	720 VA	QOB	1	20 A	Plug-in Strip	60
19	Plug-in Strip	20 A	1	QOB	720 VA	360 VA					QOB	1	20 A	Floorbox	61
20	Plug-in Strip	20 A	1	QOBGFI			480 VA	360 VA			QOB	1	20 A	Floorbox	62
21	Floorbox	20 A	1	QOB					360 VA	360 VA	QOB	1	20 A	Floorbox	63
22	Floorbox	20 A	1	QOB	360 VA	360 VA					QOB	1	20 A	Floorbox	64
23	Floorbox	20 A	1	QOB			360 VA	750 VA			QOB	2	30 A	L6-30R	65
24	Floorbox	20 A	1	QOB					360 VA	750 VA	--	--	--	--	66
25	Floorbox	20 A	1	QOB	360 VA	750 VA					QOB	2	30 A	L6-30R	67
26	Floorbox	20 A	1	QOB			360 VA	750 VA			--	--	--	--	68
27	L6-30R	30 A	2	QOB					750 VA	750 VA	QOB	2	30 A	L6-30R	69
28	--	--	--	--	750 VA	750 VA					--	--	--	--	70
29	L6-30R	30 A	2	QOB			750 VA	0 VA			--	1	20 A	Spare	71
30	--	--	--	--					750 VA	0 VA	--	1	20 A	Spare	72
31	L6-30R	30 A	2	QOB	750 VA	0 VA					--	1	20 A	Spare	73
32	--	--	--	--			750 VA	0 VA			--	1	20 A	Spare	74
33	Plug-in Strip</														

Panel: 0RA															
Location: Electrical 1005 Supply From: Tx 0RA Mounting: Surface Mounted Enclosure: NEMA 1							Volts: 120/208 Wye Phases: 3 Wires: 4 Type: NQOD				A.I.C. Rating: 10kA Mains Type: MCB Mains Rating: 225 A MCB Rating: 225 A				
CKT	Circuit Description	Trip	Poles	Breaker Type	A		B		C		Breaker Type	Poles	Trip	Circuit Description	CKT
1	Receptacles	20 A	1	QOB	540 VA	1500 VA					QOB	1	30 A	Receptacles	43
2	Receptacles	20 A	1	QOB			1260 VA	1500 VA			QOB	1	30 A	Receptacles	44
3	Receptacles	20 A	1	QOB					720 VA	1500 VA	QOB	1	30 A	Receptacles	45
4	Receptacles	20 A	1	QOB	720 VA	1500 VA					QOB	1	30 A	Receptacles	46
5	Receptacles	20 A	1	QOB			720 VA	1500 VA			QOB	1	30 A	Receptacles	47
6	Rack Receptacle	20 A	1	QOB					1500 VA	380 VA	QOB	1	20 A	Elevator Pit	48
7	Power	20 A	1	QOB	1500 VA	1200 VA					QOB	2	20 A	Elevator Cab	49
8	Hand Dryer	20 A	1	QOB			1200 VA	1200 VA			--	--	--		50
9	Hand Dryer	20 A	1	QOB					1200 VA	1176 VA	QOB	1	20 A	Sump Pump	51
10	Receptacles	20 A	1	QOB	610 VA	360 VA					QOB	1	20 A	Receptacles	52
11	DHP	20 A	2	QOB			563 VA	0 VA			--	1	20 A	Spare	53
12	--	--	--	--					563 VA	0 VA	--	1	20 A	Spare	54
13	Door Controls	20 A	1	QOB	500 VA	0 VA					--	1	20 A	Spare	55
14	Floorbox	20 A	1	QOB			360 VA	0 VA			--	1	20 A	Spare	56
15	Floorbox	20 A	1	QOB					360 VA	0 VA	--	1	20 A	Spare	57
16	Floorbox	20 A	1	QOB	360 VA	0 VA					--	1	20 A	Spare	58
17	Floorbox	20 A	1	QOB			360 VA	0 VA			--	1	20 A	Spare	59
18	Floorbox	20 A	1	QOB					360 VA	0 VA	--	1	20 A	Spare	60
19	Floorbox	20 A	1	QOB	360 VA	0 VA					--	1	20 A	Spare	61
20	Floorbox	20 A	1	QOB			360 VA	0 VA			--	1	20 A	Spare	62
21	Floorbox	20 A	1	QOB					360 VA	0 VA	--	1	20 A	Spare	63
22	Floorbox	20 A	1	QOB	360 VA	0 VA					--	--	--	Space	64
23	Floorbox	20 A	1	QOB			360 VA	0 VA			--	--	--	Space	65
24	Floorbox	20 A	1	QOB					360 VA	0 VA	--	--	--	Space	66
25	Floorbox	20 A	1	QOB	360 VA	0 VA					--	--	--	Space	67
26	Floorbox	20 A	1	QOB			360 VA	0 VA			--	--	--	Space	68
27	Floorbox	20 A	1	QOB					360 VA	0 VA	--	--	--	Space	69
28	Floorbox	20 A	1	QOB	360 VA	0 VA					--	--	--	Space	70
29	Floorbox	20 A	1	QOB			360 VA	0 VA			--	--	--	Space	71
30	Receptacles	20 A	1	QOB					360 VA	0 VA	--	--	--	Space	72
31	Receptacles	20 A	1	QOB	1025 VA	0 VA					--	--	--	Space	73
32	Receptacles	20 A	1	QOB			1080 VA	0 VA			--	--	--	Space	74
33	Receptacles	20 A	1	QOB					720 VA	0 VA	--	--	--	Space	75
34	Receptacles	20 A	1	QOB											



<div><div>Panel: 0HM</div><div><div>Location: Mech. 1010</div><div>Supply From: SE</div><div>Mounting: Surface Mounted</div><div>Enclosure: NEMA 1</div></div><div><div>Volts: 480/277 Wye</div><div>Phases: 3</div><div>Wires: 4</div><div>Type: NF</div></div><div><div>A.I.C. Rating: 65kA</div><div>Mains Type: MLO</div><div>Mains Rating: 800 A</div><div>MCB Rating: N/A</div></div><div>501/15/2021</div></div>															
CKT	Circuit Description	Trip	Poles	Breaker Type	A		B		C		Breaker Type	Poles	Trip	Circuit Description	CKT
1	CWP-1a	70 A	3	EDB	9422 VA	1108 VA					EDB	3	20 A	SAF-1	43
2	--	--	--	--			9422 VA	1108 VA			--	--	--	--	44
3	--	--	--	--					9422 VA	1108 VA	--	--	--	--	45
4	CWP-1b	70 A	3	EDB	9422 VA	15000 VA					EDB	3	80 A	Water Heater	46
5	--	--	--	--			9422 VA	15000 VA			--	--	--	--	47
6	--	--	--	--					9422 VA	15000 VA	--	--	--	--	48
7	CWP-2a	70 A	3	EDB	9422 VA	5820 VA					EDB	3	30 A	GWP-1a	49
8	--	--	--	--			9422 VA	5820 VA			--	--	--	--	50
9	--	--	--	--					9422 VA	5820 VA	--	--	--	--	51
10	CWP-2b	70 A	3	EDB	9422 VA	5820 VA					EDB	3	30 A	GWP-1b	52
11	--	--	--	--			9422 VA	5820 VA			--	--	--	--	53
12	--	--	--	--					9422 VA	5820 VA	--	--	--	--	54
13	Vacuum Pump	20 A	3	EDB	4312 VA	16667 VA					EDB	3	100 A	Duct Heater	55
14	--	--	--	--			4312 VA	16667 VA			--	--	--	--	56
15	--	--	--	--					4312 VA	16667 VA	--	--	--	--	57
16	Air Compressor	60 A	3	EDB	11085 VA	0 VA					--	3	50 A	Spare	58
17	--	--	--	--			11085 VA	0 VA			--	--	--	--	59
18	--	--	--	--					11085 VA	0 VA	--	--	--	--	60
19	SATU-1	30 A	1	EDB	5000 VA	0 VA					--	3	20 A	Spare	61
20	SATU-2	30 A	1	EDB			5000 VA	0 VA			--	--	--	--	62
21	SATU-3	30 A	3	EDB					5000 VA	0 VA	--	--	--	--	63
22	--	--	--	--	5000 VA	0 VA					--	--	--	Space	64
23	--	--	--	--			5000 VA	0 VA			--	--	--	Space	65
24	SATU-4	20 A	1	EDB					3000 VA	0 VA	--	--	--	Space	66
25	SATU-5	50 A	3	EDB	10000 VA	0 VA					--	--	--	Space	67
26	--	--	--	--			10000 VA	0 VA			--	--	--	Space	68
27	--	--	--	--					10000 VA	0 VA	--	--	--	Space	69
28	SATU-6	50 A	3	EDB	10000 VA	0 VA					--	--	--	Space	70
29	--	--	--	--			10000 VA	0 VA			--	--	--	Space	71
30	--	--	--	--					10000 VA	0 VA	--	--	--	Space	72
31	Tx OLM	25 A	3	EDB	1810 VA	0 VA					--	--	--	Space	73
32	--	--	--	--			3150 VA	0 VA			--	--	--	Space	74
33	--	--	--	--					3000 VA	0 VA	--	--	--	Space	75
34	VRF-1a	20 A	3	EDB	4157 VA	0 VA					--	--	--	Space	76
35	--	--	--	--			4157 VA	0 VA			--	--	--	Space	77
36	--	--	--	--					4157 VA	0 VA	--	--	--	Space	78
37	VRF-1b	20 A	3	EDB	4157 VA	0 VA					--	--	--	Space	79
38	--	--	--	--			4157 VA	0 VA			--	--	--	Space	80
39	--	--	--	--					4157 VA	0 VA	--	--	--	Space	81
40	ATS OS (Alternate)	100 A	3	EDB	18845 VA	0 VA					--	--	--	Space	82
41	--	--	--	--			18845 VA	0 VA			--	--	--	Space	83
42	--	--	--	--					18845 VA	0 VA	--	--	--	Space	84
Total Load:					156470 VA		157810 VA		155660 VA						
Total Amps:					565 A		570 A		562 A						
Legend:															
Load Classification					Connected Load		Demand Factor		Estimated Demand		Panel Totals				
Redutant 1+1					204520 VA		50.00%		102260 VA						
Redutant 2+1					0 VA		0.00%		0 VA						
											Total Conn. Load: 469939 VA				
											Total Est. Demand: 367679 VA				
											Total Conn. Current: 565 A				
											Total Est. Demand Current: 442 A				
Notes:															
Spare breakers shall be EDB type.															
Two equal sections.															

<div><div>Panel: 0HRD</div><div><div>Location: Electrical 1005</div><div>Supply From: SE</div><div>Mounting: Surface Mounted</div><div>Enclosure: NEMA 1</div></div><div><div>Volts: 480/277 Wye</div><div>Phases: 3</div><div>Wires: 4</div><div>Type: I-Line</div></div><div><div>A.I.C. Rating: 65kA</div><div>Mains Type: MLO</div><div>Mains Rating: 600 A</div><div>MCB Rating: N/A</div></div></div>															
CKT	Circuit Description	Trip	Poles	Breaker Type	A		B		C		Breaker Type	Poles	Trip	Circuit Description	CKT
1	Tx 0RA	125 A	3	HD	12335 VA	0 VA					--	--	--	Space	19
2	--	--	--	--			12083 VA	0 VA			--	--	--	--	20
3	--	--	--	--					10999 VA	0 VA	--	--	--	--	21
4	Tx 1RA	125 A	3	HD	17145 VA	0 VA					--	--	--	Space	22
5	--	--	--	--			16325 VA	0 VA			--	--	--	--	23
6	--	--	--	--					17070 VA	0 VA	--	--	--	--	24
7	Tx 1RB	175 A	3	JD	18630 VA	0 VA					--	--	--	Space	25
8	--	--	--	--			19810 VA	0 VA			--	--	--	--	26
9	--	--	--	--					20140 VA	0 VA	--	--	--	--	27
10	Tx 2RA	125 A	3	HD	13530 VA	0 VA					--	--	--	Space	28
11	--	--	--	--			16140 VA	0 VA			--	--	--	--	29
12	--	--	--	--					14620 VA	0 VA	--	--	--	--	30
13	Tx 2RB	125 A	3	HD	11100 VA	0 VA					--	--	--	Space	31
14	--	--	--	--			11895 VA	0 VA			--	--	--	--	32
15	--	--	--	--					8690 VA	0 VA	--	--	--	--	33
16	Tx 3RA	125 A	3	HD	15220 VA	0 VA					--	--	--	Space	34
17	--	--	--	--			14315 VA	0 VA			--	--	--	--	35
18	--	--	--	--					17380 VA	0 VA	--	--	--	--	36
Total Load:					87960 VA		90568 VA		88899 VA						
Total Amps:					318 A		327 A		321 A						
Panel Totals															
Total Conn. Load: 267426 VA															
Total Conn. Current: 322 A															
Notes:															

Panel: 0HCH

Location: Mechanical 1010

Supply From: ATS OS

Mounting: Surface Mounted

Enclosure: NEMA 1

Volts: 480/277 Wye

Phases: 3

Wires: 4

Type: NF

A.I.C. Rating: 65kA

Mains Type: MLO

Mains Rating: 100 A

MCB Rating: N/A

CKT	Circuit Description	Trip	Poles	Breaker Type	A		B		C		Breaker Type	Poles	Trip	Circuit Description	CKT
1	CWP-1a	50 A	3	EDB	9422 VA	0 VA					--	--	--	Space	10
2	--	--	--	--			9422 VA	0 VA			--	--	--	Space	11
3	--	--	--	--					9422 VA	0 VA	--	--	--	Space	12
4	CWP-1b	50 A	3	EDB	9422 VA	0 VA					--	--	--	Space	13
5	--	--	--	--			9422 VA	0 VA			--	--	--	Space	14
6	--	--	--	--					9422 VA	0 VA	--	--	--	Space	15
7	Space	--	--	--	0 VA	0 VA					--	--	--	Space	16
8	Space	--	--	--			0 VA	0 VA			--	--	--	Space	17
9	Space	--	--	--					0 VA	0 VA	--	--	--	Space	18
Total Load:					18845 VA		18845 VA		18845 VA						
Total Amps:					68 A		68 A		68 A						

Legend:

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals	
Redutant 1+1	56534 VA	50.00%	28267 VA		
Redutant 2+1	0 VA	0.00%	0 VA		
				Total Conn. Load:	56534 VA
				Total Est. Demand:	28267 VA
				Total Conn. Current:	68 A
				Total Est. Demand Current:	34 A

Notes:

Provide under alternate.

Switchboard: SE

Location: Electrical 1005

Supply From: Utility

Mounting: Floor

Enclosure: NEMA 1

Volts: 480/277 Wye

Phases: 3

Wires: 4

Type: Switchboard

A.I.C. Rating: 65kA

Mains Type: MCB

Mains Rating: 3000 A

MCB Rating: 3000 A

CKT	Circuit Description	# of Poles	Trip Rating	Load	Current	Breaker Type
1	Elevator	3	100 A	58197 VA	70 A	BJ
2	Panel OHRD	3	600 A	267426 VA	322 A	LJ
3	ATS EM	3	100 A	9411 VA	11 A	BJ
4	ATS LR	3	600 A	395338 VA	476 A	LJ
5	Panel 0HM	3	800 A	469939 VA	565 A	MJ
6	Panel 1HM	3	400 A	219000 VA	263 A	LJ
7	Panel 2HM	3	400 A	233000 VA	280 A	LJ
8	Panel 3HM	3	400 A	159447 VA	192 A	LJ
9	Panel 1HL	3	100 A	20539 VA	25 A	BJ
10	Panel 1HA	3	225 A	133020 VA	160 A	JJ
11	Spare	3	100 A	0 VA	--	--
12	Space	--	--	0 VA	--	--
13	Space	--	--	0 VA	--	--
14	Space	--	--	0 VA	--	--
15	Space	--	--	0 VA	--	--
16	Space	--	--	0 VA	--	--
				1965289 VA	2364 A	
Panel Totals						
				Total Conn. Load: 1965289 VA		
				Total Conn. Current: 2364 A		

Notes:

Provide two spaces for L Frame breakers and three spaces for J Frame breakers.

Spare breaker shall be BJ type.

Provide UL S.E. label.

Main breaker shall have ground-fault protection of equipment per NEC 230.95.

Main breaker shall have energy-reducing maintenance bypass switch with local status indicator per NEC 240.87.

All breakers shall be metered per ASHRAE 90.1 8.4.3.

Panel: 2HM

Location: Electrical 1212

Supply From: SE

Mounting: Surface Mounted

Enclosure: NEMA 1

Volts: 480/277 Wye

Phases: 3

Wires: 4

Type: NF

A.I.C. Rating: 65kA

Mains Type: MLO

Mains Rating: 400 A

MCB Rating: N/A

CKT	Circuit Description	Trip	Poles	Breaker Type	A		B		C		Breaker Type	Poles	Trip	Circuit Description	CKT
1	SATU-19	40 A	3	EDB	8333 VA	5000 VA					EDB	1	30 A	SATU-26	22
2	--	--	--	--			8333 VA	10667 VA			EDB	3	50 A	VAV 2-2	23
3	--	--	--	--					8333 VA	10667 VA	--	--	--	--	24
4	SATU-20	40 A	3	EDB	8333 VA	10667 VA					EDB	3	30 A	VAV 2-3	25
5	--	--	--	--			8333 VA	5333 VA			EDB	3	30 A	VAV 2-3	26
6	--	--	--	--					8333 VA	5333 VA	--	--	--	--	27
7	SATU-21	40 A	3	EDB	8333 VA	5333 VA					--	--	--	--	28
8	--	--	--	--			8333 VA	9000 VA			EDB	1	50 A	VAV 2-4	29
9	--	--	--	--					8333 VA	6000 VA	EDB	1	30 A	VAV 2-5	30
10	SATU-22	50 A	3	EDB	10000 VA	5000 VA					EDB	1	30 A	VAV 2-6	31
11	--	--	--	--			10000 VA	0 VA			--	1	50 A	Spare	32
12	--	--	--	--					10000 VA	0 VA	--	3	40 A	Spare	33
13	Power	20 A	3	EDB	3333 VA	0 VA					--	--	--	--	34
14	--	--	--	--			3333 VA	0 VA			--	--	--	--	35
15	--	--	--	--					3333 VA	0 VA	--	--	--	Space	36
16	SATU-24	40 A	3	EDB	6667 VA	0 VA					--	--	--	Space	37
17	--	--	--	--			6667 VA	0 VA			--	--	--	Space	38
18	--	--	--	--					6667 VA	0 VA	--	--	--	Space	39
19	SATU-25	40 A	3	EDB	8333 VA	0 VA					--	--	--	Space	40
20	--	--	--	--			8333 VA	0 VA			--	--	--	Space	41
21	--	--	--	--					8333 VA	0 VA	--	--	--	Space	42
Total Load:					79333 VA		78333 VA		75333 VA						
Total Amps:					288 A		284 A		272 A						
Panel Totals															
Total Conn. Load: 233000 VA															
Total Conn. Current: 280 A															

Notes:

Spare breakers shall be EDB type.

Panel: 3HM

Location: Electrical 1313

Supply From: SE

Mounting: Surface Mounted

Enclosure: NEMA 1

Volts: 480/277 Wye

Phases: 3

Wires: 4

Type: NF

A.I.C. Rating: 65kA

Mains Type: MLO

Mains Rating: 400 A

MCB Rating: N/A

CKT	Circuit Description	Trip	Poles	Breaker Type	A		B		C		Breaker Type	Poles	Trip	Circuit Description	CKT
1	SATU-27	40 A	3	EDB	8333 VA	0 VA					--	3	40 A	Spare	22
2	--	--	--	--			8333 VA	0 VA			--	--	--	--	23
3	--	--	--	--					8333 VA	0 VA	--	--	--	--	24
4	SATU-28	40 A	3	EDB	8333 VA	0 VA					--	3	40 A	Spare	25
5	--	--	--	--			8333 VA	0 VA			--	--	--	--	26
6	--	--	--	--					8333 VA	0 VA	--	--	--	--	27
7	SATU-29	30 A	1	EDB	6000 VA	0 VA					--	--	--	Space	28
8	AHU-2	50 A	3	EDB			7482 VA	0 VA			--	--	--	Space	29
9	--	--	--	--					7482 VA	0 VA	--	--	--	Space	30
10	--	--	--	--	7482 VA	0 VA					--	--	--	Space	31
11	VAV 2-7	40 A	3	EDB			6667 VA	0 VA			--	--	--	Space	32
12	--	--	--	--					6667 VA	0 VA	--	--	--	Space	33
13	--	--	--	--	6667 VA	0 VA					--	--	--	Space	34
14	VAV 2-8	20 A	1	EDB			3000 VA	0 VA			--	--	--	Space	35
15	VAV 2-9	30 A	1	EDB					5000 VA	0 VA	--	--	--	Space	36
16	VAV 2-10	20 A	1	EDB	4000 VA	0 VA					--	--	--	Space	37
17	VAV 2-11	20 A	1	EDB			4000 VA	0 VA			--	--	--	Space	38
18	Duct Heater	80 A	3	EDB					15000 VA	0 VA	--	--	--	Space	39
19	--	--	--	--	15000 VA	0 VA					--	--	--	Space	40
20	--	--	--	--			15000 VA	0 VA			--	--	--	Space	41
21	Spare	20 A	1	--					0 VA	0 VA	--	--	--	Space	42
Total Load:					55816 VA		52816 VA		50816 VA						
Total Amps:					203 A		192 A		183 A						
Panel Totals															
Total Conn. Load: 159447 VA															
Total Conn. Current: 192 A															

Notes:

Spare breakers shall be EDB type.

