SECTION 000007 – ADDENDUM NUMBER 7

DATE: **JANUARY 23, 2026**

TO: **ALL BIDDERS**

FROM: **PERKINS & WILL**
225 FRANKLIN STREET, SUITE 700
BOSTON, MA 02110

RE: **WORCESTER SOUTH DIVISION FIRE STATION, WORCESTER, MA**

THIS ADDENDUM FORMS A PART OF THE CONTRACT AND MODIFIES THE ORIGINAL DOCUMENTS DATED DECEMBER 2025.

PART 1 - GENERAL

1.1 This addendum must be returned with plans and specifications (if not already returned) to have your deposit returned.

1.2 This addendum modifies, amends, and supplements the Contract Documents for the above referenced project. This addendum is hereby made a part of the Contract Documents by reference and shall be as binding as though inserted in locations designated hereunder.

1.3 Each general bidder shall be responsible for notifying all his non-filed sub-bidders and suppliers of the content of this addendum. No claim for additional compensation will be considered because of lack of knowledge of changes or modifications contained in this addenda.

1.4 Questions or requests for clarification shall be in writing, addressed to Jeremy C. Flansburg, Assistant Purchasing Director at **PURCHASING DEPARTMENT,** and be sent flansburgjc@worcesterma.gov. Please include your name, phone number, and e-mail.

1.5 Part 2 of this addendum indicates revisions to the Project Manual.

1.6 Part 3 of this addendum indicates revisions to the Drawings.

1.7 Part 4 of this addendum indicates clarification to Contractors Questions.

PART 2 - SPECIFICATION

2.1 SECTION 04 43 13.13 – ANCHORED STONE MASONRY VENEER
DELETE section in its entirety and **REPLACE** with the updated version

2.2 SECTION 06 16 43 – GYPSUM SHEATING
DELETE section in its entirety and **REPLACE** with the updated version

2.3 SECTION 08 44 13 – GLAZED ALUMINUM CURTAIN WALLS
DELETE section in its entirety and **REPLACE** with the updated version

2.4 SECTION 09 30 13 – TILING
DELETE section in its entirety and **REPLACE** with the updated version

2.5 SECTION 22 13 16 – SANITARY WASTE AND VENT PIPING AND SPECIALTIES
DELETE section in its entirety and **REPLACE** with the updated version

2.6 SECTION 22 14 13 – FACILITY STORM DRAINGAGE PIPING AND SPECIALTIES
DELETE section in its entirety and **REPLACE** with the updated version

2.7 SECTION 23 09 23 – DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC
DELETE section in its entirety and **REPLACE** with the updated version

2.8 SECTION 23 35 33 – LISTED KITCHEN VENTILATION SYSTEM EXHAUST DUCTS
INSERT NEW section in its entirety

PART 3 - DRAWINGS

3.1 **DELETE** Drawing A11-01 and **INSERT** revised drawing
3.2 **DELETE** Drawing A13-01 and **INSERT** revised drawing
3.3 **DELETE** Drawing A13-02 and **INSERT** revised drawing
3.4 **DELETE** Drawing A20-01 and **INSERT** revised drawing
3.5 **DELETE** Drawing A32-13 and **INSERT** revised drawing
3.6 **DELETE** Drawing A34-01 and **INSERT** revised drawing
3.7 **DELETE** Drawing A41-01 and **INSERT** revised drawing
3.8 **DELETE** Drawing A41-02 and **INSERT** revised drawing
3.9 **DELETE** Drawing A41-03 and **INSERT** revised drawing
3.10 **DELETE** Drawing A41-50 and **INSERT** revised drawing
3.11 **DELETE** Drawing A43-01 and **INSERT** revised drawing
3.12 **DELETE** Drawing A62-01 and **INSERT** revised drawing
3.13 **DELETE** Drawing A64-01 and **INSERT** revised drawing
3.14 **DELETE** Drawing P04.00 and **INSERT** revised drawing
3.15 **DELETE** Drawing M03.02 and **INSERT** revised drawing
3.16 **DELETE** Drawing M03.03 and **INSERT** revised drawing
3.17 **DELETE** Drawing M03.04 and **INSERT** revised drawing
3.18 **DELETE** Drawing M09.00 and **INSERT** revised drawing
3.19 **DELETE** Drawing E01.01 and **INSERT** revised drawing
3.20 **DELETE** Drawing E03.00 and **INSERT** revised drawing
3.21 **DELETE** Drawing E03.10 and **INSERT** revised drawing

3.22 **DELETE** Drawing E04.01 and **INSERT** revised drawing
3.23 **DELETE** Drawing E04.02 and **INSERT** revised drawing
3.24 **DELETE** Drawing E09.01 and **INSERT** revised drawing

PART 4 - CONTRACTOR QUESTIONS

4.1 Q: Section 23 09 23-22, Paragraph 2.5 defines requirements for DDC controllers. To align with City of Worcester standard controllers, is the use of IP-based controllers without integral hardware override switches acceptable?
A: The IP based controller without integral hardware override switches is acceptable. Additionally, as clarified during the call with the City of Worcester Department of Facilities on January 16th, 2026 , the use of BACnet MSTP Alerton BACtalk field controllers is currently in place within the city buildings and is acceptable to the Owner. Note that the use of BACnet MSTP field controllers does not align with the design drawings and specifications; however, based on the Owner's directive, the substitution/replacement may proceed as instructed. Please ensure all related trades are coordinated and any cost/schedule implications are addressed per contract requirements.

4.2 Q: If mockups are required, please confirm the required sizes and locations.
A: For Curtain Wall: in place mock up to be identified during shop drawings.

4.3 Q: Please confirm whether the screen wall is included in our scope of work.
A: Specification 10 82 19 to be furnished and installed by the metal wall contractor. WTR to provide an opportunity to all to provide an add alternate for consideration.

4.4 Q: Please clarify the locations of the stool trim and curtain wall cap fins. Are these elements assumed at all curtain wall locations?
A: All CW to have perimeter fin caps and stool trims, unless shown otherwise in drawings.

4.5 Q: Door type I is not listed which type of door should I carry?
A: Door Type I should be listed as FG for door 115.1 and 115.2

4.6 Q: Please confirm whether the interior storefronts are included in our scope per the filed sub-bid. If so, does our scope include furnishing and installing the glass for these interior storefronts?
A: As identified in 08 00 01, Interior storefront is part of **non-FSB**. Furnishing and installing glazing inside storefront system is part of non-FSB scope.

4.7 Q: No exterior storefronts were identified. Please confirm that all storefront systems are limited to the interior of the building.
A: Confirmed.

4.8 Q: No specification is provided for the interior storefront systems, and the details indicate a heavy-duty thermal frame, which may not be required. Please confirm if a non-thermal framing system with 1/2" or 1/4" glass is acceptable.
A: See section 08 41 13 for interior storefronts and entrance doors.

4.9 Q: Specifications for framing systems FP-01 and FP-02 are not identified. We are assuming these are fire-rated storefront systems; however, additional information is required to provide accurate pricing.
A: FP-01 and FP-02 are 1 hour rated interior storefront (with fire rated glazing).

4.10 Q: Aluminum doors 113.2, 121a.3, and 226.1 do not have hardware sets identified. At this time, hardware set 6 has been assumed—please confirm if this is correct.
A: See Updated A62-01 for hardware designation

4.11 Q: Door Type H is not listed on the door schedule. Please confirm whether Door Type FG is to be used in lieu of Type H
A: See updated A62-01 for designation.

4.12 Q: Some curtain wall locations do not have corresponding details, which creates uncertainty regarding whether fin caps and stool trim are required, as they are on other curtain wall systems. Without complete details for these assemblies, it is extremely difficult to provide accurate pricing.
A: All CW to have perimeter fin caps and stool trims, unless shown otherwise.

4.13 Q: Curtain wall details (such as Detail 1/A32-12) show silicone sheets extending deep into the brick cavity. This installation sequence would require the sheets to be installed well in advance of the curtain wall framing, which could result in damage due to prolonged exposure. Please confirm whether a revision to the silicone sheet detail is anticipated or if installation of these sheets will be performed by the carpenter during rough opening preparation.
A: Provide as shown in detail.

4.14 Q: Detail 3/A32-12 shows metal panels on the elevations; however, the section detail indicates spandrel glass with back pans. Please confirm which condition is required. Additionally, the bottom of the curtain wall shows a back pan with insulation, while the top does not. We are assuming the top condition would also require a back pan with insulation—please confirm.
A: Backpan with insulation to be provided above the louvers. See updated drawings.

4.15 Q: Drawings C3.01. AD-6 and the attached perforated drain line do not connect to site drainage. Please confirm this in the intent.
A: There is no invert IN to AD-6. The invert OUT of AD-6 is 470.0, which is the connection to the 6" perforated PVC underdrain. The underdrain is daylighted, as noted on the plans.

4.16 Q: Drawing A42-01. Is there a waterproofing detail for the Elevator pit?
A: See updated drawing A42-01

4.17 Q: Drawing C2.01. Is there a positive limiting barrier detail at the generator and underground fuel tank? (spill protection)
A: Generator does not require spill protection in concrete pad. The fill port for the underground fuel tank has a built in secondary containment as part of the product, and spill protection in concrete pad is not necessary.

4.18 Q: Are the permit fees waived for plumbing for this project
A: See Addendum #4 for response

4.19 Q: Specification 221316.3.2.12.E – Will service weight hub & spigot cast iron piping with resilient gaskets be acceptable?
A: Service weight hub & spigot cast iron piping that meets ASTM A 74, marked with CISPI collective trademark and be listed by NSF International with resilient gaskets meeting ASTM C 564 rubber are acceptable.

4.20 Q: Specification 221413-3.14.C - Will service weight hub & spigot cast iron piping with resilient gaskets be acceptable?
A: Service weight hub & spigot cast iron piping that meets ASTM A 74, marked with CISPI collective trademark and be listed by NSF International with resilient gaskets meeting ASTM C 564 rubber are acceptable.

4.21 Q: Drawing P04.00 (GL 1/A.1) – This GD-2 drain fixture is not listed on the plumbing schedule sheet P01.01. Please provide a schedule for this GF-2 drain fixture.
A: GD-2 is scheduled as "AD-1", see updated drawing.

4.22 Q: We noted the following sections in the specifications:
Section 099640 – Fire-Retardant Coatings
Section 099656 – Epoxy Wall Coatings
Section 099713 – Insulating Steel Coatings
Could you please confirm whether these three sections are intended to be included under the painting bid scope, or if they are to be bid separately under their own specification sections?
We reviewed the painting specifications and were unable to locate these sections referenced there, so we want to ensure our bid reflects the correct scope of work.
A: 099640: this is part of division 6, not for painting.
09 96 56 : is non-trade.
09 97 13: Insulating coat is by painter FSB.

4.23 Q: Drawing M08.02 - We are trying to find out who is responsible (supplying/building) for the concrete pad underneath the fuel oil tank. Also, is there a detail for that specific pad? The standard roof application pad is all that we saw going through the plans.
A: Concrete for fuel tank is to be provided by CIP Concrete trade – non-FSB. The fuel oil tank is located underground. See updated drawings.

4.24 Q: Drawing M08.05 - See page M08.05 Detail 2 > Please clarify if the HVAC FSB is responsible for the noted insulation on that detail.
Can A VRF schematic be released because it would be easier to identify accurately the refrigerant sizes. Single line for VRF systems is preferable and more accurate.
Confirm that the only BMS allowed is Alerton – BACtalk as specified and no substitutions will be allowed
A: Radiant floor insulation is to be provided by CIP Concrete trade – non-FSB.
VRF schematic is provided in this addendum.
The BMS must align with City of Worcester standard, the Alterton BACtalk.

4.25 Q:Specification 233433 - Please release specification 233433 “Listed Kitchen Ventilation System Exhaust Ducts” – it is referred to on Metal Ducts 233113-20 paragraph 3.13 Duct Schedule B.3 Kitchen Exhaust Ductwork. Is zero clearance factory manufactured duct acceptable, if so please confirm it won’t need additional insulation.
A: Specification 233433 "Listed Kitchen Ventilation System Exhaust Ducts" is included in this addendum.

4.26 Q: Specification 077100-5 - Please refer to Page 077100-5 Paragraphs 2.7/A/2/b and 2.8/B/1. Is the architect's sample a standard or custom color? It makes a big difference in cost.
A: All extrerior breakmetal are to match PPG - Café Noir

4.27 Q: Please confirm if all concrete pads under any mechanical equipment, are owned by the concrete subcontractor.
A: Confirmed.

4.28 Q: N.B. KENNEY COMPANY, INC. HVAC RFI #1
Please advise who filling owns filling the fuel oil tank for testing purposes?
Who owns the final fill of the fuel oil tank ?
A: HVAC trade contractor to provide filling of fuel tank for testing purposes and one final fill before occupancy.

4.29 Q: N.B. KENNEY COMPANY, INC. HVAC RFI #2
Will 1" insulated linesets be acceptable for refrigeration piping from the branch controller to the indoor unit ?
A: 1" insulated lineset is not acceptable. Please refer to piping plans and specification 230719 for refrigerant piping size and insulation.

4.30 Q: N.B. KENNEY COMPANY, INC. HVAC RFI #3
Will Vacuum Cleaning New Ductwork be required, or will the HVAC Contractor only have to comply with SMACNA's "Duct Cleanliness for New Construction Guidelines; Advanced Cleanliness Level." Seal duct ends immediately after factory-fabrication is complete.
A: Please see specification 233113 section 3.10.D for Duct System Cleanliness tests and 3.11 Duct cleaning.

4.31 Q: N.B. KENNEY COMPANY, INC. HVAC RFI #4
Is the MBE/WBE/VBE subcontractor requirements for this project goals and best efforts or are these requirements mandatory?
A: Refer to section 00 17 00

4.32 Q: Drawing M03.02 - N.B. KENNEY COMPANY, INC. HVAC RFI #5 Mechanical Plan M03.02.
Can you please confirm what piping is to be double wall containment piping for the fuel oil system ?
A: Please see specification 231113 for double-containment piping schedule.

4.33 Q: HVAC - CM Supplemental scope # 10 has the permanent heating system to be up and running for temp heat by January 2027
a. Phase 3 on the Milestone schedule has the rough in starting on 11/29/2026 – this does not allow enough time to get the systems up and running for January 2027
A: Permanent heat is not required by January 2027. Temporary heating for the 26/27 winter season will be handled by the CM

4.34 Q: Will line sets be acceptable from the BS box to the fan coil units?
A: Line set is acceptable from BS Box to FCU

4.35 Q: Will CPVC be acceptable for the condensate drains?
A: CPVC is acceptable for condensate drain piping.

4.36 Q: Will the refrigerant piping from the ACCU's into the building to be underground and up through slab as shown? Or will it come through the side wall?
A: Refrigerant piping from the ACCU shall be installed underground and up through slab into the building as shown.

4.37 Q: Alternate #1 concerns a PV system. Under the base bid, it appears that the roofer would flash that one 3" conduit. Is there any work for the roofer to be included in Alternate #1? The provided information is very limited. We can't tell if this system is on ballasted racks, mounted on steel posts, or some other system. Please clarify.
A: Roofer owns flashing for all roof penetrations, including PV systems. Provide 500 attachment points for PV systems in base bid.

4.38 Q: Drawing S50-00 - Please reference detail 5/S50-00. Are relieving angles not attached to structural being provided by the structural steel sub-contractor.
A: ALL Relieving angles system are to be provided and installed by structural steel.

4.39 Q: Drawing A41-02 - Please reference detail 4/A41-50. The detail is designated "HR-01-Typical Handrail Detail" and it indicates the wall rail is painted steel. The offset rails at stair guardrails (ref. 4/A41-01 & 3/A41-50) are indicated be stainless steel. I would think that the wall rails & offset rails would be the same materials. Please clarify.
A: See updated drawings for clarifications of HR-01 finish.

4.40 Q: Drawing A41-02 - Please reference detail 3/A41-02 and details 4 & 5/A41-03. The referenced details indicate guardrails at the wall side of the stairs (where typically a wall rail is sufficient). Is it the designers intent to have guardrails at the wall side of the stairs? Please clarify.
A: See updated drawings for clarifications of HR-01 and GR-01 locations.

4.41 Q: In our review of the drawings and specifications, we have found the following discrepancies in the bidding documents:
1) The PV System size needs to be determined for an equal playing field.
A: PV system size to be determined by PV contractor. Refer to specification 26 31 20 section 1.5 "DESCRIPTION OF WORK." Contractor shall provide plan layout, equipment elevations, wiring diagrams, calculations, and equipment identification for the selected equipment. Provided design drawings are intended to demonstrate the typical installation expected for the basis of design equipment, with final design to be provided by the installer for the equipment selected and approved for installation. The design documentation shall include, but not be limited to, design drawings showing PV module layout, all AC and DC wiring associated with the system, conduit layout, details of equipment layout, equipment selection, and specifications. Also refer to section 1.15

"WARRANTY." PV system output shall be guaranteed based on the contractor's final design. Contractor shall test and verify PV output matches contractor final design drawings upon completion of the PV system installation.

4.42 Q: 2) PV Racking System needs to be specified (self=ballasted or directly attached, or both) and confirmed that the structural engineer has reviewed the loading.
A: PV racking system type to be determined by PV contractor. Refer to specification 26 31 20 section 1.9 "DESIGN CONSIDERATIONS." Ensure PV system mounting type (ballasted, rail, etc.) is coordinated with project structural engineer and architect at all building interfaces, as applicable. PV system shall conform to structural design criteria, including max point loading and max system loading for the roof structure, as detailed on structural drawing S11-03.

4.43 Q: 3) All PV engineering should be provided by the Design Team, not the electrical contractor.
A: PV system design to be provided by PV contractor. Refer to specification 26 31 20 section "DESCRIPTION OF WORK." Electrical Contractor shall provide complete design, provision, installation, commissioning, and testing for a new Panel Photovoltaic (PV), grid-tied, structurally mounted system.

4.44 Q: 4) Lighting control diagrams on E03. I0 show both wired and wireless wall switches and occupancy sensors. Please confirm that wireless devices will be allowed throughout the building for the Lighting Control system.
A: Wireless wall switches and occupancy sensors shall be provided in the following locations only:
1. Day Room 222
2. Kitchen/Dining 226

4.45 Q: 5) Due to the size and complexity of this project, we respectfully request a one week extension of the bid date.
Wayne J. Griffin Electric, Inc. requests that you advise us in writing by issuing an addendum to clarify these issues. A timely response will ensure an accurate and complete bid.
A: See addendum #6

4.46 Q: Please reference detail 4/A41.01. Could we get a sectional and or plan view so we can get better idea as to the 1/16 x ¾ x ½ perimeter angle and the 1/16 x ¾ x ¾ steel channel. The present detail is confusing.
A: see updated drawings

4.47 Q: Specification 07 00 00 - Please see the following questions relating to the 070000 WDC FSB, regarding the Worcester South Division Fire Station Project:
1) There appears to be 2 AVB sections, 072720 (not described as a Filed Sub Section) and 072726 (part of the 070000 FSB). Each section has some minor differences in scope. Should both sections be considered part of the div 070000 FSB?
A: 07 27 20 and 07 27 26 should be part of the 07 00 00 FSB scope of work.

4.48 Q: Drawing G02-01 - 2) G02-01 shows sealants at rated partition perimeters labelled as "Sealant", G02-02 shows sealants at rated partition perimeters labelled as "Fire-Resistive joints". Both instances appear to require fire rated sealants, but the way they are labelled may cause confusion to bidders. The term Sealants is frequently used to describe unrated sealants. Please verify that all the joints referred to at rated walls require fire rated sealants.
A: Refer to Section 07 84 43 for all fire resistive joint systems requirements and specifications

4.49 Drawing A32-11 - Q: 3) Details 9 and 12, on A32-11 call for "072726.A1 Vapor Retarding Membrane Air Barrier". All the other Roofing sections (A32-02, etc.) show "075423.D Vapor Barrier"
for the air barrier within the roofing system. Typically for coordination reasons and warranty requirements all Vapor Barrier within the roof system is by the roofing contractor. Please verify if all V.B. under the roofing system is the responsibility of the roofing contractor.
A: All VB under the roofing system are by roofing trade.

4.50 Q: Specification 061643-4 - 4) Section 061643-4, 3.3 describes wall prep and **transition flashing requirements for the Gypsum Sheathing contractor**. The transition flashing requirements for openings are also listed within 07 trade sections. Assigning the 06 trade to correct gaps at sheathing and blocking will result in higher quality construction at the envelope wall sheathing (less gaps at blocking and sheathing deficiencies). This would benefit the AVB and following trades quality and production as well. However, removing the transition flashing requirements from the 06 trade might help with coordination and possible overlapping scope issues.
A: See updated spec for clarification

4.51 Q: Can a FSB bid extension be considered? There are several other projects bidding on the same day and it may be difficult getting engagement from subcontractors and vendors because of this.
A: See addendum #6

4.52 Q: Drawing M05.00 - N.B. KENNEY COMPANY, INC. HVAC RFI #6 M05.00
Can you issue a specification for the sub slab refrigeration piping ?
A: Refer to specification 23 21 13.13 - Underground piping for sub slab refrigerant piping.

4.53 Q: Can you please follow send this RFI regarding occupancy sensors?
1. Control diagrams on M09.02 show occupancy sensors wired to the room VRF unit controller which is provided by the OEM. Occupancy sensors are also shown on the electrical plans as part of the networked lighting system. Are the occupancy sensors for the HVAC controls to be provided in addition to the lighting control system?
A: Confirmed, Occupancy sensors serving the VRFs are to be separate from and in addition to the occupancy sensors serving the lighting control system.

4.54 Q: Can you issue a refrigeration piping tree ?
A: Refrigerant piping diagram is attached in this addendum.

4.55 Q: Spec section 093013 – 2.4.B lists CT1 ceramic wall tile, however this is not listed on the A64-01 Finish Legend and I am also not finding it any where else on the plans. Please advise that CT1 is not used.
Spec Section 090001.1 CM Supplemental Part 2 - #6 states that all required must set floors shall be F&I by Tile Trade contractor. Upon referencing the Structural & A-Series drawings, all depressions at tiled floors are only ½" deep. Please confirm that mudset will not be needed as the tile is roughly 3/8" thick and thinset can be used.
Please confirm that WC rooms 218, 219, 220, 223, & 224 should be similar to elevations for Shower WC 120 as shown on 10/A43-01.
Spec Section 093013 -3.5 interior ceramic tile installation schedule is incomplete. Please confirm that epoxy grout will be needed at all tile installations. Please also confirm that a waterproof/crack membrane shall be used at all floor tile.
A: CT1 - NOT USED.
Thin set is acceptable
Detail 10/43-01 represents similar conditions for bathrooms 218, 219, 220, 223 & 224
See updated spec for further information.

4.56 Q: Spec section 096566 and A64-01 Finish Legend both list RSF2. This can not be located on the finish plans. Please advise that RSF2 is not used.
Spec section 090004.1 CM Supplemental Part 2 - #5 states that all adhesive for resilient flooring shall be for 99% or better. 090003 Spec Refers to Spec 090561.13 Moisture Vapor Emission Control and states to moisture mitigate at all resilient flooring. If we are mitigating, a 99% adhesive would not be required. Please confirm that it is acceptable to eliminate the moisture mitigation if 99% adhesive is available? If the adhesive is not available, we would have to mitigate.
A: See updated A13-01
Moisture mitigation are included as a unit price, see Addendum #4

4.57 Q: A64-01 Finish Legend calls for PNT22 to be bright yellow floor stripes at apparatus bay area. Finish plans do not indicate where these yellow stripes should be located. Please advise.
Please confirm that no base is needed at the following rooms: 100, 100A, 101, 103, 104, 105, 106, 107, 109, 110, 121B, & 121C.
A: See updated A13-01 for PNT22 locations
Confirmed no bases for the rooms in question.

4.58 Q: "Please confirm if Trane (open protocol BACnet) is an acceptable alternate to Alerton Controls."
A: The BMS must align with City of Worcester standard, the Alerton BACtalk.

4.59 Q: Can you please specify what product to carry at the exterior foundation walls of the elevator pit , not details shown in drawings.

A: Elevator pit to have negative side waterproofing.

4.60 Q: Drawing P08.01 - Per drawing 2/P08.01 it calls out to carry waterproofing at the interior of the gas and sand interceptor, but no product shown, can you please specify the product and who owns this scope of work
A: Refer to Plumbing Equipment Schedule on P01.01 for equipment, product shall be installed by the plumbing contractor

4.61 Q: Should we carry rubberized sheet waterproofing at all exterior foundation walls because some column lines (A.1, J, J.1, L, 2, 5, 5.1, 6, 6.1) no details or blowup provided. Please clarify ?
A: Yes. Waterproofing to be provided at all exterior foundation walls.

4.62 Q: Drawing C6.05 - Should we carry rubberized sheet waterproofing at retaining wall on page C6.05. Please specify ?
A: Yes. Waterproofing to be provided at retaining walls.

4.63 Q: CM supplemental scope (Item O) calls for the furnishing & installation of exterior site bollards. Typically, this is a furnish only item for misc. metals trade, installed by the concrete sub-contractor. Please clarify.
A: Furnish only

4.64 Q: CM supplemental scope (Item K) calls for masonry anchorage & clips. Please provide details/examples as we are unable to determine the locations & extent
A: No masonry anchorage & clips required by Misc Metal.

4.65 Q: Can you please clarify if the under-slab sheet vapor barrier is own by Section 03 15 26 or by Section 07 00 00 ?
A: Underslab VB to be provided by Div 03.

4.66 Q: In Section 093013-4 2.4.B.1 calls for CT1 Wall Tile 4”x16” by Best Tile. Where is that located? I cannot find it on the Finish Plans?
A: CT1 - NOT USED

4.67 Q: In Section 093013-5 2.6.A Metal Edge Strips says “nickel silver or stainless steel”. In 2.6.B Metal Edge Protection it says “stainless steel”.
In 2.6.B.1.a-d you have transitions (RENO-U, SCHIENE) as “AE” which is Satin Anodized Aluminum.
Please clarify which material we are to carry in Bids, Aluminum or Stainless Steel?
A: Provide stainless steel metal edge trims unless noted otherwise.

4.68 Q: In Section 093013-5 2.6.A.2 Metal Edge Strips says “Quadec and Schiene” for edge protection.
In 2.6.B.1.e Edge Protection it says “Jolly” at outside corners. Details 4 & 5 on A52-00 shows what looks like “Jolly” edge strips.
Please clarify which edge Strips to use on Wall Tile edges?

A: Provide Jolly for edge protection and outside corners.

4.69 Q: Drawing A43-01 - Details 2 & 9 on A43-01 show a "Schluter Soap Niche Model:" in the Pre-Fab Solid Surface SS2 Shower Stalls.
We are assuming these are part of the SS2 Shower Stall. Please confirm not part of the Tile Sub-Bid as it is not specified in 093013.
A: See updated A43-01

4.70 Q: There are no Elevations of the Walls in ADA WC 218, 219, 220, 223, 224 and District Chief Bath 214C.
We are assuming they are similar to Elevations 6 thru 10 on A43-01 with SS2 Shower Stalls and full height Tile outside the Showers down to Floor Tile, please confirm.
A: Detail 10/43-01 represents similar conditions for bathrooms 218, 219, 220, 223 & 224

4.71 Q: In section 093013-10 3.5 Installation Schedule, there is none for the Floor Tile. We have a ½" depression at rooms on 2nd floor.
We are assuming Floor Tile is Thin-Set with Epoxy Grout. Please confirm.
A: Thin set is acceptable

4.72 Q: There is no Waterproofing specified in 093013. Please confirm No Waterproofing floors at second level Tile floors.
A: Moisture mitigation are included as a unit price, see Addendum #4

4.73 Q: We respectfully request an Extension to the Filed Sub-Bids for 1 week please?
A: See addendum #6

4.74 Q: Can you confirm that section 07 27 20 air barrier sheet membrane should be used on CMU backup wall and section 07 27 26 fluid air barrier on other backup wall ?
A: As indicated in drawings, fluid applied air barrier are to be use at CMU back up wall.

4.75 Q: On section 07 27 26 fluid-applied air barrier membrane scope of work includes : high-build air barriers, vapor retarding and high-build air barriers, vapor permeable. Drawings only shows vapor retarding product at walls. Can you please specify where to use the high-build air barriers vapor permeable ?
A: See drawings for locations of fluid applied air barriers.

4.76 Q: 113- Exercise- Finishes Plan doesn't have finish Tag for this room please confirm this room received Resilient Athletic Flooring and Rubber base.
A: See updated A13-01

4.77 Q: Section 096536- Static Control Resilient Flooring part of Resilient Floors filed sub-bid however finish drawings or finish legend not call for Static Control Resilient Flooring, please confirm Static Control Flooring not used in this job.
A: See updated A13-01 and A64-01.

4.78 Q: Please provide locations for Static Control resilient flooring If Static control resilient flooring part of resilient floors filed sub-bid and also provide basis of design for Static control resilient flooring.
A: See previous response

4.79 Q: Section 096566-1.1.2.A.2. call for Border tile, floor pattern ,seam locations and Game line and marker paint however section 096566-2-2.1 call for Interlocking Tile, please confirm room 113 received Interlocking tile with one color and Adhesive , Game-line paint are not needed.
A: Room 113 are to receive interlocking tile with one color. No game-line paint are needed.

4.80 Q: Please provide more information regarding the T&G roof decking(i.e., product specs and manufacturer/supplier
A: See Drawings and Section 06 10 00 for product specifications.

List of Attachments

1. Section 04 43 13.13
2. Section 06 16 43
3. Section 08 44 13
4. Section 09 30 13
5. Section 22 13 16
6. Section 22 14 13
7. Section 23 09 23
8. Section 23 35 33
9. Drawing A11-01
10. Drawing A13-01
11. Drawing A13-02
12. Drawing A20-01
13. Drawing A32-13
14. Drawing A34-01
15. Drawing A41-01
16. Drawing A41-02
17. Drawing A41-03
18. Drawing A41-50
19. Drawing A43-01
20. Drawing A62-01
21. Drawing A64-01
22. Drawing P04.00
23. Drawing M03.02
24. Drawing M03.03
25. Drawing M03.04
26. Drawing M09.00
27. Drawing E01.01
28. Drawing E03.00
29. Drawing E03.10
30. Drawing E04.01
31. Drawing E04.02

32. Drawing E09.01

END OF ADDENDUM NUMBER 7

SECTION 04 43 13.13

ANCHORED STONE MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Stone masonry anchored to concrete backup.
2. Stone masonry anchored to unit masonry backup.
3. Stone masonry anchored to cold-formed metal framing and sheathing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [Project site] .

1.3 ACTION SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and manufactured product.

B. Samples for Verification:
1. For each stone type indicated. Include at least ~~[two] [three] [four]~~ five Samples in each set and show the full range of color and other visual characteristics in completed Work.
2. For each color of mortar required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, supply sources, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.
1. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents contained in mockups unless Architect approves such deviations in writing.

C. Material Test Reports:
1. Stone Test Reports: For ~~[~~each~~]~~ stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous three ~~[five]~~ years.

2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.

B. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Protect accepted mockups from the elements with weather-resistant membrane.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for staining, compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 079200 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.

D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.

B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
1. Protect base of walls from rain-splashed mud and mortar splatter using coverings spread on the ground and over the wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1.9 COORDINATION

A. Advise installers of adjacent Work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.

B. Coordinate locations of dovetail slots installed in concrete that are to receive stone anchors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Stone: Obtain each variety of stone, from single quarry, whether specified in this Section or in another Section of the Specifications, with resources to provide materials of consistent quality in appearance and physical properties.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.

2.2 GRANITE

A. Material Standard: Comply with ASTM C615/C615M.

B. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
   1. Cambria Black, Flamed finish

2.3 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.
   1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in stone masonry mortar.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Davis Colors.
      b. Lanxess Corporation.
      c. Solomon Colors Inc.

D. Aggregate: ASTM C144 and as follows:
   1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   2. White Aggregates: Natural white sand or ground white stone.
   3. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
      a. Match Architect's sample.

E. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
      b. GCP Applied Technologies Inc.
      c. Sonneborn Products.

F. Water: Potable.

2.4 STONE ANCHORS

A. Stone Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Canaren Inc.
      b. Heckmann Building Products, Inc.
      c. Hohmann & Barnard, Inc.
      d. Meadow Burke.

B. Materials: Fabricate anchors from stainless steel, ASTM A240/A240M or ASTM A666, Type 304. Fabricate dowels from stainless steel, ASTM A276, Type 304.

C. Fasteners for Stone Trim Anchors: Annealed stainless steel bolts, nuts, and washers; ASTM F593 (ASTM F738M) for bolts and ASTM F594 (ASTM F836M) for nuts, Alloy Group 1 (A1).

2.5 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing[, where flashing is exposed or partly exposed and where indicated,] complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
   1. Stainless Steel: ASTM A240/A240M, Type 304, 0.016 inch (0.4 mm) thick.
   2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
   3. Fabricate through-wall flashing with drip edge [where] [unless otherwise] indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees[and hemmed].
   4. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees[and hemmed].

B. Flexible Flashing: For flashing unexposed to the exterior, use[one of] the following unless otherwise indicated:
   1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive, rubberized-asphalt compound, bonded to a high-density, cross-laminated, polyethylene film to produce an overall thickness of not less than [0.030 inch (0.76 mm)] [0.040 inch (1.0 mm)].
      a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
         1) Advanced Building Products Inc.
         2) Carlisle Coatings & Waterproofing Inc.
         3) Fiberweb, a brand of Clark/Hammerbeam Corp.

4) GCP Applied Technologies Inc.
5) Heckmann Building Products, Inc.
6) Hohmann & Barnard, Inc.
7) Polyguard Products, Inc.
8) Williams Products, Inc.
9) Wire-Bond.

C. Application: Unless otherwise indicated, use the following:
1. Where flashing is fully concealed, use [metal flashing] [or] [flexible flashing].

D. Solder and Sealants for Sheet Metal Flashings:
1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C920, chemically curing [urethane] [polysulfide] [silicone] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Adhesives, Primers, and Seam Tapes for Flexible Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Weep/Vent Products: Use[one of] the following unless otherwise indicated:
1. Mesh Weep Holes/Vents: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches (50 mm) high by thickness of stone masonry; in color selected from manufacturer's standard.
a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
1) CavClear; a division of Archovations, Inc.
2) Mortar Net Solutions.

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
a. Advanced Building Products Inc.
b. CavClear; a division of Archovations, Inc.
c. Mortar Net Solutions.
2. Provide one of the following configurations:

a. Strips, full depth of cavity and 10 inches (250 mm) wide, with dovetail-shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
b. Strips, not less than [3/4 inch (19 mm)] [1-1/2 inches (38 mm)] thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
c. Sheets or strips full depth of cavity and installed to full height of cavity.
d. Sheets or strips not less than [3/4 inch (19 mm)] [1 inch (25 mm)] thick and installed to full height of cavity with additional strips 4 inches (100 mm) high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from being clogged with mortar.

2.7 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
      b. EaCo Chem, Inc.
      c. Hydroclean; Hydrochemical Techniques, Inc.
      d. PROSOCO, Inc.

2.8 FABRICATION

A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.
   1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   2. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

B. Select stone to produce pieces of thickness, size, and shape indicated, including details on Drawings and pattern specified in "Setting Stone Masonry" Article.

C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.

D. Cut and drill sinkages and holes in stone for anchors and supports.

E. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
   1. Clean sawed backs of stone to remove rust stains and iron particles.

F. Thickness of Stone: Provide thickness indicated, but not less than the following:
   1. Thickness: As indicated.

G. Finish exposed stone faces and edges to comply with requirements indicated for finish and to match approved samples and mockups.
   1. Finish: Thermal finish.

2.9 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride.
   2. Use portland cement-lime mortar unless otherwise indicated.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
   4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Stone Masonry: Comply with ASTM C270, [Proportion] [Property] Specification.
   1. Mortar for Setting Stone: Type N.
   2. Mortar for Pointing Stone: Type N.

D. Pigmented Mortar: Use colored cement product[or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products].
   1. Pigments do not exceed 10 percent of portland cement by weight.
   2. Pigments do not exceed 5 percent of [masonry cement] [or] [mortar cement] by weight.
   3. Mix to match Architect's sample.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.

B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.

C. Examine wall framing, sheathing, and weather-resistant sheathing paper to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.

B. Coat concrete and unit masonry backup with asphalt dampproofing.

C. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION OF STONE MASONRY

A. Perform necessary field cutting and trimming as stone is set.
   1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.

B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.

C. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.

D. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place.

E. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

F. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 1/4 inch (6 mm) at narrowest points or more than 1/2 inch (13 mm) at widest points.

G. Provide sealant joints of widths and at locations indicated.
   1. Keep sealant joints free of mortar and other rigid materials.
   2. Sealant joints are specified in Section 079200 "Joint Sealants."

H. Install metal expansion strips in sealant joints at locations indicated. Build flanges of expansion strips into masonry by embedding in mortar between stone masonry and backup wythe. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.

I. Install embedded flashing and weep holes at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
   1. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of [4 inches (100 mm)] [8 inches (200 mm)] [12 inches (300 mm)] [16 inches (400 mm)], and extend into or through inner wythe to comply with requirements in Section 042000 "Unit Masonry."
   2. At concrete backing, extend flashing through stone masonry, turned up a minimum of 8 inches (200 mm), and insert in reglet.
   3. Install metal drip edges beneath flexible flashing at exterior wall face. Stop flexible flashing 1/2 inch (13 mm) back from exterior wall face and adhere flexible flashing to top of metal drip edge.

J. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
   1. Use mesh weep holes/vents] [aluminum weep holes/vents] [vinyl weep holes/vents to form weep holes.
   2. Space weep holes 24 inches (600 mm) o.c.
   3. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (13 mm in 12 m) or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.

B. Variation from Level: For[bed joints and] lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.

C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet (13 mm in 6 m) or 3/4 inch in 40 feet (19 mm in 12 m) or more.

D. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.

E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.

F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY

A. Anchor stone with stone anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.

B. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.

C. Provide 2-inch (50-mm) cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
   1. Slope beds toward cavity to minimize mortar protrusions into cavity.
   2. Do not attempt to trowel or remove mortar fins protruding into cavity.

3.6 ADJUSTING AND CLEANING

A. Remove and replace stone masonry of the following description:
   1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
   2. Defective joints.
   3. Stone masonry not matching approved samples and mockups.
   4. Stone masonry not complying with other requirements indicated.

B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
   5. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20, Revised II, using job-mixed detergent solution.
   6. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.

3.7 EXCESS MATERIALS AND WASTE

A. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 06 16 43

GYPSUM SHEATHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Gypsum wall sheathing.

B. Sheathing joint and penetration treatment.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review air-barrier and gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and gypsum sheathing.
   2. Refer to Section 05 40 00 - Cold-Formed Metal Framing for additional information.

1.3 SUBMITTALS

A. Action Submittals:
   1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   2. Shop Drawings: Comply with provisions of Section 05 40 00 - Cold-Formed Metal Framing.
      a. Shop Drawings that are required by that Section, indicate exterior sheathing screw fastener spacing to be utilized at interior zones and corner zones of building façade, as required to ensure sheathing installation will withstand negative wind pressures imposed by design wind speeds.

B. Informational Submittals:
   1. Qualification Data: For Installer.
   2. Field quality-control reports, if required.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to set quality standards for materials and execution.
   1. Provide mock-up in accordance with provisions of Section 01 43 39 - Mockup Requirements.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Testing Agency Qualifications (If Required):
1. For testing agency provide inspections that are acceptable to Owner that periodically performs inspections to verify that material are installed correctly.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Fire-Resistance Ratings: Indicated by design designations from UL (FRD) or from the listings of another qualified testing agency.

2.2 GYPSUM SHEATHING

A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
1. Manufacturers:
a. CertainTeed Corporation; GlasRoc.
b. Georgia-Pacific Building Products; Dens-Glass Exterior Sheathing.
c. National Gypsum Company; Gold Bond eXP.
d. United States Gypsum Co.; Securock.
2. Type and Thickness: Regular, 1/2 inch (13 mm) thick and Type X, 5/8 inch where required for fire resistance.
3. Permeance: Not less than 15 perms per ASTM E96/E96M.
4. Size: 48 by 96 inches (1219 by 2438 mm).
5. Mold Growth: 10, per ASTM D3273.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
   1. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, provide one of the following:
      a. Bugle-head screws complying with ASTM C954.
      b. Wafer-head screws complying with ASTM C1513.
   2. Minimum Fastener Head Diameter: Not less than 0.42 inch (10.7 mm), unless larger diameter is required by sheathing manufacturer.

2.4 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sheathing Sealant: Refer to Section 07 27 26 - Fluid-Applied Membrane Air Barriers. Sealant must be approved by Air-Barrier manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. ASTM C1280, unless closer spacing is required in order for sheathing to resist pressures imposed by design wind speeds.

D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to cold-formed metal framing with bugle-head or wafer-head screws, with minimum head diameter of 0.42 inch (10.7 mm) , unless larger diameter is required by sheathing manufacturer.

2. Install panels with a 3/8 inch (9.5 mm) gap where non-load-bearing construction abuts structural elements.
3. Install panels with a 1/4 inch (6.4 mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
   a. Decrease spacing between fasteners where required to ensure sheathing installation will withstand negative wind pressures imposed by design wind speeds, as indicated in Shop Drawings submitted under Section 05 40 00 - Cold-Formed Metal Framing.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
   a. Decrease spacing between fasteners where required to ensure sheathing installation will withstand negative wind pressures imposed by design wind speeds, as indicated in Shop Drawings submitted under Section 05 40 00 - Cold-Formed Metal Framing.

3.3 SHEATHING JOINT-AND-PENETRATION TREATMENT

A. Seal sheathing joints according to “Air-Barrier” manufacturer's written recommendations.
1. Apply sealant on joints and fasteners and trowel flat. Apply sufficient quantity of sealant to completely cover joints and fasteners after troweling, unless directed otherwise by “Air-Barrier” manufacturer’s written instructions. Seal other penetrations and openings.
   a. Utilize primers and tapes as recommended by sealant manufacturer at corners and joints at adjacent substrates.
2. Taping of joints will not be accepted as an alternative or substitute for application of joint sealant.
3. ~~Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip, so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.~~
4. ~~Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.~~

5. ~~Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.~~
6. ~~Seal top of through-wall flashings to sheathing with an additional 6 inch (150 mm) wide, transition strip.~~
7. ~~Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.~~
8. ~~Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.~~

3.4 FIELD QUALITY CONTROL

A. Testing: Owner reserves the right to engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. The following items will be subject to testing and inspecting:
   1. Attachment of sheathing to studs and other supplemental support framing.
   2. Type and size of fasteners.
   3. Spacing of fasteners.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION

SECTION 08 44 13

GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Conventionally glazed aluminum curtain walls.

B. Two-sided, structural-sealant-glazed aluminum curtain walls.

C. Insulated metal spandrel panels.

D. Vent windows.

E. Sun-control.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 SUBMITTALS

A. Action Submittals:
   1. Product Data: For each type of product.
      a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
      a. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
      b. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
         1) Joinery, including concealed welds.
         2) Anchorage.
         3) Expansion provisions.
         4) Glazing.
         5) Flashing and drainage.
         6) Window and door position switches and concealed wiring.
      c. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
   3. Delegated-Design Submittal: Glazed aluminum curtain wall systems, including support framing, connections, and related hardware shall be designed under the direct supervision of a Professional Structural Engineer experienced in the design of the work and licensed in the State of Massachusetts, using performance and design criteria, and requirements specified in this Section.

B. Informational Submittals:
   1. Qualification Data:
      a. For Installer.
      b. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the state in which Project is located.
   2. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.
      a. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
   3. Product Test Reports: For glazed aluminum curtain walls, for tests performed by manufacturer and witnessed by a qualified testing agency.
   4. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
   5. Source quality-control reports.
   6. Field quality-control reports.
   7. Sample Warranties: For special warranties.

C. Closeout Submittals:
   1. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.
   2. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

D. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain wall assemblies.

1.5 MOCKUPS

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Provide mock-up in accordance with provisions of Section 01 43 39
   2. Build mockup of typical wall area as shown on Drawings.
   3. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
   4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Special Assembly Warranty: Manufacturer and Installer agree(s) to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
      c. Deterioration of metals and other materials beyond normal weathering.
      d. Water penetration through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage Professional Structural Engineer licensed in the State of Massachusetts, as defined in Section 01 40 00 - Quality Requirements, to design glazed aluminum curtain walls.

B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:
   1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
      a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
   3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
      a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4-inch (6. 35-mm) for spans greater than 11 feet 8-1/4 inches (3.6 m) or 1/175 times span, for spans less than 11 feet 8-1/4 inches (3.6 m).

E. Structural: Test according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
   1. Fixed Framing and Glass Area:
      a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
   1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
   1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
   2. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

I. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
   1. Design Displacement: As indicated on Drawings.
   2. Test Performance: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.

J. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.
   2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.7 at design displacement and 1.5 times the design displacement.

K. Energy Performance: Certify and label energy performance according to NFRC as follows:
   1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.28, as determined according to NFRC 100.
   2. Thermal Transmittance (U-factor): Vent windows shall have U-factor of not more than 0.32, as determined according to NFRC 100.
   3. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.29 as determined according to NFRC 200.
   4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 65 as determined according to NFRC 500.

L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
   2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

M. Structural-Sealant Joints:
1. Designed to carry gravity loads of glazing.
2. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).

N. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 MANUFACTURERS

A. Arcadia, Inc.

B. Kawneer North America.

C. Oldcastle BuildingEnvelope.

D. Shuco US LP.

E. United States Aluminum.

F. YKK AP America Inc.

G. Basis of Design Products:
1. Oldcastle:
a. Reliance HTC 2-1/2” x 7-1/4” Curtainwall (with a System U-Value = 0.269)
b. Reliance HTC 2-1/2” X 10” Curtainwall (with a System U-Value = 0.27)
c. TCR-225 2-1/4” X 5” Window Wall, using SSG Mullions (available details provided show system use with 1-inch IGU’s, but it can accept 1-3/4”) (with a System U-Value = 0.279)
d. WS-500 TC Wide Stile Door (with a System U-Value = 0.431)
e. Signature Series 3375 3-3/4” Overall Sightline Casement Window (Not Zero-Sightline) (with a System U-Value = 0.32)

H. Source Limitations: Obtain all components of curtain wall system, including framing, entrances and accessories from single manufacturer.

2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides and Retained mechanically with gaskets on two sides and structural sealant on two sides.
3. Glazing Plane: Front.
4. Finish: High-performance organic finish.
5. Fabrication Method: Either factory- or field-fabricated system.

B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
1. Include snap-on aluminum trim that conceals fasteners.
2. Provied extended trim where indicated.

C. Extruded Aluminum Interior Stools: 0.90 inch thickness, finished to match curtain wall.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

E. Shadow box back pans: Provide 0.090-inch thickness back pans shadow box spandrel areas, both sides of insulation. At fire-rated construction provide steel backpan, instad of aluminum at fire-safing.
1. Color: As selected by Architect from Manufacturer’s standards.

2.4 INSULATED SPANDREL PANELS

A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
1. Overall Panel Thickness: As indicated.
2. Exterior Skin: Aluminum.
   a. Thickness: Manufacturer's standard for finish and texture indicated.
   b. Finish: Match framing system.
   c. Texture: Smooth.
   d. Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard.
3. Interior Skin: Aluminum.
   a. Thickness: Manufacturer's standard for finish and texture indicated.
   b. Finish: Matching curtain-wall framing.
   c. Texture: Smooth.
   d. Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard.
4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
5. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 or less.

B. Glazing: As specified in Section 08 80 00 "Glazing".

C. Finish: Match adjacent glazed aluminum curtain-wall finish.

2.5 ENTRANCES

A. Entrances: Comply with Section 08 41 13 - Aluminum-Framed Entrances And Storefronts.

2.6 VENT WINDOWS

A. Project out casement.

B. Minimum Performance Class: AW.

C. Minimum Performance Grade: 50.

D. Energy Performance: Certify and label energy performance according to NFRC as follows:
   1. Thermal Transmittance (U-factor): Operable whole-window U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) as determined according to NFRC 100.
   2. SHGC: Operable whole-window SHGC of no greater than 0.40 as determined according to NFRC 200.
   3. Condensation Resistance: Operable whole-window NFRC-certified condensation resistance rating of no less than 55 as determined according to NFRC 500.

E. Window Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, or bronze; including the following:

F. Glazing: Same as adjacent glazed aluminum curtain-wall glazing.

G. Finish: Match curtain wall framing.

2.7 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
   1. Type and Location: Full, inside for project-out sashes.

B. Aluminum Frames: Complying with SMA 1004 or SMA 1201.

C. Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.
   1. Mesh Color: Manufacturer's standard.

2.8 LOUVERS

A. See Section 08 91 21 - Wind-Driven Rain-Resistant Louvers.

2.9 SUN CONTROL

A. Sunshades: Assemblies consisting of manufacturer's standard or custom outrigger brackets, designed for attachment to curtain wall with mechanical fasteners.

1. Orientation: Vertical.
2. Projection from Wall: As indicated on Drawings.
3. Perforated aluminum plate fins:
   a. Thickness: 3/8 inch, unl;ess otherwise indicated.
   b. Perforation pattern: As indicated on the Drawings, or if not indicated, as selected by the Architect, with 1-inch perimeter margine.
4. Finish: Match adjacent glazed aluminum curtain wall.

2.10 GLAZING

A. Glazing: Comply with Section 08 80 00 - Glazing.

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: Comply with Section 08 80 00 - Glazing.
   1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less.
   2. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Structural Glazing Sealants: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
   1. Color: As selected by Architect from manufacturer's full range of colors.

E. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
   1. Color: Match structural sealant.

2.11 MATERIALS

A. Sheet and Plate: ASTM B209 (ASTM B209M).

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).

C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.

D. Structural Profiles: ASTM B308/B308M.

E. Steel Reinforcement:
   1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
   2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.12 ALUMINUM TRIM ACCESSORIES

A. Formed Closures Trim Pieces:
1. ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance requirements.
   a. Jambs / Brake Metal Closures.
      1) Thickness: 0.090 inches (2.38 mm).
      2) Finish: Matching framing system.
      3) Texture: Smooth.
   b. Interior trim at abutting partitions:
      1) Thickness: 0.090 inches (2.38 mm).
      2) Finish: Matching framing system.
      3) Texture: Smooth.
   c. Sills:
      1) Thickness: 0.090 inches
      2) Finish: Matching framing system.
      3) Texture: Smooth.
      4) Joint backing plate: Aluminum 0.040 inches thickness.
      5) Joint seal: Pre-cured silicone membrane.
      6) Keeper: Continuous; Aluminum 0.040 inches thickness.
      7) Dimensions: As indicated.

B. Extruded Aluminum Closures Trim Pieces:
1. ASTM B 221 (ASTM B 221M), alloy as standard with manufacturer for finish required, with temper as required to suit extruded operations and performance requirements.
   a. Interior Window Stools:
      1) Thickness: 0.090 inches (2.38 mm).
      2) Finish: Matching framing system.
      3) Texture: Smooth.
      4) End caps: To match stools.
   b. Interior Grille Stools:
      1) Thickness: 0.090 inches.
      2) Finish: Matching framing system.
      3) Texture: Smooth.
      4) End caps: To match stools.
   c. Corner bar at structural glazed corners:
      1) Thickness: 1-inch square bar
      2) Finish: Anodized.
      3) Color: Black.

2.13 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from 300 series stainless steel.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

C. Concealed Flashing: Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.

D. Wall Jamb Closure: 'F' – shaped, 0.125-inch- (3.175-mm-) thick by 4-inches long (100-mm) aluminum jamb closure designed to install in mullion glazing pocket.

E. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.14 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from exterior.
   6. Provisions for safety railings mounted on interior face of mullions.
   7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   8. Components curved to indicated radii.

D. Fabricate components to resist water penetration as follows:
   1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.

F. Factory-Assembled Frame Units:
1. Rigidly secure nonmovement joints.
2. Prepare surfaces that are in contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
3. Preparation includes, but is not limited to, cleaning and priming surfaces.
4. Seal joints watertight unless otherwise indicated.
5. Install glazing to comply with requirements in Section 08 80 00 - Glazing.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.15 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: ~~As selected by Architect from manufacturer's full range~~.
a. Match PPG Cafe Noir, with low gloss clear topcoat

2.16 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify locations possition switches and concealed witing connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:
1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
7. Seal joints watertight unless otherwise indicated.
8. Coordinate with _____for installation of possition switches and concealed wiring.

B. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

D. Install components plumb and true in alignment with established lines and grades.

3.4 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 08 80 00 - Glazing.
1. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.5 INSTALLATION OF WEATHERSEAL SEALANT

A. Install weatherseal sealant according to Section 07 92 00 - Joint Sealants and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.6 ERECTION TOLERANCES

A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).

2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
3. Alignment:
   a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
   b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
   c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Test Area: Perform tests on one bay at least 30 feet (9.1 m), by one story.

C. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.
   1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
      a. Perform a minimum of two tests in areas as directed by Architect.
      b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
   2. Air Infiltration: ASTM E 783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
      a. Perform a minimum of two tests in areas as directed by Architect.
      b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
   3. Water Penetration: ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.

D. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
   1. Test a minimum of two areas on each building facade.
   2. Repair installation areas damaged by testing.

E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 09 30 13

TILING

(PART OF TRADE-BID SECTION 09 00 01 - TILING)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Ceramic tile.

B. Porcelain tile.

C. Stone thresholds.

D. Waterproof / Crack isolation membrane.

E. Edge Protection / Metal edge strips.

1.2 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1a, ANSI A108.1b, ANSI A108.1c, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."

C. ISO 13007-2 Standards for Ceramic Tile Grouts and Adhesives.

D. Module Size: Actual tile size plus joint width indicated.

E. Face Size: Actual tile size, excluding spacer lugs.

1.3 SUBMITTALS

A. Action Submittals:
   1. Product Data: For each type of product.
   2. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
   3. Samples:
      a. Full-size units of each type and composition of tile and for each color and finish required.

b. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches (300 mm) square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
c. Stone thresholds in 6-inch (150-mm) lengths.
d. Metal edge strips in 6-inch (150-mm) lengths.

B. Informational Submittals:
1. Qualification Data: For Installer.
2. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
3. Product Certificates: For each type of product.
4. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

C. Maintenance Material Submittals:
1. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
a. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent or 2 cases, whichever is less of amount installed for each type, composition, color, pattern, and size indicated.
b. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer having a minimum of 5 years of experience on projects of comparable size and scope who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of each type of floor tile installation.
2. Build mockup of each type of wall tile installation.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dynamic Coefficient of Friction: For tiles installed on walkway surfaces, provide products with the followings values as determined by testing identical products per ANSI A137.1:
   1. Level Surfaces: Minimum > 0.42

2.2 MANUFACTURERS

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
   1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
   2. Obtain waterproofing membrane and waterproofing/crack isolation membrane , except for sheet products, from manufacturer of setting and grouting materials.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
   1. Stone thresholds.
   2. Waterproof membrane.
   3. Waterproofing / crack isolation membrane.
   4. Metal edge strips.

2.3 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
   1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.4 TILE PRODUCTS

A. Manufacturers:
   1. American Olean Tile Company.
   2. Dal-Tile Corporation.
   3. Global Tile Design.
   4. Stone Source.
   5. Tile Bar.
   6. Creative Materials Corporation
   7. Best Tile

B. Basis of Design Products:
   1. CT1 CERAMIC TILE- WALL (4"x16") BEST TILE VILLA HIJAU, GREEN, 4"X16"
   2. CT2 CERAMIC TILE- FLOOR (12"x24") CREATIVE MATERIALS CORP. HYANNIS ANTRACITE MATTE RECTIFIED, 12"X24"
   3. CT3 CERAMIC TILE- WALL (3"x12") CREATIVE MATERIALS CORP. METROPOLIS SUBWAY, WHITE GLOSSY, 3"X12"
   4. CT4 CERAMIC TILE- WALL (2"x6.5") BEST TILE WELLFLEET, EUCALYPTUS GLOSSY, 2"X6.5"

C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
   1. Provide as indicated in Interior Finish Legend, unless otherwise indicated.

D. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:
   1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
   2. Shapes: As follows, selected from manufacturer's standard shapes:
      a. Base for Thin-Set Mortar Installations: Straight.

b. Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose.
c. External Corners for Thin-Set Mortar Installations: Surface bullnose.
d. Internal Corners: Field-butted square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

2.5 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
2. Basis of Design Products: Refer to Interior Finish Legend on Drawings.

B. Marble Thresholds: ASTM C503/C503M, with a minimum abrasion resistance of 10 according to ASTM C1353/C1353M or ASTM C 241/C 241M and with honed finish.
1. Description: Uniform, fine- to medium-grained white stone with gray veining.
2. Description: Match Architect's sample.

2.6 EDGE PROTECTION / METAL EDGE STRIPS

A. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; nickel silver or stainless-steel, ASTM A666/A666M, 300 Series exposed-edge material.
1. Manufacturers:
a. Blanke Corporation.
b. Ceramic Tool Company, Inc.
c. Schluter Systems L.P.
2. Basis of Design Manufacturer: Schluter Systems.
a. Profiles:
1) Outside Corner Edge Protection, Tile-to-Tile: QUADEC.
2) Outside Corner Edge Protection, Tile-to-Gypsum Board: SCHIENE.
3) Finishing Edge Protection, Tile-to-Gypsum Board: SCHIENE.

B. Metal Edge Protection: Roll-formed Type 304 stainless steel, height as required to accept scheduled tile thickness.
1. Acceptable Products:
a. Tile-to-Concrete: "RENO-U", Model AEU as manufactured by Schluter Systems in height as required to accommodate scheduled tile and setting bed thickness.
b. Tile to Resilient Flooring: "RENO-U", Model AE as manufactured by Schluter Systems in height required to accommodate scheduled products and setting bed thickness.
c. Tile to Terrazzo: "SCHIENE", Model AE as manufactured by Schluter Systems, in height required to accommodate scheduled products and setting bed thickness.

d. Tile to Carpet: "SCHIENE", Model AE as manufactured by Schluter Systems, in height required to accommodate scheduled products and setting bed thickness.
e. Edge Protection at Wall: "JOLLY" for outside corners as manufactured by Schluter Systems, in size as required to accommodate scheduled tile and setting bed thickness.

2.7 WATERPROOFING / CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and ANSI A118.12 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
1. Manufacturers:
a. Laticrete International, Inc.; Laticrete Hydroban.
b. MAPEI Corporation; Mapelastic AquaDefense.
c. TEC; H.B. Fuller Construction Products Inc.; Hydra Flex Waterproofing Membrane.

2.8 SETTING MATERIALS

A. Modified Dry-Set Cement Mortar (Thinset): ANSI A118.4 and ISO 13007-2.
1. Manufacturers:
a. Wall Applications, non-large format tile:
1) Ardex Engineered Cements, "X5".
2) Custom Building Products, "MegaLite Rapid Set Crack Prevention Mortar."
3) Laticrete International, Inc., "253 Gold."
4) MAPEI Corporation, "Ultraflex 2."
b. Wall Applications, large format tile:
1) Ardex Engineered Cements, "X77".
2) Custom Building Products, "ProLite".
3) Laticrete International, Inc., Laticrete; 255 MultiMax.
4) MAPEI Corporation, "Ultralite Pro".
5) TEC; H.B. Fuller Construction Products Inc. "3N1 Performance Mortar.
2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4 and ISO 13007-2.

B. Medium-Bed, Modified Dry-Set Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 1/4 to 3/4-inch (6 to 19 mm).
1. Manufacturers:
a. Ardex Engineered Cements, "X32".

b. Custom Building Products, "Marble Granite & Travertine Fortified Premium Medium Bed Mortar".
c. Laticrete International, Inc., Laticrete; "4XLT".
d. MAPEI Corporation, "Ultraflex LFT".
e. TEC; H.B. Fuller Construction Products Inc. "Ultimate Large Tile Mortar".

2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.

2.9 GROUT MATERIALS (REFERENCE "TILE INSTALLATION SCHEDULE" AT END OF SECTION)

A. Water-Cleanable Epoxy Grout: ANSI A118.3 and ISO 13007; RG, with a VOC content of 65 g/L or less.
1. Manufacturers:
a. Ardex Engineered Cements, "WA 100 percent solids epoxy grout".
b. Custom Building Products, "100 percent Solids Epoxy Grout" or "Fusion".
c. Laticrete International, Inc., "SpectraLOCK Pro Premium Grout."
d. MAPEI Corporation, "Kerapoxy CQ" or "Flexcolor CQ".
2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F (60 and 100 deg C), respectively, and certified by manufacturer for intended use.

2.10 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
1. Manufacturers:
a. Ardex Engineered Cements, Feather Finish or K15.
b. Laticrete, "L&M Duracrete" or "L&M Durapatch Industrial"
c. MAPEI, "Mapecem Quickpatch."

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
1. Basis of Design Products, Laticrete, "Stonetech Professional Stone & Tile Cleaner".

2.11 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Section 07 92 00 - Joint Sealants.
1. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
2. Colors: Provide colors of exposed sealants to match colors of grout in tile.

2.12 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   2. Verify that concrete substrates for tile floors installed with bonded mortar bed or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
      a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
      b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
   3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
   4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable or self-leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1a and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA (HB) installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
   1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
      a. Exterior tile floors.
      b. Tile floors in wet areas.
      c. Tile swimming pool decks.
      d. Tile floors in laundries.
      e. Tile floors consisting of tiles 8 by 8 inches (200 by 200 mm) or larger.
      f. Tile floors consisting of rib-backed tiles.
   2. Follow procedures in the ANSI A108 Series of tile installation standards for tile layout including but not limited to:
      a. Center and balance areas.
      b. Excess amount of cuts.
      c. Smooth edge cuts.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
   1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
   2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.

3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
1. Wall tile joint maximum 1/8 inch (0.8 mm), adjust to smaller IF the floor calibration allows.
2. Floor tile joint maximum 3/16 inch (2.4 mm), adjust to smaller IF the wall calibration allows.
3. Align joints center to center.

H. At inside corners of tile floors, base and walls, provide sealant joint. Joint width to match specified joint widths. Color of exposed sealant to match color of grout in tile.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in improved modified dry-set mortar (thinset).
2. Do not extend waterproofing/crack isolation membrane under thresholds set in improved modified dry-set mortar. Fill joints between such thresholds and adjoining tile set on waterproofing/crack isolation membrane with elastomeric sealant.

K. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

L. Metal Edge Strips: Install at locations indicated.
1. Install metal edge strips in lengths as long as practical without gaps at seams. Do not use multiple strips where one continuous strip can be installed.

M. Grout Sealer: Apply floor sealer to grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 WATERPROOFING / CRACK ISOLATION MEMBRANE INSTALLATION

A. Install waterproofing / crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproofing / crack isolation membrane to cure before installing tile or setting materials over it.

3.5 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.6 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:
   1. Ceramic Tile Installation F125: TCNA F125-Full; thinset mortar on waterproof / crack isolation membrane.
      a. Ceramic Tile Type: Refer to Interior Finish Legend on Drawings.
      b. Thinset Mortar: Medium-bed, modified dry-set mortar.
      c. Grout: High-performance grout.
      d. Locations: Floors with floor tile over 14 by 14 inches (355 by 355 mm) in size or if one side is over 18-inches (457 mm) long.

B. Interior Wall Installations, Metal Studs or Furring:
   1. Ceramic Tile Installation W248: TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.
      a. Ceramic Tile Type: Refer to Interior Finish Legend on Drawings.
      b. Thinset Mortar: Medium-bed, modified dry-set mortar.
      c. Grout: Water-cleanable epoxy grout.
      d. Locations: Wet areas, wall tile over 14 by 14 inches (355 by 355 mm) in size or if one side is over 18-inches (457 mm) long.
   2. Ceramic Tile Installation W248: TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.
      a. Ceramic Tile Type: Refer to Interior Finish Legend on Drawings.
      b. Thinset Mortar: Modified dry-set mortar.
      c. Grout: Water-cleanable epoxy grout.
      d. Locations: Kitchens, bathrooms or public restrooms.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING AND SPECIALTIES

(Part of Work of Section 22 00 01 – PLUMBING, Trade Bid Required)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.
4. Backwater valves
5. Cleanouts.
6. Floor drains.
7. Trench drains.
8. Channel drainage systems.
9. Air-admittance valves.
10. Roof flashing assemblies.

11. Through-penetration fire-stop assemblies.

12. Miscellaneous sanitary drainage piping specialties.

13. Flashing materials.

14. Solids interceptors.

B. Related Sections:

1. Division 22 Section "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

2. Division 22 Section "Sanitary Sewerage Pumps" for effluent and sewage pumps.

3. Division 22 Section "Facility Storm Drainage Piping and Specialties" for storm drainage piping inside the building, drainage piping specialties and drains.

4. Division 22 Section "Plumbing Fixtures" for hair interceptors.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water

2. Waste, Force-Main Piping: 50 psig

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated Include rated capacities, operating characteristics, and accessories for the following:

1. Gas and Sand interceptors.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that piping, equipment, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit (where applicable): Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. 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.

C. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping and specialty components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

D. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

E. 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.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

1.10 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:

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

a. ANACO-Husky.

b. Clamp-All Corp.

c. Dallas Specialty & Mfg. Co.

d. MIFAB, Inc.

e. Mission Rubber Company; a division of MCP Industries, Inc.

f. Stant.

g. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.

3. Description: Stainless-steel shield with four (4) stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. MG Piping Products Company.

2. Standard: ASTM C 1277.

3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class. Marked with CISPI collective trademark and be listed by NSF International.

B. Gaskets: ASTM C 564 rubber.

~~2.3~~2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

3. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

~~2.4~~2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Unshielded, Non-pressure Transition Couplings:

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

      1) Dallas Specialty & Mfg. Co.

      2) Fernco Inc.

      3) Mission Rubber Company; a division of MCP Industries, Inc.

      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

   b. Standard: ASTM C 1173.

   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

   d. Sleeve Materials:

      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

      2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

      3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:

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

      1) Cascade Waterworks Mfg. Co.

      2) Mission Rubber Company; a division of MCP Industries, Inc.

   b. Standard: ASTM C 1460.

   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.

2) Dresser, Inc.

3) EBAA Iron, Inc.

4) JCM Industries, Inc.

5) Romac Industries, Inc.

6) Smith-Blair, Inc.; a Sensus company.

7) The Ford Meter Box Company, Inc.

8) Viking Johnson.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Manufacturer's standard.

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. Dielectric Unions:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Hart Industries International, Inc.

4) Jomar International Ltd.

5) Matco-Norca, Inc.

6) McDonald, A. Y. Mfg. Co.

7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Pressure Rating: 50 psig.

3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Matco-Norca, Inc.

4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Factory-fabricated, bolted, companion-flange assembly.

3) Pressure Rating: 50 psig.

4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

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

1) Advance Products & Systems, Inc.

2) Calpico, Inc.

3) Central Plastics Company.

4) Pipeline Seal and Insulator, Inc.

b. Description:

1) Non-conducting materials for field assembly of companion flanges.

2) Pressure Rating: 150 psig.

3) Gasket: Neoprene or phenolic.

4) Bolt Sleeves: Phenolic or polyethylene.

5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

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

1) Elster Perfection.

2) Grinnell Mechanical Products.

3) Matco-Norca, Inc.

4) Precision Plumbing Products, Inc.

5) Victaulic Company.

b. Description:

1) Standard: IAPMO PS 66

2) Electroplated steel nipple.

3) Pressure Rating: 300 psig at 225 deg F.

4) End Connections: Male threaded or grooved.

5) Lining: Inert and noncorrosive, propylene.

~~2.5~~2.6 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.

d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.14.1.

3. Size: Same as connected piping.

4. Body: Cast iron.

5. Cover: Cast iron with bolted or threaded access check valve.

6. End Connections: Hub and spigot or hubless.

7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.

8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

~~2.6~~2.7 CLEANOUTS

A. Exposed Metal Cleanouts:

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

g. Josam Company; Blucher-Josam Div.

2. Standard: ASME A112.36.2M for cast iron; ASME A112.3.1 for stainless steel

3. Size: Same as connected drainage piping

4. Body Material: Hubless, cast-iron soil pipe test tee or Stainless-steel tee with side cleanout as required to match connected piping.

5. Closure: Countersunk, brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

7. Closure for Stainless Steel cleanouts: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

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

   a. Josam Company; Josam Div.

   b. Oatey.

   c. Sioux Chief Manufacturing Company, Inc.

   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   e. Tyler Pipe; Wade Div.

   f. Watts Drainage Products Inc.

   g. Zurn Plumbing Products Group; Light Commercial Operation.

   h. Zurn Plumbing Products Group; Specification Drainage Operation.

   i. Josam Company; Josam Div.

   j. Kusel Equipment Co.

   k. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule heavy-duty, adjustable housing cleanout.

3. Size: Same as connected branch.

4. Type: Cast-iron soil pipe with cast-iron ferrule Heavy-duty, adjustable housing.

5. Body or Ferrule: Cast iron.

6. Clamping Device: Required.

7. Outlet Connection: Inside calk or Spigot.

8. Closure: Brass plug with straight threads and gasket, Cast-iron plug.

9. Adjustable Housing Material: Cast iron with threads.

10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.

11. Frame and Cover Shape: Round.

12. Top Loading Classification: Heavy Duty.

13. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

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

   a. Josam Company; Josam Div.

   b. MIFAB, Inc.

   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   d. Tyler Pipe; Wade Div.

   e. Watts Drainage Products Inc.

   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.

3. Size: Same as connected drainage piping.

4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk, drilled-and-threaded, brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

8. Wall Access: Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

~~2.7~~2.8 FLOOR DRAINS

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Provide with trap primer connection

~~2.8~~2.9 TRENCH DRAINS

A. Trench Drains:

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Scheir

e. Tyler Pipe; Wade Div.

f. Watts Drainage Products Inc.

g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3 for trench drains.

3. Material: Ductile or gray iron.

4. Outlet: Bottom or side

5. Grate Material: Stainless steel, heavy duty

~~2.9~~2.10 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company; Elmdor/Stoneman Div.

b. Thaler Metal Industries Ltd.

c. Oatey

B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counter-flashing fitting.

1. Open-Top Vent Cap: Without cap.

2. Low-Silhouette Vent Cap: With vandal-proof vent cap.

3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

~~2.10~~2.11 THROUGH-PENETRATION FIRE-STOP ASSEMBLIES

A. Through-Penetration Fire-stop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. ProSet Systems Inc.

b. 3M

c. Hilti

2. Standard: UL 1479 assembly of sleeve and stack fitting with fire-stopping plug.

3. Size: Same as connected soil, waste, or vent stack.

4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

6. Special Coating: Corrosion resistant on interior of fittings.

~~2.11~~2.12 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.

2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stacks piping.

E. Stack Flashing Fittings:

1. Description: Counter-flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. Size: Same as connected stack vent or vent stack.

G. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.

2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter-flashing.

H. Expansion Joints:

1. Standard: ASME A112.21.2M.

2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.

4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-

sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install steel piping according to applicable plumbing code.

P. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

R. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

S. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

T. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

U. Install force mains at elevations indicated.

V. Plumbing Specialties:

1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."

3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Z. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

AA. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

BB. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.

2. In Drainage Piping: Shielded, non-pressure transition couplings.

3. In Aboveground Force Main Piping: Fitting-type transition couplings.

4. In Underground Force Main Piping:

a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.

b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.

2. Install gate or full-port ball valve for piping NPS 2 and smaller.

3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.

2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.

3. Install backwater valves in accessible locations.

4. Comply with requirements for backwater valve specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.

3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42, clamps.

6. Install individual, straight, horizontal piping runs:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.

2. NPS 3: 60 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.

2. NPS 1-1/2: 108 inches with 3/8-inch rod.

3. NPS 2: 10 feet with 3/8-inch rod.

4. NPS 2-1/2: 11 feet with 1/2-inch rod.

5. NPS 3: 12 feet with 1/2-inch rod.

6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.

8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.

2. NPS 3: 96 inches with 1/2-inch rod.

3. NPS 4: 108 inches with 1/2-inch rod.

4. NPS 6: 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.

2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

3. NPS 2-1/2: 108 inches with 1/2-inch rod.

4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.

5. NPS 6: 10 feet with 5/8-inch rod.

6. NPS 8: 10 feet with 3/4-inch rod.

M. Install supports for vertical copper tubing every 10 feet.

N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 EQUIPMENT/SPECIALTY INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.

b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Assemble and install stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.

H. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

I. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

J. Install fixture air-admittance valves on fixture drain piping.

K. Install stack air-admittance valves at top of stack vent and vent stack piping.

L. Install air-admittance-valve wall boxes recessed in wall.

M. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

N. Install through-penetration fire-stop assemblies in plastic conductors and stacks at floor penetrations.

O. Assemble open drain fittings and install with top of hub 1 inch above floor.

P. Install deep-seal traps on floor drains and other waste outlets, if indicated.

Q. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.

R. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

S. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

T. Install vent caps on each vent pipe passing through roof.

U. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

V. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

W. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

X. Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.

Y. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

Z. Install wood-blocking reinforcement for wall-mounting-type specialties.

AA. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

D. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

4. Install horizontal backwater valves with cleanout cover flush with floor.

5. Comply with requirements for backwater valves, cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

E. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.

2. Sewage Pump: To sewage pump discharge.

F. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

G. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.9 LABELING AND IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Solids interceptors.

C. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL

A. During piping installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.11 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

F. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

2. Galvanized-steel pipe, drainage fittings, and threaded joints.

3. Copper DWV tube, copper drainage fittings, and soldered joints.

4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

2. Galvanized-steel pipe, drainage fittings, and threaded joints.

3. Copper DWV tube, copper drainage fittings, and soldered joints.

   a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

D. Aboveground, vent piping NPS 5 and larger shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

E. Underground, soil, waste, and vent piping shall be any of the following:

1. Service class, cast-iron soil piping; ~~calking materials; and calked joints.~~ gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.

4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

F. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:

1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.

2. Ductile-iron, mechanical-joint piping and mechanical joints.

3. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

END OF SECTION

SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING AND SPECIALTIES

(Part of Work of Section 22 00 01 – PLUMBING, Trade Bid Required)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.
4. Miscellaneous storm drainage piping specialties.
5. Cleanouts.
6. Backwater valves.
7. Through-penetration fire-stop assemblies.
8. Flashing materials.

B. Related Sections:

1. Division 33 Section "Storm Utility Drainage Piping" for storm drainage piping outside the building.
2. Division 22 Section “Sanitary Waste and Vent Piping and Specialties” for floor drains, area drains and all other drainage systems connected to sanitary sewer.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 15-foot head of water. Storm Drainage, Force-Main Piping 100 psig

B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures" and per authority having jurisdiction.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials and specialties shall bear label, stamp, or other markings of specified testing agency.

B. 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.

C. Product Data: For each type of product indicated.

1.7 COORDINATION

A. Coordinate size and location of all roof penetrations.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301. All pipe and fittings shall be marked with CISPI's collective trademark or receive prior approval by the engineer of record.

B. Heavy-Duty, Shielded Cast-Iron, Hubless Piping Couplings:

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

a. MG Piping Products Company.

b. Tyler Pipe

c. MIFAB, Inc.

2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class. Marked with CISPI collective trademark and be listed by NSF International.

B. Gaskets: ASTM C 564 rubber.

~~2.3~~2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.

3. Unshielded, Non-pressure Transition Couplings:

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

      1) Dallas Specialty & Mfg. Co.

      2) Fernco Inc.

      3) Mission Rubber Company; a division of MCP Industries, Inc.

      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

   b. Standard: ASTM C 1173.

   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

   d. Sleeve Materials:

      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

      2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:

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

      1) Cascade Waterworks Mfg. Co.

      2) Mission Rubber Company; a division of MCP Industries, Inc.

      3) Fernco

b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.

2) Dresser, Inc.

3) EBAA Iron, Inc.

4) Ford Meter Box Company, Inc. (The)

5) JCM Industries, Inc.

6) Romac Industries, Inc.

7) Smith-Blair, Inc.; a Sensus company.

8) Viking Johnson; c/o Mueller Co.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Manufacturer's standard.

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. Dielectric Unions:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Hart Industries International, Inc.

4) Jomar International Ltd.

5) Matco-Norca, Inc.

6) McDonald, A. Y. Mfg. Co.

7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Pressure Rating: 150 psig at 180 deg F.

3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Matco-Norca, Inc.

4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Factory-fabricated, bolted, companion-flange assembly.

3) Pressure Rating: 150 psig.

4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

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

1) Advance Products & Systems, Inc.

2) Calpico, Inc.

3) Central Plastics Company.

4) Pipeline Seal and Insulator, Inc.

b. Description:

1) Non-conducting materials for field assembly of companion flanges.

2) Pressure Rating: 150 psig.

3) Gasket: Neoprene or phenolic.

4) Bolt Sleeves: Phenolic or polyethylene.

5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

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

1) Elster Perfection.

2) Grinnell Mechanical Products.

3) Matco-Norca, Inc.

4) Precision Plumbing Products, Inc.

5) Victaulic Company.

b. Description:

1) Electroplated steel nipple complying with ASTM F 1545.

2) Pressure Rating: 300 psig at 225 deg F.

3) End Connections: Male threaded or grooved.

4) Lining: Inert and noncorrosive, propylene.

~~2.4~~2.5 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

D. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

~~2.5~~2.6 CLEANOUTS

A. Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.
   c. MIFAB, Inc.
   d. Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group.
2. Standard: ASME A112.36.2M

3. Size: Same as connected branch.
4. Type: Cast-iron soil pipe with cast-iron ferrule.
5. Body or Ferrule Material: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with set-screws or other device.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

~~2.6~~2.7 THROUGH-PENETRATION FIRE-STOP ASSEMBLIES

A. Through-Penetration Fire-stop Assemblies:

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

   a. ProSet Systems Inc.

   b. 3M

   c. Hilti

   d. Or approved equal

2. Standard: UL 1479 assembly of sleeve and stack fitting with fire-stopping plug.
3. Size: Same as connected pipe.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

~~2.7~~2.8 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Solder: ASTM B 32, lead-free alloy.

F. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90

degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: Slope downward in direction of flow for piping as required by code and per authority having jurisdiction.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

O. Install underground storm drainage piping according to ASTM D 2321.

P. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Storm Drainage Piping Specialties."
2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Storm Drainage Piping Specialties."
3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Storm Drainage Piping Specialties."

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

U. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

V. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

X. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.

Y. Provide insulation on all storm drainage piping and fittings below roof.

3.3 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.4 PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, non-pressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:

a. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
3. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3 : 60 inches with 1/2-inch rod.
2. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
3. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
4. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
5. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet .

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2: 108 inches with 3/8-inch rod.

2. NPS 2: 10 feet with 3/8-inch rod.
3. NPS 2-1/2: 11 feet with 1/2-inch rod.
4. NPS 3: 12 feet with 1/2-inch rod.
5. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
6. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
7. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.9 STORM DRAINAGE SPECIALTY INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 Sections.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 6 inches above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at base of each vertical soil and waste stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install drain-outlet backwater valves in outlet of drains.

J. Install test tees in vertical conductors and near floor.

K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

M. Install through-penetration fire-stop assemblies in plastic conductors at concrete floor penetrations.

N. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

3.10 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.11 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 15-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.12 PIPE CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.13 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.14 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

C. Underground storm drainage piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.

~~1.~~2. Service class, cast-iron soil piping and fittings; gaskets; and gasketed joints.

~~2.~~3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

D. Aboveground storm drainage force mains shall be following:

1. Galvanized-steel pipe, pressure fittings, and threaded joints.
2. Fitting-type transition couplings if dissimilar pipe materials.

E. Underground storm drainage force mains shall be the following:

1. Ductile-iron, mechanical-joint piping and mechanical joints.
2. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

END OF SECTION

SECTION 23 09 23

DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

(Part of Work of Section 23 00 01 – MECHANICAL, Trade Bid Required)

PART 1 - GENERAL

1.1 CONDITIONS & REQUIREMENTS

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

B. All work shall comply with the requirements of the Conditions of the Contract (General and Special), with the Contract Drawings, and with all other contract documents.

C. Any deviations from the requirements of the Contract Documents must be submitted in writing along with bid documents.

1.2 RELATED DOCUMENTS

A. In case there is a discrepancy between this specification and Division 21, Division 22, Division 23, Division 26 and Division 28 specifications and their associated drawings, then the Bidder shall assume the more stringent requirement for his bid.

1.3 SUMMARY

A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

1.4 SCOPE OF WORK

A. Control Contractor shall:

1. Provide installations of controllers and instruments provided by system and device manufacturers for equipment monitoring and control as herein specified. The scope shall include controllers, microprocessor-based controller unit panels, instrumentation, end control devices, wiring, conduit, and related systems integration as follows:
   a. Dedicated Outside Air Units

b. Supply / Exhaust Fans
c. Electric Unit Heaters
d. DX Split Systems
e. Air Handling Units (AHU)
f. Exhaust Fans
g. Roof Mounted Water Tank System
h. Heating Hot Water System
i. Water Meters
j. Programmed Start-Stop of Systems
k. Monitoring and controlling of Space Conditions
l. Alarm Annunciation.

2. Provide a required DDC control system hardware along with sensing devices, control valves, dampers and actuators as specified herein.
3. Provide a complete operational system including all work specified herein, specified in associated specifications for mechanical and electrical work and shown on all contract drawings.
4. The Contractor shall assume all control points referred to in this specification as well as the specifications in Division 23 and Division 26. The contractor is also responsible for all instrumentation and controls shown on the controls drawings, Division 23 and Division 26 drawings.
5. The BMS system shall provide equipment supervision and control, alarm management, energy management, information management, historical data collection and archiving and be capable of integrating multiple building functions.
6. The system shall employ standard networking practices and conventions, co-exist with existing Ethernet networks, and manage system data using generally accepted database storage and retrieval methods and standards.
7. Provide all wiring, raceways and electrical work associated with the BMS. This shall include and to be limited to the following:
   a. Controls wiring and conduit between control panels.
   b. Controls wiring and conduit between control panels and field instrumentation, external equipment control systems
   c. Wiring and conduit for the BMS communication networks.
8. Provide all electrical work associated with the BMS.
9. Provide all wiring in accordance with the latest editions of the local electrical code and the NEC.
10. Divisions 26 to provide dedicated circuits as required, refer to Division 26 drawings for junction box locations. Controls contractor to provide transformers and field terminations.
11. Incorporate surge transient protection into the design of the system to protect the electrical components in all DDC controllers, TECs, panels and workstations.
12. Provide control power transformers for valve actuators, damper actuators and all instruments and devices provided under this contract for low voltage operation.
13. Provide all wells for water monitoring devices, temperature sensors, flow switches and alarms, as required.
14. Furnish control dampers actuators not integral to damper factory assemblies. Furnish damper actuators meeting or exceeding the specifications, listed in the associated sections and located as shown on all drawings. Coordination is

required with Division 23, regarding the installation, final sizing and method of fixing and delivery of the dampers.

15. Provide system graphics for each system. See section herein for requirement.
16. Provide engineering and shop drawings as specified herein.
17. Provide field supervision of the associated elements of work as specified herein.
18. Provide mechanical installation of all control instrumentation etc. as specified herein.
19. Provide testing, calibration and commissioning as specified herein.
20. Provide demonstration of operation and system performance testing as specified herein.
21. Provide as-built drawings as specified herein.
22. Provide Operation and Maintenance manuals as specified herein.
23. Provide Personnel Training as specified herein.
24. Provide attendance and support during the commissioning of the project to Divisions 23 and 26, as required by the coordinated commissioning program.
25. With commencement of the project provide test procedure documents (TPD) describing the testing of all interfaces between the BMS and other systems for approval by the Owner, the Engineer and the Management Contractor.

1.5 DEFINITIONS

A. Explanations of terms utilized in this Specification:

1. Provide: Furnish and install, complete, the specified material, equipment or other item and perform all required labor to make a finished and acceptable installation.
2. Furnish: Purchase, store and deliver the specified material, equipment or other item to the project site complete with all necessary appurtenances, supports, etc.
3. Install: Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.
4. By others: By persons or parties responsible for work at the project other than the party or parties who have been awarded the contract for the work of this trade. In the event that this document is used to acquire work as part of a general construction contract, the words "by others" or "by other trades" shall mean by persons or parties who are not anticipated to be the Contractor for this trade working together with the Construction Manager (CM). In this context, the words "by others" or "by other trades" shall not be interpreted to mean not included in the overall contract.
5. Ductwork: Ductwork, volume dampers, motorized dampers, fire and smoke dampers, diffusers, registers, supports and all other items required for a complete functional system.
6. Piping: Piping, valves, strainers, supports and all other items required for the circulation of water to and from HVAC equipment.
7. Concealed: Embedded in masonry or other construction, installed behind wall furring, within double partitions, above inaccessible ceilings, in crawl spaces, in shafts, etc.
8. Exposed: Not concealed.

1.6 RELATED WORK

A. Related Documents and Sections: Examine Contract Documents for requirements that directly affect or are affected by Work of this Section. A list of those Documents and Sections include, but is not limited to the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 General Requirements Specification Sections, apply to this Section.
2. Other Related Sections:
   a. All Division 21 Equipment Sections
   b. All Division 22 Equipment Sections
   c. All Division 23 Equipment Sections
   d. All Division 26 Equipment Sections
   e. All Division 28 Equipment Sections

1.7 COORDINATION

A. Coordinate work under provisions of Division 1 as applicable.

B. Ensure installation of components is complementary to installation of similar components in other systems.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

D. Contractor to coordinate all BMS integrations, inputs and outputs to systems and equipment with final approved submittals. Integration to devices, controllers and systems requiring special programming, hardware, network switches, gateways and wiring to perform interface or integration shall be provided by the controls contractor. All IP based equipment, including network switches, shall be submitted for review and coordinated with owner’s IT for approval.

E. Ensure system is completed and commissioned.

F. Division 23 - BMS Contractor shall be responsible for all electrical work associated with the BMS control system as detailed below.

1. Perform all wiring in accordance with all local and national codes. Refer to Division 26, Electrical Specifications for areas requiring more stringent installation procedures.
2. Provide 120-volt branch circuits from junction boxes to DDC panels.
3. Provide 120VAC for all instruments, valves, dampers, and control devices requiring 120VAC supply. All work shall be installed in accordance with Division 26.
4. Provide 24-volt power, control and network interface wiring from network DDC controllers and panels to all application specific controllers (VAVs, TECs etc.), local display devices through end control devices, complying with requirements of Division 26.

5. BMS shall monitor fire alarm system control relays responsible for equipment shutdowns and stop normal operations in order to prevent the potential of nuisance alarms during fire related events. Provide BMS internal logic to parallel to fire alarm system smoke shutdown for variable frequency drive and motor starters related to emergencies as well as fire alarm system duct mounted smoke detectors according to local code requirements.
6. Provide transformers, where required, to match control voltage with actuator or sensor voltage.

G. The Division 23, Mechanical Contractor shall provide the following:

1. All openings and pressure taps for water monitoring devices, flow switches, control valves and wells furnished by the BMS Contractor.
2. Installation of all dampers and measuring devices. All control dampers shall be furnished by BMS Contractor where not specified as an integral component of a packaged unit.
3. Furnish and install all access doors.
4. Items furnished by BMS Contractor but installed by Sections of Division 23, Mechanical Contractor:
   a. Flow elements directly installed in the piping or ductwork, such as airflow measuring inlet probes, magmeters, pressure switches and thermowells.
   b. Automatic control valves.
   c. Control dampers.

H. The Division 26, Electrical Contractor shall provide the following.

1. Wiring of power feeds through all disconnects, starters, and to electric motors.
2. Division 26 contractor to provide all line voltage 120 VAC power wiring from electrical panels to junction boxes for the purpose of powering control panels. Junction boxes to be provided by Division 26 and shall be wired in conduit from dedicated circuits. Division 26 shall provide circuit breakers at all electrical panels for use by the BMS contractor.
3. Motor starters and motor feeder
4. If upon Div. 23 contractor's final sizing of control devices it has been determined that the power required for the assembly exceeds the power available from the BMS control panel, the Div.23 contractor shall coordinate with the Div. 26 contractor for additional power.

I. The Division 28, Fire Alarm System Contractor shall provide the following.

1. Wiring of power feeds through all smoke detectors.
2. Smoke detectors shall be furnished by Division 28 and installed by Division 23.
3. All necessary monitored relays and outputs to BMS for the purposes of alarming and smoke control functions and pressurization as required by BMS and described herein and on contract drawings.

1.8 REFERENCE STANDARDS

A. All work shall conform to the following Codes and Standards, where applicable:

1. National Fire Protection Association (NFPA) Standards, as specified.

2. National Electrical Code (NEC) and applicable local Electrical Code.
3. Underwriters' Laboratories (UL) listing and labels, as specified.
4. Factory Mutual (FM).
5. American National Standards Institute (ANSI).
6. National Electric Manufacturers' Association (NEMA).
7. American Society of Mechanical Engineers (ASME).
8. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
9. Air Movement and Control Association (AMCA).
10. Institute of Electrical and Electronic Engineers (IEEE).
11. American Standard Code for Information Interchange (ASCII).
12. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS).
13. Electronics Industries Association (EIA).
14. Occupational Safety and Health Administration (OSHA).
15. American Society for Testing and Materials (ASTM).
16. NFPA 92A and 92B
17. NFPA 101, 2002

1.9 GENERAL PRODUCT DESCRIPTION:

A. The building management system provided and installed shall be a distributed logic control system complete with all software and hardware functions.

1. The controllers shall be direct digital control (DDC) type and based on ANSI/ASHRAE Standard 135, BACnet controlling all mechanical equipment using BTL (BACNET Testing Labs) Certified native BACnet-compliant components.

B. The building management system shall consist of the following:

1. BMS Server (Existing Virtual)
2. Stand-alone DDC Controllers (32 bit processors) provided for each piece of main equipment. The intent of this specification is that the loss of any one DDC controller shall not affect the operation of more than one piece of main equipment while minimizing the impact on other equipment and HVAC systems. It shall only affect the points connected to the failed DDC controller. It is not acceptable that any control loops are split across two or more DDC control panels.
3. Stand-alone Terminal Equipment Controllers (TECs), otherwise referred to as Application-Specific Controllers (ASCs), shall only be used for terminal equipment.
4. One (1) Operator workstation comprises of a laptop serving as the operator's terminal to be connected and communicating simultaneously with the entire BMS. The operator terminal shall be able to monitor, adjust, trend, edit, modify, add, delete, backup the entire BMS system (including Terminal Equipment Controllers, DDC controllers, etc.) point database and all programs, provided the operator has the appropriate password access.

C. The system shall be modular in nature and permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.

D. Controllers shall assign password access and control priorities to either fully assignable point groups or each point individually. The logon password (at PC workstation) shall enable the operator to monitor, adjust and/or control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation. (E.g. all base points shall be accessible to any base building operators, but only electrical points shall be accessible to house electricians). Passwords and priority levels for every point shall be fully programmable and adjustable.

E. The BMS system shall operate with an input voltage rated at 120 Volts, 1 phase, 60 Hertz. All units shall be grounded in accordance with the local Electrical Code and the NEC. All units shall be supplied with filtered power, if required, to preclude noise generation. Signal range shall be 4-20 mA or 0-10 VDC.

F. The BMS shall be programmed to automatically detect critical alarms that require notification, create an action statement for each alarm, and select the person to receive the notification via e-mail or SMS text message. Software shall transmit email via Owner's existing SMTP server. SMS messages shall operate with any mobile phone carrier.

G. The control system shall be a high speed, peer to peer BACnet network of DDC controllers and a web based operator interface. All schedules, setpoints, trends, and alarms shall be BACnet objects.

H. Workstation information access shall be BACnet protocol. Communications shall use ISO 8802-3 (Ethernet) Data Link/ Physical layer protocol.

1.10 SUBMITTALS

A. Submissions Requirements:

1. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
2. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.
3. The following table defines the required submittals and hierarchy for time of submission:

Action Submittals		
Submittal #	**Submittal Name**	**Pre-requisite for Review**
1	Submittal Schedule	None
2	Qualification Data	None
3	Specification Compliance Submittal	1
4	Product Data for DDC system	3
5	Individual sensor/device product data	3
6	BTL listing submittal	3
7	Software submittal	3

8	Valve, Damper, and Actuator Delegated Design	3
9	Shop Drawings	3
10	Interface Control Documents	4
11	System Description	4,5 and 10
12	Sample Package (graphics and visible sensors)	4 and 9
13	Closeout Submittal Package	10, 11, and 12

4. Multiple and large Submissions:
   a. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
   b. In instances when large or multiple submittals are provided with a single submission, the time period for review will be extended and the release of submittals will be coordinated based on contractors' priority for release of equipment. Allow 3 weeks for large submittals.
5. Submit under provisions of Section 01 3300 – SUBMITTAL PROCEDURES and Division 01 as applicable. Shop drawings to be provided in PDF Format.
6. All submittals to be digital and searchable. Scanned submittals are not acceptable.
7. General Contractor comments must be actioned on submittal before submitting to the engineer for review.
8. Submit shop drawings for each system automatically controlled and integrated. The submittals shall be provided with a comprehensive index and each page of the submittal shall be provided with a page number, drawings shall have a drawing / sheet number, date and revision. Revisions of submittals if required shall provide necessary revision clouding of affected areas on all drawings resubmitted. Drawing submittals shall comprise, at a minimum the following information:
9. Prepare Drawings using computer software, and provide digital copies to owner.
10. Scanned drawings are not acceptable.
11. Title page with submittal title, job name and address, date, contract drawing and specification information (i.e. latest bulletin number and date), and BMS contractor project manager name and phone number, at a minimum.
12. Include a drawing index sheet listing each drawing number and title that matches information in each title block. Include plans, elevations, sections, and mounting details where applicable.
13. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
14. Detail means of vibration isolation and show attachments to rotating equipment.

B. Compliance Review

1. Contractors will provide a Compliance Review of the Specifications, Drawings and Addenda (if any). The Compliance Review is a paragraph-by-paragraph (Drawing by Drawing) review of the Specifications and Drawings with the following information, "C", "D" or "E" marked in the margin of the original

Specifications and any subsequent Addenda. Narrative text shall accompany the Drawing Compliance Review.

a. "C": Comply with no exceptions.
b. "D": Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
c. "E": Exception, do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives.
d. Note: Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Bidder is in complete compliance with the plans and Specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the contractor from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review. The Bidder may submit the latest state-of-the-art components in lieu of specified items. The engineer and Owner will review deviations from the Specifications.

C. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:
   a. Loss of power.
   b. Loss of network communication signal.
   c. Loss of controller signals to inputs and outpoints.
   d. Operator workstation failure.
   e. Server failure.
   f. Gateway failure.
   g. Network failure
   h. Controller failure.
   i. Instrument failure.
   j. Control damper and valve actuator failure.
4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

D. Plan Drawings

1. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
2. Room names and numbers with coordinated placement to avoid interference with control products indicated.
3. Each desktop operator workstation, server, gateway, network switches, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.

4. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
5. Network communication cable and raceway routing.
6. Information, drawn to scale.
7. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.

E. Schematic drawings

1. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve.
2. I/O listed in table format showing point name, type of device, manufacturer, model number, point address, and cross-reference to product data sheet number. Table to clearly differentiate between analog and digital, input and output points as well as all serial integration (soft points). An allowance for future point integration shall be made to ensure any points found to be necessary during commissioning and start-up can be added.
3. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
4. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
5. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers. Indicate all required electrical wiring of connected data points, including connected control unit and input device, field control panel layout and locations, and parts list coordinated with power panel locations. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
6. A contractors written sequence of operation for all systems, with specific IO reference by name and number.

F. Control Panel Drawings

1. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
2. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
3. Unique drawing for each panel.

G. System Network Riser Diagram

1. Each device connected to network with unique identification for each.
2. Interconnection of each different network in DDC system.
3. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
4. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

H. Power Riser Diagram:

1. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
2. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
3. Each product requiring power with requirements (volts/phase/ hertz / amperes/ connection type) listed for each.
4. Power wiring type and size, race type, and size for each.
5. Descriptive data and sequence of operation of operating, user, and application software.

I. Valve and Actuator Schedule

1. Valve Schedule and design calculations for control valves, and actuators.
   a. Valve Tag.
   b. Valve Service.
   c. Line Size.
   d. Valve Type.
   e. Valve Size.
   f. Pipe connection style.
   g. Flow (with Units) at Project design and minimum flow conditions.
   h. Pressure-differential drop across valve at Project design flow condition.
   i. Valve authority at design conditions.
   j. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
   k. Design and minimum control valve coefficient with corresponding valve position.
   l. Coil Pressure Drop (approved equipment)
   m. Design Pressure
   n. Maximum close-off pressure.
   o. Leakage flow at maximum system pressure differential.
   p. Torque required at worst case condition for sizing actuator.
   q. Valve model and manufacturer.
   r. Actuator operating voltage.
   s. Actuator position feedback or end switches.
   t. Actuator selection indicating torque provided.
   u. Actuator signal to control damper (on, close or modulate).
   v. Actuator position on loss of power.
   w. Actuator position on loss of control signal.
   x. Actuator model and manufacturer

J. Damper and actuator schedule

1. Schedule and design calculations for control dampers, and actuators.
   a. Flow at Project design and minimum flow conditions.
   b. Pressure-differential drop across damper at Project design flow condition.
   c. Maximum close-off pressure.
   d. Leakage flow at maximum system pressure differential.
   e. Torque required at worst case condition for sizing actuator.
   f. Actuator operating voltage.
   g. Actuator selection indicating torque provided.

h. Actuator signal to control damper (on, close or modulate).
i. Actuator position feedback or end switches.
j. Actuator position on loss of power.
k. Actuator position on loss of control signal.
l. Actuator model and manufacturer

K. Interface Control Documents

1. For each subsystem being integrated into the BAS system (VFDs, lighting controls, chillers, etc.) the contractor shall submit a complete interface control document, coordinated with the approved 3rd party submittals, detailing at a minimum:
   a. Communication type
   b. Connection point
   c. All input and output capability between the two systems
   d. Connection coordination with 3rd party

L. Product Data

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Documentation on submitted BMS controllers that have been tested and listed by the BTL or a letter from manufacturer's indicating the anticipated date by which testing is expected to be complete. If for any reason, BTL testing and listing has not been completed, a written commitment shall be provided to upgrade installed controls to a version that meets BTL testing and listing requirements should deficiencies be found during BTL testing.
5. Installation, operation and maintenance instructions including factors effecting performance.
6. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product. A complete index shall be provided with page numbering included on each product sheet.
   a. Servers.
   b. Workstations.
   c. Gateways.
   d. Network Switches and Routers.
   e. Protocol analyzers.
   f. BMS controllers.
   g. Enclosures.
   h. Electrical power devices.
   i. UPS units.
   j. Accessories.
   k. Instruments.
   l. Control dampers and actuators.

m. Control valves and actuators.

7. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
8. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

M. Software Submittal

1. As part of the submittal package, the contractor shall include a complete copy of specifications, with confirmation of conformance to all specifications. In the case of non-conformance, the contractor shall specifically highlight the specification section of non-conformance.
2. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, network switches and DDC controller.
3. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
4. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
5. Description of operator interface to alphanumeric and graphic programming.
6. Description of each network communication protocol.
7. Description of system database, including all data included in database, database capacity and limitations to expand database.
8. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

N. Samples:

1. For each of the following exposed product, installed in finished space for approval of selection of aesthetic characteristics including all proposed space temperature, humidity, CO2, pressure, and occupancy sensors for review and written approval by owner’s representative.
2. Provide sample of label to be provided for each control device with setting or adjustable range of control for written approval by Owner’s Representative.
3. Provide sample(s) of proposed graphic for review and written approval by Owner’s Representatives. Graphic samples must be included as part of the original shop drawing submittal package for owner and engineer to review.

O. Color graphics

1. Itemized list of color graphic displays to be provided.
2. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
3. Intended operator access between related hierarchical display screens.
4. Graphical interface capability
5. System graphics and inclusive of a master organizational plan.

1.11 CLOSEOUT SUBMITTALS

A. Factory Testing Results

1. Submit for approval test reports from the factory program testing procedures.

B. Final Graphic Submittal

1. Submit for approval final graphic samples of all system types (AHU's,VAV's, energy management, integrated systems, etc.).

C. Sensor Calibration Report

1. Submit for approval, a detailed report of the sensor calibration process. The report shall consist of both testing procedures and testing results. Any sensor that has been factory calibrated shall have the factory calibration report included in the calibration submittal.

D. DDC System I/O Checkout Report

1. Submit for approval, a detailed report highlighting the process and results as described in section, "DDC SYSTEM I/O CHECKOUT PROCEDURES".

E. As-built documentation

1. Submit for approval, as-built versions of shop drawings and product data in electronic PDF format. The as-built drawings, drawings, sequences, and products shall accurately reflect every change made to the system operation since approval of the shop drawings. Accurately record actual location of control components, including panels, thermostats, and sensors

F. System readiness confirmation

1. Submit for approval written confirmation of system readiness for testing as defined in section "Final Review".

G. Validation test report

1. Submit for approval all procedures and results as described in section "DDC System Validation Tests".

H. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
   a. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
   b. As-built versions of submittal Product Data.
   c. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
   d. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports,

trending data, overriding computer control and changing set points and variables.

e. A complete alarm list, with criticality levels, and distribution assignment.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to:
   1) Design and install new points, panels, and other hardware.
   2) Perform preventive maintenance and calibration.
   3) Debug hardware problems.
   4) Repair or replace hardware.
h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Submission of actual programming language used for each system type.
j. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
k. List of recommended spare parts with part numbers and suppliers.
l. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
m. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
n. Licenses, guarantees, and warranty documents.
o. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
p. Owner training materials.

1.12 QUALIFICATIONS / QUALITY ASSURANCE

A. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the Specification requirements.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of DDC control equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 10 years. The manufacturer shall be ISO 9000 certified.

C. Installer's Qualifications: Company specializing in applying the work of this Section with minimum ten years documented experience and approved by manufacturer.

D. Install system using competent workmen who are fully trained in the installation of temperature control equipment, and are direct employees of the controls installer. Installing wholesalers, franchisers, dealers, distributors are not acceptable. Electrical subcontractors for the installation of distribution wiring and power are acceptable.

E. Single source responsibility of BMS Contractor to include complete software, graphics installation and proper operation of the control system, debugging, and proper calibration of each component in the entire system. Third party software/programming and graphics package is not acceptable.

F. BMS Contractor shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment for a period of not less than 10 years.

G. Manufacturers shall submit evidence of electric and DDC parts availability through authorized parts wholesaler at time of bid.

H. Commissioning of a system or systems specified in this section is part of the construction process which includes documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel.

I. Quality Assurance Program

1. The BMS Contractor shall implement a Quality Assurance Program. At minimum, this program shall consist of the following requirements.
   a. The BMS Contractor shall assign a single individual to serve as the Quality Assurance Manager, who is responsible for the management of the program.
   b. The Quality Assurance Manager shall provide or maintain
      1) Documentation of training for employees-including office, field, and subcontractors- on the Quality Assurance Program.
      2) Written verification that each worker on the project has read the Specification sections outlining the project requirements for his or her area of specialty. The initial project team shall be documented in the first project submittal.
      3) A detailed audit trail for all Quality Assurance issues, including: problem ID number, date of original problem report, name of individual initiating report, and individual assigned responsibility for resolving the problem.
   c. Each individual team member shall be responsible for identifying and reporting Quality Assurance problems and for assisting, as requested by the Quality Assurance Manager, in the resolution thereof.

1.13 PRE-INSTALLATION CONFERENCE

A. Convene a conference one week prior to commencing work of this Section, under provisions of General Conditions and Division 1 as applicable.

B. Require attendance of parties directly affecting the work of this Section.

1.14 EXTRA MATERIALS

A. Submit maintenance materials under provisions of General Conditions and Division 1 as applicable.

B. Provide spare parts list.

1.15 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.
5. Provided they are available at a cost satisfactory to the owner warranties of unlimited duration.

1.16 CODES AND APPROVALS

A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local and state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with current editions in effect 90 days prior to receipt of bids of the following codes. All products of the DDC system shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products shall be provided. Systems or products not currently offering the following approvals are not acceptable.

1. NEMA standards pertaining to components and devices for DDC control systems.
2. NEMA EMC1 - Energy Management Systems Definitions.
3. Requirements of NEC pertaining to installation of DDC control systems, including, but not limited to, remote-control, signaling and power-limited circuits.
4. Provide DDC control system components and ancillary equipment which are UL-listed and labeled.
5. The BMS system shall be UL916PAZX listed.
6. Federal Communications Commission (FCC) Rules, pertaining to components and devices for DDC control systems and Section 15 governing radio frequency electromagnetic interference and be so labeled
7. Electronic Industries Association (EIA) Std RS-232 pertaining to interfacing requirements for connecting data terminals and communication equipment.
8. IEEE Std 488, "Standard Digital Interface for Programmable Instrumentation", for interfacing instrumentation into system.
9. ANSI X3.4, "Code for Information Interchange", requirements for interfacing computer data processing with communication terminal equipment.
10. ASME MC85.1 - Terminology for Automatic Control

B. The following current NFPA and ASHRAE Standards and Guides are applicable.

1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences
2. NFPA 90B Warm Air Heating, Air Conditioning
3. NFPA 92A, Recommended Practice for Smoke-Control Systems
4. NFPA 92B, Guide for Smoke Management Systems in Malls, Atria, and Large Areas
5. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning
6. ASHRAE 135 - Building Automation and Control Networks (BACnet)

C. All system components are to be designed and built to be fault tolerant.

1. Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at +3 hertz variation in line frequency.
2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be AC. coupled, or equivalent so that any single failure will not disrupt or halt bus communication.

1.17 WARRANTY

A. The system, including all hardware, software and workmanship, shall be guaranteed for a period of one (1) year from the date of final acceptance. Any manufacturing defects arising during this warranty period shall be corrected at no cost to the Owner. Warranty shall include one complete heating and cooling season.

B. All applicable software, as detailed in this specification, shall be updated by the BMS contractor free of charge during the warranty period to insure that the system software is the most up-to-date software available, for the system hardware installed, at the end of the warranty.

C. The system shall be free from defects in installation workmanship for a period of one year from acceptance. The BMS Contractor shall, free of charge, correct any defects in workmanship within one week of notification in writing by the Owner.

D. All corrective software modifications made during the warranty service period shall be updated on all user documentation and on user and manufacturer archived software disks.

1.18 TRAINING

A. Provide five (5) full days of training on site.

B. The BMS Contractor shall provide instructors to give full instructions to designated personnel in the adjustment, operation and maintenance of the system installed. Instructors shall be thoroughly familiar with all the aspects of the subject matter they

are to teach. All training shall be held during the normal work hours of 8:00am to 4:30pm weekdays.

C. Training shall include but not limited to:

1. Explanation of drawings and operations and maintenance manuals.
2. Walk thru of the job to locate control components.
3. DDC Controller and TEC (ASC) operation.
4. Explanation of adjustment, calibration and replacement procedures.

D. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory, authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Construction Manager after submission and approval of formal training plans.

1.19 TECHNICAL PROPOSALS

A. Technical proposals shall be prepared in accordance with these specifications. Two (2) copies of the proposal shall be submitted to the owner, general contractor, and consulting engineer at time of bid. Proposals that are unbound, loose, in a file folder, stapled, stapled in a manila file folder, etc., will not be acceptable. The technical proposal shall include the following data/information as a minimum. The order of listing here is not intended to indicate, nor should it be construed to indicate, the relative importance of the data/information:

1. Information on organizational capability to handle this (project management, personnel, manufacturing, single source responsibility, etc). Including contact references.
2. Information on training program to demonstrate specification compliance.
3. System Configuration as proposed including technical data to support the information below:
    a. Describe system architecture including a schematic layout with location and type (model number) of all DDC control panels.
    b. Describe system operation, functions and control techniques.
    c. Modularity.
    d. Provisions against obsolescence due to technological advancement.
    e. Provide hardware and software data sheets on system interfaces and integration requirements.
4. Detailed description of all operating, command, application, and energy management control software provided for this project.
5. A written guarantee of how long the system proposed will be a standard product and backed by ongoing parts availability and factory trained field support.
6. A signed certificate stating the Contractor has read the performance and functional requirements, understands them and his technical proposal shall comply (line by line conformance) with all parts of the specification. (Concordance Summary-).

7. Supply with the proposal a recommended spare parts listing, which the Owner should maintain at the site, with the associated costs of each part. Contractor shall provide lists for both warranty period spare parts requirements as well as spare parts needed beyond the warranty period. Spare parts shall be made available for 10 years beyond warranty period.
8. Proposal will provide a Compliance Review of the Specifications, Drawings and Addenda (if any). The Compliance Review is a paragraph-by-paragraph (Drawing by Drawing) review of the Specifications and Drawings with the following information, "C", "D" or "E" marked in the margin of the original Specifications and any subsequent Addenda. Narrative text shall accompany the Drawing Compliance Review.
   a. "C": Comply with no exceptions.
   b. "D": Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
   c. "E": Exception, do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives.
   d. Note: Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Bidder is in complete compliance with the plans and Specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the contractor from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review. The Bidder may submit the latest state-of-the-art components in lieu of specified items. The engineer and Owner will review deviations from the Specifications.
9. Information on the maintenance during warranty period.
10. Information on service contract.

B. Submit technical proposals with pricing in accordance with the Instructions to Bidders.

PART 2 - PRODUCTS

2.1 ACCEPTABLE BMS MANUFACTURERS / PRODUCT LINE

A. Alerton - BACtalk

2.2 ACCEPTABLE INSTALLERS/INTEGRATORS

A. Installers/Integrators: Company specializing in applying the work of this section with minimum 10 years documented experience approved by the manufacturer and determined acceptable following a review of pre bid qualification package.

2.3 ENVIRONMENT

A. All equipment detailed in this specification or other equipment associated with the BMS shall be capable of operation in the following conditions without detriment to the equipment.

1. 0-45°C (32°F – 113°F)
2. 0-95% RH

2.4 NETWORKING COMMUNICATIONS:

A. The design of the BMS shall network the operator workstations, DDC and TEC Controllers all communicating via BACnet. The network architecture shall consist of two levels, a primary high performance Building Level Network (BLN) for all DDC controllers and operator workstations and a secondary, Floor Level Network (FLN) that connects TECs for terminal units.

B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.

C. Building Level Network

1. The operator workstation and DDC Controllers shall communicate on the BLN such that communications may be executed directly between DDC Controllers, directly between workstations and between DDC Controllers and workstations via a BACnet LAN.
2. All operator devices shall have access to all point status and application report data or execute control functions for any and all other devices via the BLN or FLN. Access to data shall be based upon logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to the network data.
3. BLN shall provide the following minimum performance:
   a. Provide high-speed data transfer rates for alarm reporting, report generation and upload/download network devices. System performance shall insure than an alarm occurring at any DDC Controller is displayed at the PC workstation or other DDC controllers or alarm printers within 5 seconds.
   b. Support of any combination of DDC Controllers and operator workstations directly connected to the BLN. A minimum of 30 devices shall be supported on a single BLN.
   c. Message and alarm buffering to prevent information from being lost.
   d. Error detection, correction and re-transmission to guarantee data integrity.
   e. Synchronization of real-time clocks between DDC Controllers, including automatic daylight savings time corrections.
   f. All network wiring between DDC Controllers and DDC Controllers and operator workstations shall be in conduit (as a minimum).

g. The BLN shall allow the DDC Controllers to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall send alarm reports to multiple operator workstations without dependence upon a control or intermediate processing device. The peer-to-peer network shall also allow any DDC controller to access, edit, modify, add, delete, back up, restore all system point database and all programs.

h. The BLN shall allow the operators to assign password access and control priorities to each point individually. The logon password (at any PC workstation) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation. (e.g. all base building points shall be accessible to any base building operators, but only electrical points shall be accessible to house electricians). Passwords and priorities for every point shall be fully programmable and adjustable.

D. Floor Level Network

1. This level communication shall support a family of Terminal Equipment Controllers and shall communicate be-directionally with the BLN through DDC Controllers for transmission of global data via a BACnet LAN.
2. Terminal Equipment Controllers shall be arranged on the FLN in a functional relationship manner with DDC Controllers.

E. Web Browser Interface

1. The web browser shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser. The web browser shall provide for Navigation and Action for display of animated colorgraphics, schedules, alarms/events, live graphic program, active graphic setpoint controls, configuration menus for operator access, reports, trends, reporting actions for events.
2. On launching the web browser and selection of appropriate domain name of IP address, the operator shall be presented with a login page that will require a login name and password. Navigation of the system shall dependent on the operator's security access privileges.
3. Provide remote alarm notification utilizing e-mail and SMS text messages.

2.5 DDC CONTROLLER

A. Controllers shall be complete with uninterruptible power supplies (1/2 hour rated), a real time clock, input and output modules, memory, processors and all other items necessary for proper and correct interfacing and operation of the control functions described in this Specification.

B. All controllers shall have peer-to-peer communications. All controllers shall have a standalone capability such that a failure of the operator's station shall still permit the

plant and controls associated with the controllers, to continue to operate normally with the controllers continuing to communicate with one another.

C. In the event of transmission failure in the controller network the controllers shall continue to operate with all sequence interlocks and control strategies operating normally except those that require global information. Either user adjustable default values or the last sensed value (user selectable) shall then be assumed for these global parameters.

D. Controllers shall be able to provide the operator's station with status information concerning their internal operations. This information shall include, but not be limited to:

1. Data transmission and verification.
2. Input/output point status (i.e. sensor fault, point forced, etc).
3. Program status (i.e. program error, program running, etc).
4. Internal battery condition.

E. All necessary interfacing equipment shall be provided so that the controllers are fully compatible with all items of plant and equipment.

F. The controller shall be capable of accepting binary, analog, pulsed inputs and providing binary and analog outputs as necessary to meet application requirements.

1. Binary input - Shall monitor the change of state of a dry contact.
2. Pulsed input - Pulses (dry contact closures i.e. binary type input) originating typically from flow meters, electrical kWh or kVA meters, etc. and shall be accumulated into registers. A register shall be resettable to zero either by software or operator command. The input must be able to accept pulses up to a frequency of 10Hz with a minimum duration of 50ms. All counts must be stored in a non-volatile register so the count value is not affected by a power failure.
3. Binary output - A dry contact. Contact ratings shall be coordinated with the equipment being controlled.
4. Analog inputs - Analog to digital conversion (ADC) with a minimum resolution of 1024 counts (10 Bit) over the input range (i.e. 0-10V, 2-10V, 0-20mA, 4-20mA etc.) of the sensor. The sensor range shall match the process control range. Any equipment necessary for the conversion of an input signal to the required input level shall be provided.
5. Analog outputs - Digital to analog conversion (DAC) shall be performed by the controllers with a minimum resolution of 256 counts (8 Bit) over the output range which shall also match the control range of the device and/or system being controlled. Any equipment necessary for the conversion of the output signal to the required process level (i.e. 0-10V, 2-10V, 0-20mA, 4-20mA etc.) shall be provided. Where analog outputs are specified driving damper and valve actuators, they shall not be used to drive raise/lower actuators through interface devices.
6. Universal inputs-Shall be configurable to either binary or analogue input and shall have the features defined above.

G. Hardware Override Switches: The operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, on-board hand/off/auto switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not. In lieu of onboard switches, switches may be flush mounted on a panel adjacent to the DDC panel.

H. Each controller or controller location shall be provided with spare hardware capacity for future additions of at least 15 percent of each type of point and 25% spare memory capacity for future connection. Universal inputs may be counted as either a spare digital or analog point, but not both. Note that this spare capacity may be accomplished by the addition of input/output modules. Memory shall also be sufficient to allow all programs associated with these points to be run in the controller. The Contractor shall state in his offer how many spare points are actually available on each controller or at each controller location and the expansion capability.

I. The controllers shall be provided with their own internal battery backup power supply, capable of maintaining all memory including the real time clock for not less than 72 hours. The battery shall be easily replaceable i.e. not soldered to the PCB. A capacitor-based alternate to maintaining memory and real time clock for not less than 72 hours shall also be acceptable.

J. Each analog input shall be calibrated (to compensate for non-linear characteristics of input devices, line resistance and similar items) to achieve an accuracy, of the displayed value on the operator's station, as detailed in this specification for each sensing device. Calibration and scaling data shall be retained in the controller memory. Open or closed circuits on sensor inputs shall be recognized by the controller and annunciated as alarms on the system operator's station(s).

K. It shall be possible to characteristics each analog output to an actuator in order to obtain a near-linear response from the device the actuator is controlling. This may take the form of a look up table with a minimum of 6 coordinates, such that the linear output from a control loop is converted into a non-linear control signal to the actuator.

L. The controllers shall be mounted in control panels, which shall meet the following environmental requirements:

1. Control panels located in heated areas shall be NEMA Type 1.
2. Control panels located in unheated areas or in areas subject to dust or oil shall be NEMA Type 12.
3. Control panels located in exterior areas or in areas subject to rain, dripping liquid, or hosing, including kitchen areas shall be NEMA Type 4X, stainless steel.
4. All installations shall provide necessary heating or cooling to support installed equipment based on local environmental conditions.

M. The controllers shall be constructed so that the control panels and internal terminal strips can be mounted, and electrical terminations made, with all electronics being added at a later date during the testing and commissioning.

N. DDC controllers shall be used for main HVAC equipment controls.

O. Power fail restart: In the event of a loss of normal power there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for critical control configuration data, including storage of controller firmware, controller application program, schedules, and the values of any setpoints, variables, constants, or other parameters which will not automatically be refreshed by the workstation or a peer device within 60 seconds of restoration of power. Battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual operation.

2.6 DDC CONTROLLER RESIDENT SOFTWARE FEATURES

A. All software relating to plant control and monitoring detailed in this Specification shall reside at controller or unitary controller level. Only management software shall reside at the operator station.

B. All programs shall be scanned every two seconds as a minimum.

C. Software shall include diagnostic routines that check hardware for correct operation. All hardware faults shall be annunciated on the operator’s station(s).

D. For further details see Device Schedule in this Specification.

2.7 TERMINAL EQUIPMENT CONTROLLERS (TEC)

A. Where a controller is used to monitor and control exhaust fans, FCUs, etc, they shall be classed as terminal equipment controllers (TECs).

B. TECs shall be either small freely programmable controllers or firmware application specific controllers, which shall be selected to meet the performance requirements of the Specification.

C. Each TEC shall meet the specified requirements of a controller except where specified to the contrary.

D. Each TEC shall have its application program, setpoints, limits and schedules etc., backed up on non-volatile memory or maintained via batter for a minimum of 2 years.

E. Real time clock functions are not essential where these commands are generated by other controllers, which shall also control the transfer of information to, from and between TECs on the same communications network.

F. Each TEC shall be interrogated and adjusted by an operator’s station that may plug into the network at any point.

G. Only input and output points necessary to meet the functional requirements of this specification are required to be supplied. The spare capacity requirement, as detailed in the section covering DDC Controllers, is not required.

2.8 Workstation / Laptop Computer

A. Provide a laptop computer and a full featured keyboard.

B. The laptop operator's terminal shall communicate to the Ethernet network or plug directly into individual DDC panels. Provide a user-friendly English language-prompted interface for quick access to system information.
   1. The Contractor shall supply the Notebook type PC computers, indicated on the Contract Drawings and as specified herein, that shall be capable of accessing all system data.
   2. Each laptop shall be purchased within 6 months of substantial completion of the Contract. Each notebook computer shall be Dell Precision 7680 or approved equal, with the following minimum requirements:
      a. CPU: Intel Core i9-13950HX, 24 Core / 32 Thread, 5.50 GHz, 36MB cache.
      b. Memory (RAM): 32GB 5600MT/s CAMM, non-ECC
      c. Graphics Card: NVIDIA RTX 2000 Ada, 8 GB GDDR6
      d. Hard Drive: 1TB Sold State Drive
      e. Wireless network card, Wi-Fi 6 compatible.
      f. Display: 16-inch display, FHD+, minimum 1920x1200 resolution.
      g. Integral touchpad, speakers, and webcam.
      h. External optical wireless mouse.
      i. Each notebook computer shall be supplied with a padded carrying case.
   3. Each notebook computer shall be equipped with the most recent issue of the following software:
      a. Microsoft Windows 11 operating system, latest version with latest service pack version.
      b. Microsoft Office, latest version.
      c. McAfee Antivirus, latest version
      d. DVD+RW and CD-RW "Roxio" editing software, latest version, and 10 blank DVD+RW DVDs.
      e. All software necessary for viewing CD-ROM O&M Manual.
      f. All utilities necessary for management of the network of controllers and devices.
      g. All BMS software and licenses necessary to perform all the all the monitoring, command and diagnostic functions required by a system operator or a service technician. Usage shall be controlled by License Keys installed on the notebook computer.
   4. Laptop is to be used for System Monitoring and System Maintenance shall be equipped with the latest version of the following software:
      a. All BMS software necessary to perform all the monitoring functions specified herein.
      b. All BMS software necessary to perform all the monitoring, command and data management functions required by the OWS.

c. All utilities necessary for management of the network of controllers and devices.

2.9 SECTION NOT USED. ~~Building Management System Server - Rack Mounted:~~

~~A. BMS server shall be provided for information management, network alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater fault tolerance and reliability.~~

~~B. Contractor shall provide a wall mounted or free standing rack for mounting server and install server according to server manufacturer's recommendations.~~

~~C. The Contractor shall supply the Server indicated on the Contract Drawings or specified herein. The Server shall be an IBM compatible, blade type computer no larger than 2U.~~

~~D. Each Server shall have Server a hard drive capacity sufficient to store all data collected by the system for one calendar year, and device for transferring data and programs onto an external hard drive or USB memory key.~~

~~E. Each Server shall be purchased within 6 months of substantial completion of the Contract. Each Server shall be Dell Precision Rack 7910 Workstation Series or approved equal, with the following minimum requirements (hardware shall be the latest version available at time of purchase):~~

~~1. Processor: Intel Xeon Gold 5218, 16 Core / 32 Thread, 2.30 GHz, 22MB Cache.~~
~~2. Memory (RAM): 32GB, DDR4-2666MHz.~~
~~3. Solid State Drive (Boot): 512GB Solid-State Drive.~~
~~4. Hard Drive (Storage): 10TB 7200 RPM SATA Hard Drive 6.0 Gb/s~~
~~5. Integrated Network Adapter: 10/100/1000 Ethernet.~~
~~6. Power Supply: 550W (minimum), 80 Plus Platinum.~~
~~7. Operating System Windows Server, 64Bit, English, or as required by BMS software packages.~~
~~8. Rack-mounted console with 19" LCD display, full 88-key keyboard and touch. Console shall be within 1U rack-mountable housing.~~
~~9. All necessary serial, parallel, and network communication ports and all cables for proper system operation.~~
~~10. Contractor shall supply two (2) 64 GB (minimum) USB 3.0 Flash Drives.~~

~~F. Each Server is to be used for System Monitoring and System Maintenance shall be equipped with the latest version of the following software:~~

~~1. All BMS software necessary to perform all the monitoring functions specified herein.~~
~~2. All BMS software necessary to perform all the monitoring, command and data management functions required by the Server.~~
~~3. All utilities necessary for management of the network of controllers and devices.~~

2.10 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire size shall be at least 14 AWG and meet all electrical local code requirements and in accordance with Div 26 requirements. AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
4. Conductor colors shall be black (hot), white (neutral), and green (ground).
5. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable 24 V and Less:

1. Wire size shall be a minimum No. 18 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

C. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Cable shall be plenum rated.
2. Cable shall comply with NFPA 70.
3. Cable shall have a unique color that is different from other cables used on Project.
4. Copper Cable for Ethernet Network:
   a. 100BASE-TX.
   b. TIA/EIA 586, Category 5e or Category 6.
   c. Minimum No. 22 AWG solid.
   d. Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP).
   e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

D. UNINTERRUPTABLE POWER SUPPLY

1. The following equipment shall be provided with uninterruptible power supplies:
   a. BMS Control Panels
   b. BMS Workstation.
   c. Servers
   d. Gateways and network switches

2. Uninterruptible power supply (UPS): provide a self-contained UPS designed for installation and operation sized for at least 125% of the peak demand, and to provide a minimum of 15 minutes of full operation of the controller and input/output expansion modules connected to that controller.
3. Equipment connected to the UPS shall not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS.
4. Each UPS shall be wired such that primary power to the controller will be maintained upon failure of the UPS, including either a relay switch upstream of the UPS or two UPSs in parallel.
5. UPS shall be complete with necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power.
6. UPS shall be provide an alarm contact for monitoring by the BAS of UPS general alarm inclusive On Battery, Low Battery and UPS Shutdown.
7. UPS shall be provided with means for integration for monitoring of general alarm including battery failure.
8. BMS workstation, UPS, and gateways/network switches shall be complete with uninterruptible power supply capable of running all hardware for a period of 1/2 hour.
9. Manufacturer
    a. Sola SDU Off-Line DIN Rail HeviDuty UPS Series
    b. Schneider Electric Smart-UPS SUA500PDR
    c. or equal

2.11 WORKSTATION OPERATOR INTERFACE

A. Basic Interface Description

1. Provide scaled floor plans (Auto Cad or approved equivalent) indicating equipment location, service, and system data as required by the Owner. Graphics to incorporate integrated points communicated via BMS. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
2. All graphics to include dynamic screen link points for the following as a minimum;
    a. Manufacturer cut sheets files, either in PDF or other file format for instrumentation and control device represented. All cut sheets to be provided with selection of model provided clearly identified by markings.
    b. Sequence of operations text file for the systems and devices represented.
    c. Control system As-Builts
3. Operator workstation interface software shall minimize operator training through the use of English language prompting, 30 character English language point identification, on line help and industry standard PC application software. The software shall provide, as a minimum, graphical viewing and control of environment, scheduling and override of building operations, collection and analysis of historical data, definition and construction of dynamic color graphic displays, editing, programming, storage and downloading of controller

databases, and the ability to export data with Microsoft Word for Windows and Excel for Windows.

4. Provide a graphical user interface which shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change set points from graphical displays through the use of a mouse or similar pointing device. Provide functionality such that all operations can also be performed using the keyboard as a backup interface device. Provide additional capability that allows at least 10 special function keys to perform often-used operations
5. The software shall provide a multi-tasking Microsoft Windows environment that allows the user to run several applications simultaneously. Other Windows applications shall run simultaneously with the BMS software including Word, Excel, Access, etc. Provide functionality such that any of the following may be performed simultaneously, and in any combination, via user-sized windows. The operator shall be able to drag and drop information between applications (e.g. click on any point in the alarm screen and drag it into the dynamic trend graph screen to initiate a dynamic trend).
    a. Dynamic color graphics and graphic control
    b. Alarm management coordinated with other specification sections
    c. Week or Month at a Glance with 365 day time-of-day scheduling
    d. Trend data definition and presentation
    e. Graphic definition
    f. Graphic construction
6. Operator specific password access protection shall allow the user to limit workstation control, display and data base manipulation capabilities for each object in the system. An object shall be defined as any input or output point, set point, system program, etc. The operator privileges shall "follow" the operator to the operator terminal or DDC controller that the operator logs on to. Provide a minimum of 200 passwords.
7. Operators will be able to perform only those commands on the objects available based on their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.
8. An audit trail report to track system object changes, accounting for operator initiated actions, change made by a particular person or changes made to a specific piece of equipment, designated time frame shall be printed out on command or automatically and archived for future reference. The operator activity tracking data shall be stored in a tamper proof buffer.
9. Software shall allow the operator to perform commands including, but not limited to start up or shutdown of equipment, adjust set points (including multiple TEC subpoints to new settings with one command), add/modify/delete time programming, enable/disable process execution, lock/unlock alarm reporting, enable/disable totalization, enable/disable trending, override PID loop set points, enter temporary override schedules, define holiday schedules, change time/date, automatic daylight savings time adjustments, enter/modify analog warning and alarm limits, View limits, Enable/disable demand limiting for each meter, Enable/disable duty cycle for each load. All values (including setpoints) indicated within specification sequences, including those labelled as adjustable (adj.), shall be modifiable, with the proper password level, from the

operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

10. Reports shall be generated and directed to either display or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
    a. A general listing of all points in the network
    b. List of all points currently in alarm.
    c. List of all points currently in override status.
    d. List of all disabled points.
    e. List of all points currently locked out.
    f. DDC Controller trend overflow warning.
    g. List all weekly schedules.
    h. A DDC controller point module status report.
    i. A change of value cross reference report indicating user defined limit changes.
    j. Summaries shall be provided for specific points, for a logical point group, for a user-selected group or groups or for the entire facility without restriction due to the hardware configuration of the building management system. Under no conditions shall the operator need to specify the address of the hardware controller to obtain system information.
    k. Provide a custom reporting package that allows the operator to select, modify, or create custom reports. Each report shall be definable as to data content, format, interval and date. Report data shall be capable of being archived on hard disk for historical reporting. Each physical point or pseudo point shall be assigned an English descriptor for use in reports. The integrated Custom Report Writer capability shall allow the user to format reports of any mix of text, points with status, value and descriptors. The user shall have the capability to modify the defined reports or design unique reports that collect and disperse different combinations of data from the system. A custom report drop down item under the report bar item displays a report dialog box that allows you to schedule, run and view these reports. Spreadsheet packages which require off-line execution or manual translation of date files from one program format to another are not acceptable.
11. User-definable, automatic log-off timers of from 5 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

B. Scheduling

1. Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide the following spreadsheet types: weekly, monthly and yearly schedules for a minimum of 365 days in advance.
2. Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Each schedule shall include columns for each day of the week as well as holiday and special day columns for alternate scheduling on user-defined days. Equipment scheduling shall be accomplished by simply inserting occupancy and vacancy times into appropriate information blocks on the graphic. In addition, temporary overrides and associated times

may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.

3. Zone schedules shall be provided for each building zone as previously described. Each schedule shall include all controllable points residing within the zone. Each point may have a unique schedule of operation relative to the zone's occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and rescheduling of points may be accomplished easily via the zone schedule graphic.
4. Monthly calendars for a 24-month period shall be provided which allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

C. Collection and Analysis of Historical Data

1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting.
2. Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 10 points. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package such as Microsoft Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.
3. Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both static and/or real-time dynamic point data. A minimum of 6 points may be viewed simultaneously on a single graph, with color selection and line type for each point being user-definable. Displays shall include an 'X' axis indicating elapsed time and a 'Y' axis indicating a range scale in engineering units for each point. The 'Y' axis shall be manually or automatically scalable at the user's option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the 'Y' axis. All 'Y' axis data shall be color-coded to match the line color for the corresponding point.
    a. Static graphs shall represent actual point data that has been trended and stored on disk. Exact point values may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a building management and diagnostics tool.
    b. Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future

recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.

D. Dynamic Color Graphic Displays:

1. Provide graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, supply and exhaust fans and condensate systems to optimize system performance analysis and speed alarm recognition.
2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
3. Dynamic point values (e.g. temperature values, humidity values, flow values and status indication) shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
4. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
5. Graphic generation software shall be provided to allow the user to add, modify or delete system graphic displays via an off the shelf graphics package.
    a. The BMS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems and electrical symbols.
    b. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.
    c. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC Controllers including Terminal Equipment Controllers or terminal units.
6. Provide an automatically updated, dynamic display of the site specific BMS architecture indicating the status of all controllers, PC workstations and networks.
7. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
    a. Define symbols.
    b. Position and size symbols.
    c. Define background screens.
    d. Define connecting lines and curves.
    e. Locate, orient and size descriptive text.
    f. Define and display colors for all elements.
    g. Establish correlation between symbols or text and associated system points or other displays.

8. For each air handling unit provide a tabular graphic summary of that unit and its associated air distribution system. Graphics shall contain, at a minimum, the following information:
   a. Supply fan's current operating speed and setpoint.
   b. Manual adjustment of supply fan speed.
   c. Supply air static pressure and temperature.
   d. Current damper position or command.
   e. Current associated space temperature.
   f. Current preheat, reheat, and cooling valve positions or commands.
   g. A commandable override point to place all associated terminal units at maximum airflow.
   h. A commandable override point to place all associated terminal units at minimum airflow.

E. System Configuration and Definition

1. All temperature and equipment 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.
2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add, delete or modify any system object including DDC controllers, operator workstations, equipment controllers, reporting definitions, control loops, energy management applications, time and calendar-based programming, totalization, historical data trending, custom control processes, graphic displays, operator passwords, alarm messages, dial up telecommunications definitions, points of any type, etc.
3. Definition of operator device characteristics for individual points, applications and control sequences shall be performed using instructive prompting software.
   a. Libraries of standard application modules such as temperature, humidity and static pressure control may be used as "building blocks" in defining or creating new control sequences. In addition, the user shall have the capability to easily create and archive new modules and control sequences as desired via a word processing type format. Provide a library of standard forms to facilitate definition of point characteristics. Forms shall be self-prompting and incorporate a fill-in-the-blank approach for definition of all parameters. The system shall immediately detect an improper entry and automatically display an error message explaining the nature of the mistake.
   b. Programming shall be performed with the BMS system online, and not interfere with BMS system operation.
   c. Inputs and outputs for any process shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of 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).
   d. Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Similarly, changes made

at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.

e. Provide a program testing utility which allows visual dynamic simulation capability of the symbolically displayed control programs provided. User shall be able to select any portions of inputs, outputs and intermediate program points for visual dynamic display of intermediate values and or results. Provide ports for symbolic engineering tool at each DDC Controller, and (for TECs) at space temperature sensors noted on the plans or as described herein. The symbolic engineering utility shall be self-documenting and shall generate a complete controller program including I/O definition and engineering unit processing requirements, alarm limits, DDC operational program, and English text for all data points. Engineering program documentation shall include computer-driven output of all program data.

f. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

2.12 ALARM PROCESSING

A. Alarms shall be classified by their alarm type. The means shall be provided for enabling and disabling each individual alarm on the system. The contractor is responsible for enabling and setting all alarms within the BMS.

B. Once generated, the alarm shall be processed by its associated Alarm Type and Alarm Level as defined in either the I/O Point Schedules or collaboration with the Owner/Facilities Manager.

C. The Alarm Types shall be as follows:

1. Mismatch Alarm Type- Mismatch: The alarm is associated with an output command point and its related input giving status feedback of the output command. The alarm is generated when the status feedback does not correspond with the output command status for longer than a defined time delay period, initially set to 1 minute(adjustable).
2. Binary Alarm Type - The alarm is associated directly with an external volt free contact (i.e. a digital input). The alarm may be generated by transitions from either open to closed status, closed to open status, or any change of state. A time delay shall be associated with the alarm such that the alarm does not occur until the required alarm state has existed for longer than the delay period, initially set to 15 seconds(adjustable).
3. Analog Alarm Type - The alarm is associated directly with an analog input. The alarm is generated by the BMS due to a measured variable exceeding specified limits. It shall be possible to define the limits in two ways:
   a. Fixed limits. The point has fixed upper and lower alarm limits. If the measured variable rises above the upper limit, or falls below the lower limit, then an alarm is generated. e.g. high alarm limit = 80°F, low alarm limit = 45°F.

b. Floating limits. The point has an associated setpoint, and an alarm is generated when the measured variable deviates either above or below the setpoint by more than a given alarm limit value. If the setpoint is changed, the alarm limits are automatically moved to suit, e.g. setpoint = 66°F, alarm limits = Setpoint ± 2°F.

4. Hand/Off/Auto (HOA) Type - The alarm is associated with the placement of the HOA switches in the Hand or Off position. HOA switches include but are not limited to controllers and variable frequency drives.

D. The Alarm Levels shall be as follows:

1. Level 1: Life Safety.
2. Level 2: Critical Equipment Message.
3. Level 3: Urgent Message.
4. Level 4: Normal / Maintenance Message.

E. Alarm Initiation - Entry delay:

1. All alarms have an adjustable delay time such that the alarm is not triggered unless the alarm condition exists for the delay time. Default entry delays are as follows:
   a. Level 1 alarms: 1 second
   b. Level 2 alarms: 10 seconds
   c. Level 3 alarms: 1 minute
   d. Level 4 alarms: 5 minutes

F. Alarm Exit Hysteresis:

1. Each alarm has an adjustable time-based hysteresis to exit the alarm. The default is 5 seconds for all alarms. Once set, the alarm does not return to normal until the alarm conditions have ceased for the duration of the hysteresis.
2. Each analog alarm additionally has an adjustable percent-of-limit-based hysteresis. The hysterias requires the alarmed variable to be a percentage above or below (as applicable) the triggering threshold before the alarm is cleared. The default value is 0% for all alarms.

G. Latching:

1. Any alarm can be configured as latching or non-latching. A latching alarm requires acknowledgement from the operators before it can return to normal, if the exit hysteresis has been met. A non-latching alarm does not require acknowledgement. Default latching status is as follows:
   a. Level 1 alarms: latching
   b. Level 2 alarms: latching
   c. Level 3 alarms: non-latching
   d. Level 4 alarms: non-latching

H. The operator’s station display shall have a dedicated area at the top or bottom of the screen for use as an alarm banner. The alarm banner shall display, as a minimum, the two latest unacknowledged alarms at the top of the current alarm list. Alarms shall be entered into the list according to their type and event order, with the most

recent alarm being at the top of the list. As new alarm events occur, the list shall be sorted to keep the list in the desired order.

I. On occurrence, all alarms shall be put in the alarm list. In addition, the following actions shall be taken dependent upon the alarm type.

J. Alarm Actions

1. Level 1: Life Safety.
   a. Initiate remote notification via email/text.
   b. The alarm printout shall be in bold text or color-coded to clearly differentiate it from Urgent or Normal / Maintenance alarms. It shall be possible to sort or filter the alarm printout by alarm level.
   c. The banner alarm message display shall be differentiated by means of text size or color from general alarms.
   d. Shall generate an audible alarm at the operator's station.
   e. Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.
2. Level 2: Critical Equipment Message.
   a. The alarm printout shall be in bold text or color-coded to clearly differentiate it from Urgent or Normal / Maintenance alarms. It shall be possible to sort or filter the alarm printout by alarm level.
   b. The banner alarm message display shall be differentiated by means of text size or color from general alarms.
   c. Shall generate an audible alarm at the operator's station.
   d. Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.
3. Level 3: Urgent Message.
   a. Shall generate a banner alarm message.
   b. Shall generate an audible alarm at the operator's station.
   c. Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.
4. Level 4: Normal / Maintenance Message.
   a. Shall generate a banner alarm message.
   b. Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.

K. It shall be possible, at the highest operator password level, to enable and disable the audible alarm feature of the operator's station for such reasons as maintenance . In addition the keyboard facility to mute the audible alarm shall be provided. Alarms that have been muted shall be re-annunciated if not acknowledged within a user specified time.

1. All alarms associated with a device in maintenance mode, except for level 1 alarms, are suppressed.
2. If a device is in maintenance mode, a daily level 3 alarm is issued at midnight indicating the devices is still in maintenance mode.

L. Alarms shall remain active until acknowledged by an operator logged on with the appropriate password level, even if the alarm has physically cleared. Upon acknowledgement, the alarm shall be moved to the appropriate place in the alarm list, the alarm banner shall be updated as necessary. When an alarm is acknowledged, the audible alarm, if enabled, shall be muted unless another unacknowledged critical or general alarm exists on the system.

M. The system shall be capable of alarm notification escalation during periods in which alarms go unacknowledged for a period of time. The escalation shall provide means to notify assigned individuals and/or groups via all means addressed within this specification. The escalation shall be tiered in a manner so that multiple stages of escalation are programmable. Escalation shall be developed by contractor in collaboration with the Owner/Facilities Manager

N. Post exit suppression period:

1. To limit alarms, any alarm may have an adjustable suppression period such that, if the alarm is triggered, its post-suppression timer is triggered and the alarm may not trigger again until the post-suppression time has expired. Default post suppression periods are as follows:
   a. Level 1 alarms: 0 minutes
   b. Level 2 alarms: 5 minutes
   c. Level 3 alarms: 24 hours
   d. Level 4 alarms: 7 days

O. It shall be possible to acknowledge alarms on both an individual and group basis.

P. Upon clearance of an alarm, it shall be removed from the alarm list.

Q. All alarm events shall be included in the historical data program.

1. All alarms in the alarm list.
2. Level 1: Life Safety alarms only.
3. Level 2: Critical Equipment Message. alarms only.
4. Level 3: Urgent Message alarms only.
5. Level 4: Normal Message alarms only.
6. Hand/Off/Auto alarms only.
7. Acknowledged alarms only.
8. Selection of alarms associated with an individual drive or plant equipment only.

2.13 CONFIGURATION

A. Configuration data shall be stored in the DDC Controllers or the Terminal Equipment Controllers. Configuration data shall include but not be limited to the following:

1. The point identifier (minimum of 12 characters).
2. The point descriptor (minimum of 32 characters).
3. The engineering unit applicable (°F, psi, gpm etc).
4. The point alarm message if applicable (minimum of 80 characters).

5. Other miscellaneous information necessary for the correct operation of the entire BMS (e.g. trending run hours, accumulation, access levels etc).

2.14 BMS INTEGRATION WITH OTHER SYSTEMS AND DEVICES

A. DX PACKAGED AIR HANDLING UNIT

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Allow for a minimum of 30 points	TBD	TBD	TBD	TBD	Yes

B. Energy Recovery System

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Allow for a minimum of 30 points	TBD	TBD	TBD	TBD	Yes

C. VFD(s)

1. The BMS shall be able to start and stop and control the VFD speed via a hardwired point based on the sequence of operations program.
2. The communication interface shall allow the BMS read capabilities.
3. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the VFD manufacturer for this integration. This integration shall be done via BACnet IP where available or BACnet MSTP if BACnet IP is not available.
4. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Start / Stop	DO	No	Yes	Yes	Yes
Speed Modulation	AO	No	Yes	Yes	Yes
Status (Current Sensor)	AI	Yes	Yes	Yes	Yes
VFD Fault	DI	Yes	Yes	Yes	Yes
HOA Not in Auto	DI	Yes	Yes	Yes	Yes
VFD in Bypass	DI	Yes	Yes	Yes	Yes
Forward / Reverse Status	SW	No	No	No	Yes
Drive Ready Status	SW	No	No	No	Yes
At Setpoint Status	SW	No	No	No	Yes
Resets Faults	SW	No	No	No	Yes
Output Speed min-1	SW	No	No	No	Yes
Output Frequency Hz	SW	No	No	No	Yes
DC Bus Voltage V	SW	No	No	No	Yes
Motor Voltage V	SW	No	No	No	Yes
Motor Current A	SW	No	No	No	Yes
Motor Torque %	SW	No	No	No	Yes
Motor Power %	SW	No	No	No	Yes
Drive Thermal State %	SW	No	No	No	Yes
Energy Counter kWh	SW	No	No	No	Yes
Run Time	SW	No	Yes	Yes	Yes
Last Error Code	SW	No	No	No	Yes

D. Split Air Conditioning Units /Computer Room Air Conditioning (CRAC) Units

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the CRAC manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Space Temperature	SW	Yes	Yes	Yes	Yes
Space Humidity	SW	Yes	Yes	Yes	Yes
Unit Status	SW	No	Yes	Yes	Yes
Unit Runtime	SW	No	Yes	Yes	Yes
General Alarm	SW	Yes	Yes	Yes	Yes

E. Packaged Air Handling Unit

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.

3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Allow for a minimum of 30 points	TBD	TBD	TBD	TBD	Yes

F. Fuel Oil System

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Allow for a minimum of 45 points	TBD	TBD	TBD	TBD	Yes

G. Electric Power Meters and EPMS

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. BMS shall monitor and store both total production and power output data from meters at minimum 5-minute intervals.

2.15 INFORMATION REDIRECTION

A. It shall be possible for the system to redirect information to other locations and/or printers on a time schedule basis (including holiday programming) or manual command basis.

2.16 RESPONSE TIMES

A. The response times detailed below are the maximum acceptable response times.

B. Alarms: The time from activation of an alarm (at the source) to annunciation on an operator's station, printer or to another DDC controller shall not exceed 10 seconds.

C. Graphic Displays: A graphic display shall be displayed complete with updated information from the field for all points, within 15 seconds of the operator request.

D. Once displayed all point information will be updated from the field and displayed at intervals not exceeding 30 seconds.

E. Logical Groups: A logical group shall be displayed complete with updated information from the field for all points within 15 seconds of the operator's request. Once displayed the value shall be refreshed every 10 seconds.

F. Selected Points: The field value of a single input, output or virtual point shall be displayed on the operator's station screen within 5 seconds of a request.

G. Global Program: the time from occurrence of an event tom one controller or unitary controller to the activation of the output of another controller or unitary controller shall not exceed 10 seconds.

2.17 TRANSIENT/SPIKE PROTECTION

A. Suppressors shall be fitted to all controller input points for protection against voltage transients, spikes etc.

B. The communication network(s), the BLN and the FLN, shall be isolated against transient disturbances via optical couplers or other approved means. Where running between buildings, lightning protection devices shall be installed on the communications network at the point of entry to each building.

2.18 ELECTROMAGNETIC PROTECTION

A. All components of BMS and the entire BMS system shall comply with the requirements of the relevant Emission and Immunity Standards.

B. In order to avoid corruption of the BMS equipment operation by electrical interference, all wiring shall be installed to minimize coupling of electromagnetic and electrostatic interference on low voltage signals and data wiring. Where mixed wiring is unavoidable braided screen mains cable, dressed close to metalwork, is preferred, but the Tendered shall clearly specify the methods by which he intends to eliminate any such interference with his signal and data transmission.

C. The BMS shall be protected from interference by the operation of hand held radio transmitters, radio pagers, etc. within 1 meter of the equipment.

2.19 BMS STANDARD PROGRAMS

A. The device schedules included in this Specification provide details of inputs monitored and outputs controlled by the BMS. All point types are described in the section covering DDC Controllers in this Specification. The BMS system shall allow for the following point functionality and standard programs to be available:

1. Point Override
2. Manual Start/Stop
3. Fixed Time Program

4. Optimum Start/Stop – program shall calculate the optimum start time for plant systems, e.g. the AHU, based on occupancy time and on internal space and outside conditions.
5. Control Loops
6. Rotational Point
7. Run Time Totalization
8. Anti-short Cycling
9. Staggered Start
10. User Definable Software
11. General Control Requirements

2.20 FIELD DEVICES

A. General

1. All control signals shall be via 4-20 mA or 0-10 VDC loops.
2. It is the contractor's responsibility to properly select all instruments for process and application suitability, inclusive of materials and operating ranges.
3. Input/Output sensors and devices shall be closely matched to the requirements of the BMS for accurate, responsive, noise-free signal input/output. Control input response shall be highly sensitivity and matched to the loop gain requirements for precise and responsive control. Provide the following instrumentation as required by the monitoring, control and optimization functions.

B. Temperature Sensors/Transmitters/Thermowells

1. Thermistors based temperature sensors shall be paired with a 4 wire 4-20 mA output transmitter. Transmitter shall have built-in circuit protection against reverse polarity and supply voltage transients.
2. RTD based temperature sensors shall use platinum elements only, nickel or silicon RTDs are not acceptable.
3. Air stream averaging type
   a. The assembly shall consist of a capillary type element, housed in a flexible sheath contained in housing suitable for duct mounting.
   b. Probe length: 1 ft./4 square ft. of duct area
   c. All duct cross sections greater than 10 square feet to have serpentine-averaging element to adequately average stratified air temperature.
   d. Temperature Monitoring Range: +20 to +120°F
   e. Factory calibration point: 70°F.
   f. Accuracy: ± 0.5 °F.
4. Air stream insertion / non-averaging type.
   a. The assembly shall consist of an insertion type element contained in a housing suitable for duct mounting and mounted on probe whose maximum length shall be 12 inches or ½ duct diameter, whichever is smaller.
   b. Temperature Monitoring Range: +20 to +120°F
   c. Factory calibration point: 70°F.
   d. Accuracy: ± 0.5 °F.

e. For outside air applications, mount with weather protection and sun shield.

5. Space monitoring type - Traditional
   a. The assembly shall consist of an element contained in a ventilated enclosure.
   b. Temperature Monitoring Range: +20 to +120°F
   c. Factory calibration point: 70°F.
   d. Accuracy: ± 0.5 °F.
   e. Provide low profile combination temperature and humidity sensors for Gallery/Exhibit Areas as applicable
   f. Coordinate Temperature Sensor faceplate requirements with architect/ owner and engineer. Faceplates options shall include color, blank faceplate option, display faceplate option, setpoint adjustment option and occupied/unoccupied override option) Submit for approval.

6. Space monitoring type – Wall Mounted Button/Bullet Sensor
   a. Sensors are to provide space temperature via hardwired connection.
   b. The assembly shall consist of a stainless steel button wall mounted style sensor/element.
   c. Temperature Monitoring Range: +20 to +120°F
   d. Factory calibration point: 70°F.
   e. Accuracy: ± 0.5 °F.

7. Space monitoring type – Electric /Line Voltage Thermostats
   a. Furnish and install all line voltage thermostats for unit heaters.
   b. Thermostats contacts shall be rated for maximum heater amperage and shall be snap acting, SPDT.
   c. Thermostat cover shall provide exposed set point and key adjust.
   d. When used for unit heaters - Furnish and install strap on aquastats to prevent unit heaters from operating without hot water or steam

8. Liquid insertion type
   a. The assembly shall be provided with a housing suitable for pipe mounting.
   b. The transmitter shall be compatible with the temperature element and the DDCP.
   c. Transmitter shall have built-in circuit protection against reverse polarity and supply voltage transients.
   d. Include a stainless steel thermowell, maximum length shall be 6 inches or 3/4 of pipe diameter, whichever is smaller.
   e. Temperature Monitoring Range: The sensor range shall be suitable to the process being monitored.
   f. Factory calibration point: Middle of process range.
   g. Accuracy: ± 0.5 °F.

9. Outside Air Assembly
   a. The assembly shall be contained in an enclosure suitable for outdoor applications.
   b. Temperature Monitoring Range: -50 to +120°F
   c. Factory calibration point: 70°F.
   d. Accuracy: ± 0.5 °F.

10. Averaging Temperature RTD for Cooling tower basin

a. A multipoint RTD capable of monitoring a multitude of temperatures over a vertical length as specified to cover depth of cooling tower basins.
b. Sensor shall be paired with a transmitter capable of an averaging process and 4-20mA output to the BMS.
c. Include a stainless steel thermowell.
d. Transmitter shall have built-in circuit protection against reverse polarity and supply voltage transients. Transmitter shall be a two wire device, loop powered.
e. Assembly shall be coordinated with cooling tower basing manufacturer to allow for proper mounting hardware installation. All mounting hardware to be provided by Controls contractor.
f. Manufacturer – Moore Industries.

11. Freezestats
    a. Furnish and install for each air handling unit with outdoor air connections, a low temperature safety thermostat (freezestat) with 20 ft sensing element installed in a serpentine fashion across the inlet of the cooling coil (one freezestat per coil section) in the air stream arranged to stop the unit supply fan and its associated return air fan should the temperature at any point along the sensing element fall below 39°F (adjustable) for an adjustable time period.
    b. Low temperature detector shall be automatic reset, DPDT type unless specified in sequences within specification.
    c. Provide manufacturer specified / accept able clips for recommended support.

12. Thermowells
    a. Provide a Thermowell for every thermistor temperature sensing element installed in piping and equipment. Provide a separate calibration thermowell for every thermistor. Refer to installation detail shown on drawings.
    b. Thermowells shall be Type 304 stainless steel, or brass tapered pattern, 3/4 inch NPT external process connection, 1/2 inch NPT internal thread, with lagging extension, equal to insulation thickness, where installed in insulated piping. Thermowells shall have an insertion length of at least 1/3 of pipe diameter but in no case shall wells be less than 4-1/2 inch insertion length. Maximum immersion length shall be 6 inches or 3/4 of pipe diameter, whichever is smaller. Thermowells shall be rated for maximum system operating pressure, temperature and fluid velocity.
    c. Internal bore of Thermowells shall be sized to exactly fit the diameter of the sensing element to be installed.
    d. Provide necessary thermally conductive material for proper sensor to thermowell contact.

13. Smart Sensors (for Residences)
    a. The assembly shall consist of an element contained in a ventilated enclosure.
    b. Temperature Monitoring Range: +20 to +120°F
    c. Factory calibration point: 70°F.
    d. Accuracy: ± 0.5 °F.

e. Unit shall be capable of occupancy monitoring. Sensor shall use either passive infrared or ultrasonic technology with sensitivity adjustment
f. Unit shall be classified as a Terminal Equipment Controller, refer to specific section for additional requirements.
g. Provide functionality (inclusive of hard wired outputs) required to control residence unit heating and cooling valves. In accordance with design details and sequence of operations.
h. Coordinate Temperature Sensor faceplate requirements with architect/ owner and engineer. Faceplates options shall include color, blank faceplate option, display faceplate option, setpoint adjustment option and occupied/unoccupied override option) Submit for approval.

C. Pressure Sensors/Transmitters/Switches

1. Air Differential Pressure Switch
   a. Differential pressure switches shall be diaphragm type, with die-cast aluminum housing and an adjustable set point.
   b. Output: Switches contact shall be DPDT and rated a minimum of 5 amps at 120 VAC.
   c. Switch pressure range shall be suited for application (e.g. filter 0-2.0", fan status 0-5.0", etc.).
   d. Sensor shall be adjustable for zero and span.
   e. All exposed tubing shall be capped with static pressure tips.

2. Air Differential Pressure Transmitter
   a. Sensors shall be suitable for low pressures likely to be encountered and be selected for approximately 50% over range and have 4-20ma output.
   b. Connect to measuring points with valved lines for testing and calibration.
   c. Sensors shall be adjustable for zero and span.
   d. Sensors for VFD fan control shall be located 2/3rds downstream of fan.
   e. All exposed tubing shall be capped with static pressure tips.

3. Air Static Pressure Transmitter
   a. Sensors shall be suitable for low pressures likely to be encountered and be selected for approximately 50% over range and have
   b. Output: 4-20 mA
   c. Connect to measuring points with valved lines for testing and calibration.
   d. Sensors shall be adjustable for zero and span.
   e. Sensors shall be located 2/3rds downstream of index run.
   f. All exposed tubing shall be capped with static pressure tips.

4. Water Pressure / Differential Pressure Switch
   a. Switches shall be diaphragm actuator type, with epoxy coated aluminum housing and an adjustable set point.
   b. Output: Switch contact shall be SPDT, 15A 120VAC.
   c. Switch pressure range shall be suited for application
   d. Actuator seal to be compatible with process temperature limits
   e. Accuracy : 1% of nominal range
   f. Sensor shall be adjustable for zero and span.
   g. Manufacturer: Ashcroft

5. Water Pressure / Differential Pressure Transmitter

a. Provide a variable capacitance 2-wire, 4-20 mA differential pressure transmitter assembly. Differential pressure transmitters shall be enclosed in a gasketed, dust and watertight housing. All body cavities open to the process fluid shall be provided with drain ports at the cavity bottom and vent ports at the top of the cavity. Both drain and vent ports shall be minimum ¼ inch – 18 NPT.
b. The transmitter shall have continuously adjustable (externally) zero and span. These adjustments shall be made within the transmitter housing without a change of parts.
c. The transmitter shall be capable of sustaining differential pressures in either direction, up to the body rating without damage to the instrument or a loss of accuracy or zero shift.
d. The transmitter shall be fully compensated for both process and ambient temperature variations and a calibrated accuracy of ±0.25% of calibrated span.
e. Provide local LCD display and wire-on-tag with instrument service information.
f. Provide manufacturers standard 316 stainless steel, 5-valve manifold and pressure gauges for supply and return pressures.
g. Manufacturer: Rosemount 3051S, 316 stainless steel or approved equal.

6. Building Pressurization System
   a. System layout shall include: both indoor and outdoor sensor locations with mounting design; where fire-rated penetrations are required in walls or ceilings with reference to penetration details which describe material transitions as required; where plenum-rated tubing is required; locations of control panels; requirements for power provided under Division 26; zone pressure sensors shall not be located near mailroom exhaust, kitchen hood exhaust, AHU return ducts, medical lab exhaust hoods, or other sources of positive or negative pressure which will adversely affect the stability and accuracy of the sensor readings

7. Indoor Pressure Pickup Ports
   a. Wall mount: Plate compatible with J-box.
   b. Ceiling mount: Plate compatible with J-box or designed to fit a ¾” thick suspended ceiling tile.
   c. Brushed stainless steel with gasket seals.
   d. Brass fitting for standard 1/8” to 5/32” I.D. tubing.
   e. Equal to Building Automation Products, Inc. ZPS-ACC.

8. Outdoor Static Pressure Pickup Ports
   a. Wall or roof mount.
   b. UV resistant and flame retardant plastic housing.
   c. ½” EMT conduit connection.
   d. Barbed fitting for standard 1/8” to 5/32” I.D. tubing
   e. Rated for -40 to 212°F, 0-100% non-condensing.
   f. Equal to Building Automation Products, Inc. ZPS-ACC-10.

9. Outdoor Static Pressure Manifold Enclosure
   a. Wall mounted, weatherproof (NEMA 3 or 4), steel enclosure.
   b. Powder coated finish.
   c. Hinged door.

d. Oil resistant door gasket.
e. Accessories:
   1) Powder coated, heavy gauge steel louvers, one per side for minimum 2 inch by 1.75 inch panel opening.
   2) Lockable door latch.
   3) Insect screen on over louver openings inside of enclosure.

D. Flow Sensors/Transmitters/Switches

1. Through the wall Airflow Measurement Device:
   a. Provide through the wall airflow measuring device for the monitoring air flow between the Fan Rom #1 and the adjacent corridor and Fan Rom #2 and the adjacent corridor as shown on mechanical and controls drawings.
   b. Each measuring device shall consist of one sensor and one transmitter to maintain specified accuracy and performance.
   c. A single manufacturer shall provide both the airflow measuring sensor and transmitter.
   d. The operating airflow range shall be 0 fpm to 5,000 fpm. . The operating environmental range for the airflow probes shall be 20°F to 140°F, 99% R (non-condensing).
   e. The operating environmental range of the transmitter shall be 30°F to 120°F protected from the weather.
   f. The sensor shall have an accuracy of ± 2% of reading over the entire operating range and be fully temperature compensated.
   g. Provide a 4-20 ma transmitter for interface to the BMS system.
   h. Provide all necessary hardware including, stainless steel faceplate with protective mesh, hose barbs, extensions, copper tubing, bleed sensor assembly, fittings, transmitter and panel enclosure.
   i. Installation method shall be coordinated with device manufacturer and approved by Owner and Controls Engineer prior to any and all work.
   j. Acceptable manufacturers:
      1) Ebtron Inc (Gold Series)including GB1/SB1Bleed Sensors

2. Air Flow Measurement Stations - Fan Inlet and Outside Air Intake / Exhaust Air Flow
   a. General: The airflow measurement stations shall be capable of monitoring airflow and temperature rates at each measurement location. The system shall be factory tested prior to shipment and shall not require calibration or adjustment over the life of the equipment, when installed in accordance to manufacturer’s guidelines.
   b. Provide fan inlet and outdoor airflow measuring devices for air handling units as shown on drawings. Each airflow measuring device shall consist of multiple measuring probes.
   c. Installed accuracy shall be percent of reading and demonstrated at both maximum and minimum airflow rates for each measurement location..
   d. The operating airflow range shall be 0 fpm to 5,000 fpm. .
   e. A single manufacturer shall provide both the airflow measuring probe and transmitter.
   f. Sensor assembly
      1) Each sensing point shall independently measure airflow and temperature prior to averaging. Sensors shall be calibrated to

NIST-traceable standards for both airflow and temperature. Heated element, bead in glass hermetically sealed thermistor probes.

2) Provide quantity of probes to meet manufacturer's minimum installation requirements. Provide quantity of airflow measuring probes to maintain specified accuracy and performances.
3) Each airflow measuring device shall consist of multiple measuring probes. Provide quantity of airflow measuring probes to maintain specified accuracy and performances.
4) The operating environmental range for the airflow probes shall be -20 deg f to 160 deg f, 100% R (non-condensing).
5) The sensor shall have an accuracy ± 2% of reading over the entire operating range and be fully temperature compensated.

g. Transmitter and Electronics Enclosure
1) The transmitter shall operate on 24 VAC. The transmitter shall have a minimum 16 character alphanumeric LCD display for airflow, temperature, and system diagnostics. Analog output signals shall be user selectable (0-10 VDC or 4-20 mA). All inputs and outputs shall be fused, protected, and internally isolated from the 24 VAC power supply. The transmitter shall have a non-drifting adjustment for output signal offset/gain. The transmitter display shall be capable of being configured in either I.P. or S.I. units. The transmitter shall accept a user-defined area to display volumetric flow rates in CFM.
2) The enclosure shall be aluminum alloy for indoor use and capable of operating over a temperature range of -20° F to +120° F. The electronics shall be installed inside and protected from the weather. Exterior installation or areas acceptable to high levels of moisture use NEMA4 enclosure.

h. Temperature Output to BMS
1) Provide temperature monitoring output to BMS in accordance with mechanical drawings.

i. Acceptable manufacturers:
1) Ebtron, Inc (Gold Series)

j. BMS contractor shall employ or subcontract factory trained Ebtron technician as part of this contract to assist in design and to inspect all outside air measurement installations and assist in calibrating and adjusting the Ebtron outside air sensors as required to meet final balancing setting to provide accurate BMS monitoring and control.

3. Air Flow Measurement Stations - Fan Array
a. Probe and Sensor Node Configurations
1) Fan Arrays (less than or equal to 4 fans): 2 probes x 1 sensor node per probe or 1 probe x 1 sensor node per probe in each fan
2) Fan Arrays (greater than 4 fans): 1 probe x 1 sensor node per probe in each fan (8 probe maximum)

b. Installed Airflow Accuracy
1) ±(3% to 10%) of reading, depending on fan type and installation.

c. Sensor Node Averaging Method
1) Airflow: Independent, arithmetic average per fan
2) Temperature: Independent, velocity weighted average

d. Listings and Compliance
   1) UL: UL-873 and CSA C22.2 No. 24
   2) BACnet International: BTL Listed (GTC108 and GTM108 transmitters)
e. Environmental Limits
   1) Temperature:
      a) Probes: -20 to 160 ºF [-28.9 to 71.1 ºC]
      b) Transmitter: -20 to 120 ºF [-28.9 to 48.9 ºC]
   2) Humidity: (non-condensing)
   3) Probes: 0 to 100%
   4) Transmitter: 5 to 95%
f. Sensing Node Sensors
   1) Self-heated sensor: Precision, hermetically sealed, bead-in-glass thermistor
   2) Temperature sensor: Precision, hermetically sealed, bead-in-glass thermistor
g. Sensing Node Housing
   1) Material: Glass-filled Polypropylene
   2) Sensor Potting Materials: Waterproof marine epoxy
h. Airflow Measurement
   1) Accuracy: ±2% of reading to NIST-traceable airflow standards (includes transmitter uncertainty)
   2) Calibrated Range: 0 to 10,000 fpm [0. to 50.8 m/s]
   3) Calibration Points: 16
   4) Temperature Measurement
   5) Accuracy: ±0.15 ºF [0.08 ºC] to NIST-traceable temperature standards (includes transmitter uncertainty)
   6) Calibrated Range: -20 to 160 ºF [-28.9 to 71.1 ºC]
   7) Calibration Points: 3
i. Sensor Probe Assembly
   1) Mounting Rods
      a) Material: Zinc plated steel
   2) Mounting Brackets
      a) Material: 304 stainless steel
   3) Probe to Transmitter Cables
      a) Type: FEP jacket, plenum rated CMP/CL2P, UL/cUL listed, -67 to 302 ºF [-55 to 150 ºC], UV tolerant
      b) Standard Lengths: 10, 25, and 50 ft. [3.1, 7.6 and 15.2 m]
   4) Connecting Plug: 9/16” [14.29 mm] nominal diameter with gold-plated connector pins
j. Power Requirement:
   1) 24 VAC (22.8 to 26.4 under load) @16V-A
k. User Interface:
   1) 2 line x16-character backlit LCD display and 4 button interface

l. BMS Connectivity
   1) All Transmitter: Three field selectable (0-5/0-10 VDC or 4-20mA), scalable and isolated analog output signals (AO1=airflow,AO2=temperature or alarm, AO3=Not used.
   2) GTC108e Transmitter: One additional field selectable (BACnet MS/TP or Modbus RTU) and isolated RS-485 network connection - Individual sensor node airflow rates and temperatures are available via the network (as applicable)
   3) GTM108e Transmitter: One additional isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection – Individual sensor node airflow rates and temperatures are available via the network
m. Airflow Alarm
   1) Type: Low and/or high user defined setpoint alarm
n. Tolerance: User defined % of setpoint
o. Delay: User defined
p. Zero Disable: Alarm can be disabled when the airflow rate falls below the low limit cutoff value (unoccupied periods)
q. Reset Method: Manual or automatic
r. Visual Indication: Yes, LCD display
s. Network Indication: Yes (GTM108 and GTC108 only)
t. Analog Signal Indication: Yes, on AO2 assignment
u. Fan Alarm
v. Type: Minimum airflow, % deviation from median airflow, or % deviation from maximum airflow stored in memory
w. Tolerance: User defined % of setpoint
x. Delay: User defined
y. Zero Disable: Alarm can be disabled when the airflow rate falls below the low limit cutoff value (unoccupied periods)
z. Reset Method: Manual or automatic
aa. Visual Indication: Yes, LCD display
bb. Network Indication: Yes (GTM108 and GTC108 only)
cc. Analog Signal Indication: Yes, on AO2 assignment
dd. System Status Alarm
ee. Type: Sensor diagnostic system trouble indication
ff. Visual Indication: Yes, LCD display
gg. Network Indication: Yes
hh. Analog Signal Indication: Yes, on AO2 assignment
ii. EB-Link Bluetooth Interface for Android® and iPhone®:
jj. Download individual sensor node airflow/temperature data, settings and diagnostics

4. Airflow/Temperature Measurement Devices
   a. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans and/or schedule.
   b. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices unless an authorized EBTRON representative deems duct work to be too restrictive for probes. Written authorization is required by EBTRON and the specifying engineer.
   c. FLOW STATION CONSTRUCTION:

1) Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
2) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
3) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
4) The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.
5) The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.
6) Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.
7) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
8) Devices using less than two thermistors in each sensor assembly are not acceptable.
9) Devices using platinum wire RTDs are not acceptable.
10) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
11) Pitot tubes and arrays are not acceptable.
12) Vortex shedding devices are not acceptable.

d. ALL SENSOR PROBES
1) Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.
2) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
3) Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range.
4) Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
5) Temperature accuracy shall be +/-0.15° F over the entire operating temperature range of -20° F to 160° F.
6) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).
7) Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
8) Each sensor assembly shall not require matching to the transmitter in the field.
9) A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

e. DUCT AND PLENUM PROBES
1) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
2) Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
3) Insertion mounted through the side or top of the duct
4) Internally mounted inside the duct or plenum
5) Standoff mounted inside the plenum
6) The number of sensor housings provided for each location shall be as follows:

f. Duct or Plenum Area g. (sq.ft.)	h. Total # Sensors / Location
i. <2	j. 4
k. 2 to < 4	l. 6
m. 4 to < 8	n. 8
o. 8 to <16	p. 12
q. >=16	r. 16

1) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

s. TRANSMITTERS
1) The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor assembly.
2) The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.
3) The transmitter shall have a power switch and operate on 24 VAC (isolation not required).
4) The transmitter shall use a switching power supply fused and protected from transients and power surges.
5) The transmitter shall use "watch-dog" circuitry to assure reset after power disruption, transients and brown-outs.
6) All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
7) The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be installed at a location that is protected from weather and water.
8) The transmitter shall be capable of communicating with other devices using one of the following interface options:
9) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
10) RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus

11) BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
12) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP
13) Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.
14) LonWorks Free Topology
15) The transmitter shall be capable of accepting an infra-red interface card for downloading airflow and temperature data or uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).
16) Provide PDA upload/download software.
17) Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rate, individual sensor temperatures and the average temperature received from the transmitter.
18) Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.
19) Provide a Microsoft Excel file capable of creating balance reports from PDA data files transferred to a Windows 98 or higher based PC.
20) Provide a Microsoft Excel file to create configuration data files that can be transferred from a Windows 2000, Windows XP or higher based PC to a PDA for upload to one or more transmitters.
21) The ATMD shall be UL listed as an entire assembly.
22) The ATMD shall carry the CE Mark for European Union shipments.
23) The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.
24) A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

t. INSTALLATION
1) Install airflow / temperature measurement devices in accordance with manufacturer's instructions at the locations indicated on the plans.
2) A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.
3) Install labels and nameplates to identify control components according to Section 23 33 00 or 25 35 00.
4) Install electronic cables according to Section 25 05 00 "Common Work Results for Integrated Automation."
5) Install low-voltage power, signal and communication cable according to Sections 25 05 13 "Conductors and Cables for Integrated Automation," 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and/or 27 15 00 "Communications Horizontal Cabling."

u. ADJUSTING
   1) Duct and plenum devices shall not be adjusted without approval from the consulting mechanical engineer.

v. ACCEPTABLE MANUFACTURERS
   1) Subject to compliance with requirements of this Section, provide products that comply with this specification by one of the following vendors:
   2) EBTRON, Inc. Model GTx116-P (basis of design)
   3) Kurz Instruments
   4) Fluid Components International (FCI)
   5) Alternatives requesting acceptance as "equals" less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered. For any product to be considered for substitution a written section-by-section detailed exceptions/compliance document shall be submitted to the Engineer before any approval will be considered. Before a product can be considered as an equal to EBTRON for substitution to this specification, a "non-fan powered" working demo must be made available for a side by side evaluation to EBTRON in the specifying engineer's office. The products must demonstrate accurate airflow measurement, repeatability and response time as well as specification compliance. Providing a working demo in and of itself does not constitute the products approval.

5. Liquid Flow - Magnetic Flow Meter
   a. The flow transmitter shall be a full sized magnetic flow meter.
   b. The flow meter shall be field-programmable with all site criteria being capable of input or change on-site by the use of plug-in hand-held terminal. All programming will be menu-driven and input in plain English.
   c. System Requirements
      1) Intrinsic Accuracy: Within 1 percent of actual flow above 1 fps.
      2) Calibrated Accuracy: 0.5 percent of actual flow above 1 fps.
      3) Flow Range Ability: Bidirectional including active zero sensitivity.
      4) Sensitivity: 0.001 ft./sec.
      5) Respectability: High precision: 0.15%.
   d. Flow Transmitter
      1) The flow transmitter shall be solid state design utilizing high reliability circuit elements and compound shall be micro-computer controller. The transmitter shall be housed in a NEMA 4X enclosure suitable for remote mounting. The transmitter shall be furnished with built-in fault alarm, and self diagnostic program to accurately track the metering systems performance. The programming shall be battery backed in RAM.
      2) The transmitter shall be equipped with an isolated 4-20 ma output signal, proportioned to flow, and be able to drive a restive load of up to 800ohms.
   e. The flow meter shall be provided will flow sizing calculation data.
   f. Manufacturer / Model
      1) Rosemount / Sensor Model 8705, Transmitter Model 8732C

E. Energy Metering System

1. Water Metering System
   a. Liquid Flow - Magnetic Flow Meter
      1) The flow transmitter shall be a full sized magnetic flow meter.
      2) System Requirements

         a) Intrinsic Accuracy: Within +/-0.25 percent of actual flow 0.04 to 6 fps

         b) Flow Range Ability: Bidirectional including active zero sensitivity.

         c) Sensitivity: 0.001 ft./sec.

         d) Repeatability: High precision: 0.15%.
      3) Flow Transmitter

         a) The flow transmitter shall be solid state design utilizing high reliability circuit elements and compound shall be micro-computer controller. The transmitter shall be housed in a NEMA 4X enclosure suitable for remote mounting. The transmitter shall be furnished with built-in fault alarm, and self-diagnostic program to accurately track the metering systems performance. The programming shall be battery backed in RAM.

         b) The transmitter shall be equipped with an isolated 4-20 ma output signal, proportioned to flow, and be able to drive a restive load of up to 800ohms.
      4) The flow meter shall be provided will flow sizing calculation data.
      5) The flow meter shall be field-programmable with all site criteria being capable of input or change on-site by the use of plug-in hand-held terminal. All programming will be menu-driven and input in plain English.
      6) Manufacturer / Model

         a) Rosemount / Sensor Model 8705, Transmitter Model 8732C
   b. Precision matched RTDs: 1,000 ohm platinum
      1) Differential Temperature Accuracy: 0.2 Deg F (with ice bath calibration).
      2) Transducers: (High Temperature)
   c. Installation, programming and Start-Up
      1) The manufacturer and/or factory representative of the energy meter shall provide field supervision at the project site for the installation of the metering equipment. The manufacturer and/or factory representative of the meter shall provide on-site programming of the meter, installation check and commissioning of the meter.
   d. Energy Meter

1) Provide a Kessler Ellis Products Supertroll II energy flow meter (with matched supply and return temperature sensors) for hot and chilled water BTU measurement applications.
2) Provide local LCD display and wire-on-tag with instrument service information.
3) NEMA 4X front.
4) The computer shall have on board self-diagnostics, and ROM based stored fluid properties for water.
5) The computer shall be capable of a Modbus RTU output for all the device parameters monitored including, but not limited to instantaneous flow.
6) Energy meter shall be provided with manufacturer's gateway to convert meter data from Modbus/RTU to BACnet/MSTP for compatibility with BMS.

e. Training
1) The manufacturer and factory representative of the flow-meter shall provide a minimum of one half-day of operation orientation and instruction on the operation of the flow-meter consecutive with the installation of the flow meter.

F. Miscellaneous Sensors

1. Humidity Sensors
a. The assembly shall consist of a humidity sensor utilizing a resistance change bulk polymer sensing element mounted in a housing suitable for the following applications – Outdoor, Return, and Space.
b. Sensor Humidity Operating Range: 0 to 100%.
c. Accuracy: ±2.5% RH between 50 and 104 DegF.
d. Repeatability: 0.5% RH/year
e. Sensitivity: 0.4%RH
f. Hysteresis: Less than 1%.
g. Stability: Better than 1.0% RH over a year. (Long term stability)
h. Temperature effect: Temperature compensated with less than 0.06% per °F.
i. Supply voltage: 18-38 VDC
j. Output: Two-wire loop-powered, 4-20 ma, %0 to 100% linear
k. Adjustments: One point with calibrator (duct mounted applications).
l. Operating temperature: -40°F to 130°F
m. Storage temperature: -85°F to 158°F
n. Max load: (Supply voltage 10VDC)/0.02, 700Ohms@ 24VDC
o. Connections screw terminals for loop terminations.
p. Provide 2 years warranty.
q. Sensor manufacturer shall send samples, mounting options and appearance to architect for approval prior to shipment.
r. Manufacturer - Vaisala

2. Combination Temperature and Humidity Sensors
a. The assembly shall consist of a temperature and humidity sensor mounted in a ventilated housing suitable for wall mounting.
b. Coordinate Temperature Sensor faceplate requirements with architect/ owner and engineer.

c. Faceplates options shall include color, blank faceplate option, display faceplate option, setpoint adjustment option and occupied/unoccupied override option) Submit for approval.
d. Humidity Sensor
   1) Sensor Humidity Operating Range: 0 to 100%.
   2) Accuracy: ±2.5% RH between 50 and 104 DegF.
   3) Repeatability: 0.5% RH/year
   4) Sensitivity: 0.4%RH
   5) Hysteresis: Less than 1%.
   6) Stability: Better than 1.0% RH over a year. (Long term stability)
   7) Temperature effect: Temperature compensated with less than 0.06% per °F.
e. Temperature Sensor
   1) Sensor Operating Range: 20 DegF to 120 DegF
   2) Accuracy: ±1 DegF.
   3) Repeatability: 0.5% RH/year
   4) Sensitivity: 0.4%RH
   5) Hysteresis: Less than 1%.
   6) Stability: Better then 1.0% RH over a year. (Long term stability)
f. Output: Two - Two-wire loop-powered, 4-20 ma, %0 to 100% linear
g. Adjustments: One point with calibrator (duct mounted applications).
h. Operating temperature: -40°F to 130°F
i. Storage temperature: -85°F to 158°F
j. Max load: (Supply voltage 10VDC)/0.02, 700Ohms@ 24VDC
k. Connections screw terminals for loop terminations.
l. Provide 2 years warranty.
m. Manufacturer - Vaisala

3. Carbon Dioxide Sensor – Duct Mounted
   a. Provide duct mounted carbon dioxide infrared microprocessor based sensor.
   b. Measurement range of 0 to 2000 PPM; accuracy +/-40 ppm (+/- 3% of reading)
   c. Analog Output: 4-20mA or 0-10VDC and Modbus proportional output signal, temperature compensated Maximum drift of ±100 PPM per year.
   d. Relay Output: 1 DPDT contact 5A, 30 VDC or 250VAC, Alarm contacts to close when user defined setpoint is reached. Adjustable alarm limit of 0 to 2000 PPM, factory set at 1000 PPM of carbon dioxide.
   e. Microprocessor based offset algorithm to automatically compensate for drift.
   f. Maximum response time: < 60 sec.
   g. Power requirements: 24VAC/VDC 200mA
   h. Manufacturer / Model
      1) Vulcain / 90DM3A

4. Carbon Dioxide Sensor– Wall / Surface Mounted
   a. The carbon dioxide sensor shall provide an output signal correspondence linearly to 0-2000 ppm/0-5000 ppm (user adjustable) of CO2 using Non-dispersive Infrared (NDIR) technology.
   b. The CO2 concentration shall be determined by measuring the attenuation of a specific wavelength of infrared light travels from its source to a

detector along a defined optical path. The sensor shall detect the amount of attenuation and convert it into a 0 to 10 VDC analog output signal, which corresponds linearly to 0 to 2000 ppm sensed concentration of CO2.

c. The sensor features shall have a membrane filter to help prevent contaminants from entering the sensing chamber and yet remain permeable to CO2.
d. A microprocessor-based offset compensation algorithm shall automatically compensate for drift. The compensation algorithm shall include a self-test that can detect problems (such as excessive drift) and initiate an alarm signal.
e. In addition to compensating for drift, the microprocessor shall speed the full calibration process by automatically adjusting the span (of the 0 to 2000 ppm output range). One easy accessed button shall complete this process.
f. Provide a separate 24 VAC transformer and power and control wiring.
g. The sensor shall be suitable for duct and space mounting as shown on the drawings. Provide carbon dioxide sensors as quantified in device schedule and shown mechanical drawings.
h. Sensor minimum requirements:
    1) Accuracy ±30 ppm + 2 % of reading (at room conditions).
    2) Repeatability ±10ppm CO2
    3) Maximum Drift ±50ppm CO2 per year
    4) Output Signal 0 to 10 VDC/4-20 mA proportional over the 0 to 2000 ppm/0-5000ppm CO2 range
i. Alarm Relay: SPST normally open dry rated for 10W maximum, 100 or 500 mA DC maximum with adjustable limit (0-2000 CO2 factory set at 1000ppm ±50ppm CO2)
j. Alarm Set Resolution ±20ppm CO2 minimum
k. Alarm Hysteresis 50ppm CO2
l. Calibration Adjustments Automatic zero compensation and span calibrations; uses calibrated span and zero.
m. Calibration interval – greater than two (2) years
n. Adjustment Resolution 20ppm CO2 minimum
o. Response Time: <30 seconds to 63 percent of step change, <60 seconds to 100 percent of step change
p. Warm up time: 5 minutes
q. Ambient Operating Conditions 32 to 122°F
r. 5 to 95 percent RH, non-condensing
s. Provide a calibration kit (flow system type) including zero gas and test carbon dioxide gas. Turn over complete kit to owner at warranty start date
t. Provide weatherproof enclosure for outdoor air mounting
u. Manufacturer / Model
    1) Vaisala / GMW90.

5. Gas Detection System – Garage CO & NO2
    a. Gas detection system shall be designed to alarm and initiate ventilation via the BMS upon the presence of Carbon Monoxide (CO) and Nitrous Oxide (NO2) generated by the operation of vehicles within the garage,

loading dock areas and similar spaces. The system shall consist of the following:

b. Controller
   1) Controller shall be a microprocessor based system, complete with power supplies, input and output modules, real time clock, memory, processors and all other items necessary for proper and correct interfacing with the gas monitoring system devices, operation of the control functions as described in the sequence of operations and the BACnet network communications capabilities as required by the BACnet building management system (BMS). The BACnet communication feature shall allow the BMS the capability of remote monitoring of the sensors as well as the status of the system.
   2) The controller shall be provided with additional expansion I/O modules as required capable of accepting binary, analog, and providing binary and analog outputs. The controller shall be modular and be capable of future field upgrades to include additional modules and sensors.
   3) The system controller shall be capable of communicating digitally with networked gas sensors and annunciator assemblies through three RS485 communication busses. Each bus shall be capable of accepting 32 devices including sensors, relay modules, annunciator panels, and horn/strobe modules.
   4) Each controller shall have an indicator which shows each sensors gas value as it sequences through the sensors. It shall immediately terminate the sequence and display any sensor in alarm and its location. The panel shall have a minimum 65 dB audible alarm and a silence switch. The panel will have a real time clock and shall be capable of timed operation of external devices such as fans should the application warrant it.
   5) The controller shall operate from a 120VAC/24VAC low voltage supply as provided by the manufacturer.
   6) The controller(s) shall be wall mounted in NEMA 4X enclosures.
c. Central Control Panel shall meet the following requirements:
   1) Each channel shall have 3 concentration levels and a fault alarm.
   2) Internal battery backup for complete operation of system for up to ½ hour of power loss.
   3) Digital display of concentration and alarm condition
   4) Event data logger
   5) Manual reset pushbutton
d. Sensors
   1) CO and NO2 sensors shall be of the electrochemical type. Each sensor shall be addressable over the RS485 bus. Each sensor shall include a local DPDT relay. All sensors shall be installed per manufacturer’s recommended installation. Sensors shall have a minimum radius of coverage of 50ft.
   2) Sensors shall be powered by low voltage as provided by the system controller.
   3) Sensors shall operate and report to the controller continuously. Sample draw type systems shall not be permitted.
   4) Gas sensor shall meet the following requirements

a) Loop powered

b) Local Display and keypad.(model dependent)

c) Display concentration, output and fault condition

d) NEMA 4x Enclosure.

e) Automatic Temperature Compensation

e. Warning /Activation Assemblies
   1) Warning /activation assemblies shall be provided and located by the main exits.
   2) The assemblies shall be comprised of a beacon, strobe and pushbutton/reset pull station.
f. Startup service shall be provided by a factory trained technician
g. Test and Calibration Equipment
   1) All necessary calibration and testing equipment shall be provided to perform the testing, commissioning and acceptance testing as part of the deliverable.
h. Test and Calibration Equipment
i. All necessary calibration and testing equipment shall be provided to perform the testing, commissioning and acceptance testing as part of the deliverable
j. Manufacturer:
   1) Sensidyne
   2) MSA
   3) Or Approved Equal.

6. Carbon Monoxide Detection System
   a. Provide a UL listed gas semiconductor or electrochemical sensors in an enclosure suitable for loading dock applications networked to a gas detection controller.
   b. BMS Contractor to provide wiring, conduit, relays, etc., for a complete system.
   c. Controller
      1) Fully programmable with up to 2 levels of alarm plus system fault relay to initiate the area exhaust fans and notification devices
      2) Controller shall be Modbus or BACnet compatible with capability to manage the total number of sensors required or a maximum of 96 transmitter inputs
      3) Back lit Alphanumeric or LED display
      4) Relay Outputs: a minimum of 4 DPDT contacts 5A, 30 VDC or 250VAC rated, shall be supplied in order to notify alarm status to the BMS
      5) Audible Output: minimum 65dBA Alarm with local reset button
      6) Enclosure shall be designed for use in NEMA 4X installations
      7) Controller shall be design to communicate with a network of sensors (RS-485 Modbus) and include the capability to provide digital communication output of BACnet or Modbus.
   d. Warning /Activation Assemblies

1) Warning /activation assemblies shall be provided and located by the main exits.
2) The assemblies shall be comprised of a beacon, strobe and pushbutton/reset pull station.

e. Manufacturer:
1) Sensidyne
2) MSA

7. Current Transducers - Analog Output
a. Provide and install split core current sensors to interface with the DDC system as described in Sequence of Operations and as shown on Control Drawings.
b. Units shall be UL listed.
c. Each sensor shall be two wire, loop powered and sized for expected amperage.
d. Analog Output Current Transducer
e. Typical installations used for the determination of current consumption of fan and pump motor in remote starter enclosures.
f. Power requirements: Self powered, 0-60 Amp rating
g. Output: 0-5 VDC
h. Accuracy +/-2.0% Full scale
i. Manufacturer: Veris - Hawkeye H922

8. Current Transducers - Analog Output - Variable Frequency Drive Applications
a. Typical installations used for the determination of VFD driven fan and pump motor status points in remote starter enclosures.
b. Self-adjusting setpoint, automatic compensation for effects of frequency and amperage changes related to VFD (insensitive to frequencies 10-80 hz)
c. Current sensor 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. Power requirements: Self powered induced from line
e. Accurate to 0.5% full scale
f. Output: 4-20mA
g. Manufacturer: Veris - Hawkeye H720

9. Digital Output Current Switch
a. Typical installations used for the determination of fan and pump motor status points in remote starter enclosures.
b. 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.
c. Power requirements: Self powered induced from line
d. Adjustable setpoint 2.5-135A
e. Output: One normally open contact; 1 A rating at 30VAC/VDC
f. Manufacturer: Veris - Hawkeye H908

10. Digital Output Current Switch (Variable Frequency Drive Applications)
a. Typical installations used for the determination of VFD driven fan and pump motor status points in remote starter enclosures.

b. Self-adjusting setpoint, automatic compensation for effects of frequency and amperage changes related to VFD
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. Power requirements: Self powered induced from line
e. Output: One normally open contact; 0.1 A rating at 30VAC/VDC
f. Manufacturer: Veris - Hawkeye H904

11. Digital Output Current Switch (Electronically Commutated Moter (ECM) Applications)
    a. Typical installations used for the determination of ECM controlled fan and pump motor status points in remote starter enclosures.
    b. Adjustable minimum turn-on to prevent false trip due to ECM stand-by current
    c. Current sensing switches shall be split core.
    d. 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.
    e. Power requirements: Self powered induced from line
    f. Output: One normally open contact; 1.0 A rating at 30VAC/VDC
    g. Manufacturer: Senva C-2320-L-ECM

12. Occupancy Sensors
    a. Occupancy sensors shall be provided to interface with the DDC system as described in Sequence of Operations.
    b. Occupancy Switch can be combined with space temperature sensor. Sensor shall use either passive infrared or ultrasonic technology with sensitivity adjustment
    c. Power requirements: 24 VDC
    d. Output: 2 Form C contacts; 1 A rating at 24VDC
    e. Manufacturer:

13. Water Leak Detection Sensors - Point
    a. Water leak detection sensors shall be provided to interface with the DDC system as shown on Control Drawings.
    b. Sensors: Shall be comprised of two gold-plated sensing probes for corrosion resistance and microchip technology for dependable and accurate detection of conductive liquids. Supervised operation—signals on leak detected, circuit failure or power loss
    c. Power requirements: 24 VAC/VDC, 100mA, 50/60Hz, 3 VA (max)
    d. NEMA 1 Enclosure
    e. Output: 2 Form C contacts; 3 A rating at 24VAC
    f. Manufacturer: Emerson, Liqui-tect

14. Water Leak Detection System - Areas
    a. Provide advanced system water leak detection system for detecting water in individual area and area floor drain as reflected in drawings.
    b. The liquid sensing cable shall detect the presence of water and other conductive liquids. The cable shall consist of four wires: two wires serve as liquid sensors and two other wires serve as continuity and alarm signal links. All four wires shall be helically winded around a central core

(function as carrier) and away from the surface area of this core (to protect the four wires physically). The cable shall be made of material which is non-flame propagating and self-extinguishing.

c. The sensing cables shall be of such construction that no metallic parts shall be exposed to the environment. The system shall be provided with the flexibility of custom "cut-to-length" sensing cable to meet the exact length requirement at each AHU gallery and with pre-connectors sensing cable components. The cable shall be UL listed and FM approved.

d. Provide all mounting clips and accessories for a complete system.

e. Sensing cable in each area shall be connected to its independent detection system via leader cable. System shall consist of a main control panel and interface modules. Each main panel system (mounted on wall) shall provide a dry contact upon detection of water in floor drain to BMS. Each main panel system shall be capable of monitoring up to 5000 ft of sensing cable.

f. Main Panel:
   1) Summary relay contacts, LED status lights, LCD information display at the panel.
   2) Standard external interface modes include:
      a) dry contacts
      b) BACnet MSTP communication.
   3) Event history accessible from the front panel or via serial port to identify type of event, time, location, and other parameters for all sensor events or user adjustments and interventions.
   4) Layered password protection for setup changes.
   5) Adjustable sensitivity and selectable measurement units.
   6) Universal power supply for 120/240 Vac 50/60 Hz.
   7) Non-volatile memory for event history, setup and network configuration.
   8) Precision to locate leak: ± 0.5% maximum of circuit length.

g. Interface / Auxiliary Module:
   1) Monitor up to 500 feet (150 meters) of sensing cable.
   2) Precision: 0.5% of sensor length ±2 ft (0.6m).
   3) Voltage-free contact for alarm signaling.
   4) LED indicators.
   5) Serial connection between modules and main panel up to 4000 feet witout amplification.
   6) Power supplied by Main panel.
   7) Provide with NEMA 4 enclosure.

h. Leak detection system panel shall be able to operate between within 32 deg F (0 deg C) to 122 deg F (50 deg C) and 5 to 95% RH. Provide laminated or framed (glass or plastic protective cover) leak detection identification map indicating the leak detection system layout with reference points. Install a map in each associated area.

i. Approved Manufacturers
   1) Trace Tek (Raychem)
   2) ELSA
   3) Liebert

4) Pentair
5) Approved equal

15. Window Position Switches
    a. Provide and install window switches according to design drawings and manufacturer installation requirements.
    b. Coordinated installation with Architect
    c. Get written approval of final selection and installation method of devices with architect
    d. Manufacturer - Sentrol
    e. Model- Guardswitch Series 100

16. Door Switches
    a. Provide and install door switches according to design drawings and manufacturer installation requirements.
    b. Coordinated installation with Architect
    c. Get written approval of final selection and installation method of devices with architect
    d. Manufacturer – United Security
    e. Model- SP3000A

G. Automatic Control Valves

1. Control valves assemblies shall be provided and delivered from a single manufacturer as a complete assembly.
2. The manufacturer shall warrant all components for a period of 5 years from the date of production with the first two years unconditional.
3. Characterized Control Valves - Modulating
    a. Control valves shall be globe or characterized ball valves.
    b. A TEFZEL flow-characterizing disc shall be installed in the inlet of two-way characterized control valves and in the control port of three-way valves. The valve trim shall utilize a stainless steel ball and stem for all water or glycol solutions up to 60%. For water applications, an optional chrome plated brass ball and brass stem may be used for sizes ¾” and smaller.
    c. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1 ¼” shall be rated at 600 psi and sizes 1 ½” to 3” at 400 psi.
    d. Characterized Control Valves shall have a self-aligning, blowout proof, brass stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon seats shall be used.
    e. The valves shall have a four bolt mounting flange to provide a 4 position, field changeable, electronic actuator mounting arrangement.
    f. A non-metallic coupling, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

4. Two Position Control Valves
    a. Control valves shall be globe or ball valves.
    b. Line size full ported valves shall be used to minimize pressure drop.

c. The valve trim shall utilize a stainless steel ball and stem for all water or glycol solutions up to 60%. For water applications, an optional chrome plated brass ball and brass stem may be used for sizes ¾" and smaller.
d. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1 ¼" shall be rated at 600 psi and sizes 1 ½" to 3" at 400 psi.
e. Valves shall have a self-aligning, blowout proof, brass stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon seats shall be used.
f. The valves shall have a four bolt mounting flange to provide a 4 position, field changeable, electronic actuator mounting arrangement.
g. A non-metallic coupling, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

5. Valve Actuators:
a. Valve actuators shall be electric, and properly selected for the valve body and service. Actuators shall be fully proportioning and be fail in place, spring return for fail open or fail closed operation as specified. Floating control actuators shall not be acceptable.
b. The controls contractor shall provide control power transformers for valve actuators for low voltage operation as required.
c. If upon contractor's final sizing of valve and actuators it has been determined that the power required for the assembly exceeds the power available from the BMS control panel, the contractor shall coordinate with the Div. 26 contractor for additional power.
d. Manufacturer:
1) Belimo

6. Thermostatic radiator valve
a. Assembly shall be selected to maintain room temperature within ±1°F.
b. The operator shall be of a bellows design with a vapor or liquid charge and shall be connected to the valve via a snap-on fast mounting system or secured by an Allen screw.
c. The thermostatic operator shall be capable of temperature adjustment between 45° and 86°F (7 and 30°C) and be locked and limited by the use of limiting pins or internal mechanism.
d. The valve shall be of nickel plated brass construction with a fully replaceable packing gland capable of replacement while the system is in operation. The valve disc shall be constructed of EPDM, capable of withstanding 250°F (121°C).
e. Provide a separate remote wall mounted dial and remote sensor (as applicable).
f. The thermostatic radiator valve and accessories shall be Danfoss or an approved equal.

H. Dampers

1. Motorized Control Dampers

a. Motorized Control Dampers shall have 13 gauge galvanized frames of not less than 3" in width and blades of 16 gauge, or double 22 gauge, galvanized steel and shall be adequately braced to from a rigid assembly where required in galvanized ductwork. Dampers shall have blades not more 8" wide. Linkage and hardware shall be zinc plated steel. Damper blades and rods shall be installed in horizontal position.
b. All dampers shall be of the opposed blade type, and shall be electric motor operated. Dampers shall have continuous elastomer or stainless steel stops to avoid leakage. Bearings shall be oil tight non-ferrous sleeve type. All dampers shall be provided with continuous 3/16" x 1/2" closed cell neoprene gasketing around perimeter of the frame and at interlocking blade edges to form an airtight seal.
c. All dampers shall be constructed to provide a maximum leakage in accordance with ASHRAE/IES 90.1 and tested to ANSI /AMCA Std 500. Submit leakage and flow characteristic data for all dampers.
d. All outside air dampers shall automatically close in the event of a loss of power, unless otherwise noted.
e. Outdoor air applications in costal environments shall be provided with TAMCO SW (saltwater), Ruskin CE or approved equal, construction features
f. Dampers shall be Imperial, Ruskin or approved equal.

2. Damper Operators:
   a. Damper operators shall be electric, spring return or fail in place, and shall be properly sized so as to stroke the damper smoothly and efficiently throughout its range. Actuator response shall be linear in response to sensed load.
   b. The controls contractor shall provide control power transformers for damper actuators for low voltage operation as required.

3. Damper End Switches
   a. Damper end switches shall comprise of high temperature micro switches, mercury switches are not acceptable.
   b. Damper end switch shall comprise of one switch which closes when the blades are fully open and the second switch closes when the blades are fully closed
   c. Damper end switches shall be provided for each actuator controlled damper section. If more than one end switch is provided for a damper assembly, the wiring of damper section end switches in parallel is acceptable.
   d. Manufacturer: Ruskin

I. Electrical metering devices

1. Division 26 shall provide electrical meters which shall provide inputs to the BMS via a Modbus or BACNET communications protocol. Refer to Division 26 specifications for additional details as to the data being monitored. The interface shall allow for full monitoring of the device encompassing multiple inputs to the BMS.

J. Field Equipment Cabinets:

1. All indoor control cabinets shall be fully enclosed NEMA 1 (minimum, see NEMA rating for enclosures within this specification) construction with (hinged door) key-lock latch and removable sub panels. A single key shall be common to all field panels and sub panels. All transformers, electric relays, manual override switches, etc., shall be mounted within the enclosure and factory wired to terminal strips.
2. Interconnections between internal and face mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service (or in accordance with line voltage), individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.
4. Provide 6" x 6"trough the width of the control panel, minimum 24" in length, above the control panel to provide an entrance for cabling and tubing into the panel, with 50% spare nipple capacity.
5. Panels shall be located to avoid conflicts with ductwork, piping, equipment, the work of other trades, and building conditions. Panel locations indicated on the Drawings shall be coordinated prior to installation and adjusted to avoid conflicts.

K. Test and Calibration Equipment

1. All necessary calibration and testing equipment shall be provided to perform the testing, commissioning and acceptance testing as part of the deliverable.

L. Component Tags

1. Valve Tags:
   a. All automatic and manual valves provided by this contractor, shall be identified with 2" diameter brass tags and brass chains. Lettering shall be 1/2" high, stamped and painted black. Automatic valve tags shall be stamped with the letters "AV" and sequentially numbered. Provide valve schedule and sample tags for approval.
2. Sensor Tags:
   a. All sensors/instruments shall be identified with 1"x 3" black lamacoid labels with engraved white lettering. Lettering shall be 1/4" high. Provide sensor number, Air handling unit number/pump/source equipment (as relevant), part number and sensor range on tag.

PART 3 - EXECUTION

3.1 Building MANAGEMENT SYSTEM - GENERAL

A. Space mounted devices are to be identical in appearance. All devices shall be mounted under the same style cover.

B. Provide all relays, switches, sources of electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified.

C. Install controls so that adjustments and calibrations can be readily made.

D. Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.

E. Conceal control conduit and wiring in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install control conduit and wiring in parallel banks with all changes in directions made at 90 degree angles.

F. Install control valves horizontally with the power unit up. Installation of control valves will be by the Division 23 Contractor.

G. Unless otherwise noted, install wall mounted sensors, thermostats and humidistats at 5'-0" above the finished floor measured to the centerline of the instrument. Submit device locations, mounting heights and details for approval.

H. Install outdoor thermostats in perforated tube and sun shield or engineer approved installation assembly designed for application.

3.2 PNEUMATIC TUBING & INSTALLATION

A. Concealed spaces: Pneumatic tubing shall be polyethylene tubing.

B. Exposed: Where pneumatic tubing is installed in exposed areas susceptible to damage (i.e., located outdoors, exposed to heavy pedestrian or maintenance traffic), tubing shall be polyethylene tubing installed in conduit.

C. Splicing of pneumatic tubing is not acceptable.

3.3 SENSOR TUBING & INSTALLATION

A. Concealed spaces: Tubing shall be copper tubing.

B. Exposed: Where tubing is installed in exposed areas susceptible to damage (i.e., located outdoors, exposed to heavy pedestrian or maintenance traffic), tubing shall be installed in conduit.

3.4 ELECTRICAL INSTALLATION

A. General

1. For conduit support and installation of wires and cables see applicable paragraphs of the latest edition of the NEC.

B. Raceways and Conduit

1. All conduit/cable entry to control panels shall be from the bottom or sides to prevent condensation from draining into electronic equipment contained within.
2. Conduit / EMT percent fill shall not exceed maximum NEC allowable fill.
3. Use liquid tight flexible metal conduit for making connections at instruments and devices mounted on piping or vessels or on equipment subject to vibration.

C. Wiring

1. Line voltage wiring, concealed or exposed, shall be installed in accordance with Division 26, local electrical code and the NEC.
2. Low voltage data transmission wiring, except the primary peer-to-peer communications trunk,
   a. installed in concealed, accessible areas shall be plenum rated cable
   b. installed in concealed, non-accessible areas shall be installed in EMT(metal).
   c. installed in exposed areas, such as mechanical equipment rooms, shall be installed in EMT(metal).
3. Peer-to-peer communications including trunk low voltage data transmission and wiring between controllers shall be installed in EMT(metal).
4. Cables for 120/24 VAC wiring and low level signal wiring shall always be run in separate raceways.
5. Wire splices within conduit are prohibited under any circumstances.
6. All smoke control wiring including Fire Alarm System Relay and Monitoring Modules shall be in accordance with Division 26.
7. All wiring shall be in accordance with this specification and Division 26, including tagging, labeling and identification.
8. Controllers shall be provided with an independent terminal strip for field wiring. All control wiring internal to the panel landing direct on I/O will be done through a terminal strip. Under no circumstances will field wiring be terminated from inputs or outputs direct to the I/O controllers.

D. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements.

3.5 SEQUENCE OF OPERATIONS

A. Initial Space Setpoints – Unless otherwise noted in Sequence of Operations.

	COOLING	**HEATING**

Room Type	Temperature Setpoint (Cooling) Deg F		Temperature Setpoint (Heating) Deg F	
	Occupied	Vacancy Setback (if applicable)	Occupied	Vacancy Setback (if applicable)
Garages	N/A	N/A	60	N/A
MEP	75	80	68	60
Closets/Storage Rooms	75	80	68	60
Health Club/waiting room	72	80	68	60
Conference/meeting rooms	72	80	68	60
Office Spaces	72	80	68	60
Corridors	75	80	68	60
Locker/Dressing Rooms	75	80	68	60
Dormitory/Sleeping Areas	72	80	68	60

B. ASP and Slab Heating Radiant System
   1. General:
      a. The Heating Hot Water System is comprised of a modular ASHP, capable of providing heating hot water (HHW) to the slab. The system is arranged in a variable primary / variable secondary system.
      b. The ASHP system shall be provided with a master controller capable of staging the heat pump modules and the production of the HHW at setpoint. The BMS shall enable/disable the ASHP based on the required operation.
      c. The system shall monitor space temperatures.
      d. The system shall include both BMS and OEM Slab Temperature Controller (Tekmar or equal) to provide the functions depicted on the mechanical and control design drawings.
      e. The OEM controller shall be integrated to the BMS, contractor to coordinate with approved submittals and provide all necessary hardware, and programming to integrate.
   2. System Equipment
      a. Packaged 2 pipe Air Source Heat Pump modular system with OEM master controller and two modules.
      b. HHW Pump 1, Duty, ECM, 0% speed output - ASHP.
      c. HHW Pump 2, Duty, ECM, 0% speed output - Slab.
      d. 3 Way Blending Temperature Control valve, modulating type, fail in place, normally open to HHW recirculation.
   3. System off:
      a. When the system is off all valves, pumps, and control devices shall be in their normal positions.
   4. System on:

a. The system shall be started based on a call for space heating or manually via the BMS.
b. Once the system is started, the BMS shall
   1) Start HHWP 1 and ramp pump to minimum speed
   2) Start HHWP 2 and ramp pump to minimum speed
   3) Send an enable signal to the ASHP.
c. Once complete the BMS shall initiate HHW differential pressure, flow and temperature control sequences.

5. HHW Differential Pressure Control - ASHP HHW
   a. The HHWP 1 shall ramp up to speed and modulate to meet the ASHP water differential pressure setpoint (adj.). DP setpoint to be coordinated with the ASHP approved submittal manufacturer specific requirements, initially set to 2 psi(adj.).
6. HHW Flow Control - Slab
   a. The HHWP 2 shall ramp up to speed setpoint, setpoint to be coordinated with testing and balancing contractor.
7. HHW Temperature Control – Space Temperature
   a. The BMS shall upon proof of HHWP 2 flow, modulate the three way temperature control blending valve to meet the HHW supply temperature as measured upstream of the slab manifolds. The HHW setpoint shall be set initially to 100.
8. Alarms
   a. Space temperature is below 50 DegF (Adj.)
   b. The system pressure monitored at expansion tank shall be monitored by the BMS. On indication of a low or high pressure condition 10% deviation from setpoint an alarm will be generated on the bms workstation.
   c. The BMS shall monitor the ASHP common alarm.
   d. The BMS shall monitor the Glycol Feeder common alarm.

C. DX Packaged Air Handling Unit (DOAS-X) (OEM Controller)
1. General
   a. Packaged unit, normally off.
   b. System shall be controlled via manufacturer provided controller.
   c. BMS shall integrate to controller via BACnet or Modbus, final protocol to be determined based on approved shop drawings.
2. System Off
   a. When the system is off, all devices shall be in their normal position as stated above.
3. System Start Up
   a. The system shall be enabled via the BMS based on a time of day schedule or manual command from the BMS workstation.
   b. Whenever the system is called to run, a request to run signal (unique to system) shall be sent to the FAS. the FAS shall then command all associated FSD'S to their open position.
   c. The manufacturer provided controller shall operate the unit to meet the supply air temperature setpoints (adj – provided via the BMS) and humidity setpoints (adj – provided via the BMS) and supply and exhaust duct static pressure (adj – determined during testing and balancing).

d. The manufacturer provided controller shall include programming for fire alarm system request to run, morning warmup, and morning cooldown modes.

4. Alarms
   a. The BMS shall monitor the unit status and common alarms, in addition to any alarms provided via integration.

D. Energy Recovery Ventilator (ERV-X) (OEM Controller)
1. General
   a. Packaged unit, normally off.
   b. System shall be controlled via manufacturer provided controller.
   c. BMS shall start and stop the ERV via hardwired control to the OEM controller.
2. System Off
   a. When the system is off, all devices shall be in their normal position as stated above.
3. System Start Up
   a. The system shall be enabled via the BMS, based on a time of day schedule or manual command from the BMS workstation.
   b. The manufacturer provided controller shall operate the unit to meet the supply and return constant air flow control.
4. Alarm
   a. Status mismatch –
      1) Fan is commanded on and the fan status is off as determined by the current sensor.

E. VRF FCU SERVING BOH SPACES TYPICAL
1. The system shall be controlled via manufacturer provided thermostats, occupancy sensor (As Applicable), gas detection, leak sensor and controllers furnished with the unit.
2. BMS integration:
   a. The unit controller shall be integrated with the BMS
   b. The following points shall be provided with direct control from the BMS over the integration
      1) System enable
      2) Cooling setpoint and setback
      3) Heating setpoint and setback (If applicable)
   c. The BMS shall be programmed for occupied and unoccupied time determination of the spaces served. The schedule is to be initially set for the following;
      1) Occupied - Monday through Friday (6am to 6-pm)
      2) Unoccupied - at all other times.
   d. Temperature setpoints are to be as follows;
      1) Scheduled Occupied cooling: 75 °F(adj.)
      2) As- Applicable - Standby cooling: 77 °F(adj.) (Occupancy Sensor Based)
      3) Scheduled Unoccupied cooling: 80°F(adj.)
      4) Scheduled Occupied heating: 70 °F(adj.) (If applicable)
      5) As- Applicable - Standby heating: 67 °F(adj.) (Occupancy Sensor Based)

6) Scheduled Unoccupied heating: 60 °F(adj.) (If applicable)

e. Temperature control:
1) On a call for cooling, the manufacturer's controller shall begin to modulate fan speed and refrigerant flow to the DX coil unit in order to control to the cooling setpoint.
2) On a call for heating, the manufacturer's controller shall begin to modulate fan speed and refrigerant flow to the DX coil unit in order to control to the heating setpoint. (If applicable)
3) The mfr controller shall automatically energize the outdoor condensing unit to accommodate the temperature control requirements.

3. The BMS shall be monitor space temperature via space thermostat
4. The zone shall be monitored by OEM provided occupancy sensors (As- Applicable - refer to mechanical plans for applicability). The zone shall be indexed to the standby setpoint during scheduled occupied mode if occupancy is not detected for a period of 30 minutes (adjustable).
5. The BMS shall be monitor space temperature via space thermostat
6. Each unit shall be equipped with a high-level water sensor in the condensate pan Leak detection shall be provided by the manufacturer. If the sensor is tripped the unit shall automatically shut down.
7. Additional monitoring and alarms:
a. Normal Alarms:
1) Space temperature is {5°F} lower than the setpoint for {15 consecutive minutes}.
2) Space temperature is {5°F} higher than the setpoint for {15 consecutive minutes}.

F. VAV AND EVAV SERVING VRF TYPICAL

1. For operation of VRF refer to VRF FCU SERVING BOH SPACES TYPICAL sequence.
2. VAV - Exhaust VAV With VAV Flow Offset
a. SUMMARY
1) Variable air volume (EVAV), modulating type, fail last position.
2) The VAV consists of an exhaust air volume damper and pressure pick-up probes for airflow measurement.
b. The local VAV controller shall control the airflow to each CAV terminal box. Each terminal box shall be programmed for a design flow setpoint as measured by a flow sensor.
c. Provide a time of day schedule for each CAV. Initially set each schedule for Occupied during building business hours and Unoccupied at all other times and coordimnate with VRF schedule.
d. The terminal box flow shall be indexed to the unoccupied flow setpoint during unoccupied hours in accordance with the mechanical schedule.
e. The terminal box flow shall be indexed to the occupied flow setpoint during occupied hours in accordance with the mechanical schedule.
f. Demand Control Ventilation – Applicable to zones with CO2 Sensors
1) During Occupied mode, BMS will generate Demand Control ventilation signal based on current zone CO2 level and zone CO2

setpoint. Zone CO2 setpoint will be equal to 600 PPM plus the outdoor air CO2 concentration.

2) As DCV control signal increases from 0% to 100%, BMS will reset active zone minimum supply air CFM limit from scheduled minimum to scheduled maximum CFM.

g. ALARMS

1) Space CO2 level, if monitored, is higher than {1000 PPM} for {15 consecutive minutes}.
2) Supply Air temperature is {5°F} lower than the setpoint for {10 consecutive minutes}.
3) Supply Air CFM is {10%} higher than the setpoint for {15 consecutive minutes}.
4) Supply Air CFM is {10%} lower than the setpoint for {15 consecutive minutes}.

3. EVAV - Exhaust VAV With VAV Flow Offset

a. SUMMARY

1) Exhaust variable air volume (EVAV), modulating type, fail last position.
2) The EVAV consists of an exhaust air volume damper and pressure pick-up probes for airflow measurement.

b. OPERATION

1) BMS shall modulate the airflow from each EVAV. Each EVAV shall be programmed for design flow setpoint as measured by a flow sensor.
2) The EVAV operating schedule is to be coordinated with the VAV serving the space.
3) When the VAV is in operation, the EVAV box shall index to the VAV airflow minus a scheduled offset. Offset shall initially be set to 50CFM (adj.) Final value to be coordinated with TAB contractor to provide slight negative pressurization to the space.
4) When the VAV is closed, the exhaust VAV box shall be closed.

c. ALARMS

1) Exhaust Air CFM is {10%} higher than the setpoint for {15 consecutive minutes}.
2) Exhaust Air CFM is {10%} lower than the setpoint for {15 consecutive minutes}.

G. VAV and EVAV serving VRF, And Window/Door Switches Typical

1. For operation of system see VRF FCU SERVING BOH SPACES and VAV AND EVAV SERVING VRF sequence.
2. Window and door switches have been provided as noted on design drawings. Upon window or door switch proving open the associated VRF serving the space shall be disabled. VRF to be reenabled upon space temperature falls below low temperature setpoint, initially set to 50 Deg F (adj.).
3. Alarm

1) Space air temperature is at low temperature setpoint for {5 consecutive minutes}.

H. Exhaust Fan (Starter) – EF-01
   1. This sequence of operations applies to each of the following exhaust fans:
      a. EF-01
   2. General
      a. Exhaust Fan, constant speed, off.
      b. Exhaust air isolation damper, two position type, normally closed, fail closed (Only if damp applicable)
   3. System Off:
      a. When the system is off, the exhaust fan and damper shall be in the normal position as stated above.
   4. System On:
      a. Exhaust fan shall be started based on a time-schedule program resident in the BMS, or manually by an operator. The time-schedule program shall be adjustable at the operator workstation. Time schedule shall be as coordinated with the owner.
      b. When the exhaust fan is enabled, its exhaust air isolation damper shall open. Once the damper proves open, the fan shall be permitted to start.
      c. Exhaust fan shall operate at a constant speed.
   5. Fan status shall be monitored at the BMS via a current sensor.
   6. Maintenance alarms are generated at the operator workstation when:
      a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor
      b. Damper Mismatch (isolation dampers):
         1) Position feedback and damper command disagree for more than 120 seconds (adj).

I. Diesel Exhaust Extraction System (Exhaust Fan (Starter) – EF-02
   1. This sequence of operations applies to each of the following exhaust fans:
      a. EF-02
   2. General
      a. Exhaust Fan, constant speed, off.
      b. Exhaust air isolation damper, two position type, normally closed, fail closed (If applicable)
   3. System Off:
      a. When the system is off, the exhaust fan and damper shall be in the normal position as stated above.
   4. System On:
      a. Exhaust fan shall be started by an OEM controller/starter serving the vehicle exhaust extraction system.
      b. Exhaust fan shall operate at a constant speed.
   5. Fan status shall be monitored at the BMS via a current sensor.
   6. Maintenance alarms are generated at the operator workstation when:
      a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor
      b. Damper Mismatch (isolation dampers):
         1) Position feedback and damper command disagree for more than 120 seconds (adj).

J. Motorized Modulating Dampers
   1. Motorized modulating dampers shall be controlled by the BMS.

2. Damper position shall be monitored by the BMS.
3. Alarms & Additional Monitoring:
    a. Damper Position Deviation:
        1) Difference between damper command and position feedback deviates beyond ±10% (adj) for 10 minutes (Adj)
        2) Generate Alarm to BMS

K. Motorized Isolation Dampers
1. Motorized isolation dampers shall be controlled by the BMS.
2. Damper end switches shall be monitored by the BMS.
3. Alarms & Additional Monitoring:
        1) Damper Mismatch (isolation dampers):
            a) Position feedback and damper command disagree for more than 120 seconds (adj).
            b) Generate Alarm to BMS

L. Kitchen System

1. For operation of system see VRF FCU SERVING BOH SPACES and VAV AND EVAV SERVING VRF sequence.
2. Space includes a kitchen exhaust hood.
3. The BMS shall monitor operation of kitchen exhaust hood via a current switch. Upon the hood proving operational via the current sensor status the VAV shall be ramped to 600 cfm (Adj.) and the EVAV shall be closed.
4. Upon the kitchen hood being off, the VAV and EVAV shall return to normal operation.
5. The space shall also be provided with a self-controlled space heater, the BMS shall monitor the status of the heater via a current sensor.

M. Laundry Room Controls

1. For operation of system see VRF FCU SERVING BOH SPACES and VAV AND EVAV SERVING VRF sequence. No EVAV is provided as part of this system, sequences relating to EVAV are to be ignored.
2. Space includes a dryer.
3. The BMS shall monitor operation of dryer via a current switch. Upon the dryer proving operational via the current sensor status the BMS shall initiate the following;
    a. The exhaust fan shall be turned on.
    b. The VAV shall be ramped to 400 cfm (Adj.).
4. Upon the dryer being off, the exhaust fan shall be turned off and the VAV shall return to normal operation.
5. The space shall also be provided with a self-controlled space heater, the BMS shall monitor the status of the heater via a current sensor.
6. Maintenance alarms are generated at the operator workstation when:
    a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor

N. PPE Drying Room Controls

1. For operation of system see VRF FCU SERVING BOH SPACES and VAV AND EVAV SERVING VRF sequence.
2. Space includes a dehumidifier and a recirculation fan.
3. The dehumidifier system is enabled by the BMS and operates on a single interlocked "Drying Mode."
4. Upon the space dewpoint exceeding setpoint: 55 Deg F Dewpoint (Adj.) the BMS shall initiate the following.
   a. Circulator Fan is turned on.
   b. Exhaust Fan is turned on.
   c. Dehumidifier is turned on (enabled).
   d. VRF system Room temperature setpoint changed to 80F
   e. VAV flow setpoint changed to 300 CFM
   f. EVAV flow setpoint changed to 0 CFM
5. Upon the space dewpoint less than setpoint: 52 Deg F Dewpoint (Adj.) for 5 minutes the BMS shall initiate the following.
   a. Circulator Fan is turned off.
   b. Exhaust Fan is turned off.
   c. Dehumidifier is turned off (disabled).
   d. VRF system Room temperature setpoint changed to back to 75F in summer, 68F in winter.
   e. VAV flow setpoint changed to 110 CFM
   f. EVAV flow setpoint changed to 160 CFM
6. The Dehumidifier shall be provided with a Condensate Pump High-Level Switch, upon activation the dehumidifier shall be turned off. The BMS shall monitor the alarm and announce at the BMS.
7. Maintenance alarms are generated at the operator workstation when:
   a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor

O. Gas Detection System and Exhaust Fan (EF-3)
   a. System Equipment
      1) Gas Detection system, comprising of sensors and horn strobes.
      2) Exhaust Fan EF-3, VFD, 0% speed output.
      3) Makeup air isolation damper, two position type, normally closed, fail closed
   b. System Operation
      1) The Gas Detection System (GDS) shall continuously monitor carbon monoxide (CO) and nitrogen dioxide (NO_2) levels in the garage areas. It shall control the operation of the exhaust system fan based on gas concentration thresholds.
      2) The Gas Detection System (GDS) system shall sense for high levels of CO and NO2 gases from the cars and trucks in the garage areas.
      3) The system shall for a high level detection alarm activate the exhaust system and high level detection alarm which shall alarm locally and generate a BMS alarm at the BMS workstations.
      4) The CO and NO2 ppm settings for the level alarms shall be programmable.
      5) In the event of a high level alarm, makeup isolation air damper shall be opened, the exhaust system (EF-3) shall be ramped up to

setpoint to achieve design flow, contractor to coordinate with testing and balancing contractor to determine proper VFD setting.

6) The BMS shall monitor the running status of the exhaust system via a current sensing relays and damper end switches.
7) In the event of a high high level alarm, the exhaust system shall continue to run at 100% and the horn / strobe shall be activated. The system shall not be re-set until the system is re-set and the BMS operator has and cleared the alarm event.
8) The system shall not be reset until the system is reset and the BMS operator has acknowledged and cleared the alarm event.

c. Maintenance alarms are generated at the operator workstation when:
1) Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor
2) Damper Mismatch (isolation dampers):

a) Position feedback and damper command disagree for more than 120 seconds (adj).

P. Destratification Fan – (Wall Switch)
1. General
a. Fan, normally off.
b. Wall mounted switch.
2. System Off:
a. When the system is off, fan shall be in its normal position as stated above.
3. System Operation:
a. The fan shall be started/ stopped by manual operation of the wall mounted switch.
4. Monitoring
a. BMS shall monitor fan status
5. Maintenance alarms are generated at the operator workstation when:
a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor

Q. Electric Unit Heater
1. General
a. BMS shall monitor space temperature and heater status.
b. Wall mounted or integral space thermostat shall control the unit heater by either cycling on/off or modulating the heater SCR (Silicon-controlled Rectifier) to maintain the zone temperature at setpoint (adjustable), initially set to {55 deg F}.
2. ALARMS
a. The BMS shall generate an alarm if the space temperature is below {50 deg F} for {10 minutes}.

R. Emergency Generator
1. Generator control

a. Emergency Generators shall be controlled by the Generator Control System (GCS) provided under Division 26. The BMS shall not issue control commands to the generator.

2. BMS Monitoring
   a. The controls contractor shall coordinate with approved manufacturer shop drawings to identify available monitoring points. The BMS shall monitor and annunciate the following critical generator alarms as a minimum, refer to detail for additional requirements:
      1) Generator status (Running, Stopped, Fault)
      2) Engine alarms (Overtemperature, Low Oil Pressure, Overspeed, etc.)
      3) Battery status
      4) Fuel level
   b. All alarms shall be displayed on the BMS graphical interface and logged per the BMS alarm protocol.

S. Automatic Transfer Switch (ATS) Monitoring
1. ATS Control
   a. The Automatic Transfer Switch shall be provided under Division 26 and shall be controlled by the ATS manufacturer's control system. The BMS shall not issue control commands to the ATS.
2. BMS Monitoring
   a. The BMS shall monitor ATS status and alarms via available outputs provided by the ATS control panel. Monitoring points may include:
      1) Source availability (Normal/Standby)
      2) Transfer status (Source 1/Source 2)
      3) ATS position
      4) Alarm or fault conditions
3. The controls contractor shall coordinate with:
   a. Electrical design drawings for ATS quantities and locations
   b. Approved manufacturer shop drawings for available monitoring signals and interface requirements
4. Alarm Handling
   a. All ATS alarms shall be displayed on the BMS graphical interface and logged per the BMS alarm protocol. Alarm priorities shall reflect the critical nature of emergency power systems.

T. Outdoor Weather Station Monitoring
1. Sensor Integration.
   a. The BMS shall monitor the following environmental parameters via hardwired outputs from the outdoor weather station:
      1) Outdoor Air Dry Bulb Temperature
      2) Outdoor Air Relative Humidity
      3) Outdoor Air Carbon Dioxide (CO_2) Concentration
   b. The weather station shall be furnished and installed by the controls contractor. All sensor outputs shall be connected to the BMS for real-time monitoring and trending.
2. Installation Requirements
   a. The outdoor weather station shall be installed on the north side of the building, at a location free from direct sunlight, localized heat sources,

and obstructions to ensure accurate readings. Mounting height and shielding shall comply with manufacturer recommendations and industry best practices.

3. Data Utilization
    a. BMS shall use weather station data for:
        1) Economizer control logic
        2) Demand-controlled ventilation strategies
        3) Outdoor air quality monitoring
        4) Trending and diagnostics
4. Alarms
    a. Sensor failures or out-of-range values shall generate alarms per the BMS alarm protocol.

U. Fire Smoke Damper (FSD) Control and Monitoring Sequence
1. FSD Control
    a. Fire Smoke Dampers shall be controlled by the Fire Alarm System (FAS) in accordance with local code and life safety requirements. The BMS shall not override or interfere with FAS control logic.
2. FSD Monitoring
    a. The BMS shall monitor the status of each FSD via two discrete end switches:
        1) Open Position Switch
        2) Closed Position Switch
    b. The controls contractor shall provide wiring from each FSD to the BMS for status indication.
    c. Refer to contract drawings for quantities and locations.
3. Status Display and Alarming
    a. FSD status shall be displayed on the BMS graphical interface, showing:
        1) Damper position (Open/Closed)
        2) Fault condition (if applicable)
    b. Alarms
        1) The BMS shall generate an alarm if both switches indicate open and closed simultaneously (fault condition).
        2) The BMS shall generate an alarm if neither switch is active for more than 120 seconds.
    c. Alarms shall be logged and annunciated per the BMS alarm handling protocol.

V. Electrical Power Monitoring System
1. The systems shall be provided by Div 26 and monitored by the BMS:
    a. BMS shall monitor electrical power consumption at each electrical power meter.
    b. BMS shall integrate to meter via BACnet or Modbus, final protocol to be determined based on approved shop drawings.

W. Plumbing Water Meter - Typical
1. The systems shall be provided by Div 22 and monitored by the BMS:
    a. Water Meter – BMS shall monitor domestic water via pulsed input or analog input. To be determined based on final approved water meter shop drawings.

X. Fuel Oil System
   1. The Fuel Oil System shall be controlled by the dedicated Fuel Oil Control System (FOCS).
   2. The BMS shall not issue control commands to fuel oil pumps, valves, or tank level systems.
   3. BMS shall integrate to the fuel oil system via BACnet or Modbus, final protocol to be determined based on approved shop drawings.
   4. BMS Monitoring and Alarming
      a. The BMS shall monitor and annunciate the alarms from the Fuel Oil System components, refer to approved submittal for quantities and types of available alarms.

Y. Sump Pump (Plumbing)
   1. The Sump system shall be provided under Div 22 and monitored for alarms by the BMS.
   2. Controls contractor to coordinate with approved manufacturer shop drawings for available alarms.

Z. Recirculation Pump (Plumbing)
   1. The Recirculation Pump system shall be provided under Div 22 and monitored by the BMS.
   2. Controls contractor to coordinate with approved manufacturer shop drawings.
   3. Refer to contract drawings for quantities and locations.

AA. Hot box temperature monitoring
   1. General
      a. BMS shall monitor hot box temperature.
   2. Alarms:
      a. The BMS shall generate an alarm if the hot box temperature is below 40 Deg F (adj.) for 10 mins (adj.)

3.6 COMMISSIONING, TESTING AND ACCEPTANCE

A. Refer to Section 230593 for requirements of controls system testing and balancing to be carried out by an independent contractor.

B. The installation contractor shall perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets as contained in this specification or alternatively on commissioning data sheets as provided by the independent controls testing contractor and submitted for review prior to the work being carried out. Commissioning work, which requires shutdown of system or deviation from normal function, shall be performed when the operation of the system is not required. The commissioning must be coordinated with the Owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the Owner and construction manager are present throughout the commissioning procedure.

C. Field I/O Calibration and Commissioning

1. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications and approved shop drawings. Test, calibrate and bring on line each control sensor and device. Commissioning to include, but not be limited to:
   a. Sensor accuracy at 10, 50 and 90% of range.
   b. Sensor range.
   c. Verify analog limit and binary alarm reporting.
   d. Point value reporting.
   e. Binary alarm and switch settings.
   f. Actuator and positioner spring ranges.
   g. Fail safe operation on loss of control signal, electric power, network communications, etc.
2. Record calibration and test data on commissioning data sheets. Sufficient space should be provided near each point name for sign off.

D. System Program Commissioning

1. After control devices have been commissioned (i.e. calibrated, tested and signed off), each DDC program shall be put on line and commissioned. The contractor shall, in the presence of the Owner demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracies. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and retested.

E. Loop Tuning

1. The BMS contractor shall tune each control loop per ASHRAE Fundamentals IP. Tuning shall consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. The derivative portion of loops shall not be used unless field tuning is not possible without it.
2. For all control loops, the BMS contractor shall tune the loops to ensure the fastest stable response without hunting, offset, or overshoot with the tolerances defined below. Except from a startup, maximum allowable variance from setpoint for controlled variables under normal load fluctuations shall be as follows:
   a. Duct air temperature: ±1°F.
   b. Space temperature: +/- 3°F within 3 minutes and control within +/- 2°F.
   c. Chilled water temperature: +/- 1°F.
   d. Hot water temperature: +/- 2°F.
   e. Duct pressure: +/- 0.25" w.g.
   f. Water pressure: +/- 1 psid.
   g. Duct humidity: +/- 3 percent when adding humidity.
   h. Space humidity: +/- 5 percent when adding humidity to control.
   i. Terminal air flow control: +/- 5 percent of setpoint.

j. Space Pressurization: +/- 0.03" w.g. with no door or window movements.
k. Steam Pressure: +/- 3 psig.
l. Water Level: +/- 5 percent tank height.

3. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, the tolerances shall be maintained with exceptions as noted.
4. Loop tuning shall take place during periods of high gain.
5. Maintain a record of control loops that require tuning at alternate times of year.
6. Document all loop tuning by capturing text, short interval trends, or screen shots of trend graphs documenting the final response.
   a. Trend Logs:
      1) Trends logs are historical archives stored in the BMS that document the operation of the systems and equipment. Trends can be interval recordings of system I/O parameters or Change of Value based trends that record when a system value changes by more than a specified threshold.
      2) Sample times indicated as COV (±) or change of value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record.
      3) Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals.
      4) Trending Requirements: As described in previous sections
      5) Trending to document Sequence of Operation Tests may require a more frequent interval than final trending requirements. Coordinate with the CxA to determine the correct intervals to prove operational testing and modify intervals as required.
      6) The BMS contractor shall set up the trends logs, ensure they are being stored properly, and then, if requested by the CxA, forward the data in electronic format to the CxA. Data shall be forwarded in one of the following formats:
         a) Microsoft EXCEL Spreadsheet (.xls)
         b) Comma Separated Value (.csv or .txt) preferably with quotes delimiting text fields and # delimiting date/time fields
      7) The CxA shall analyze trend logs of the system operating parameters to evaluate normal system functionality.
      8) The BMS contractor shall allow the CxA BMS access to view the trend log data and allow downloading to a remote location. The BMS contractor shall also provide instruction for accessing the trend logs.
   b. Trend Graphs:
      1) Trend graphs are generally used to facilitate and document testing. The BMS contractor shall prepare controller and workstation software to display graphical trends.

2) On the trend graphs, lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.
3) Indicate engineering units of the y-axis values; e.g. °F, inches w.g., Btu/lb, percent wide open, etc. The y-axis scale shall beset such that all trended values are in a readable range.
4) Trend outside air temperature, humidity, and enthalpy during each period in which any other points impacted by these parameters are trended.
5) All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend interval. On renovation projects with existing to remain controls on air or water generation equipment, these trend graphs need only address the new BMS renovation work.
6) Each graph shall be clearly labeled with HVAC subsystem title, date, and times.
7) The BMS contractor shall forward the trend graphs as part of the CxA BMS Pre-Requisite Package to the CxA for review.

F. Integrated System Commissioning:

1. After all DDC programs have been commissioned, the contractor shall verify the overall system performance as specified. Tests shall include, but not be limited to the following:
2. Data communication, both normal and failure modes.
3. Fully loaded system response time.
4. Impact of component failures on system performance and system operation.
5. Time/Date changes.
6. End of month/ end of year operation.
7. Season changeover.
8. Global application programs and point sharing.
9. System backup and reloading.
10. System status displays.
11. Diagnostic functions.
12. Power failure routines.
13. Battery backup.

G. Acceptance Testing

1. Submit for approval, a detailed acceptance test procedure designed to demonstrate step by step testing of all BMS related sequences, systems and equipment, integration with external systems and compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure, in addition to the testing described above the testing will verify that sensors and control devices maintain specified accuracies and the system performance does not degrade over time.
2. Using the commissioning test data sheets, the contractor shall demonstrate all point types as required by Owner/engineer. The contractor shall supply all instruments for testing and turn over same to the Owner after acceptance testing.
   a. All test instruments shall be submitted for approval.

H. Test instrument accuracy

Temperature:	1/4°F or 1/2% full scale, whichever is less.
High Pressure (psi):	1/2 psi or 1/2% full scale, whichever is less.
Low Pressure (in w.c.):	1/2% of full scale
Humidity:	2% RH
Electrical:	1/4% full scale

1. Test instruments to be factory calibrated with calibration certificates provided valid at least 6 months from installation.

I. Commissioning Testing Support

1. System verification testing is part of the Commissioning Process.
2. Verification testing shall be performed by the contractor and witnessed and documented by the Engineer.
3. The commissioning process requires detailed O&M documentation.
4. The controls contractor shall assist the commissioning authority with performing verification and performance testing. This includes the following:
   a. Attend Commissioning (Cx) progress and coordination meetings.
   b. Prepare and submit required draft forms and systems information.
   c. Establish trend logs of system operation as specified herein.
   d. Demonstrate system operation.
   e. Manipulate systems and equipment to facilitate testing.
   f. Provide instrumentation necessary for verification and performance testing.
   g. Manipulate control systems to facilitate verification and performance testing.
   h. Provide a BMS technician(s) to work at the direction of the commissioning authority for software optimization assistance.
5. Software Optimization Assistance
   a. At no additional cost to owner, controls contractor will provide the services of a BMS technician as specified above at the project site and at the disposal of the commissioning authority and owner. The purpose of this requirement is to make changes, enhancements, and additions to the control unit and/or workstation software that have been identified during the construction and commissioning of the project in order to complete functional testing and the integrated systems test.
   b. The BMS technician will be thoroughly trained in the programming and operation of the controller and workstation software. If the BMS technician provided cannot perform every software task requested by the commissioning authority and owner in a timely fashion, the controls contractor will provide additional qualified personnel at the project site in order to meet the total specified requirements on-site.

J. Verification Testing

1. System verification testing is part of the Commissioning Process. Verification testing shall be performed by the contractor and witnessed and documented by

the Engineer. The commissioning process requires detailed O&M documentation.

3.7 CLOSEOUT

A. Substantial completion requirements:

1. Provide final cleaning immediately prior to substantial completion inspection.
2. Corrective work:
   a. Remove, repair and reinstall, or restore in place damaged items.
   b. Replace damaged materials or items with new if repair not acceptable to Architect.
3. Provide product data to complete operation & maintenance manuals.
4. Submit executed warranties.

3.8 DEVICE AND INPUT/OUTPUT SCHEDULE

A. Refer to design drawings for device and input/output schedules.

END OF SECTION 230923

SECTION 23 35 33

LISTED KITCHEN VENTILATION SYSTEM EXHAUST DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Listed grease ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for listed grease ducts.

B. Shop Drawings: For listed grease ducts.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in listed grease ducts and field-fabricated grease ducts.

1.6 WARRANTY

A. Listed grease duct shall have a limited lifetime warranty to begin at the date of installation when installed in accordance with the manufacturer’s published installation instructions.

PART 2 - PRODUCTS

2.1 LISTED GREASE DUCTS (ZERO-CLEARANCE TO COMBUSTIBLES)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Duravent
2. CaptiveAire
3. Metal-Fab, Inc.
4. Schebler Co.
5. Selkirk Corporation
6. Or equal

B. Description: Factory-fabricated, -listed, and -labeled, double-wall ducts tested according to UL 1978 and UL 2221 classified for zero clearance to combustibles with a 2-hour fire rating. Duct systems shall be rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

C. Construction: Inner shell and outer jacket, fully welded at seams, and separated by at least a 3-inch annular space filled with high-temperature, ceramic-fiber insulation.

1. Inner Shell: ASTM A666, Type 304 stainless steel. 20 ga. Minimum.
2. Outer Jacket: Aluminized steel where concealed. Stainless steel where exposed. 24 ga. Minimum.

D. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at 1500 deg F minimum.

E. Hood Connectors: Constructed from the same material as grease duct with internal or external continuously welded or brazed joints.

F. Accessories: Tees, elbows, increasers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 (or governing code of local jurisdiction) including cleanouts, transitions, adapters, and drain fittings.

G. Grease Duct Supports: Construct duct bracing and supports from non-combustible material.

1. Design bracing and supports to carry static and seismic loads within stress limitations of the International Building Code.
2. Ensure that bolts, screws, rivets and other mechanical fasteners do not penetrate duct walls.

H. Comply with ASTM E2336.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install ducts in accordance with NFPA 96,"Ventilation Control and Fire Protection of Commercial Cooking Operation"; Internation Mechanical Code; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines" unless otherwise indicated.

B. Install all ducts without dips and traps that may hold grease and sloped a minimum of 2 percent to drain grease back to the hood.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Comply with requirements in Section 077200 "Roof Accessories."

D. Coordinate connections to kitchen exhaust hoods.

E. Coordinate firestopping where grease ducts penetrate fire separations with requirements in Section 078413 "Penetration Firestopping."

F. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211 and UL 2221, whichever is most stringent.

G. Seal between sections of grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

H. Connections: Make grease duct connections according to the International Mechanical Code.

1. Grease duct to exhaust fan connections: Connect grease ducts to inlet side of fan using flanges, gaskets, and bolts.

2. Grease duct to hood connections:

a. Make grease duct to hood joints connections using internal or external continuously welded or brazed joints.

I. Support ducts at intervals recommended by manufacturer to support weight of ducts and accessories, without applying loading on kitchen hoods.

1. Securely attach supports and bracing to structure.

J. Grease Duct Enclosures: Comply with requirements of the International Building Code and ASTM E2336.

K. Coordinate fire-rated enclosure construction with Section 092116.23 "Gypsum Board Shaft Wall Assemblies."

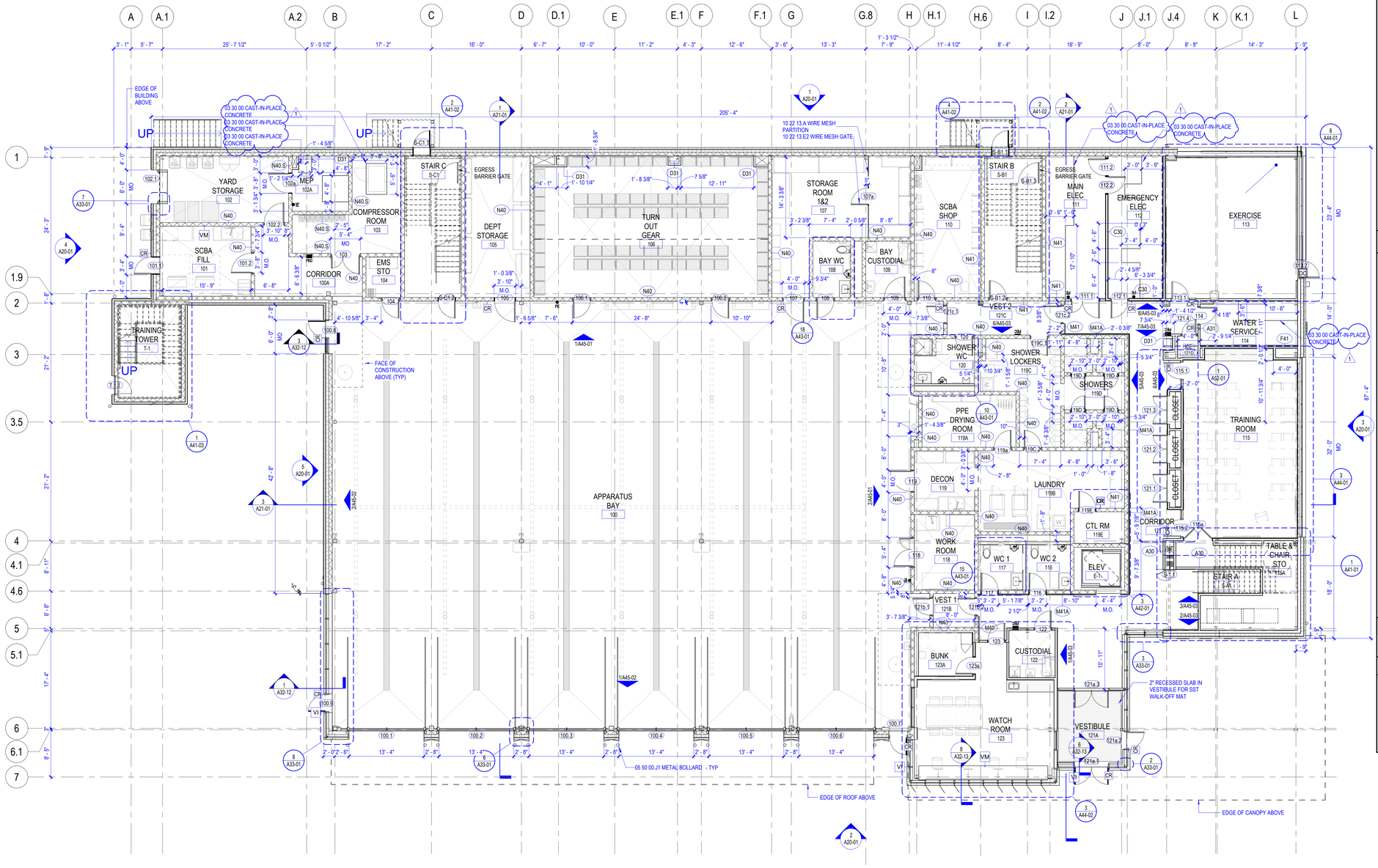
L. Repair damage to adjacent materials caused by listed kitchen ventilation system exhaust ducts installation.

3.3 FIELD QUALITY CONTROL

A. Perform air leakage test in presence of Owner before concealment of any portion of the grease duct system.

1. Notify Owner a minimum of seven- days before test is performed.

END OF SECTION 233533



1 LEVEL 01 FLOOR PLAN
SCALE 1/8" = 1'-0"

FLOOR PLAN GENERAL NOTES

1. SEE THE A61 SERIES FOR PARTITION TYPES
2. ALL PARTITIONS ARE TYPE A31 UNLESS NOTED OTHERWISE
3. DOOR DIMENSIONS ARE TO EDGE OF DOOR LEAF UNLESS NOTED OTHERWISE.
4. FOR SWINGING DOORS, THE HINGE SIDE OF OF THE DOOR JAMB SHALL BE LOCATED 4" FROM THE ADJACENT PERPENDICULAR WALL, UNLESS NOTED OTHERWISE
5. REFER TO A32-01 AND A32-02 FOR EXTERIOR ASSEMBLIES
6. PROVIDE 3" (EQUAL TO R-15) UNDERSLAB INSULATION UNDER APPARATUS BAY AND WEST OF STAIR C BETWEEN GRIDLINES 1 AND 2 ON LEVEL 1.
7. INTERIOR MASONRY OPENINGS TO BE 3'-4" UNLESS NOTED OTHERWISE.
8. REFER TO STRUCTURAL FOR SHEAR WALLS LOCATIONS AND REQUIREMENTS.
9. WALL TYPE N40.S IS A FULLY GROUTED MASONRY WALL PROVIDED FOR ACOUSTICS ONLY, REFER TO 04 20 00
10. WALL TYPES M41A & N41A CONTAIN AN ADDITIONAL LAYER OF 5/8" GYPSUM WALL BOARD.
11. ROLLER SHADES, "R" INDICATE RECESSED OR "S" FOR SURFACE MOUNTED

FLOOR PLAN LEGEND

- 270 DEGREE IP SECURITY CAMERA
- FIXED IP SECURITY CAMERA
- VI — VIDEO INTERCOM SUBSTATION
- VM — VIDEO INTERCOM SUBSTATION
- DC — DOOR CONTACT / POSITION SWITCH
- CR — ACCESS CONTROL CARDR READER
- COMMUNICATION OUTLET
- W — WALL PHONE COMMUNICATION OUTLET
- TV — IN-WALL BOX TELEVISION COMMUNICATIONS OUTLET WITH AV INFRASTRUCTURE
- STATUS — STATUS BOARD DATA OUTLET
- DIS — IN-WALL BOX DISPLAY COMMUNICATIONS OUTLET WITH AV INFRASTRUCTURE

FLOOR PLAN KEYNOTES

<<< Indicates Sheet Keynote on Plan

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MEP/FP/LIGHTING
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33 ARCH ST, BOSTON, MA 02110

ENERGY MODEL
ANDELMANLELEK
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PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

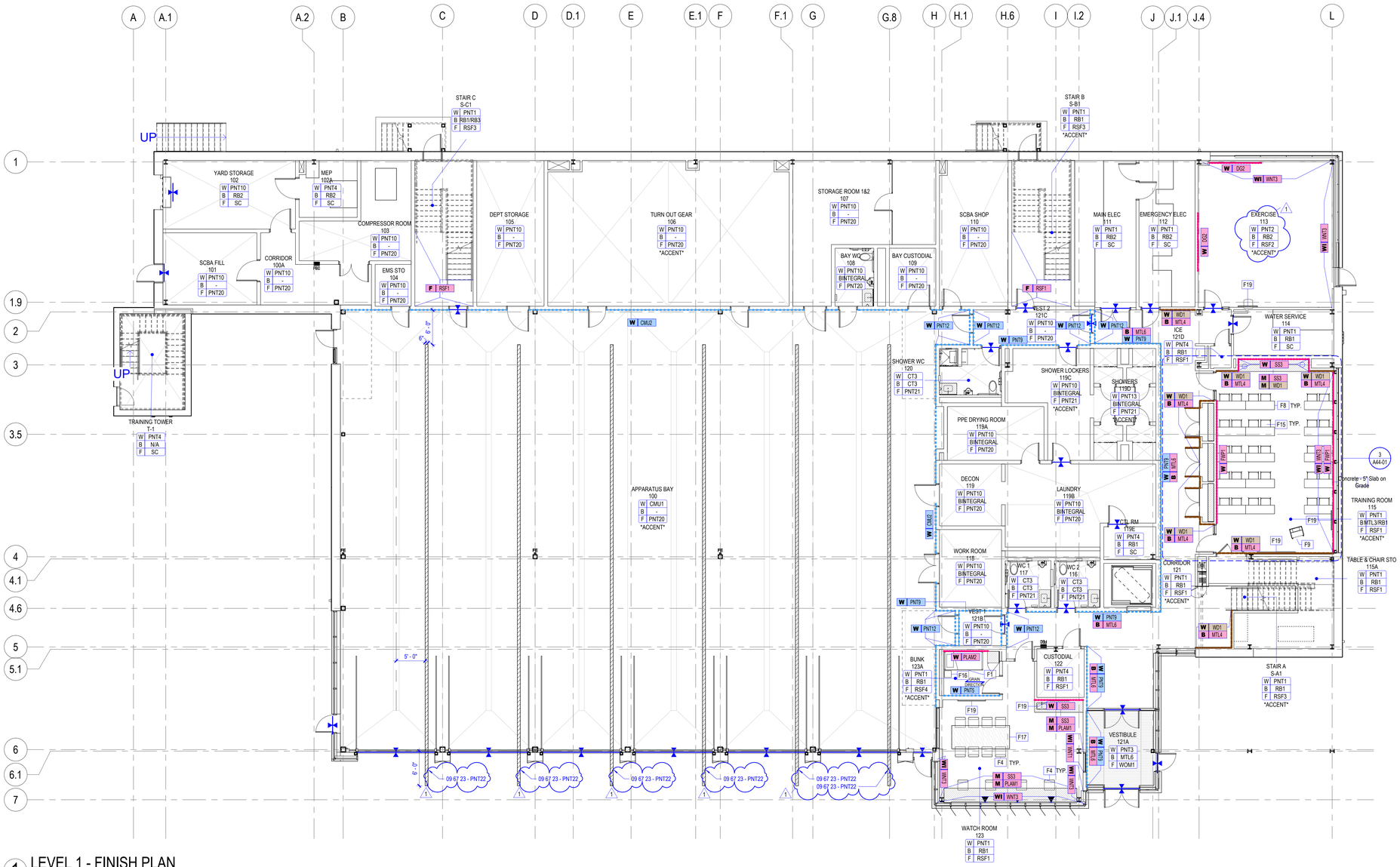
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SHEET NUMBER

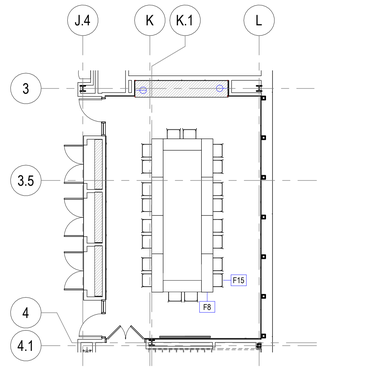
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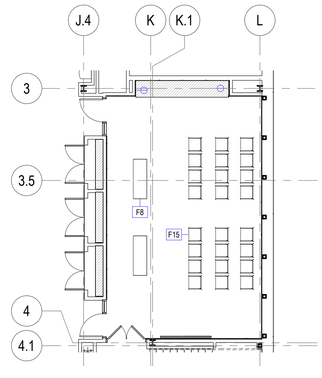
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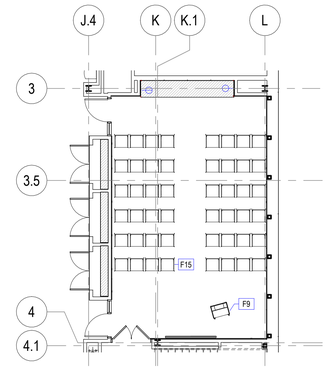
1 LEVEL 1 - FINISH PLAN
SCALE 1/8" = 1'-0"



2 LEVEL 1 - "AFTER ACTION" LAYOUT
SCALE 1/8" = 1'-0"



3 LEVEL 1 - "CPR TRAINING" LAYOUT
SCALE 1/8" = 1'-0"



4 LEVEL 1 - "LECTURE" LAYOUT
SCALE 1/8" = 1'-0"

INTERIOR FINISH PLAN GENERAL NOTES

1. REFER TO INTERIOR FINISH LEGEND IN A60 SERIES FOR INFORMATION.
2. SEE A50 SERIES FOR CASEWORK INFORMATION
3. TYPICAL FLOOR FINISH TO BE RSF1, UNO.
4. TYPICAL WALL FINISH TO BE PNT1, UNO.
5. TYPICAL WALL BASE TO BE RB1, UNO.
6. ALL FINISHES INSIDE COAT AND STORAGE CLOSETS SHALL BE CONSISTENT WITH THE ADJACENT ROOM FINISHES, UNO. FLOOR COVERINGS SHALL CONTINUE FROM ADJACENT ROOM INTO CLOSETS
7. PROVIDE A FINISH AT ALL AREAS THAT ARE EXPOSED BEHIND MILLWORK, FILE CABINETS, PANELING, ETC. DUE TO REVEALS, JOINTS, END CONDITIONS, ETC.
8. SEE ELEVATIONS ON A40 SERIES FOR ADDITIONAL FINISH INFORMATION.

BASE:

9. NEW WALL BASE SHALL BE INSTALLED ON ALL NEW AND EXISTING WALLS AND COLUMNS, UNO.
10. RESILIENT WALL BASE AT ALL HARD SURFACE FLOORS SHALL BE COVED BASE, UNO.

PAINT:

11. PAINT REVEALS AND FILER PANELS TO MATCH ADJACENT FINISHES, UNO.
12. PAINT EXPOSED ELECTRICAL RACEWAYS TO MATCH THE ADJACENT WALL SURFACE. PAINT ALL EXPOSED MISC METAL AND STRUCTURAL STEEL WITH PNT7
13. PROVIDE A PRIME PAINT COAT IN UNEXPOSED AREAS COVERED BY MILLWORK, PANELING, AND OTHER FIXED ARCHITECTURAL ELEMENTS UNO.
14. DOORS TO RECEIVE PAINT SHALL BE PAINTED PNT1, UNO.
15. HOLLOW METAL FRAMES SHALL BE PAINTED PNT1, UNO.
16. FIRE EXTINGUISHER CABINETS SHALL BE PAINTED TO MATCH ADJACENT WALL, UNO.
17. ACCESS PANELS SHALL BE PAINTED TO MATCH ADJACENT SURFACE.
18. GYPSUM BOARD SOFFITS ABUTTING A WALL SHALL BE PAINTED TO MATCH THE WALL. GYPSUM BOARD SOFFITS NOT ABUTTING A WALL SHALL BE PAINTED TO MATCH ADJACENT GYPSUM BOARD CEILING, IF APPLICABLE. GYPSUM BOARD SOFFITS ADJACENT TO ONLY ACOUSTICAL PANEL CEILINGS SHALL BE PAINTED FLAT WHITE.

FLOORING:

19. FLOORING TRANSITIONS AT DOORWAYS SHALL BE ALIGNED WITH THE FACE OF THE FRAME'S STOP FACING THE DOOR.
20. REFER TO SHEET A60 SERIES FOR ADDITIONAL INFORMATION ON FLOORING TRANSITIONS.

WINDOW TREATMENT:

1. ALL BUNK ROOMS TO RECEIVE WNT2 , PRIVATE BATH ROOM AND OFFICES ON L2 TO RECEIVE WNT1, CLERESTORY AT EXERCISE AND TRAINING ROOM TO RECEIVE WNT3, CLERESTORY AT DAY ROOM TO RECEIVE WNT4.
2. WATCH ROOM TO RECEIVE WNT1 AND WNT 3, SEE PLANS.

LEGEND

- DENOTES AREA "NOT IN CONTRACT"
- MILLWORK

ROOM FINISH TAG

Name
101

W XXX	WALL FINISH
B XXX	WALL BASE FINISH
F XXX	FLOOR FINISH
ACCENT	IF ACCENT IS PRESENT

FINISH TAG LEGEND

W PNT1 — MATERIAL APPLICATION / FINISH KEY

W WALL	M MILLWORK
B BASE	WI WINDOW
F FLOOR	P PARTITION
C CEILING (RCP ONLY)	EX EXISTING TO REMAIN

ACCENT FINISHES

W ELEV	SEE ELEVATION
	OTHER
	PAINT
	CERAMIC TILE
	WOOD

FINISH SYMBOLS

- FLOOR FINISH TRANSITION
- WP1 — CORNER GUARD TAG. REFER TO A** SERIES FOR INFORMATION.
- WPX — WALL PROTECTION TAG. REFER TO A** SERIES FOR INFORMATION.
- MATERIAL SEAM
- GRAIN DIRECTION — MATERIAL PATTERN DIRECTION
- PATTERN START POINT

FINISH PLAN KEYNOTES

<<< Indicates Sheet Keynote on Plan

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1408 PROVIDENCE HWY, NORWOOD, MA 02062

PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER
455 MAIN STREET
WORCESTER, MA 01605

CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

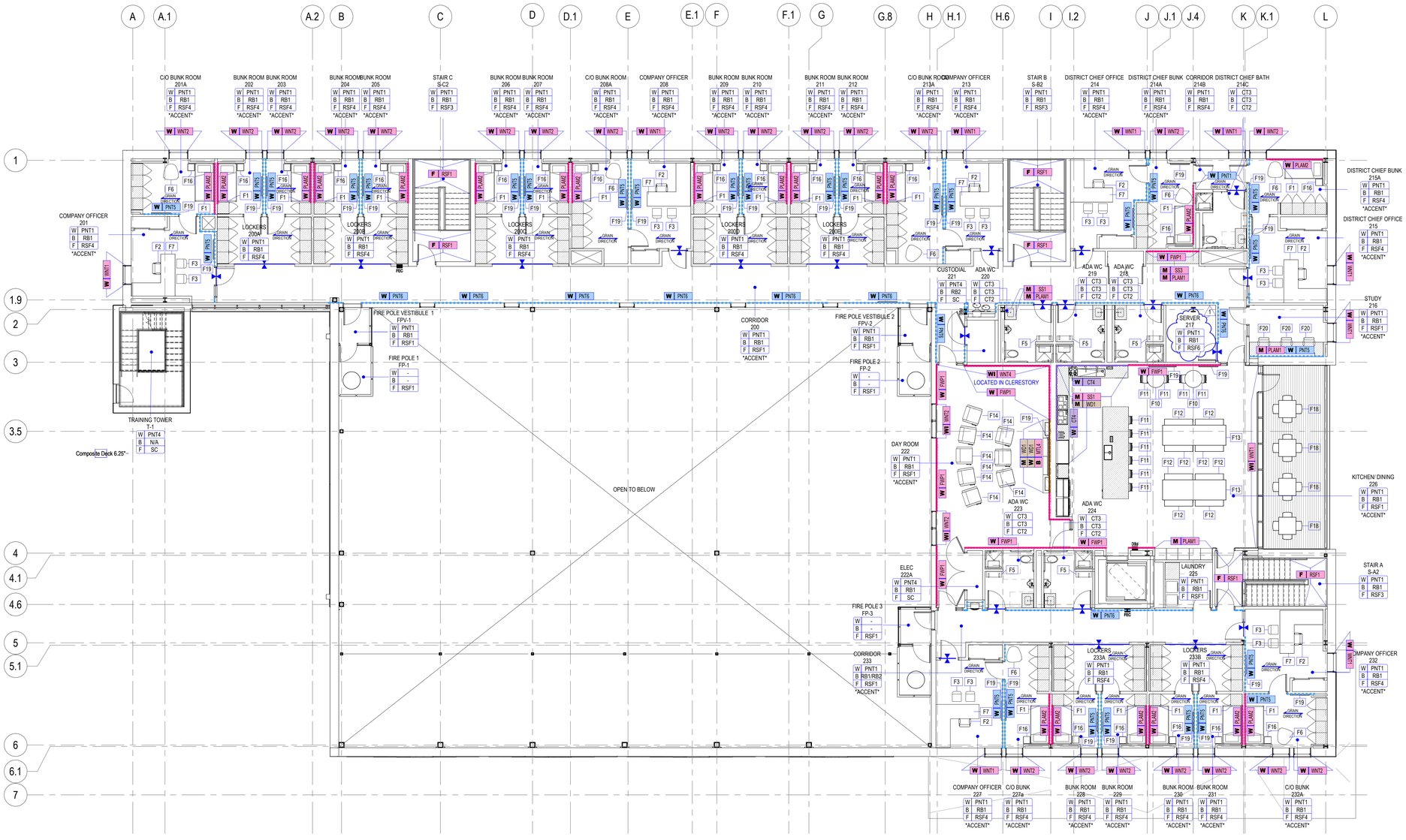
ARCHITECTURAL FURNITURE, EQ. & FINISHES PLAN - LEVEL 1

SHEET NUMBER

A13-01

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1 LEVEL 2 - FINISH PLAN
SCALE 1/8" = 1'-0"

INTERIOR FINISH PLAN GENERAL NOTES

1. REFER TO INTERIOR FINISH LEGEND IN A60 SERIES FOR INFORMATION.
2. SEE A50 SERIES FOR CASEWORK INFORMATION
3. TYPICAL FLOOR FINISH TO BE RSF1, UNO.
4. TYPICAL WALL FINISH TO BE PNT1, UNO.
5. TYPICAL WALL BASE TO BE RB1, UNO.
6. ALL FINISHES INSIDE COAT AND STORAGE CLOSETS SHALL BE CONSISTENT WITH THE ADJACENT ROOM FINISHES, UNO. FLOOR COVERINGS SHALL CONTINUE FROM ADJACENT ROOM INTO CLOSETS
7. PROVIDE A FINISH AT ALL AREAS THAT ARE EXPOSED BEHIND MILLWORK, FILE CABINETS, PANELING, ETC. DUE TO REVEALS, JOINTS, END CONDITIONS, ETC.
8. SEE ELEVATIONS ON A40 SERIES FOR ADDITIONAL FINISH INFORMATION.

BASE:

9. NEW WALL BASE SHALL BE INSTALLED ON ALL NEW AND EXISTING WALLS AND COLUMNS, UNO.
10. RESILIENT WALL BASE AT ALL HARD SURFACE FLOORS SHALL BE COVED BASE, UNO.

PAINT:

11. PAINT REVEALS AND FILER PANELS TO MATCH ADJACENT FINISHES, UNO.
12. PAINT EXPOSED ELECTRICAL RACEWAYS TO MATCH THE ADJACENT WALL SURFACE. PAINT ALL EXPOSED MISC METAL AND STRUCTURAL STEEL WITH PNT7
13. PROVIDE A PRIME PAINT COAT IN UNEXPOSED AREAS COVERED BY MILLWORK, PANELING, AND OTHER FIXED ARCHITECTURAL ELEMENTS UNO.
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FLOORING:

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20. REFER TO SHEET A60 SERIES FOR ADDITIONAL INFORMATION ON FLOORING TRANSITIONS.

WINDOW TREATMENT:

1. ALL BUNK ROOMS TO RECEIVE WNT2 , PRIVATE BATH ROOM AND OFFICES ON L2 TO RECEIVE WNT1, CLERESTORY AT EXERCISE AND TRAINING ROOM TO RECEIVE WNT3, CLERESTORY AT DAY ROOM TO RECEIVE WNT4.
2. WATCH ROOM TO RECEIVE WNT1 AND WNT 3, SEE PLANS.

LEGEND

- DENOTES AREA "NOT IN CONTRACT"
- MILLWORK

ROOM FINISH TAG

Name
101

W	XXX	WALL FINISH
B	XXX	WALL BASE FINISH
F	XXX	FLOOR FINISH

"ACCENT" — IF ACCENT IS PRESENT

FINISH TAG LEGEND

W PNT1 — MATERIAL APPLICATION; FINISH KEY

W	WALL	M	MILLWORK
B	BASE	WI	WINDOW
F	FLOOR	P	PARTITION
C	CEILING (RCP ONLY)	EX	EXISTING TO REMAIN

ACCENT FINISHES

W	ELEV	SEE ELEVATION
		OTHER
		PAINT
		CERAMIC TILE
		WOOD

FINISH SYMBOLS

- FLOOR FINISH TRANSITION
- WP1 — CORNER GUARD TAG. REFER TO A** SERIES FOR INFORMATION.
- WPX — WALL PROTECTION TAG. REFER TO A** SERIES FOR 'INFORMATION.
- MATERIAL SEAM
- GRAIN DIRECTION — MATERIAL PATTERN DIRECTION
- PATTERN START POINT

FINISH PLAN KEYNOTES

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KEY PLAN

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CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

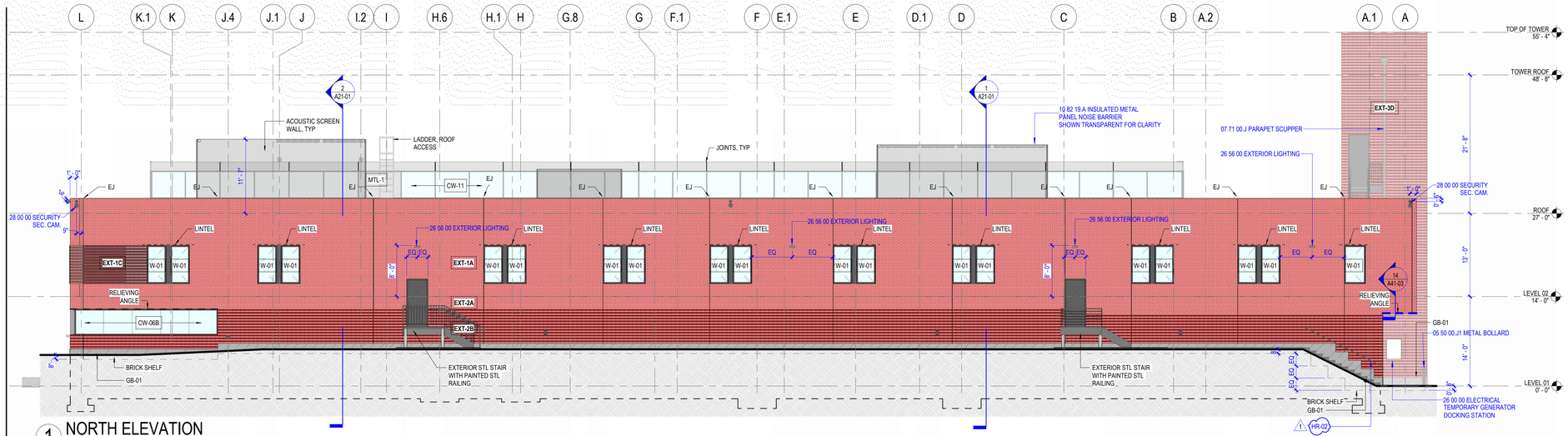
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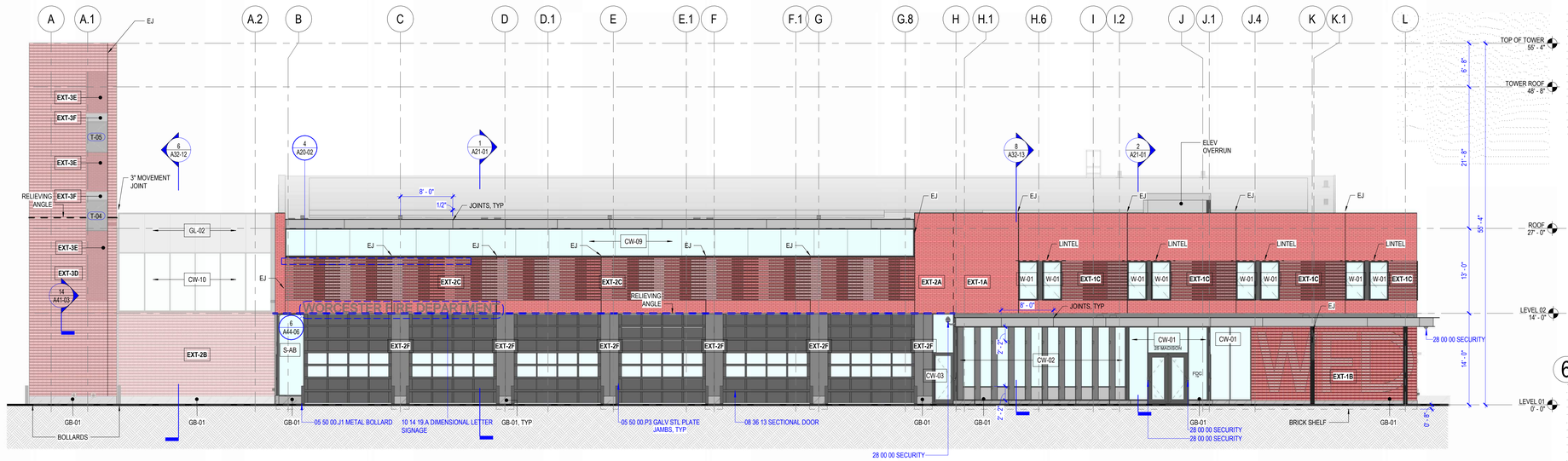
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A13-02

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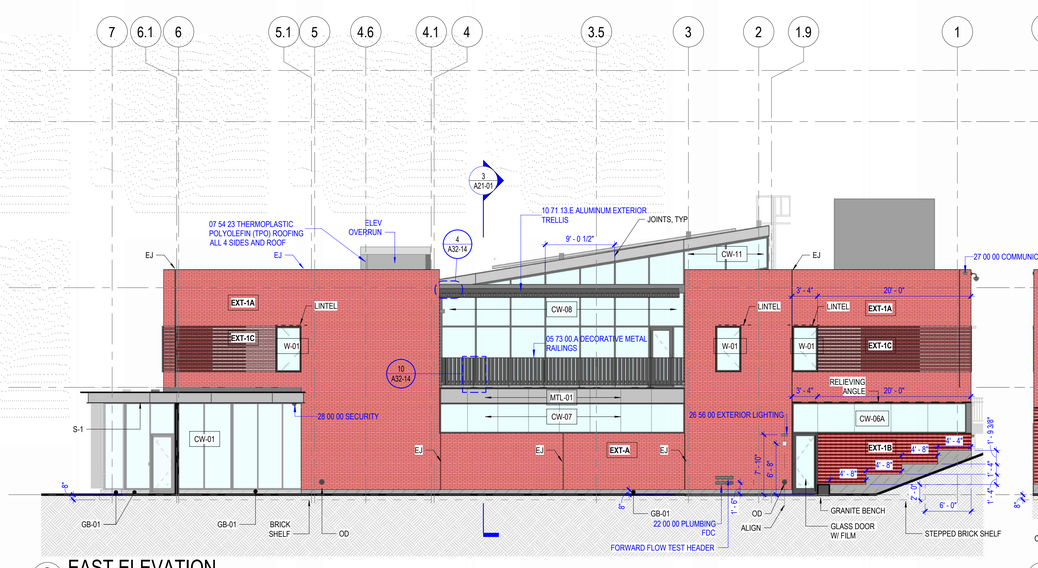
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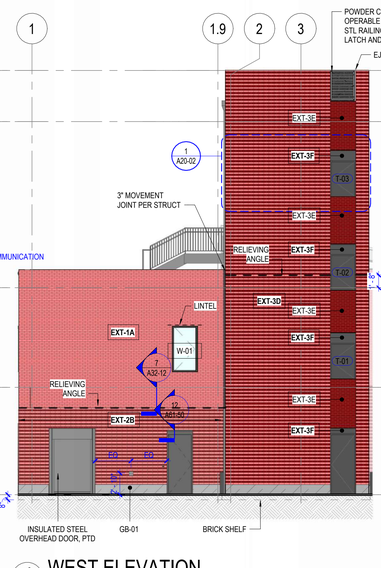
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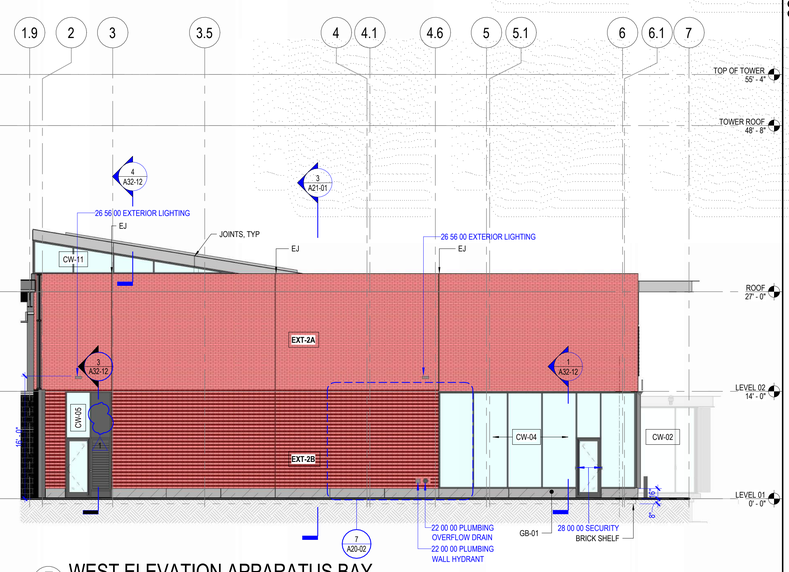
2 SOUTH ELEVATION
SCALE 1/8" = 1'-0"



3 EAST ELEVATION
SCALE 1/8" = 1'-0"



4 WEST ELEVATION
SCALE 1/8" = 1'-0"



5 WEST ELEVATION APPARATUS BAY
SCALE 1/8" = 1'-0"

6 NORTH DECK
SCALE 1/8" = 1'-0"

7 SOUTH DECK
SCALE 1/8" = 1'-0"

EXTERIOR ELEVATION GENERAL NOTES

1. MATERIAL SYMBOLS ON ELEVATIONS ARE TO DISPLAY THE EXTENT OF THE MATERIAL ONLY. THEY ARE NOT TO SCALE.
2. FINISH GRADE ELEVATIONS AND TAKEOFFS MAY VARY BASED ON GRADE COORDINATION
3. SEE A32-01 AND A32-02 FOR EXTERIOR WALL & ROOF ASSEMBLIES

EXTERIOR ELEVATION LEGEND

- SMOOTH FACE BRICK
- TEXTURED FACE BRICK
- MTL -01 - METAL PANEL
- GB-01 - GRANITE BASE
- GL-01 - WINDOW GLAZED ASSEMBLY
- GL-02 - SHADOWBOX GLAZED ASSEMBLY

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1	Addendum #6	1/23/26

Job Number 157132.000

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EXTERIOR ELEVATIONS

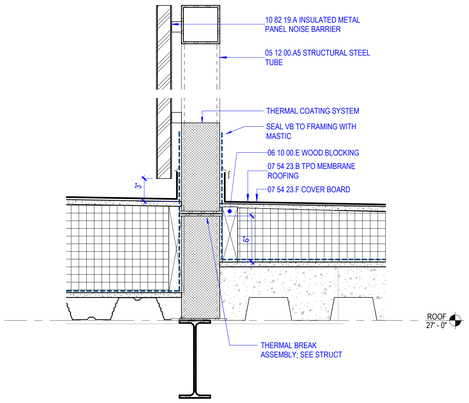
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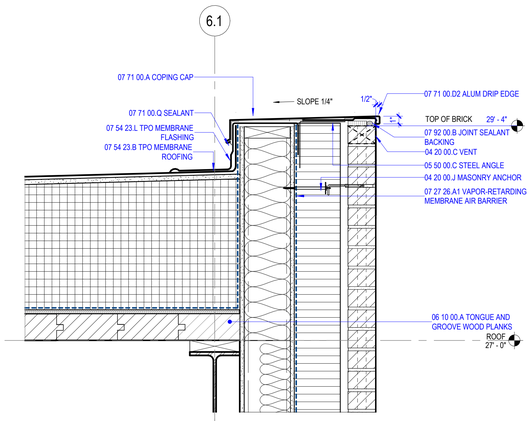
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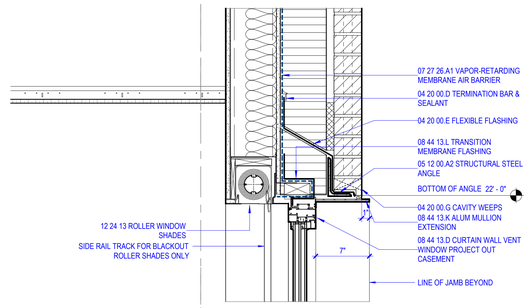
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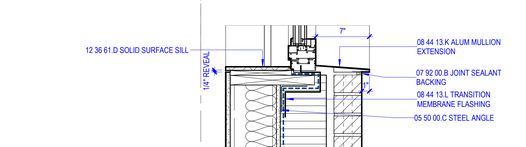
7 ACOUSTICAL SCREEN WALL
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5 TYP PARAPET @ STUD BACK UP
SCALE 1 1/2" = 1'-0"

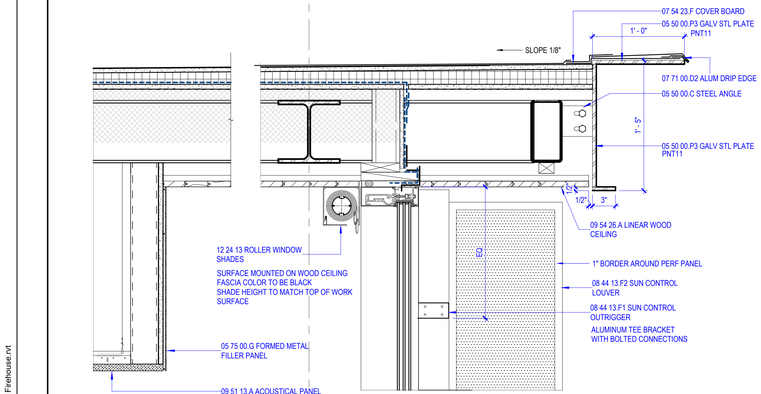


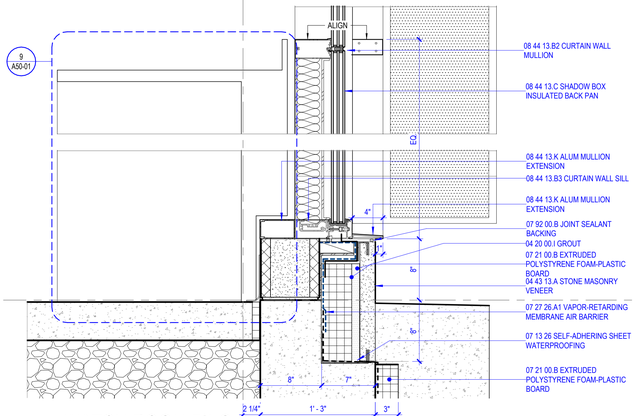
4 TYP WINDOW HEAD
SCALE 1 1/2" = 1'-0"



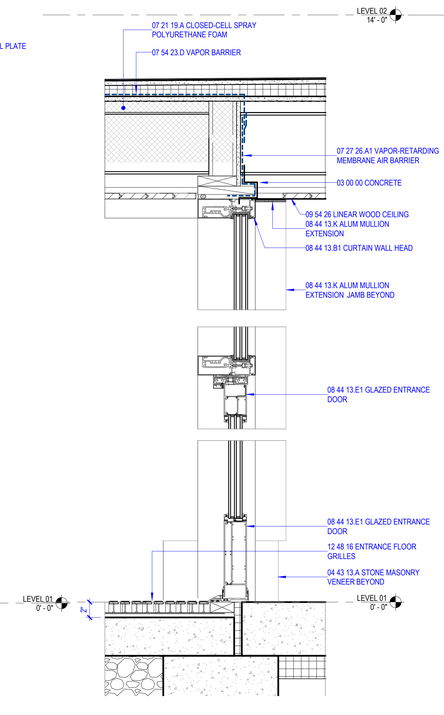
3 TYP WINDOW SILL
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2 ENTRY CANOPY
SCALE 1 1/2" = 1'-0"

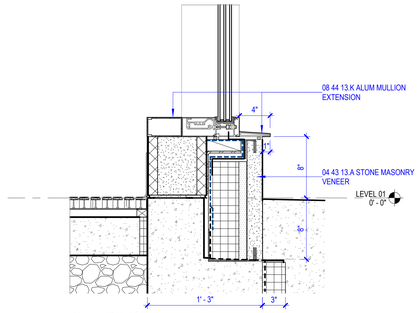




8 WATCH ROOM FINS
SCALE 1 1/2" = 1'-0"



6 ENTRY VESTIBULE DOOR
SCALE 1 1/2" = 1'-0"



1 CW BASE
SCALE 1 1/2" = 1'-0"

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KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

BUILDING ENCLOSURE SECTION DETAILS - BUNKS & ENTRY

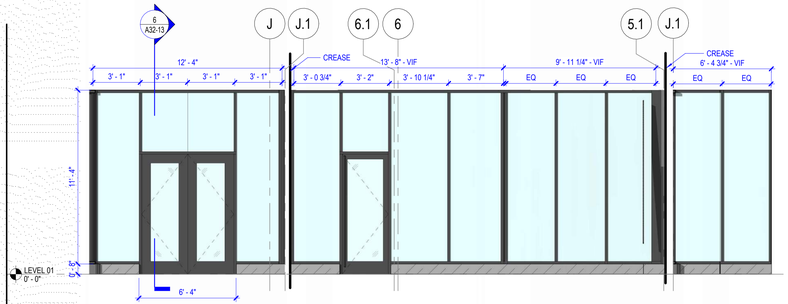
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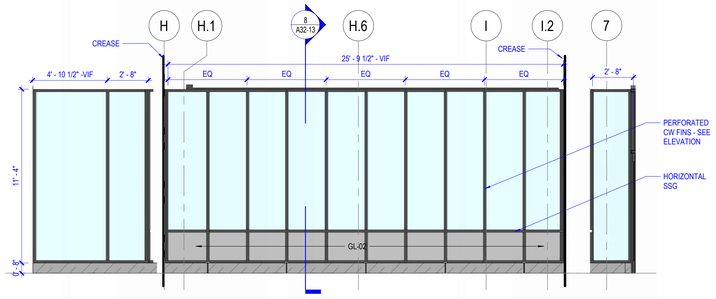
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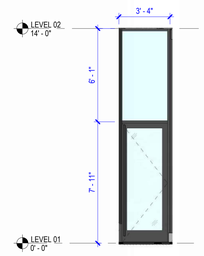
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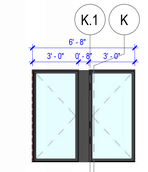
1 CW-01 - ENTRY - UNFOLDED (EGA-1.2)
SCALE 1/4" = 1'-0"



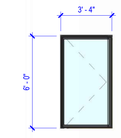
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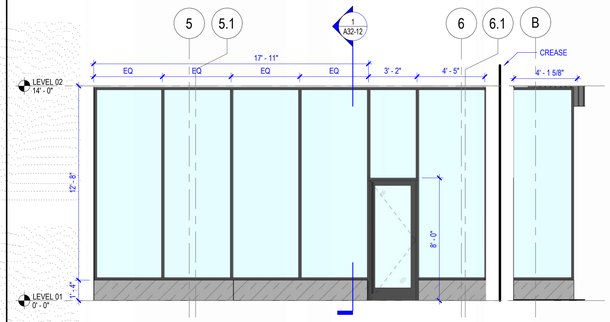
3 CW-03 - APPARATUS BAY ENTRY (EGA-1.2)
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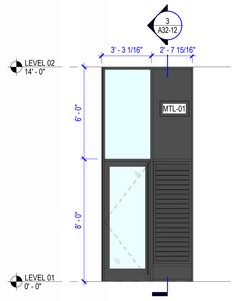
21 CW-21
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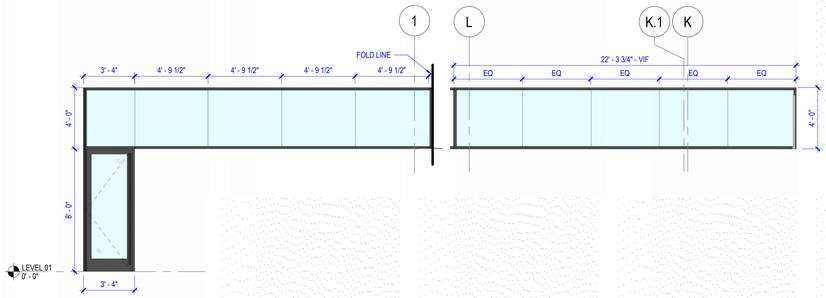
22 CW-22
SCALE 1/4" = 1'-0"



4 CW-04 - APPARATUS BAY - WEST ENTRY (EGA-1.2)
SCALE 1/4" = 1'-0"

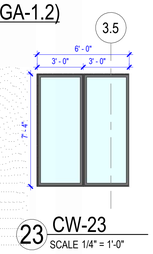


5 CW-05 - NORTH WEST ENTRY (EGA-1.2)
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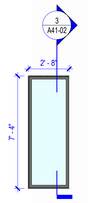


6A CW-06A - FITNESS EAST (EGA-1.1)
SCALE 1/4" = 1'-0"

6B CW-06B - FITNESS NORTH (EGA-1.1)
SCALE 1/4" = 1'-0"

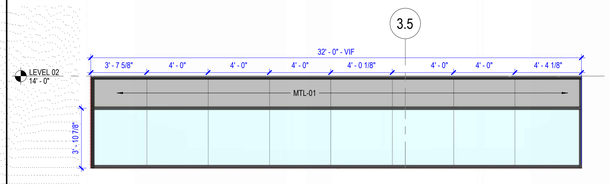


23 CW-23
SCALE 1/4" = 1'-0"

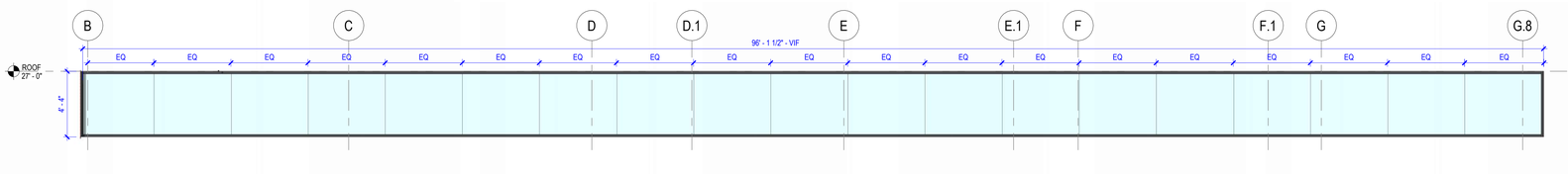


24 CW-24
SCALE 1/4" = 1'-0"

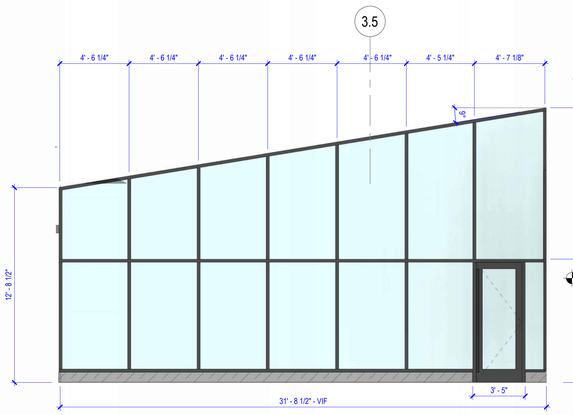
NOTE:
1. SEE A32-01 FOR EXTERIOR GLAZING INFORMATION
2. SEE A45-03 FOR SF-07
3. ALL CW FRAMES TO HAVE PERIMETER EXTENDED SNAP COVER, UNLESS SHOWN OTHERWISE. SEE 3/A34-11 FOR SILL AND HEAD DETAIL. SEE 8/33-01 FOR JAMB DETAIL



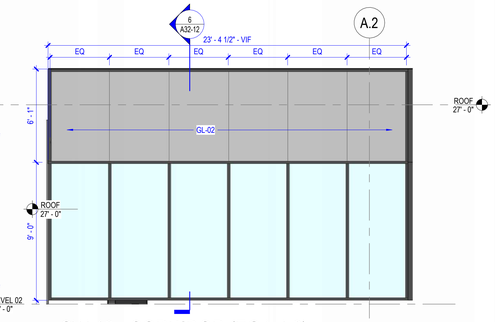
7 CW-07 - TRAINING ROOM (EGA-1.1)
SCALE 1/4" = 1'-0"



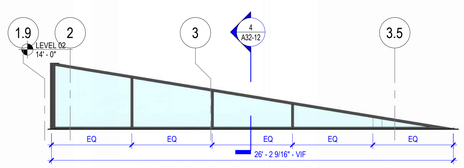
9 CW-09 - SOUTH CLERESTORY (EGA-1.1)
SCALE 1/4" = 1'-0"



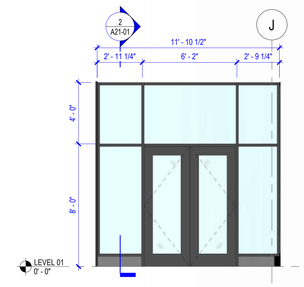
8 CW-08 - KITCHEN (EGA-1.3)
SCALE 1/4" = 1'-0"



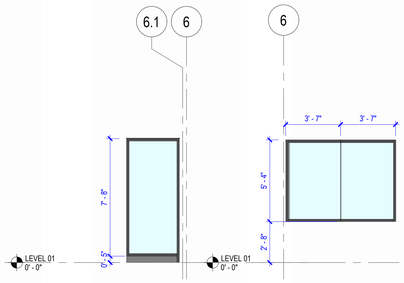
10 CW-10 - CORRIDOR (EGA-1.2)
SCALE 1/4" = 1'-0"



11B CW-11B - CLERESTORY WEST (EGA-1.1)
SCALE 1/4" = 1'-0"

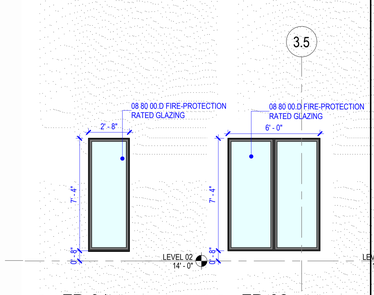


12 SF-01 (ENTRY VESTIBULE)
SCALE 1/4" = 1'-0"



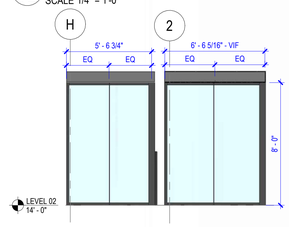
13 SF-02
SCALE 1/4" = 1'-0"

14 SF-03
SCALE 1/4" = 1'-0"

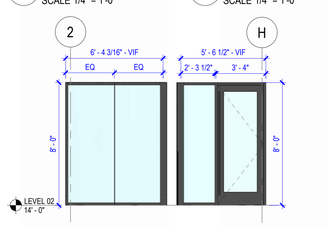


18 FP-01
SCALE 1/4" = 1'-0"

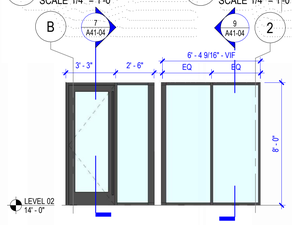
19 FP-02
SCALE 1/4" = 1'-0"



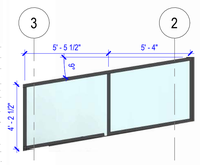
15 SF-04 - UNFOLDED
SCALE 1/4" = 1'-0"



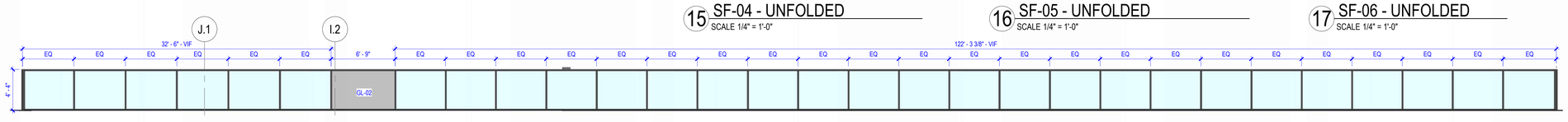
16 SF-05 - UNFOLDED
SCALE 1/4" = 1'-0"



17 SF-06 - UNFOLDED
SCALE 1/4" = 1'-0"



11A CW-11A - CLERESTORY EAST (EGA-1.1)
SCALE 1/4" = 1'-0"



11 CW-11 - CLERESTORY NORTH (EGA-1.1)
SCALE 3/16" = 1'-0"

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PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
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CITY OF WORCESTER

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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

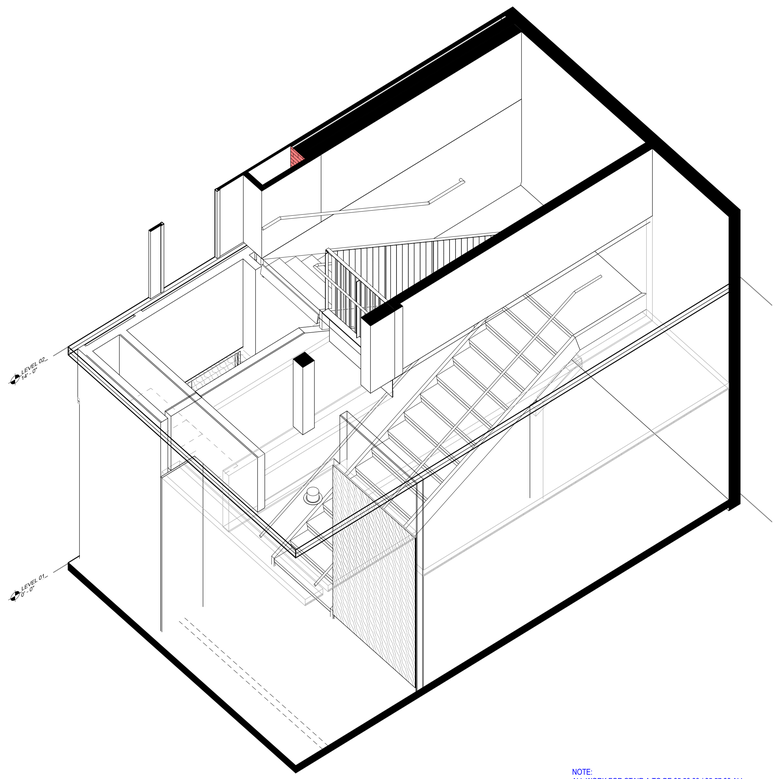
EXTERIOR GLAZING ELEVATIONS

SHEET NUMBER

A34-01

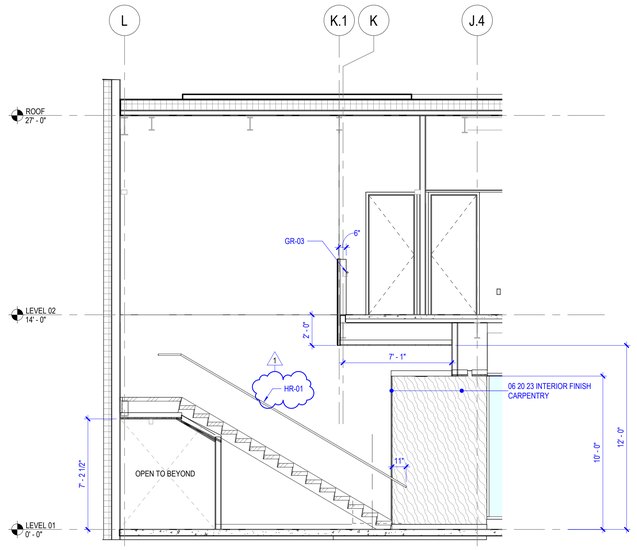
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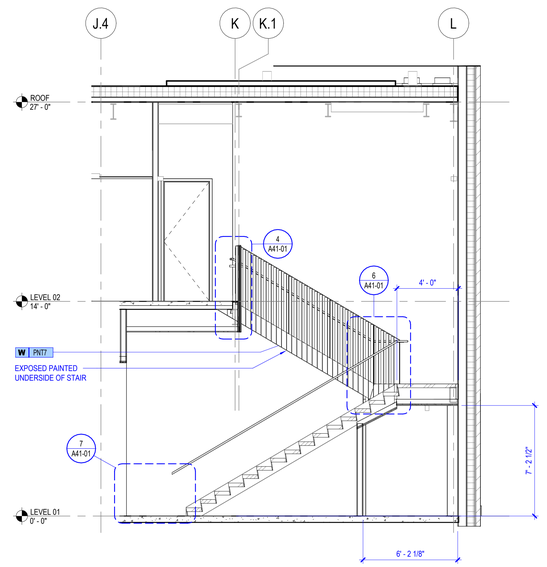


NOTE:
ALL WORK FOR STAIR A TO BE 05 50 00 / 05 57 00 ALL EXPOSED STEEL TO BE PAINTED WITH PNT7

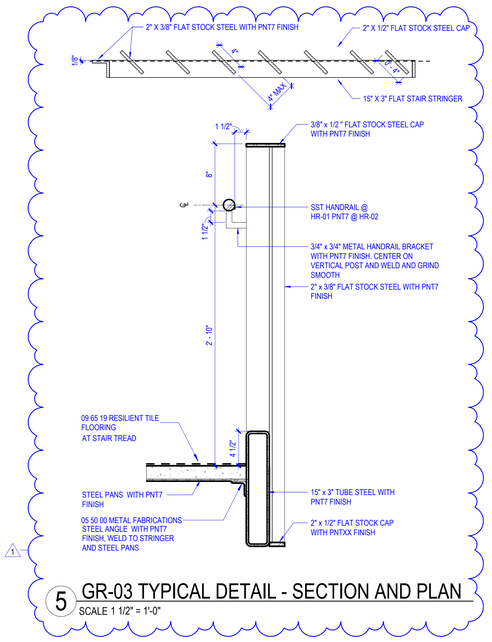
9 STAIR A - AXON
SCALE



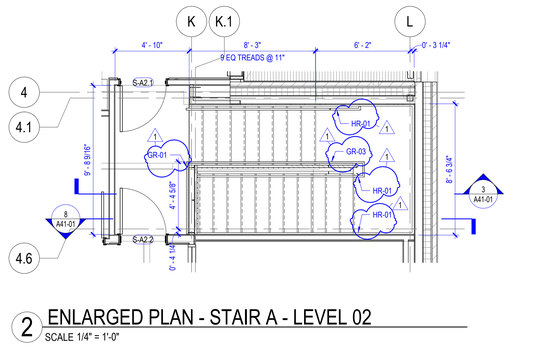
8 ENLARGED STAIR PLAN NORTH SECTION - STAIR A
SCALE 1/4" = 1'-0"



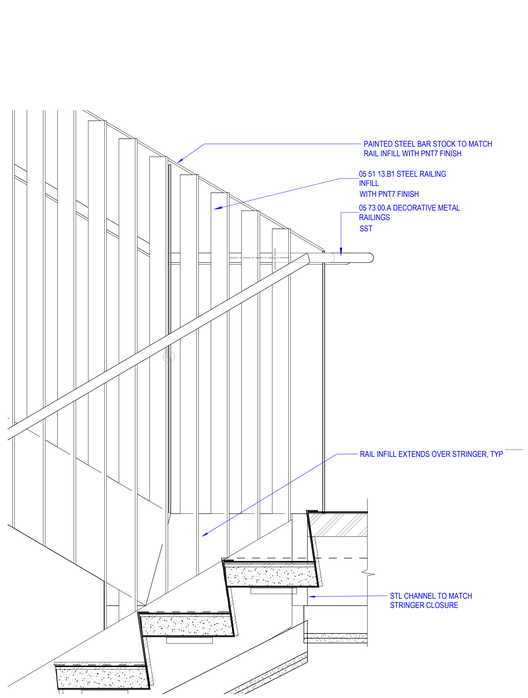
3 ENLARGED STAIR SECTION - STAIR A
SCALE 1/4" = 1'-0"



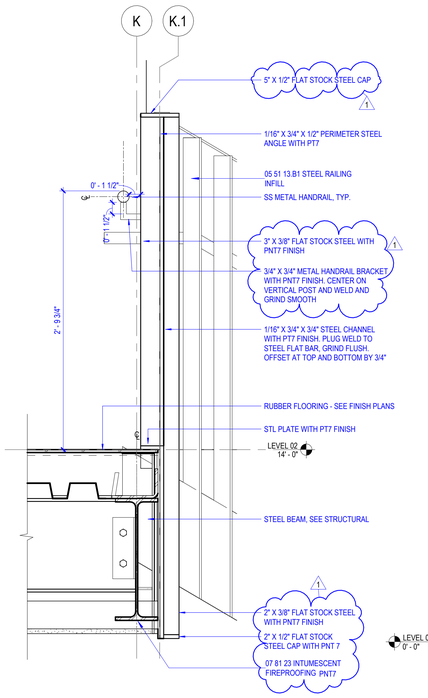
5 GR-03 TYPICAL DETAIL - SECTION AND PLAN
SCALE 1 1/2" = 1'-0"



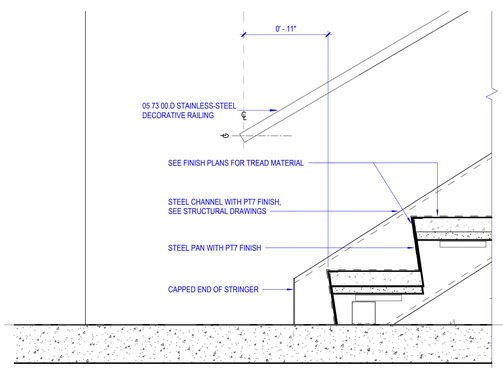
2 ENLARGED PLAN - STAIR A - LEVEL 02
SCALE 1/4" = 1'-0"



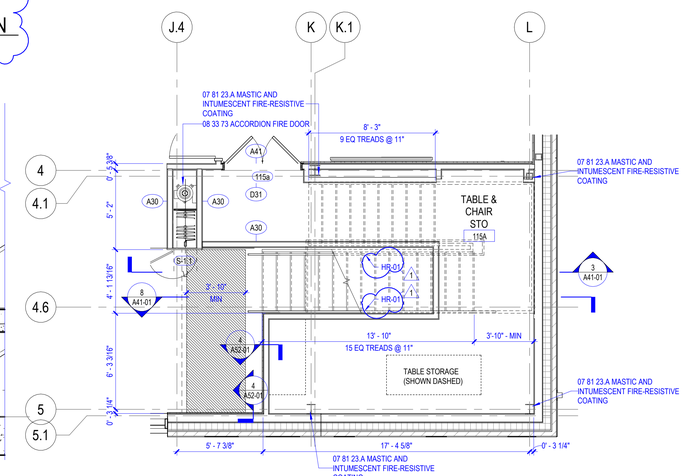
6 STAIR A - MID-LANDING GUARDRAIL
SCALE 1 1/2" = 1'-0"



4 STAIR A - LEVEL 2 LANDING GUARDRAIL GR-03
SCALE 1 1/2" = 1'-0"



7 STAIR A - BOTTOM LANDING
SCALE 1 1/2" = 1'-0"



1 ENLARGED PLAN - STAIR A - LEVEL 01
SCALE 1/4" = 1'-0"

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KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

ENLARGED STAIR A PLANS AND SECTIONS

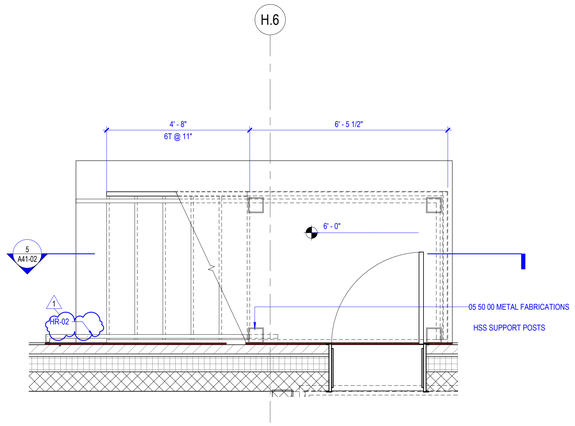
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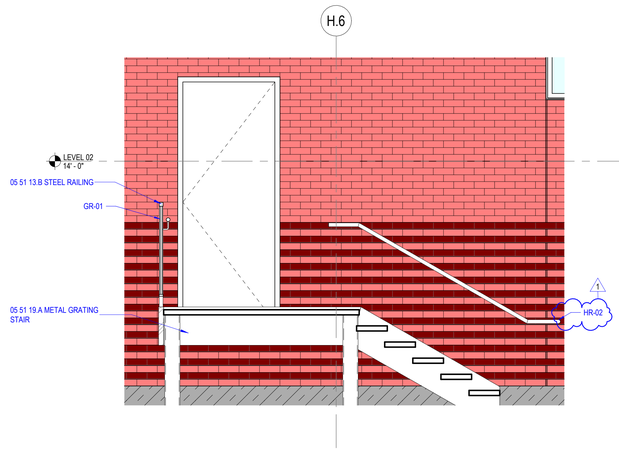
CONSTRUCTION DOCUMENTS 12/19/25

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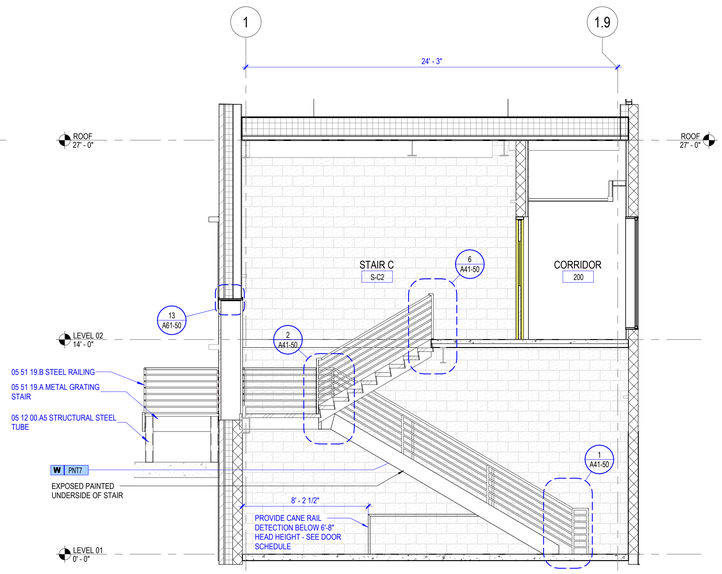
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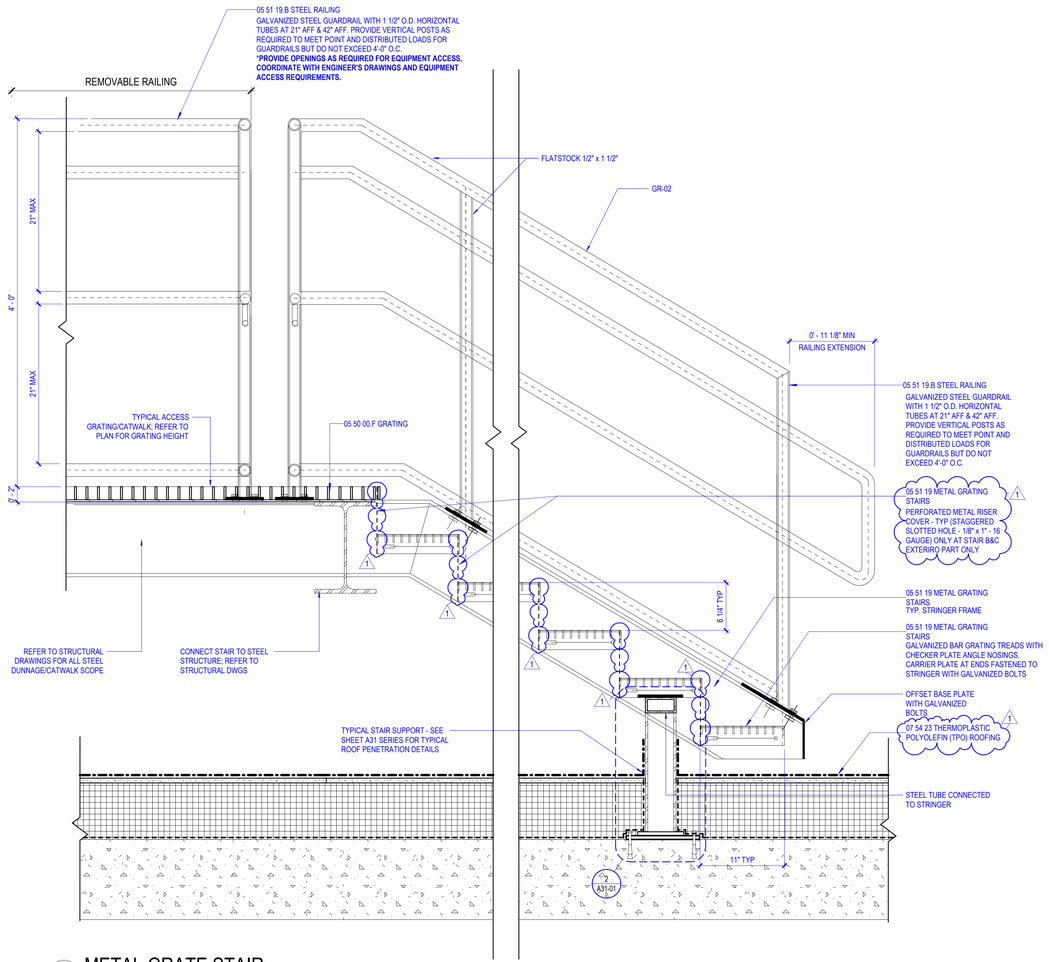
4 LEVEL 01 - TYP. EXTERIOR STAIR
SCALE 1/2" = 1'-0"



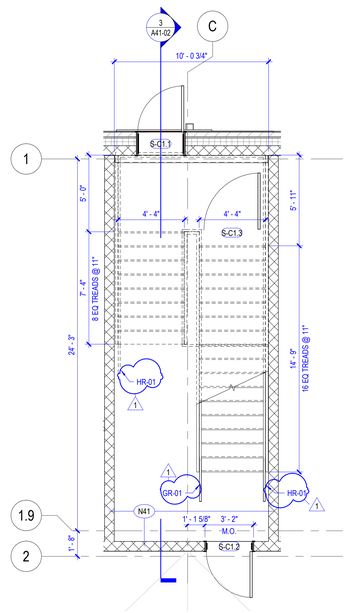
5 ENLARGED TYP. EXTERIOR STAIR SECTION
SCALE 1/2" = 1'-0"



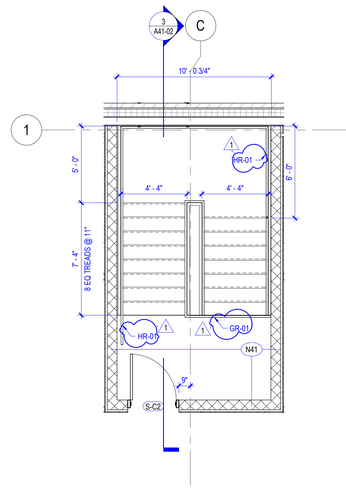
3 ENLARGED STAIR SECTION - STAIR B/C
SCALE 1/4" = 1'-0"



6 METAL GRATE STAIR
SCALE 1 1/2" = 1'-0"



2 ENLARGED PLAN - STAIR B/C - LEVEL 01
SCALE 1/4" = 1'-0"



1 ENLARGED PLAN - STAIR B/C - LEVEL 02
SCALE 1/4" = 1'-0"

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CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

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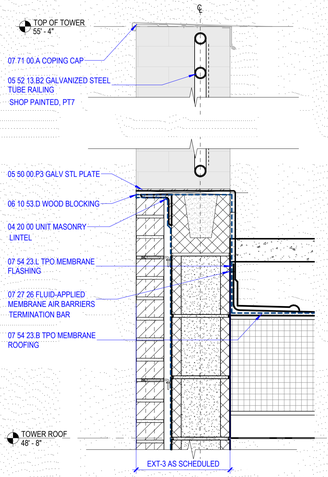
ENLARGED STAIR B,C,D,E, AND F PLANS AND SECTIONS

SHEET NUMBER

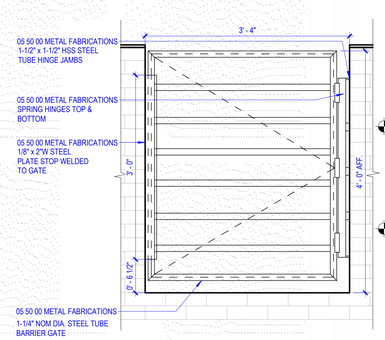
A41-02

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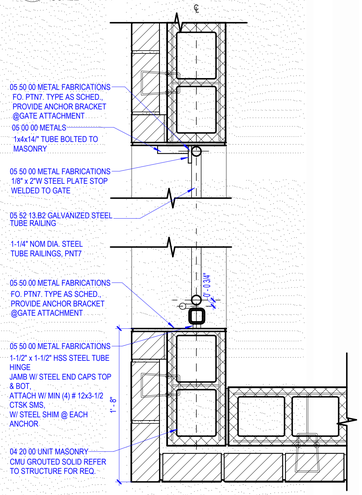
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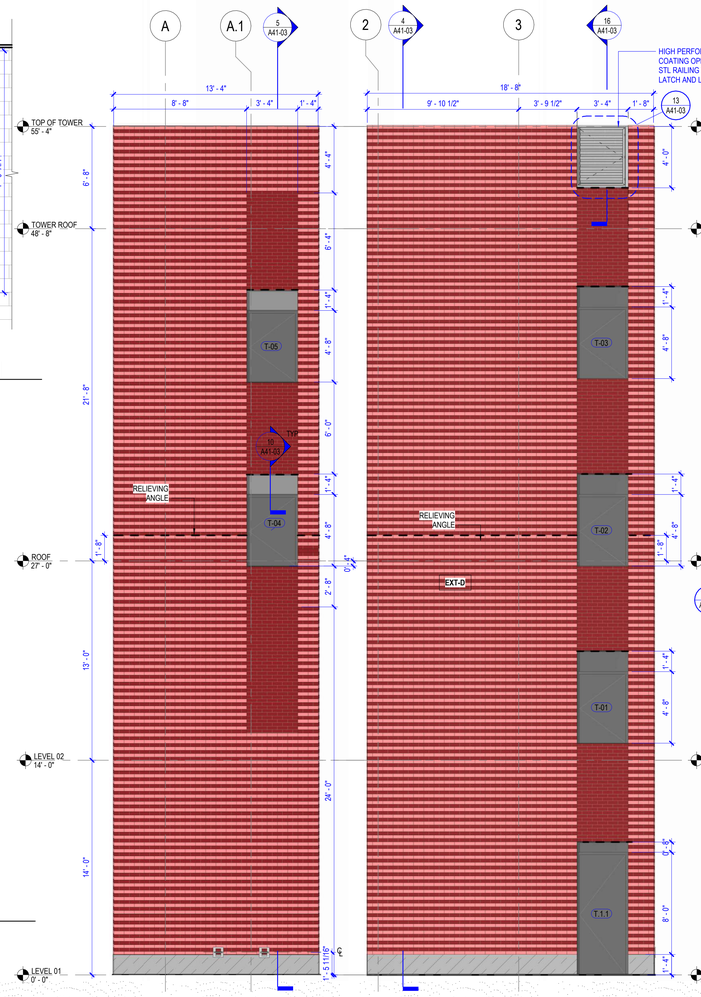
16 TRAINING TOWER GATE SECTION
SCALE 1 1/2" = 1'-0"



13 TRAINING TOWER GATE ELEVATION
SCALE 1" = 1'-0"

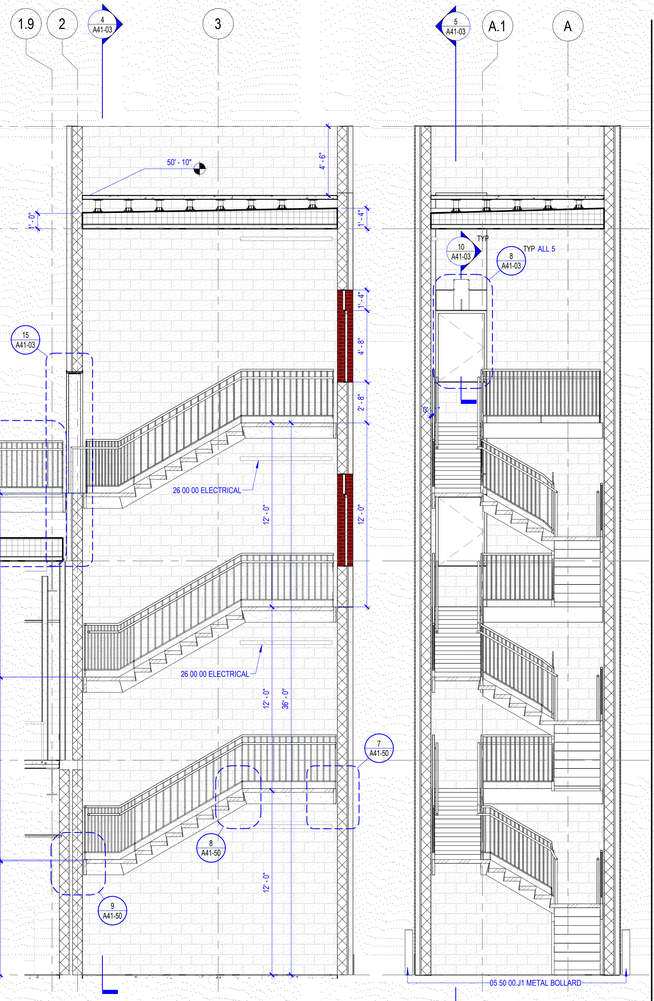


12 TRAINING GATE PLAN DETAIL
SCALE 1 1/2" = 1'-0"



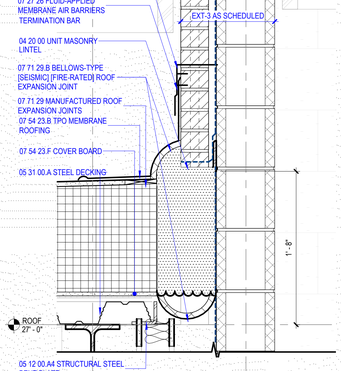
7 TOWER SOUTH ELEVATION
SCALE 1/4" = 1'-0"

6 TOWER WEST ELEVATION
SCALE 1/4" = 1'-0"

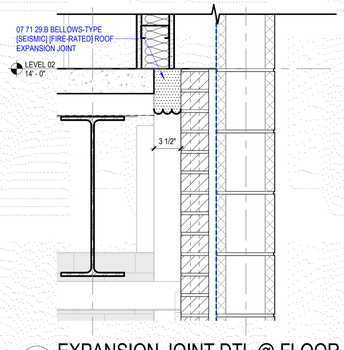


5 TRAINING TOWER SECTION - WEST
SCALE 1/4" = 1'-0"

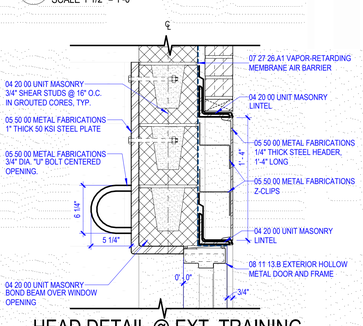
4 TRAINING TOWER SECTION - SOUTH
SCALE 1/4" = 1'-0"



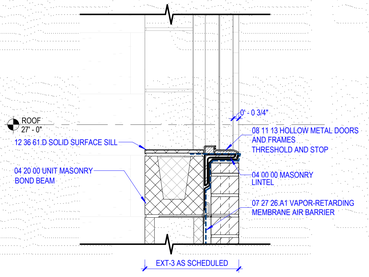
15 DOOR FRAME - TOWER ROOF
SCALE 1 1/2" = 1'-0"



14 EXPANSION JOINT DTL @ FLOOR
SCALE 1 1/2" = 1'-0"

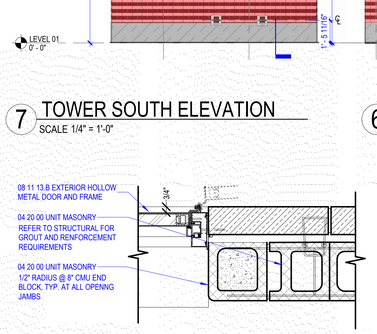


11 HEAD DETAIL @ EXT. TRAINING WINDOW
SCALE 1 1/2" = 1'-0"

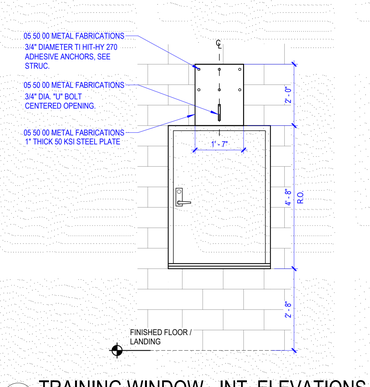


NOTES:
1. U BOLT ANCHOR POINT DESIGNED FOR 10,000# MAXIMUM ULTIMATE LOAD PER NFPA 1402 SECTION 11.2.1.
2. INDICATOR OF ALLOWABLE LOAD REQUIRED.
3. REFER TO STRUCTURAL FOR REINFORCEMENT.
4. DO NOT PAINT "U" BOLT TO ALLOW FOR INSPECTION.

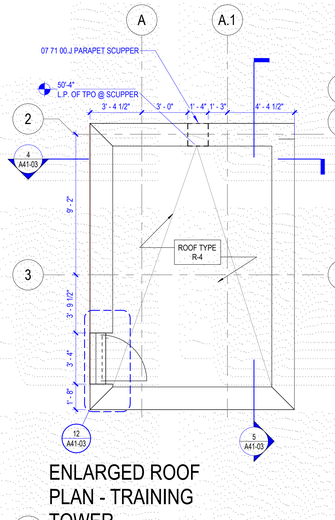
10 FRAME @ EXTERIOR TRAINING WINDOW
SCALE 1 1/2" = 1'-0"



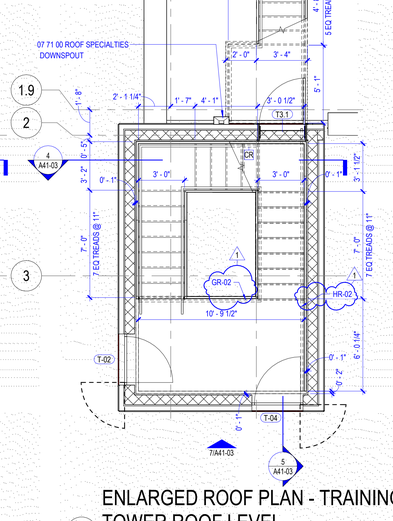
9 TRAINING WINDOW JAMB
SCALE 1 1/2" = 1'-0"



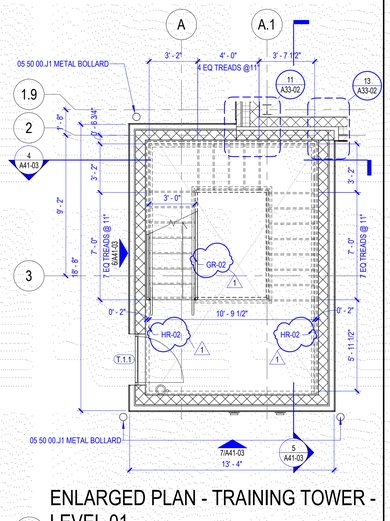
8 TRAINING WINDOW - INT. ELEVATIONS
SCALE 1/2" = 1'-0"



3 ENLARGED ROOF PLAN - TRAINING TOWER
SCALE 1/4" = 1'-0"



2 ENLARGED ROOF PLAN - TRAINING TOWER ROOF LEVEL
SCALE 1/4" = 1'-0"



1 ENLARGED PLAN - TRAINING TOWER - LEVEL 01
SCALE 1/4" = 1'-0"

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CODE
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ANDELMANLELEK
1408 PROVIDENCE HWY, NORWOOD, MA 02062

PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CONSTRUCTION DOCUMENTS 12/19/25

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

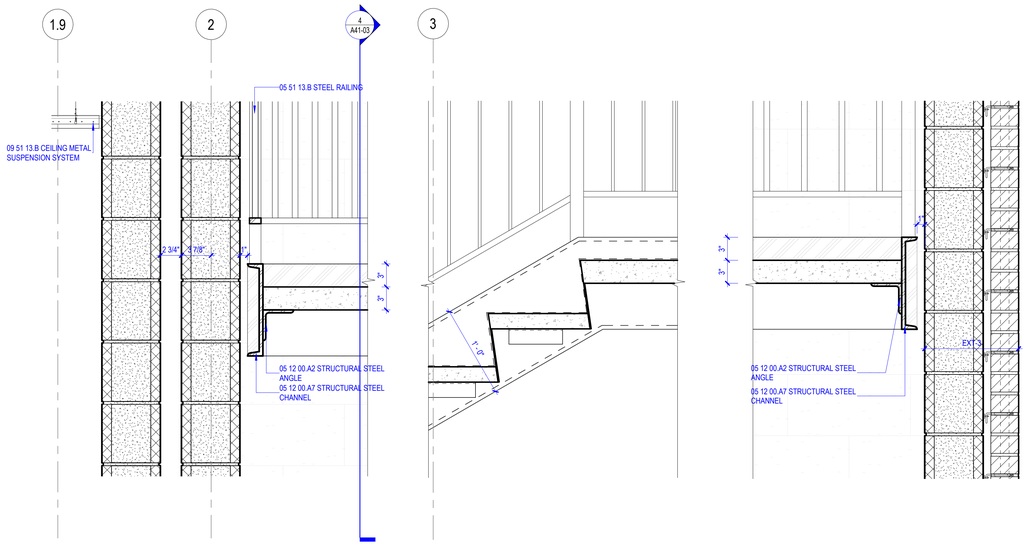
TRAINING TOWER PLANS & SECTION

SHEET NUMBER

A41-03

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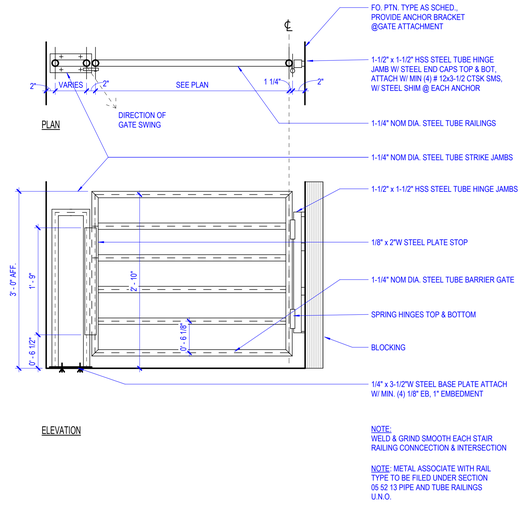
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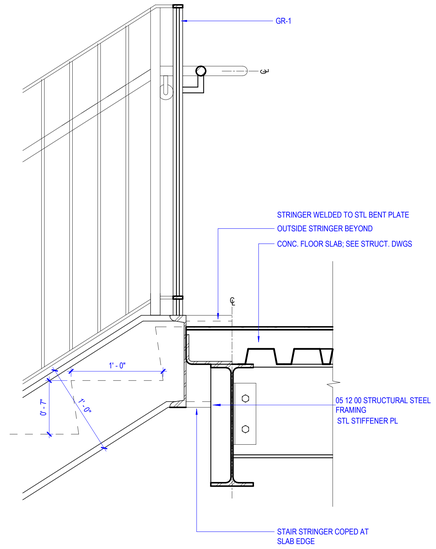
9 TOWER STAIR - TRAINING PLATFORM AT MID LANDING
SCALE 1 1/2" = 1'-0"

8 TOWER STAIR - TRAINING PLATFORM
SCALE 1 1/2" = 1'-0"

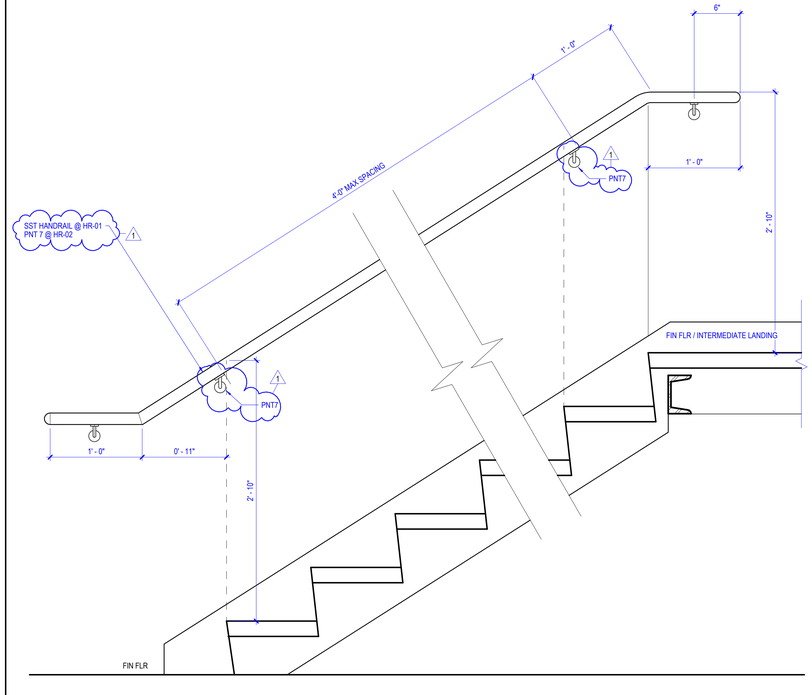
7 TOWER STAIR SECTION DETAIL - EXTERIOR WALL
SCALE 1 1/2" = 1'-0"



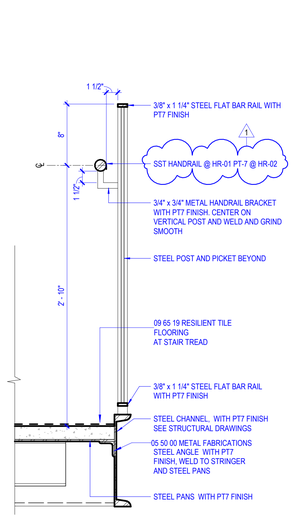
5 STAIR BARRIER GATE EXIT LANDING
SCALE 1" = 1'-0"



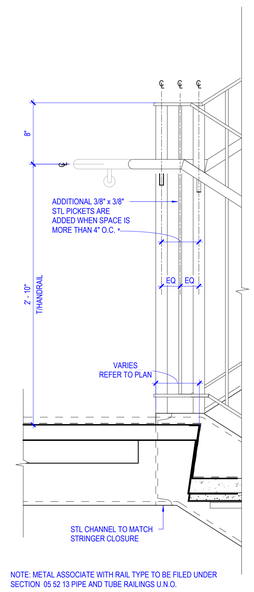
6 STAIR B/C - LEVEL 2 TOP OF LANDING
SCALE 1 1/2" = 1'-0"



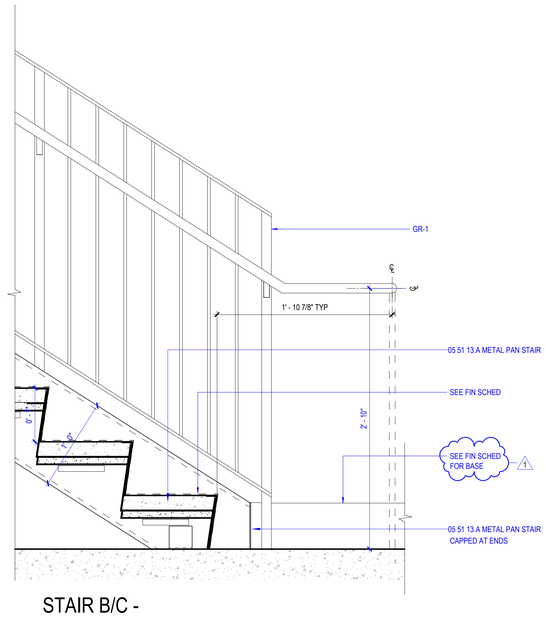
4 HR-01 & HR-02 - TYP HANDRAIL DETAIL
SCALE 1 1/2" = 1'-0"



3 GR-01 & GR-02 - TYP. GUARDRAIL DETAIL
SCALE 1 1/2" = 1'-0"



2 STAIR B/C - MID-LANDING GUARDRAIL
SCALE 1 1/2" = 1'-0"



1 STAIR B/C - BOTTOM LANDING
SCALE 1 1/2" = 1'-0"

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CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

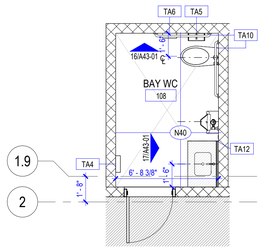
STAIR DETAILS

SHEET NUMBER

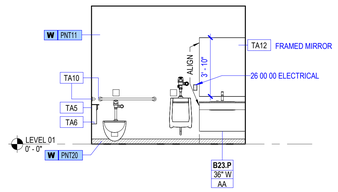
A41-50

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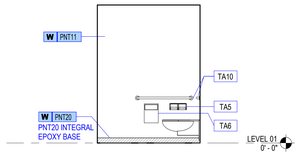
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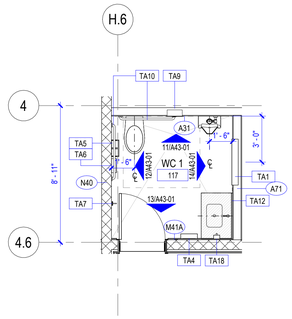
18 ENLARGED PLAN - BAY LAVATORY
SCALE 1/4" = 1'-0"



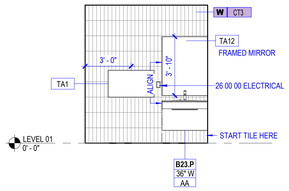
17 ENLARGED ELEVATION - BAY LAVATORY (EAST)
SCALE 1/4" = 1'-0"



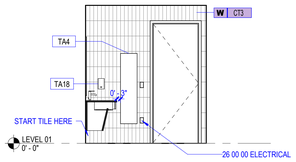
16 ENLARGED ELEVATION - BAY LAVATORY (NORTH)
SCALE 1/4" = 1'-0"



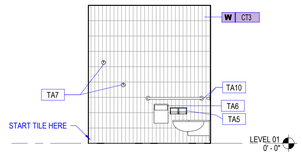
15 ENLARGED PLAN - LAVATORY
SCALE 1/4" = 1'-0"



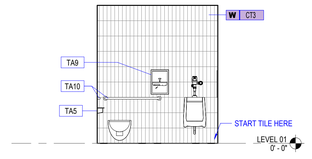
14 ENLARGED ELEVATION - LAVATORY (EAST)
SCALE 1/4" = 1'-0"



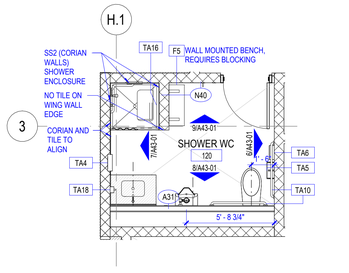
13 ENLARGED ELEVATION - LAVATORY (SOUTH)
SCALE 1/4" = 1'-0"



12 ENLARGED ELEVATION - LAVATORY (WEST)
SCALE 1/4" = 1'-0"



11 ENLARGED ELEVATION - LAVATORY (NORTH)
SCALE 1/4" = 1'-0"

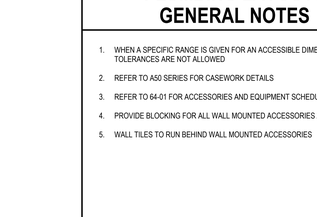


10 ENLARGED PLAN - SHOWER/LAVATORY
SCALE 1/4" = 1'-0"

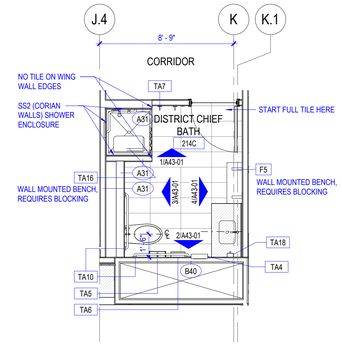
9 ENLARGED ELEVATION - SHOWER LAVATORY (NORTH)
SCALE 1/4" = 1'-0"

8 ENLARGED ELEVATION - SHOWER LAVATORY (SOUTH)
SCALE 1/4" = 1'-0"

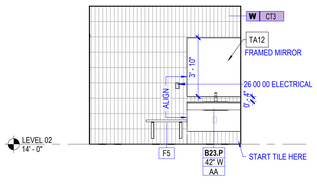
7 ENLARGED ELEVATION - SHOWER LAVATORY (WEST)
SCALE 1/4" = 1'-0"



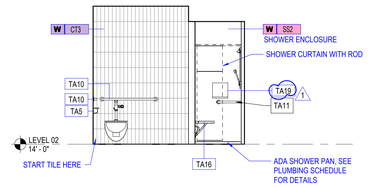
6 ENLARGED ELEVATION - SHOWER LAVATORY (EAST)
SCALE 1/4" = 1'-0"



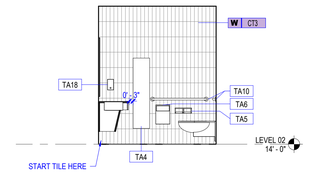
5 ENLARGED PLAN - DISTRICT CHIEF BATHROOM
SCALE 1/4" = 1'-0"



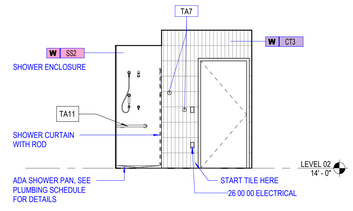
4 ENLARGED ELEVATION - DISTRICT CHIEF BATHROOM (EAST)
SCALE 1/4" = 1'-0"



3 ENLARGED ELEVATION - DISTRICT CHIEF BATHROOM (WEST)
SCALE 1/4" = 1'-0"



2 ENLARGED ELEVATION - DISTRICT CHIEF BATHROOM (SOUTH)
SCALE 1/4" = 1'-0"



1 ENLARGED ELEVATION - DISTRICT CHIEF BATHROOM (NORTH)
SCALE 1/4" = 1'-0"

PLUMBING LAYOUTS GENERAL NOTES

1. WHEN A SPECIFIC RANGE IS GIVEN FOR AN ACCESSIBLE DIMENSION, TOLERANCES ARE NOT ALLOWED
2. REFER TO A50 SERIES FOR CASEWORK DETAILS
3. REFER TO 64-01 FOR ACCESSORIES AND EQUIPMENT SCHEDULE
4. PROVIDE BLOCKING FOR ALL WALL MOUNTED ACCESSORIES AND EQUIPMENT
5. WALL TILES TO RUN BEHIND WALL MOUNTED ACCESSORIES

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CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

ENLARGED TOILET PLANS AND ELEVATIONS

SHEET NUMBER

A43-01

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DOOR SCHEDULE

MARK	To Room: Number	MARK		DOOR						FRAME						HARDWARE SET NUMBER	REMARKS
			FIRE	SIZE									DETAILS				
DOOR NO		ROOM NAME	RATING	W	HT	THK	TYPE	MATERIAL	FINISH	TYPE	MATERIAL	FINISH	HEAD	JAMB			
LEVEL 01																	
101.2	101	SCBA FILL	-	3' - 6"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
102.2	102	YARD STORAGE	-	3' - 6"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
102a	102	YARD STORAGE	-	3' - 6"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	19.0		
103	103	COMPRESSOR ROOM	-	5' - 0"	7' - 10"	0' - 1 3/4"	FF	HM	PNT3	D	HM	PNT3	12/A61-50	15/A61-50	25.0		STC 35-40
104	104	EMS STO	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
105	105	DEPT STORAGE	-	3' - 8"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
106.1	106	TURN OUT GEAR	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
106.2	106	TURN OUT GEAR	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
107	107	STORAGE ROOM 1&2	-	3' - 8"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	10.0		
107a	107	STORAGE ROOM 1&2	-	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	19.0		
108	108	BAY WC	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	10.0		
109	109	BAY CUSTODIAL	-	3' - 8"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	21.0		
110	110	SCBA SHOP	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
111.1	121	CORRIDOR	60	5' - 0"	7' - 10"	0' - 1 3/4"	FF	HM	PNT1	D	HM	PNT1	10/A61-50	9/A61-50	23.0		STC 35-40
111.2	111	MAIN ELEC	90	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	22.0		
112.1	121	CORRIDOR	90	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	22.0		STC 35-40
112.2	112	EMERGENCY ELEC	90	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	22.0		
113.1	113	EXERCISE	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	20.0		STC 35-40
114	114	WATER SERVICE	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	19.0		STC 35-40
115.1	115	TRAINING ROOM	-	3' - 0"	8' - 0"	0' - 1 3/4"	FG	AL	PNT11	S1L1	AL	PNT11	10&11/A61-50	8&9/A61-50	20.0		STC 35-40
115.2	115	TRAINING ROOM	-	3' - 0"	8' - 0"	0' - 1 3/4"	FG	AL	PNT11	S1L1	AL	PNT11	10&11/A61-50	8&9/A61-50	20.0		STC 35-40
115a	115	TRAINING ROOM	60	5' - 0"	7' - 8"	0' - 1 3/4"	FF	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	18.0		
116	116	WC 2	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	7/A41-04	16/A61-50	10.0		
117	117	WC 1	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	7/A41-04	16/A61-50	10.0		
118	118	WORK ROOM	-	5' - 0"	7' - 10"	0' - 1 3/4"	FF	HM	PNT3	D	HM	PNT3	12/A61-50	15/A61-50	25.0		
119	119	DECON	20	3' - 8"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	7.0		
119a	119A	PPE DRYING ROOM	20	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
119C.1	119C	SHOWER LOCKERS	-	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	15.0		
119C.2	119C	SHOWER LOCKERS	20	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	15.0		
119D.1	119D	SHOWERS	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	FB	-	S	FB	-	12/A61-50	15/A61-50	24.0		
119D.2	119D	SHOWERS	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	FB	-	S	FB	-	12/A61-50	15/A61-50	24.0		
119D.3	119D	SHOWERS	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	FB	-	S	FB	-	12/A61-50	15/A61-50	24.0		
119D.4	119D	SHOWERS	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	FB	-	S	FB	-	12/A61-50	15/A61-50	24.0		
119E	119E	CTL RM	60	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	19.0		
120	120	SHOWER WC	-	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	10.0		
121.1	121.1	CLOSET	-	5' - 0"	7' - 8"	0' - 1 3/4"	FF	WD	SEAL	S	MW	PNT3	7/A52-01	12/A52-01	18.0		BLIND CUT DOORS - REFER TO A52-01
121.2	215.4	CLOSET	-	5' - 0"	7' - 8"	0' - 1 3/4"	FF	WD	SEAL	S	MW	PNT3	7/A52-01	12/A52-01	18.0		BLIND CUT DOORS - REFER TO A52-01
121.3	121.2	CLOSET	-	5' - 0"	7' - 8"	0' - 1 3/4"	FF	WD	SEAL	S	MW	PNT3	7/A52-01	12/A52-01	18.0		BLIND CUT DOORS - REFER TO A52-01
121.4	121D	ICE	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	HM	PNT1	D	HM	PNT1	10/A61-50	9/A61-50	18.0		
121a.3	121A	VESTIBULE	-	6' - 0"	7' - 10"	0' - 1 3/4"	FGFG	AL	PNT11		AL	PNT11		16/A61-50	3.0		
121b.1	121B	VEST 1	-	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT1	S	HM	PNT1	12/A61-50	15/A61-50	7.0		
121b.2	121B	VEST 1	-	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	8.0		
121c.1	121C	VEST 2	-	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PTD	S	HM	PNT1	12/A61-50	15/A61-50	7.0		
121c.2	121C	VEST 2	-	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	8.0		
122	122	CUSTODIAL	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	21.0		
123	123	WATCH ROOM	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	20.0		
123a	123A	BUNK	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
S-1.1	S-A1	STAIR A	60	1' - 6"	10' - 6"	0' - 3"	AC	HM	PNT1	S	HM	PNT8	1/A41-01	1/A41-01	-		ACCORDION FIRE DOOR - POCKET OPENING
S-B1.2	S-B1	STAIR B	60	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	12/A61-50	15/A61-50	16.0		
S-B1.3			-	3' - 8"	3' - 0"	0' - 1 3/4"	BG	-	-	-	-	-			-		EGRESS BARRIER GATE
S-C1.2	S-C1	STAIR C	60	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	12/A61-50	15/A61-50	7.0		
S-C1.3			-	3' - 8"	3' - 0"	0' - 1 3/4"	BG	-	-	-	-	-			-		EGRESS BARRIER GATE
LEVEL 02																	
200F	200	CORRIDOR	-	6' - 0"	7' - 10"	0' - 1 3/4"	FF	HM	PNT3	D	HM	PNT3	10/A61-50	9/A61-50			
201	201	COMPANY OFFICER	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	SEAL	S1L1	HM	PNT3	10&11/A61-50	8&9/A61-50	9.0		STC 35-40
201.1	201.1	CLO	-	5' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		
201a	201	COMPANY OFFICER		3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	SEAL	S	HM	PNT3	10/A61-50	9/A61-50	11.0		
202	202	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	PNT1	SEAL	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
203	203	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
204	204	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
205	205	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
206	206	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
207	207	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
208.1	208	COMPANY OFFICER		3' - 0"	7' - 10"	0' - 1 3/4"	FG	WD	PNT7	S	HM	PNT7	10/A61-50	9/A61-50	9.0		STC 35-40
208.2	208.1	CLO	-	4' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		
208a	208A	C/O BUNK ROOM		3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		
209	209	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
210	210	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
211	211	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
212	212	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
213.1	213	COMPANY OFFICER		3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S	HM	PNT7	10&11/A61-50	8&9/A61-50	9.0		STC 35-40
213.2	213.1	CLO	-	4' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		STC 35-40
213A.1	213	COMPANY OFFICER	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		
214.1	214	DISTRICT CHIEF OFFICE		3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S	HM	PNT7	10/A61-50	9/A61-50	9.0		
214.2	214.1	CLO	-	5' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	S	HM	PNT3	10/A61-50	9/A61-50	13.0		
214A.1	214	DISTRICT CHIEF OFFICE	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	9.0		STC 35-40
214B.1	214B	CORRIDOR	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	12.0		
214B.2	214B	CORRIDOR	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	12.0		
214C	214B	CORRIDOR	-	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	10.0		
215.1	215	DISTRICT CHIEF OFFICE	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT7	S1L1	HM	PNT7	10&11/A61-50	8&9/A61-50	9.0		STC 35-40
215.2	215.1	CLO	-	6' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		
215a	215	DISTRICT CHIEF OFFICE	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
216	216	STUDY	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	9.0		STC 35-40
217	217	SERVER	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	14.0		
218	218	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
219	219	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
220	220	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
221	221	CUSTODIAL	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	21.0		
222.1	222	DAY ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	16.0		STC 35-40
222.2	222	DAY ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	16.0		STC 35-40
222a	222A	ELEC	-	6' - 4"	7' - 10"	0' - 1 3/4"	FF	HM	PNT3	D	HM	PNT3	10/A61-50	9/A61-50	17.0		
223	223	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
224	224	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
225	225	LAUNDRY	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	20.0		STC 35-40
226.2	226	KITCHEN/ DINING	20	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L1	HM	PNT7	10&11/A61-50	8&9/A61-50	20.0		
226.3	226	KITCHEN/ DINING	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L2	HM	PNT7	10&11/A61-50	8&9/A61-50	20.0		STC 35-40
227.1	227	COMPANY OFFICER		3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S	HM	PNT7	10/A61-50	9/A61-50	9.0		STC 35-40
227.2	227.1	CLO	-	5' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		
227A.1	227	COMPANY OFFICER	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		
228	228	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
229	229	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
230	230	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
231	231	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
232.1	232	COMPANY OFFICER	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	9.0		STC 35-40
232.2	232.1	CLO	-	5' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10&11/A61-50	8&9/A61-50	13.0		
232A.1	232	COMPANY OFFICER	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	7/A41-04	16/A61-50	11.0		
FP-1.1	100	APPARATUS BAY	20	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
FP-1.2	100	APPARATUS BAY	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	AL	PNT8	S	AL	PNT8	7/A41-04	16/A61-50	8.0		
FP-2.1	100	APPARATUS BAY	20	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
FP-2.2	100	APPARATUS BAY	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	AL	PNT8	S	AL	PNT8	7/A41-04	16/A61-50	8.0		
FP-3.1	100	APPARATUS BAY	20	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
FP-3.2	100	APPARATUS BAY	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	AL	PNT8	S	AL	PNT8	7/A41-04	16/A61-50	8.0		
S-A2.1	226	KITCHEN/ DINING	60	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT7	S	HM	PNT7	10/A61-50	9/A61-50	16.0		
S-A2.2	S-A2	STAIR A	60	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
S-B2	S-B2	STAIR B	60	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
S-C2	S-C2	STAIR C	60	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		

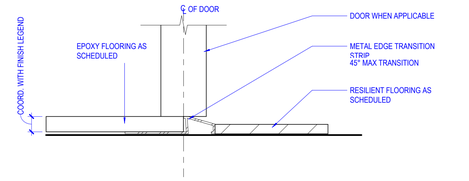
DOOR SCHEDULE - EXTERIOR

MARK	To Room: Number	MARK		DOOR						FRAME						HARDWARE SET NUMBER	REMARKS
			FIRE	SIZE									DETAILS				
DOOR NO		ROOM NAME	RATING	W	HT	THK	TYPE	MATERIAL	FINISH	TYPE	MATERIAL	FINISH	HEAD	JAMB			
LEVEL 01																	
100.1	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.2	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.3	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.4	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.5	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.6	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.7	100	APPARATUS BAY		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	-	ALUM	PNT11	13/A61-50	5/A33-01	6.0		EXTERIOR
100.8	100	APPARATUS BAY		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	-	ALUM	PNT11	6/A32-13	SIM 10/A33-02	6.0		EXTERIOR
100.9	100	APPARATUS BAY		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	-	ALUM	PNT11	6/A32-13	8/A33-01	4.0		EXTERIOR
101.1	101	SCBA FILL		3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	SIM 13/A61-50	14/A61-50	6.0		EXTERIOR; SEE 4/A20-01
102.1	102	YARD STORAGE		6' - 0"	8' - 8"	0' - 3"	OH2	HM	PNT3	-	HM	PNT3	13/A61-50	7/A33-01			EXTERIOR
113.2	113	EXERCISE	-	3' - 0"	8' - 0"	0' - 1 3/4"	FG	AL	PNT11	S	AL	PNT11	6/A32-13	8/A33-01	4.0		POSITIONING SENSOR, EXTERIOR
121a.1	121A	VESTIBULE		6' - 0"	7' - 10"	0' - 1 3/4"	FGFG	ALUM	PNT11	-	ALUM	PNT11	6/A32-13	8/A33-01	1.0		EXTERIOR
121a.2	121A	VESTIBULE		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	-	ALUM	PNT11	6/A32-13	8/A33-01	2.0		EXTERIOR
S-B1.1	SB-1	STAIR B		3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	13/A61-50	14/A61-50	4.0		EXTERIOR
S-C1.1	SC-1	STAIR C		3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	13/A61-50	14/A61-50	4.0		EXTERIOR
T-01	T-1	TRAINING TOWER		3' - 4"	4' - 7 3/4"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT1	11/A41-03	7/A41-03			EXTERIOR
T-02	T-1	TRAINING TOWER		3' - 4"	4' - 7 3/4"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
T-03	T-1	TRAINING TOWER		3' - 4"	4' - 7 3/4"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
T-04	T-1	TRAINING TOWER		3' - 4"	4' - 7 1/2"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
T-05	T-1	TRAINING TOWER		3' - 4"	4' - 7 1/2"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
T-1.1	T-1	TRAINING TOWER		3' - 4"	8' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
LEVEL 02																	
226.1	226	KITCHEN/ DINING		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	S	ALUM	PNT11	6/A32-13	10/A33-02	27.0		EXTERIOR
ROOF																	
T3.1	T-1	TRAINING TOWER		3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	-	HM	PNT3	15/A61-03	7/A41-03	27.0		EXTERIOR

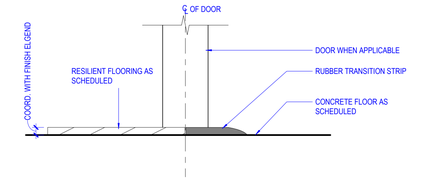
FLOOR TRANSITION GENERAL NOTES

HEIGHT CHANGE RULES
1. UP TO 1/4 INCH: NO ADDITIONAL TREATMENT IS REQUIRED FOR A VERTICAL CHANGE.
2. 1/4 TO 1/2 INCH: THE EDGE MUST BE BEVELED AT A SLOPE NOT STEEPER THAN 1:2 (A 1-TO-2 SLOPE MEANS FOR EVERY 1 INCH OF VERTICAL RISE, THERE IS 2 INCHES OF HORIZONTAL RUN).
3. OVER 1/2 INCH: THE CHANGE MUST BE HANDLED AS A RAMP, FOLLOWING ALL APPLICABLE RAMP SLOPE AND LANDING REGULATIONS.

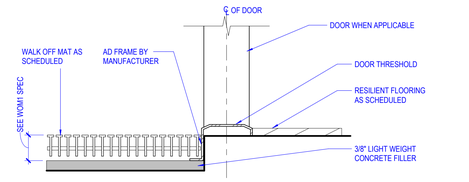
FLOOR TRANSITION DETAILS



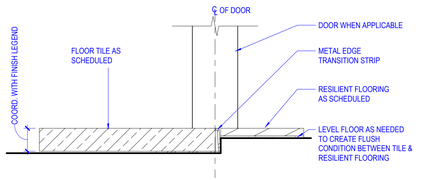
4 EPOXY TO RESILIENT TRANSITION DETAIL
SCALE 12" = 1'-0"



3 RESILIENT TO CONCRETE TRANSITION DETAIL
SCALE 12" = 1'-0"



2 WOM TO RESILIENT TRANSITION DETAIL
SCALE 12" = 1'-0"


℄ OF DOOR
DOOR WHEN APPLICABLE
FLOOR TILE AS SCHEDULED
METAL EDGE TRANSITION STRIP
RESILIENT FLOORING AS SCHEDULED
LEVEL FLOOR AS NEED

EQUIPMENT SCHEDULE

TAG	DESCRIPTION	MODEL	FINISH	COMMENTS	Install Code
E1	30" COOKTOP	RECESSED, COUNTER DEPTH		8 COOKING ZONE IN TOTAL, ADA COMPLIANT	1
E2	60" WALL RANGE HOOD	WALL MOUNTED	STAINLESS STEEL	ADA COMPLIANT	1
E3	30" ELECTRIC OVEN	RECESSED, COUNTER DEPTH	STAINLESS STEEL	ADA COMPLIANT	1
E4	FRENCH DOOR REFRIGERATOR, BOTTOM FREEZER	FREE STANDING, COUNTER DEPTH	STAINLESS STEEL		3
E5	ELECTRIC TOASTER	COUNTERTOP	STAINLESS STEEL		3
E6	MICROWAVE	RECESSED DRAWER	STAINLESS STEEL		1
E7	DISHWASHER	RECESSED, COUNTER DEPTH	STAINLESS STEEL	ADA COMPLIANT, QUIET OPERATION	1
E8	COFFEE BREWERS	COUNTERTOP			3
E9	WASHING MACHINE	FREE STANDING			3
E10	DRYER	FREE STANDING			3

FURNITURE SCHEDULE

TAG	DESCRIPTION	INSTALL CODE	COMMENTS
F1	BUNK BED, 39" X 80"	3	METAL FRAME
F2	EXECUTIVE TASK CHAIR - ARMS	3	5-STAR CASTORS BASE, FOR RESILIENT FLOOR
F3	GUEST CHAIR - NO ARM	3	SLED BASE
F4	TASK CHAIR - NO ARM	3	SLED BASE
F5	BATHROOM SEATING 36" x 16"	2	WALL MOUNTED BENCH, STAINLES STEEL BRACKETS, PLAM2 FINISH SEAT
F6	LOUNGE CHAIR	3	
F7	OFFICE DESK WITH RETURN	3	7'-6" x 5'-6"
F8	DESK, 20" x 48"	3	
F10	HIGH TOP TABLE - 36" DIAMETER	3	34" H
F11	COUNTER HEIGHT STOOL	3	
F12	KITCHEN BENCH, 18" x 60"	3	
F13	KITCHEN TABLE, 42" x 132"	3	
F14	RECLINER CHAIR	3	
F15	STACKING TRAINING CHAIR	3	CASTORS OR SLED BASE
F16	BED SIDE TABLE, 30"x30"	3	
F17	CONFERENCE TABLE, 48" x 120"	3	
F18	OUTDOOR TABLE SET WITH (4) CHAIRS,TABLE SIZE 36" x 36"	3	
F19	WALL MOUNTED TV/DISPLAY	3	
F20	TASK CHAIR - ARMS	3	CASTORS OR SLED BASE

ACCESSORY SCHEDULE

TAG	DESCRIPTION	INSTALL CODE	COMMENTS
TA1	WALL MOUNTED BABY CHANGING STATION	1	SEMI-RECESSED, STAINLESS STEEL
TA4	WALL PAPER TOWEL DISPENSER AND WASTE RECEPTACLE	1	SEMI-RECESSED, STAINLESS STEEL
TA5	WALL MOUNTED TOILET TISSUE DISPENSER AND UTILITY SHELF	1	SURFACE-MOUNTED, STAINLESS STEEL
TA6	WALL MOUNTED SANITARY NAPKIN DISPOSAL	1	SURFACE-MOUNTED, STAINLESS STEEL
TA7	COAT HOOK	1	STAINLESS STEEL
TA9	RECESSED SHARP DISPOSAL	1	STAINLESS STEEL
TA10	1-1/2" GRAB BARS WITH SNAP FLANGE, 42" long	1	STAINLESS STEEL
TA11	HORIZONTAL TWO-WALL BAR for Shower Stall	1	STAINLESS STEEL
TA12	MIRROR	1	FRAMED - BRUSHED NICKEL 1/4" DEEP NOSE ALUMINUM J-CHANNEL
TA16	ADA FOLDING SHOWER SEAT	1	PADDED SEAT, WALL MOUNTED REQUIRES WALL BLOCKING
TA17	COUNTER PAPER TOWEL DISPENSER, C-FOLD	1	RECESSED, STAINLESS STEEL
TA18	SOAP DISPENSER	3	WALL MOUNTED, BY OWNER
TA19	SOAP AND SHAMPOO DISPENSER	3	WALL MOUNTED, BY OWNER

EQUIPMENT / FURNITURE NOTES :

1. REFER TO A13 SERIES FOR FURNITURE/EQUIP. LOCATIONS
2. FOR FIREMATIC FURNITURE, SEE A17 DRAWING SERIES.

INSTALL CODE KEY

1: FURNISHED & INSTALLED BY CONTRACTOR (CF/CI)
2: FURNISHED BY OWNER; INSTALLED BY CONTRACTOR (OF/CI)
3: FURNISHED & INSTALLED BY OWNER (OF/OI)
4: FURNISHED BY CONTRACTOR & INSTALLED BY OWNER (CF/OI)

FINISH LEGEND

SPEC	TAG	TYPE	MFR	STYLE	COLOR/FINISH	SIZE	COMMENTS
ALUMINUM PANEL/WALL							
07 42 13	MTL1	ALUMINUM PANEL/WALL		WALL ALUMINUM PANEL	TO MATCH PPG - BLACK NOIR		ALUMINUM PANEL
ALUMINUM TRIM/BASE							
05 75 03	MTL2	ALUMINUM TRIM/BASE		ALUMINUM BASE, FLUSH	BLACK MATTE	4"H	ANODIZED ALUMINUM METAL BASE C, 4" H (POWDER COAT FINISH)
05 75 03	MTL3	ALUMINUM TRIM/BASE		ALUMINUM BASE	ALUMINUM, BLACK COLOR	4"H	ANODIZED ALUMINUM METAL BASE A, 4" H (POWDER COAT FINISH)
05 75 03	MTL4	ALUMINUM TRIM/BASE		ALUMINUM BASE	ALUMINUM, BLACK COLOR	4"H	ANODIZED ALUMINUM METAL BASE B, 4" H (POWDER COAT FINISH)
05 75 03	MTL5	ALUMINUM TRIM/BASE		ALUMINUM TRIM / REVEAL / CORNER	ALUMINUM, BLACK COLOR	1/4"	ANODIZED ALUMINUM CORNER (POWDER COAT FINISH)
05 75 03	MTL6	ALUMINUM TRIM/BASE		ALUMINUM TRIM / REVEAL / CORNER	ALUMINUM, BLACK COLOR	1/2"	ANODIZED ALUMINUM CORNER (POWDER COAT FINISH)
05 75 03	MTL7	ALUMINUM TRIM/BASE		ALUMINUM TRIM / REVEAL / CORNER	ALUMINUM, BLACK COLOR	1/4" x 1/2"	ANODIZED ALUMINUM REVEAL MOLDING (POWDER COAT FINISH)
CEILING							
09 51 13	APC1	CEILING		ACOUSTIC PANEL CEILING, 2X6	WHITE	2x6	HIGH NRC, LAY-IN TILE, T GRID, 9/16"
09 51 13	APC2	CEILING		ACOUSTIC PANEL CEILING, 2X2	WHITE	2x2	HIGH NRC, LAY-IN TILE, T GRID, 9/16"
09 51 13	APC3	CEILING		MOISTURE RESISTANT PANEL CEILING, 2X2	WHITE	2x2	HIGH NRC, LAY-IN TILE, T GRID, 9/16"
09 54 26	AWC1	CEILING		LINEAR WOOD CEILING	HEMLOCK, SOLID WOOD CORE	3"x5/8"	TONGUE & GROOVE LINEAR CEILING
CERAMIC TILE							
09 30 13	CT2	CERAMIC TILE		FLOOR TILE	MATTE CERAMIC/PORCELAIN	12"x24"	FOR LAYOUT INSTALLATION SEE ELEVATION. GROUT COLOR TO MATCH TILE
09 30 13	CT3	CERAMIC TILE		WALL TILE	GLOSSY GLAZED CERAMIC	3"x12"	FOR LAYOUT INSTALLATION SEE ELEVATION. GROUT COLOR TO MATCH TILE
09 30 13	CT4	CERAMIC TILE		WALL TILE	GLOSSY GLAZED CERAMIC	2"x6.5"	FOR LAYOUT INSTALLATION SEE ELEVATION. GROUT COLOR: OFF-WHITE
EPOXY							
09 67 23	INTEGRAL BASE	EPOXY		INTEGRAL COVE AT EPOXY FLOORING			SEE DETAIL FOR WALL TRANSITION
FABRIC WRAPPED PANEL							
09 84 33	FWP1	FABRIC WRAPPED PANEL			XOREL, WINDSOR 6131 - COLOR 36		UNBACKED TEXTILE, 56 INCH WIDE, 1" MINERAL FIBER CORE
MIRROR							
08 81 13	DG2	MIRROR		MIRROR		7'-8"H	EXERCISE ROOM WALLS
PAINT							
09 91 23	PNT1	PAINT		GENERAL PAINT	BM_OC-57 White Heron		EGGSHELL FOR WALLS AND METAL PAINT FOR DOORS
09 91 23	PNT2	PAINT		ACCENT	BM_HC-151 Whipple Blue		
09 91 23	PNT3	PAINT		METAL PAINT	BM_2121-20 STEEL WOOL		DOORS
09 91 23	PNT4	PAINT		ACCENT	BM_2125-40 Shadow Gray		
09 91 23	PNT5	PAINT		ACCENT	BM_2127-60 Feather Gray		
09 91 23	PNT6	PAINT		ACCENT	BM_2121-30 Pewter		
09 91 23	PNT7	PAINT		STEEL/METAL/MEP/FP PAINT	BM_2126-10 Black Tar		METAL STRUCTURE / STAIRS / RAILINGS/ EXPOSED MEPFP
09 91 23	PNT8	PAINT		METAL PAINT	SW 6905-GOLDFINCH		"YELLOW ZONE" DOOR
09 96 13.13	PNT9	PAINT		HIGH PERFORMANCE, TEXTURED	GOH 34806376		HIGH PERFORMANCE PAINT, TEXTURED. TO MATCH BM_2121-20 Steel Wool
09 91 23	PNT10	PAINT		EPOXY	SW_7671 On he Rocks		CMU WALLS IN LOCKERS ROOMS AND BAY SUPPORT SPACES
08 41 13	PNT11	PAINT		SHOP APPLIED 3-COAT FINISH	TO MATCH PPG - BLACK NOIR		ALUMINUM FRAME, CURTAIN WALL
09 91 23	PNT12	PAINT		EPOXY	TO MATCH SW 6905-GOLDFINCH		CMU - PORTAL ACCENT EPOXY
09 96 56	PNT13	PAINT		EPOXY	LIGHT GREY WITH SMALL CHIPS		MICROFLAKES 1/16"
09 67 23	PNT20	PAINT		EPOXY FLOORING	Medium/Dark Grey		TEXTURED FINISH, HIGH TRAFFIC, APARATUS BAY AREA AND FIREMATIC SPACES
09 67 23	PNT21	PAINT		EPOXY FLOORING W/ INTEGRAL COVE	MEDIUM GREY W/ GREY SPECKLES		LOCKERS AND TOILETS IN FIREMATIC SPACES
09 67 23	PNT22	PAINT		EPOXY PAINT	BRIGTH YELLOW		FLOOR STRIPES AT APARATUS BAY AREA
PLASTIC LAMINATE							
06 41 16	PLAM1	PLASTIC LAMINATE		SOLID COLOR, MATTE	LIGTH GRAY		
06 41 16	PLAM2	PLASTIC LAMINATE		WOOD TEXTURE, WOODBRUSH FINISH	WOOD PATTERN		
PREFACED CMU							
04 20 00	CMU1	PREFACED CMU		PREFACED	WHITE WITH SMALL CHIPS		CMU AT BAY
04 20 00	CMU2	PREFACED CMU		PREFACED	LIGHT GREY WITH SMALL CHIPS		CMU AT BAY
RESILIENT TILE FLOORING							
09 65 19	RSF1	RESILIENT TILE FLOORING		LARGE FORMAT TILE, NO WELDING	MEDIUM GREY W/ GREY SPECKLES	39.45"X39.45"	
09 65 19	RSF4	RESILIENT TILE FLOORING		RESILIENT PLANK	WOOD PATTERN		STAGGERED LAYOUT INSTALLATION
RUBBER ATHLETIC FLOOR							
09 65 66	RSF2	RUBBER ATHLETIC FLOOR		RUBBER TILE, FITNESS	BLACK W/ IVORY SPECKLES		
RUBBER BASE							
09 65 13	RB1	RUBBER BASE		GENERAL BASE	CHARCOAL GREY	4"H, COVE	
RUBBER SHEET FLOORING							
09 65 19	RSF5	RUBBER SHEET FLOORING		LARGE FORMAT TILE, NO WELDING	DARK GREY W/ GREY SPECKLES	39.45"X39.45"	ED
RUBBER TREAD/RISER FLOORING							
09 65 66	RSF3	RUBBER TREAD/RISER FLOORING		RUBBER STAIR TREAD/RISER	TO MATCH RSF1 COLOR		
SEALED CONCRETE							
09 61 61	SC	SEALED CONCRETE					
SOLID QUARTZ							
06 61 19	SS1	SOLID QUARTZ		JUMBO SLAB	POLISHED, SMALL WHITE-CHIP PATTERN		3CM
SOLID SURFACE							
09 75 23	SS2	SOLID SURFACE		SHOWER CLADDING, WINDOW SILL	MODERN WHITE		1/2" THICK, WIDESHEET FOR SHOWER CLADDING
09 75 23	SS3	SOLID SURFACE		TRAINING CREDENZA, WATCH ROOM	LIGHT MEDIUM GREY, LEATHER FINISH		1/2" AND 3/4" THICKNESS
09 75 23	SS4	SOLID SURFACE		BUNK NICHE	DARK CHARCOAL/BLACK COLOR		1/2" THICK
STATIC-CONTROL RESILIENT FLOORING							
09 65 36	RSF6	STATIC-CONTROL RESILIENT FLOORING		RUBBER FLOOR TILE	SMOOTH	24" x 24"	WELDED SEAMS
WALK OFF MAT							
12 48 13	WOM1	WALK OFF MAT		RECESSED ENTRANCE GRILLE	STAINLESS STEEL		
WINDOW TREATMENT							
12 24 13	WNT1	WINDOW TREATMENT		MANUAL ROLLER WINDOW SHADE - 5%	WHITE/LIGHT GREY		REFER TO DETAIL SHEETS FOR MOUNTING TYPE
12 24 13	WNT2	WINDOW TREATMENT		MANUAL ROLLER WINDOW SHADE - BLACKOUT	WHITE/LIGHT GREY		REFER TO DETAIL SHEETS FOR MOUNTING TYPE
12 24 13	WNT3	WINDOW TREATMENT		MOTORIZED ROLLER WINDOW SHADE - 5%	WHITE/LIGHT GREY		REFER TO DETAIL SHEETS FOR MOUNTING TYPE
12 24 13	WNT4	WINDOW TREATMENT		MOTORIZED ROLLER WINDOW SHADE - BLACKOUT	WHITE/LIGHT GREY		REFER TO DETAIL SHEETS FOR MOUNTING TYPE
WOOD PLANKS							
06 20 23	WD1	WOOD PLANKS		SOLID RUSTIC, RECLAIMED DOUGLAS FIR SPECIES, TONGUE & GROVE	STAINED AND SEALED, LOW SHEEN FINISHED	7" WIDE	REFER TO DETAIL SHEETS FOR PLANK THICKNESS, LENGTH AND PANEL SIZES

PAINT & WALL COVERING NOTES

1. GYPSUM BOARD WALLS SHALL HAVE EGGSHELL FINISH, UNLESS NOTED OTHERWISE.
2. GYPUSM BOARD CEILINGS SHALL HAVE FLAT FINISH, UNLESS NOTED OTHERWISE.
3. ALL DOORS AND FRAMES SCHEDULED TO RECEIVE PAINT SHALL HAVE SATIN FINISH, UNLESS NOTED OTHERWISE.

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WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

ARCHITECTURAL EQ., FURNITURE & FINISHES SCHEDULES AND LEGENDS

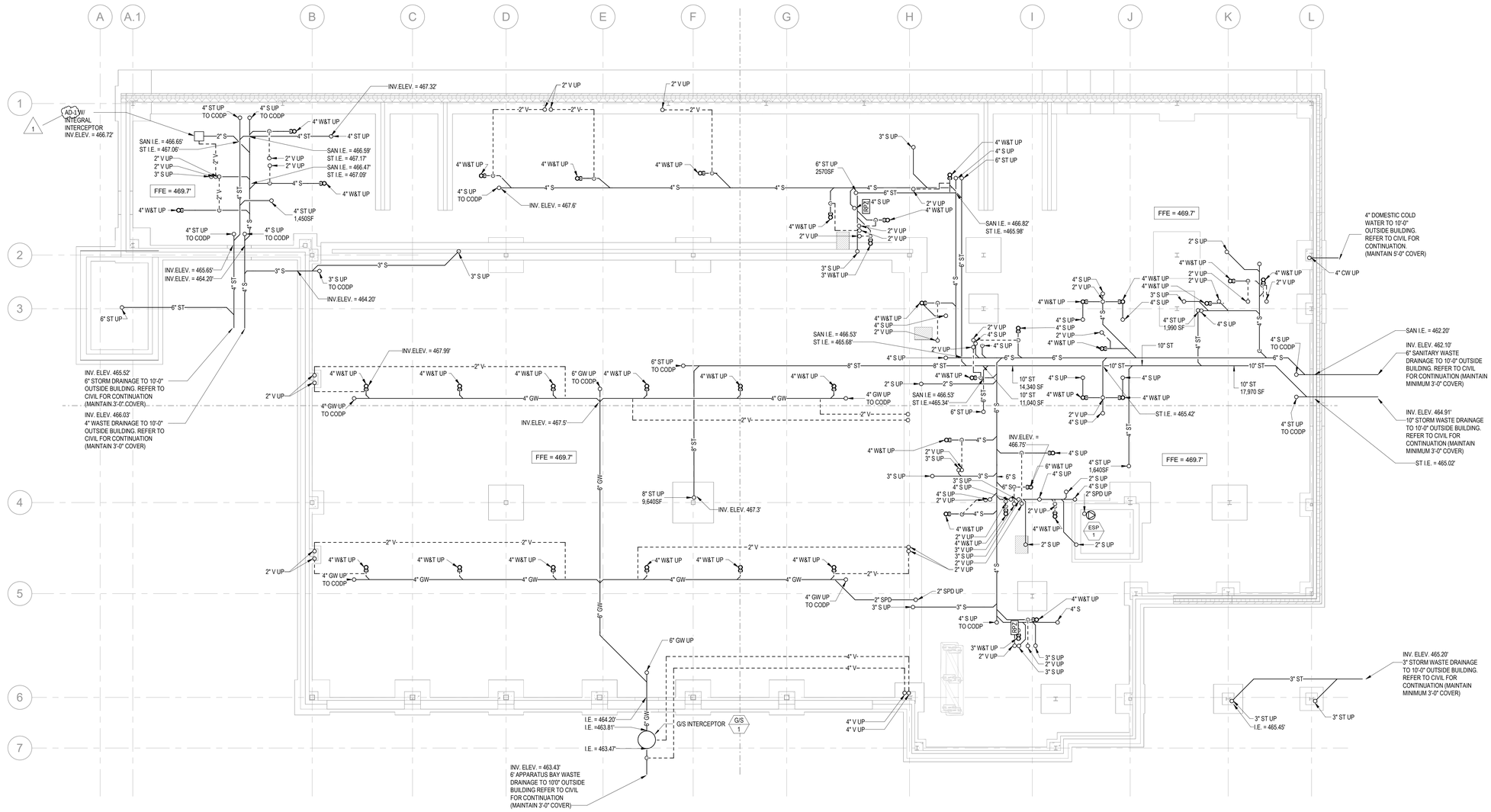
SHEET NUMBER

A64-01

CONSTRUCTION DOCUMENTS 12/19/25

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1 PLUMBING FIRST FLOOR UNDERSLAB PLAN
1/8" = 1'-0"

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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

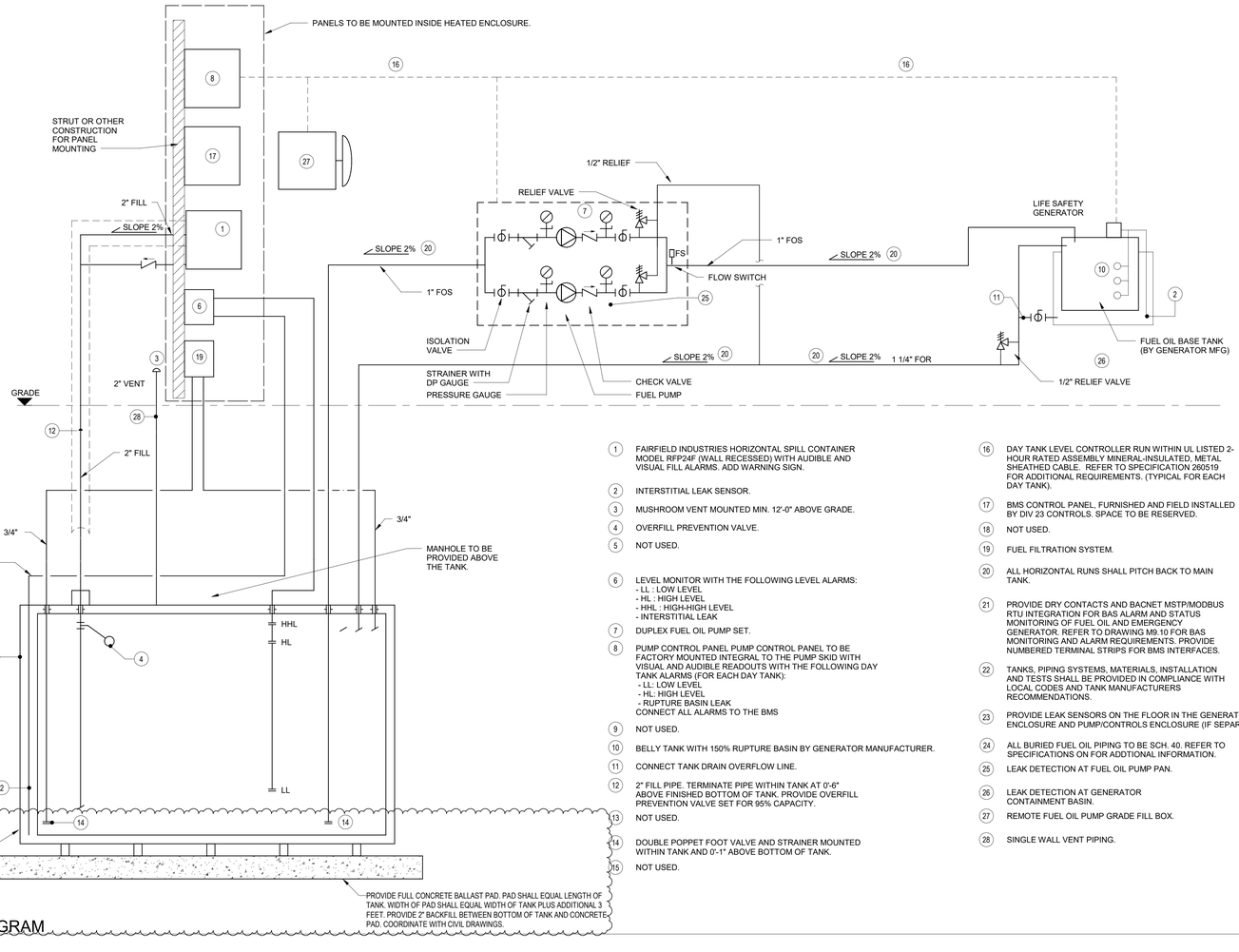
PLUMBING UNDERGROUND PLAN

SHEET NUMBER

P04.00

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FUEL OIL LINE DIAGRAM
NTS

1. FAIRFIELD INDUSTRIES HORIZONTAL SPILL CONTAINER MODEL RFP24F (WALL RECESSED) WITH AUDIBLE AND VISUAL FILL ALARMS. ADD WARNING SIGN.
2. INTERSTITIAL LEAK SENSOR.
3. MUSHROOM VENT MOUNTED MIN. 12'-0" ABOVE GRADE.
4. OVERFILL PREVENTION VALVE.
5. NOT USED.
6. LEVEL MONITOR WITH THE FOLLOWING LEVEL ALARMS:
   - LL : LOW LEVEL
   - HL : HIGH LEVEL
   - HHL : HIGH-HIGH LEVEL
   - INTERSTITIAL LEAK
7. DUPLEX FUEL OIL PUMP SET.
8. PUMP CONTROL PANEL PUMP CONTROL PANEL TO BE FACTORY MOUNTED INTEGRAL TO THE PUMP SKID WITH VISUAL AND AUDIBLE READOUTS WITH THE FOLLOWING DAY TANK ALARMS (FOR EACH DAY TANK):
   - LL: LOW LEVEL
   - HL: HIGH LEVEL
   - RUPTURE BASIN LEAK

   CONNECT ALL ALARMS TO THE BMS
9. NOT USED.
10. BELLY TANK WITH 150% RUPTURE BASIN BY GENERATOR MANUFACTURER.
11. CONNECT TANK DRAIN OVERFLOW LINE.
12. 2" FILL PIPE. TERMINATE PIPE WITHIN TANK AT 0'-6" ABOVE FINISHED BOTTOM OF TANK. PROVIDE OVERFILL PREVENTION VALVE SET FOR 95% CAPACITY.
13. NOT USED.
14. DOUBLE POPPET FOOT VALVE AND STRAINER MOUNTED WITHIN TANK AND 0'-1" ABOVE BOTTOM OF TANK.
15. NOT USED.
16. DAY TANK LEVEL CONTROLLER RUN WITHIN UL LISTED 2-HOUR RATED ASSEMBLY MINERAL-INSULATED, METAL SHEATHED CABLE. REFER TO SPECIFICATION 260519 FOR ADDITIONAL REQUIREMENTS. (TYPICAL FOR EACH DAY TANK).
17. BMS CONTROL PANEL, FURNISHED AND FIELD INSTALLED BY DIV 23 CONTROLS. SPACE TO BE RESERVED.
18. NOT USED.
19. FUEL FILTRATION SYSTEM.
20. ALL HORIZONTAL RUNS SHALL PITCH BACK TO MAIN TANK.
21. PROVIDE DRY CONTACTS AND BACNET MSTP/MODBUS RTU INTEGRATION FOR BAS ALARM AND STATUS MONITORING OF FUEL OIL AND EMERGENCY GENERATOR. REFER TO DRAWING M9.10 FOR BAS MONITORING AND ALARM REQUIREMENTS. PROVIDE NUMBERED TERMINAL STRIPS FOR BMS INTERFACES.
22. TANKS, PIPING SYSTEMS, MATERIALS, INSTALLATION AND TESTS SHALL BE PROVIDED IN COMPLIANCE WITH LOCAL CODES AND TANK MANUFACTURERS RECOMMENDATIONS.
23. PROVIDE LEAK SENSORS ON THE FLOOR IN THE GENERATOR ROOM ENCLOSURE AND PUMP/CONTROLS ENCLOSURE (IF SEPARATE).
24. ALL BURIED FUEL OIL PIPING TO BE SCH. 40. REFER TO SPECIFICATIONS ON FOR ADDTIONAL INFORMATION.
25. LEAK DETECTION AT FUEL OIL PUMP PAN.
26. LEAK DETECTION AT GENERATOR CONTAINMENT BASIN.
27. REMOTE FUEL OIL PUMP GRADE FILL BOX.
28. SINGLE WALL VENT PIPING.

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CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

MECHANICAL SINGLE LINE DIAGRAMS

SHEET NUMBER

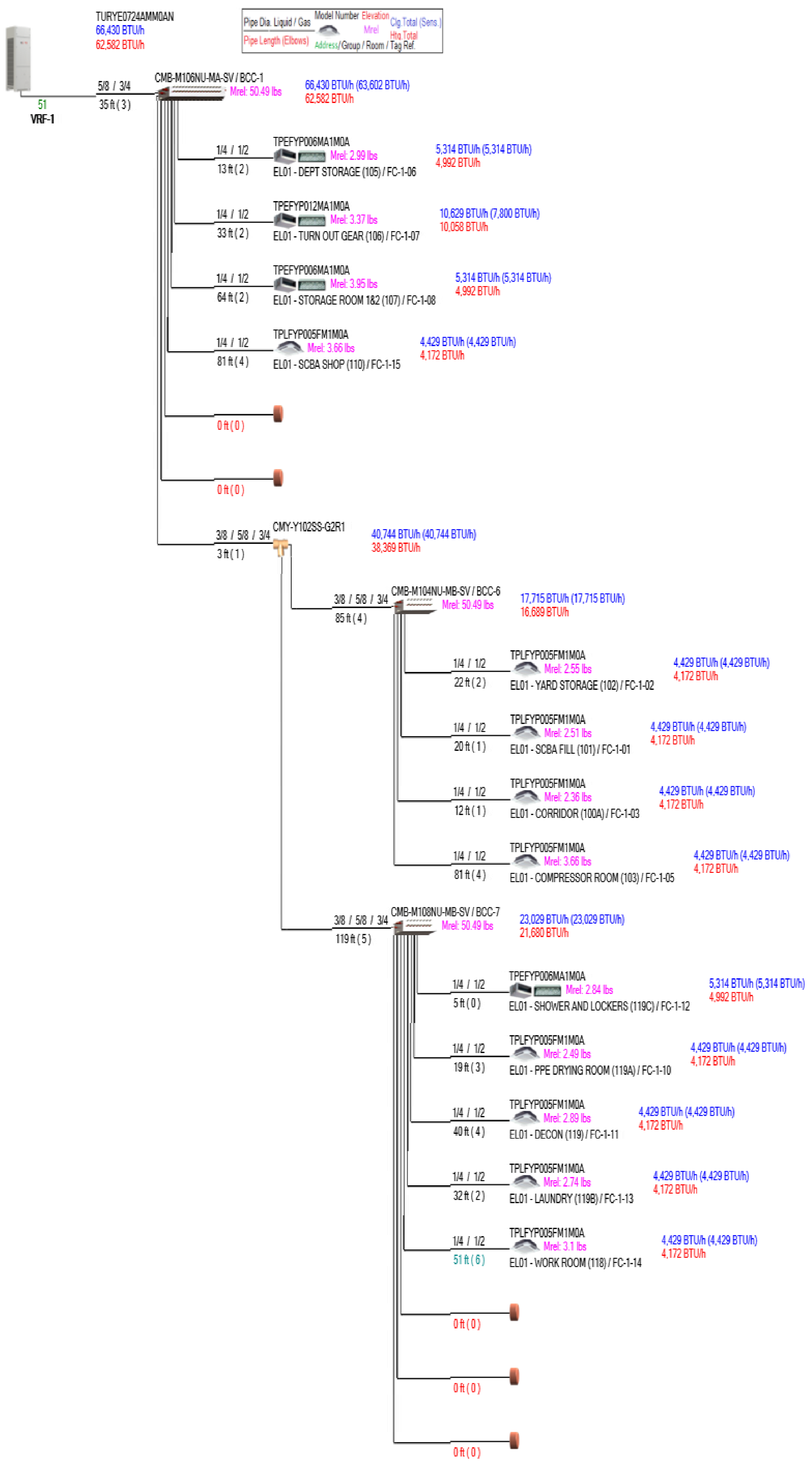
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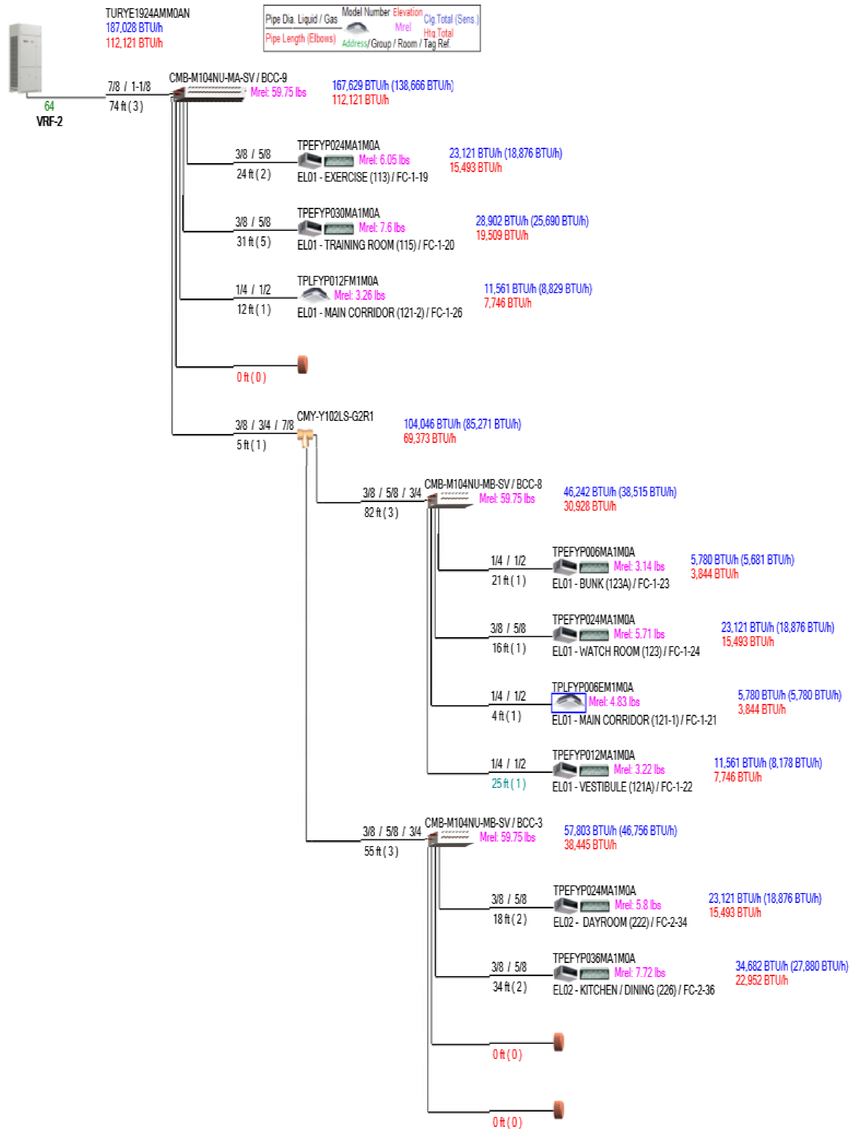
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GENERAL:

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PROJECT

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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

MECHANICAL VRF SINGLE LINE DIAGRAMS

SHEET NUMBER

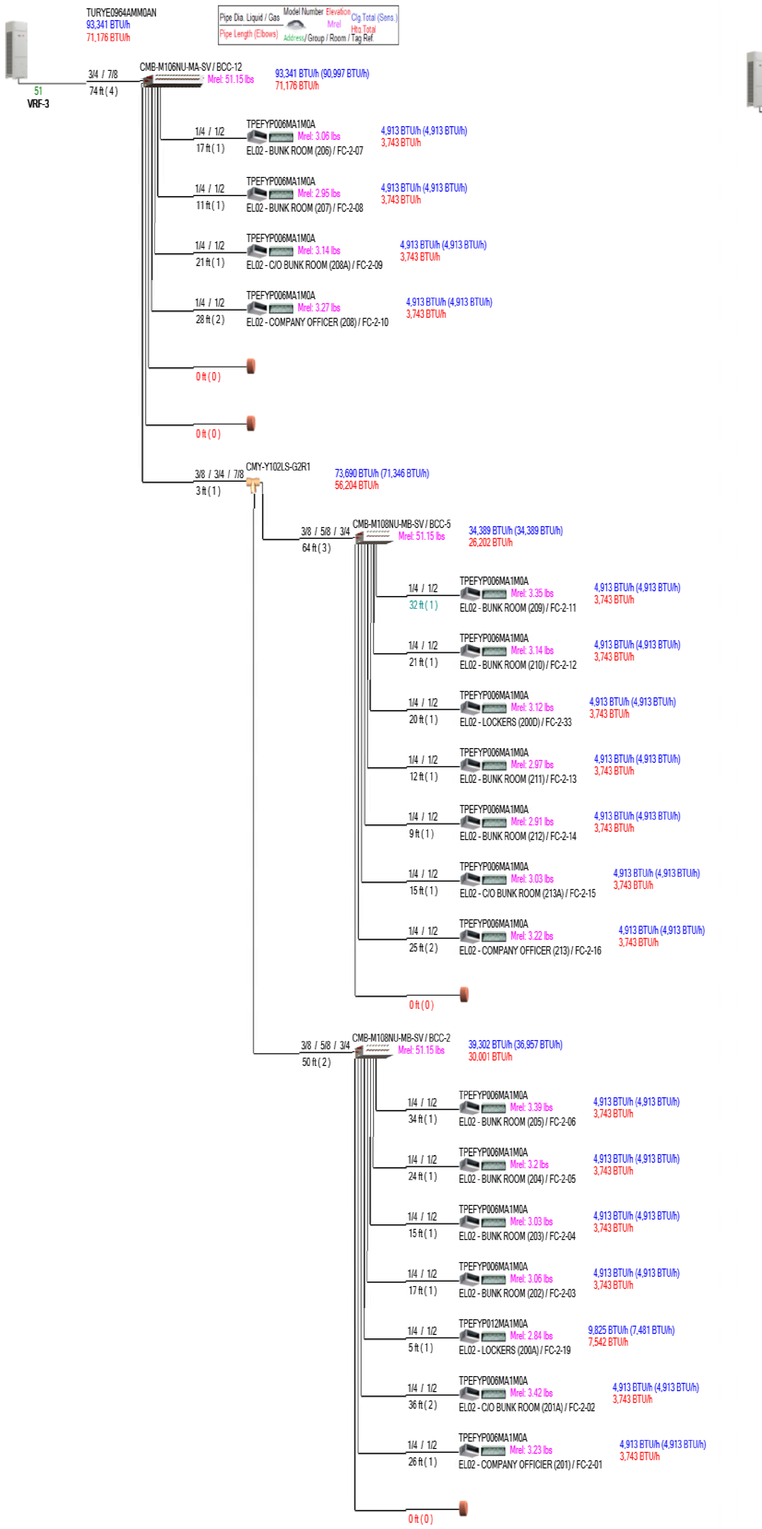
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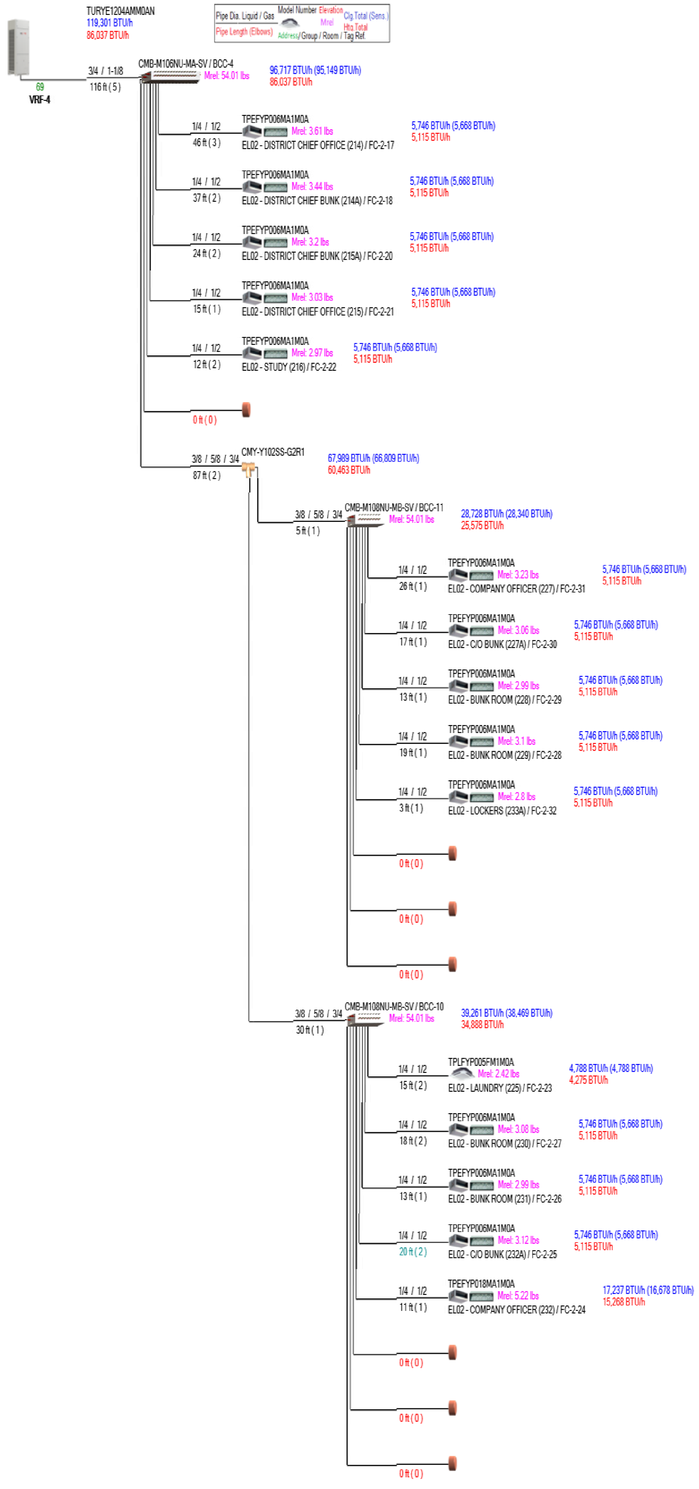
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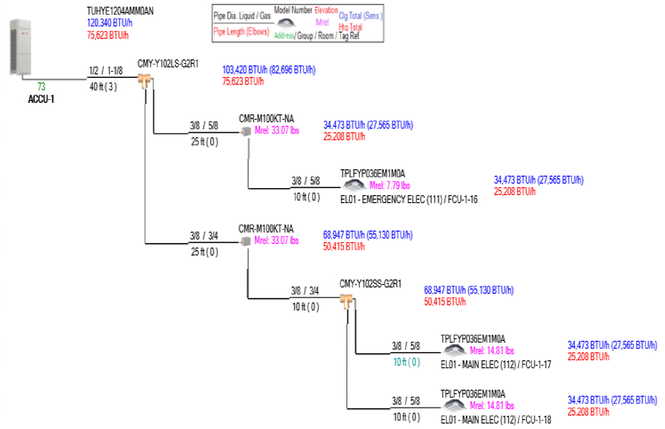
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CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

MECHANICAL VRF SINGLE LINE DIAGRAMS

SHEET NUMBER

M03.04

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SYMBOLS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	FAN - CENTRIFUGAL		THERMOWELL
	FAN - AXIAL		AVERAGING ELEMENT
	FAN - PLENUM / PLUG		VALVE - 2 WAY
	PUMP		VALVE - 3 WAY
	FILTER - PLEATED		ACTUATOR - MOTOR
	FILTER - BAG		ACTUATOR - DIAPHRARM
	FILTER - CARBON		ACTUATOR - PISTON
	COIL - HEATING		DAMPER
	COIL - COOLING		DAMPER - FIRE/SMOKE
	COIL - PREHEATING		MANUAL SWITCH
	COIL - REHEATING		HORN / STROBE
	HUMIDIFIER		STROBE
VFD	VARIABLE FROQUENCY DRIVE		PANIC BUTTON
	MOTOR STARTER		UNDERFLOOR TEMPERATURE SENSOR
XXX	PANEL (SEE ABBREVIATIONS)	AA YY	EQUIPMENT TAG XX - DEVICE TYPE YY - DEVICE NUMBER
		TT 01	BMS DEVICE TT - DEVICE TYPE 01 - DEVICE NUMBER
		PT 02	NON-BMS DEVICE PT - DEVICE TYPE 02 - DEVICE NUMBER
			LOCAL HARD WIRED CONNECTION
			IP COMMUNICATIONS CAT-5E/6/6A IN SUPPORT OF BACNET / IP, BACNET SC, MODBUS / TCPIP
			SERIAL COMMUNICATIONS RS-485, RS-232 IN SUPPORT OF BACNET / MSTP, MODBUS / RTU
			IP COMMUNICATIONS FIBER IN SUPPORT OF BACNET / IP, BACNET SC, MODBUS / TCP

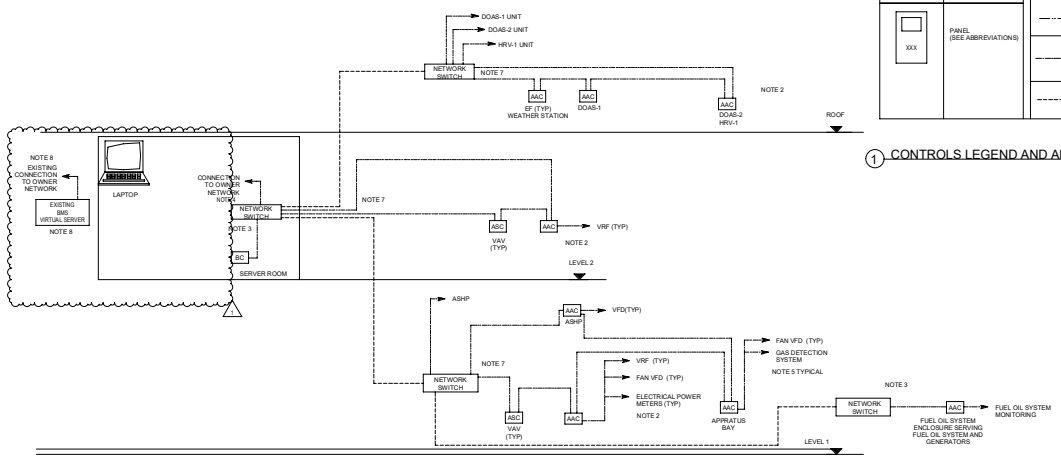
ABBREVIATIONS

SYMBOL	DESCRIPTION
A	AQUASTAT
AAC	ADVANCED APPLICATION CONTROLLER
AC	ALARM CONTACT
AFS	AIR FLOW SWITCH
AFT	AIR FLOW TRANSMITTER
AHU	AIR-HANDLING UNIT
AI	ANALOG INPUT
AO	ANALOG OUTPUT
AS	AIR SEPERATOR
ASC	APPLICATION SPECIFIC CONTROLLER
BC	BUILDING CONTROLLER
BCP	BOILER CONTROL PANEL
BMS	BUILDING MANAGEMENT SYSTEM
CA	COMMON ALARM
CCP	CHILLER CONTROL PANEL
CHWR	CHILLED WATER RETURN
CHWS	CHILLED WATER SUPPLY
CO2	CARBON DIOXIDE
CP	CONTROL PANEL
CPF	CHEMICAL POT FEEDER
CRAC	COMPUTER ROOM A/C UNIT
CS	CURRENT SENSOR
DC	DRY COOLER
DDCP	DIRECT DIGITAL CONTROL PANEL
DES	DAMPER END SWITCH
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
DRS	DAMPER RESET SWITCH
EF	EXHAUST FAN
EFSO	EMERGENCY FUEL SHUT OFF SYSTEM
EGCP	EMERGENCY GENERATOR CONTROL PANEL
ET	EXPANSION TANK
FAS	FIRE ALARM SYSTEM
FBK	FEEDBACK
FCU	FAN COIL UNIT
FLP	FAIL LAST POSITION
FLSS	FIRE AND LIFE SAFETY STSTEM
FLT	FAULT
FMS	FACILITY MANAGEMENT SYSTEM
FMS	FLOW MEASURING STATION
FS	FLOW SWITCH
FSC	FAN START CIRCUIT
FSD	FIRE SMOKE DAMPER
FT	FLOW TRANSMITTER
FOCP	FUEL OIL CONTROL PANEL
FZ	FREEZE PROTECTION DEVICE (FREEZESTAT)
GCP	GENERATOR CONTROL PANEL
GWR	GLYCOL WATER RETURN
GWS	GLYCOL WATER SUPPLY
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
HT	HUMIDITY TRANSMITTER
HX	HEAT EXCHANGER
IMH	IMMERSION HEATER
IP	INTERNET PROTOCOL
LS	LEAK SENSOR
MIV	MOTORIZED ISOLATION VALVE
NIC	NETWORK INTERFACE CONTROLLER
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
P	PUMP
PCD	PRESSURE CONTROL DAMPER
PCV	PRESSURE CONTROL VALVE
PDS	PRESSURE DIFFERENTIAL SWITCH

ABBREVIATIONS

SYMBOL	DESCRIPTION
PI	PRESSURE INDICATOR
PSH	PRESSURE SWITCH HIGH
PSL	PRESSURE SWITCH LOW
PT	PRESSURE TRANSMITTER
RFL	RESETTABLE FUSIBLE LINK
SCD	SMOKE CONTROL DAMPER
SD	SMOKE DETECTOR
ST	STATUS
SW	SWITCH
TCD	TEMPERATURE CONTROL DAMPER
TCV	TEMPERATURE CONTROL VALVE
TF	TRANSFER FAN
THL	TEMPERATURE HIGH LIMIT
TSD	TOUCH SCREEN DISPLAY
TT	TEMPERATURE TRANSMITTER
UPS	UNINTERRUPTIBLE POWER SUPPLY
UH	UNIT HEATER
VAV	VARIABLE AIR VOLUME
VES	VALVE END SWITCH
VFD	VARIABLE FREQUENCY DRIVE

1 CONTROLS LEGEND AND ABBREVIATIONS



2 CONTROLS SYSTEM ARCHITECTURE

NOTES:
1. CONTRACTOR TO PROVIDE ALL WIRING INCLUSIVE OF NETWORK SWITCHES.
2. EQUIPMENT INTEGRATION TYPICAL - COORDINATE INTEGRATION PROTOCOLS WITH APPROVED EQUIPMENT SUBMITTALS.
3. LOCATE NETWORK SWITCH WITHIN NEAREST BMS PANEL.
4. COORDINATE WITH OWNER'S IT.
5. REFER TO MECHANICAL AND ELECTRICAL PLANS FOR PANEL LOCATIONS.
6. N/A
7. CONTRACTOR TO IMPLEMENT LOOP NETWORK ARCHITECTURE WITH RAPID SPANNING TREE PROTOCOL (RSTP). CONTRACTOR TO CONFIGURE ALL NETWORK SWITCHES IN SUPPORT OF THIS TOPOLOGY.
8. EXISTING BMS VIRTUAL SERVER TO BE UTILIZED. CONTRACTOR TO COORDINATE WITH OWNER'S IT OPERATIONS AND THE CONTROLS VENDOR AS REQUIRED.

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CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

1	Addendum #1	12/2/25
DESC	DESC	DATE

Job Number 157132.000

TITLE

MECHANICAL CONTROLS

SHEET NUMBER

M09.00

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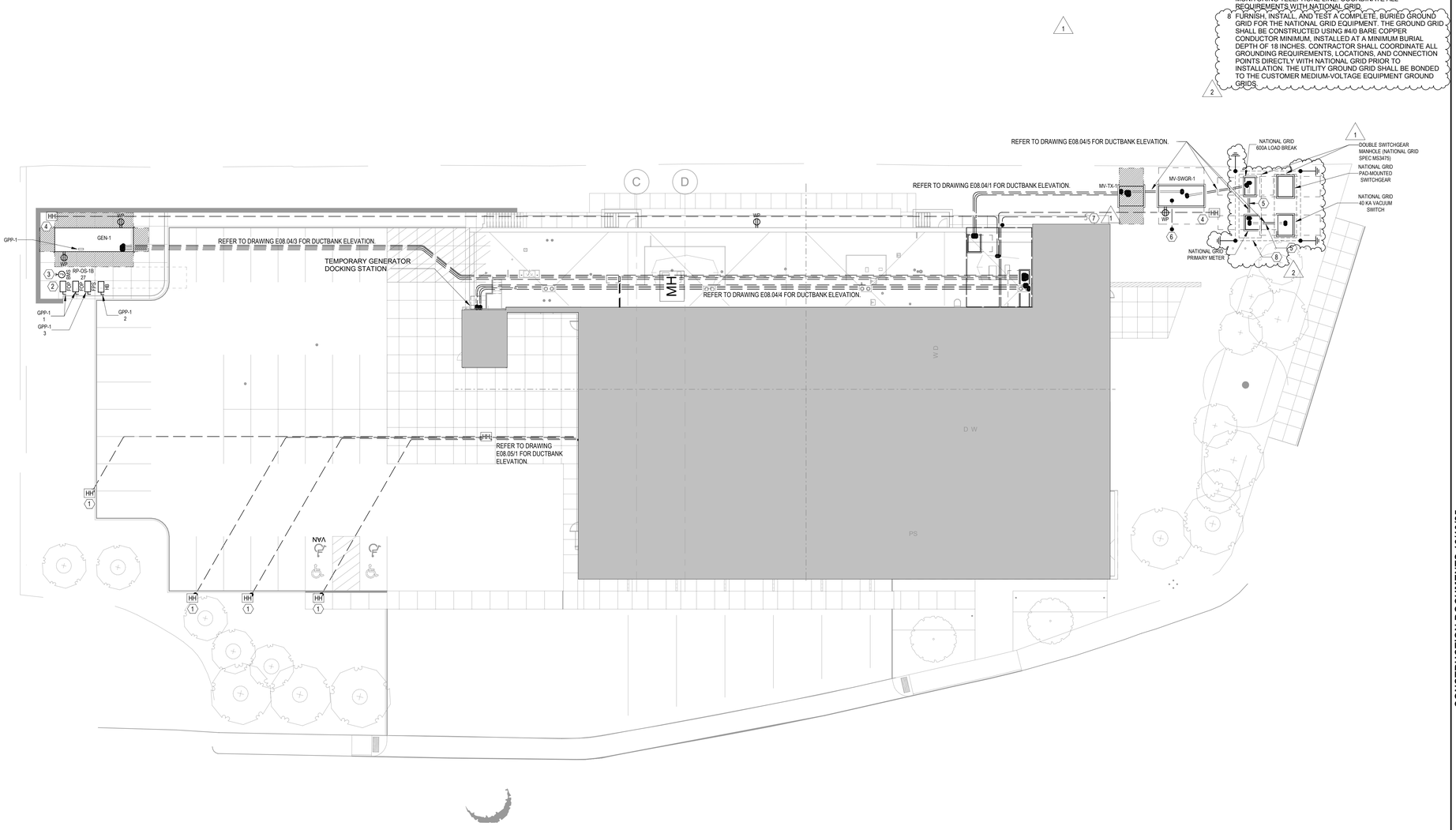
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GENERAL NOTES

1. SEE DRAWING E00.00 FOR LEGENDS, NOTES, AND ABBREVIATIONS.
2. UNDERGROUND CONDUIT ROUTING IS DIAGRAMMATIC AND INTENDED TO CONVEY CONNECTIVITY RATHER THAN ACTUAL CONDUIT ROUTINGS. CONDUIT RUNS, WHERE SHOWN, ARE INTENDED TO REPRESENT THE GENERAL CONDUIT ROUTING ONLY. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXACT QUANTITY, CONFIGURATION AND ROUTING IN THE FIELD. NOT ALL CONDUIT RUNS ARE SHOWN.

KEY NOTES

1. CONDUIT AND WIRE SHALL BE FURNISHED AND ROUTED FROM PANEL PP-EV TO FUTURE EV CHARGER HANDHOLES.
2. FUEL OIL PUMPS, FUEL POLISHING SYSTEM, BMS AND HOTBOX SYSTEM SHALL BE LOCATED WITHIN THE ENCLOSURE PROVIDED BY DIVISION 23.
3. POWER CONNECTION FOR BMS PANEL. COORDINATE EXACT LOCATION WITH MECHANICAL CONTRACTOR. BMS POWER LOCATED INSIDE FUEL PUMP ENCLOSURE.
4. FURNISH AND INSTALL HANDHOLE FOR FUTURE EXTERIOR LIGHTING. PROVIDE 1" EMPTY CONDUIT WITH PULLSTRING FROM HANDHOLE TO PANEL LP-1A.
5. FURNISH AND INSTALL (2) 4" EMPTY CONDUIT WITH PULLSTRING BETWEEN NATIONAL GRID EQUIPMENT.
6. PROVIDE SPARE CONDUIT FROM SWITCHGEAR AND STUB OUT UNDERGROUND 5 FEET BEYOND CONCRETE PAD FOR FUTURE USE. CONDUIT SHALL BE CAPPED AND SEALED UNDERGROUND.
7. FURNISH AND INSTALL CONDUIT UNDERGROUND FROM FUTURE RTU LOCATION TO SITE PROPERTY LINE FOR RTU MONITORING TELEPHONE LINE. COORDINATE ALL REQUIREMENTS WITH NATIONAL GRID.
8. FURNISH, INSTALL, AND TEST A COMPLETE, BURIED GROUND GRID FOR THE NATIONAL GRID EQUIPMENT. THE GROUND GRID SHALL BE CONSTRUCTED USING #4/0 BARE COPPER CONDUCTOR MINIMUM, INSTALLED AT A MINIMUM BURIAL DEPTH OF 18 INCHES. CONTRACTOR SHALL COORDINATE ALL GROUNDING REQUIREMENTS, LOCATIONS, AND CONNECTION POINTS DIRECTLY WITH NATIONAL GRID PRIOR TO INSTALLATION. THE UTILITY GROUND GRID SHALL BE BONDED TO THE CUSTOMER MEDIUM-VOLTAGE EQUIPMENT GROUND GRIDS.



1 ELECTRICAL SITE PLAN
1/16" = 1'-0"

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KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
2	Addendum #7	1/23/26
1	Addendum #5	1/16/26

Job Number 157132.000

TITLE

ELECTRICAL SITE POWER PLAN

SHEET NUMBER

E01.01

CONSTRUCTION DOCUMENTS 12/19/25

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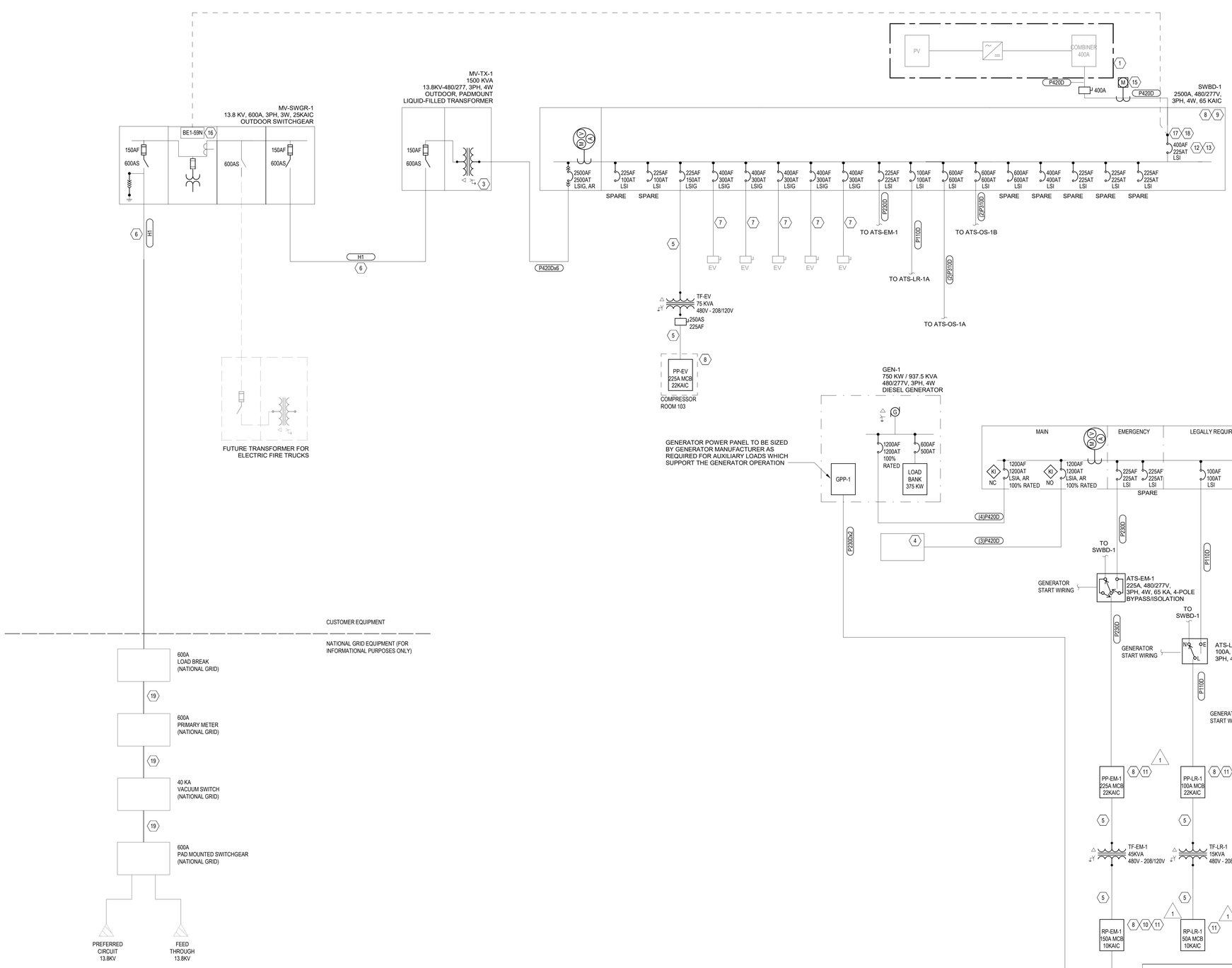
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GENERAL NOTES:

1. SEE DRAWING E00.00 FOR LEGENDS, NOTES, AND ABBREVIATIONS.
2. SEE DRAWING E00.01 FOR DRY TYPE TRANSFORMER WIRING SCHEDULE.
3. HALFTONE DASH INDICATES FUTURE SCOPE.

KEY NOTES: (XX)

1. PV SYSTEM EQUIPMENT PROVIDED BY OTHERS. REFER TO PV DRAWINGS FOR MORE INFORMATION.
2. EMERGENCY SWITCHBOARD SHALL BE CONSTRUCTED WITH BARRIERED, VERTICAL SECTIONS TO SEPARATE THE EMERGENCY BRANCH FROM ALL OTHER LOADS.
3. ROUTE CONDUITS IN AN UNDERGROUND CONCRETE-ENCASED DUCTBANK FROM THE PADMOUNTED TRANSFORMER TO THE MAIN ELECTRICAL ROOM. REFER TO DETAIL 1 AND 2 ON DRAWING E08.04.
4. TEMPORARY GENERATOR CONNECTION BOX AS PER NEC 700.3. LOCATED OUTDOORS ON BUILDING EXTERIOR WALL. TYPE 4X ENCLOSURE, PHASE ROTATION MONITOR, 1200A LSIA/AR 100% RATED INTERNAL BREAKER, 16-SERIES CAM-TYPE CONNECTOR RATED 480V, 1200A. REFER TO DETAIL 1 AND 4 ON DRAWING E08.04 FOR CONDUIT ROUTING.
5. REFER TO TRANSFORMER SCHEDULE.
6. ELEC CONTRACTOR TO FURNISH AND INSTALL CONDUIT AND WIRING. PROVIDE (1) SPARE 5" CONDUIT.
7. FURNISH AND INSTALL EMPTY 3.5"C CONDUIT WITH PULL STRING.
8. PROVIDE SURGE PROTECTIVE DEVICE.
9. ALL FEEDER CIRCUIT BREAKERS SHALL HAVE INTEGRAL METERING TRIP UNITS.
10. PROVIDE MAIN CIRCUIT BREAKER WITH ELECTRONIC TRIP UNIT WITH INTEGRAL METERING FUNCTION.
11. PROVIDE BRANCH CIRCUIT MCNIT MONITORING FOR ALL POLES.
12. BREAKER SHALL BE FURNISHED WITH WARNING LABEL STATING "POWER SOURCE OUTPUT CONNECTION - DO NOT RELOCATE THIS OVERCURRRENT DEVICE.
13. PV BREAKER SHALL BE LOCATED IN POSITION FURTHEST FROM SWITCHBOARD MAIN BREAKER.
14. PROVIDE 2-POLE AND 3-POLE FEEDER BREAKERS WITH INTEGRAL METERING TRIP UNITS.
15. PV SYSTEM TO BE PROVIDED WITH BIDIRECTIONAL REVENUE UTILITY METER MEETING NATIONAL GRID REQUIREMENTS.
16. PROVIDE BASLER BE1-59N RELAY. PART NUMBER SHALL BE A6F-A1J-C2N0F. RELAY TO BE MOUNTED IN MV-SWGR-1 AND CONNECTED ON THE LOAD SIDE OF THE DISCONNECT. PROVIDE (3) PTs CONNECTED WYE-PRIMARY AND BROKEN DELTA-SECONDARY. PTs SHALL PROVIDE RESISTOR ACROSS THE BROKEN DELTA SECONDARY TO MITIGATE FERRORESONANCE.
17. FOR PV POI CIRCUIT BREAKER, PROVIDE REMOTE TRIP CONTACT TO ACCOMODATE SIGNALS FROM THE BE1-59N RELAY IN MV-SWGR-1. PROVIDE PRE-CLOSE AND POST-CLOSE BREAKER TRIP CIRCUIT HEALTHY SUPERVISION.
18. PROVIDE CIRCUIT BREAKER WITH UNDERVOLTAGE RELEASE (UVR). UVR SHALL BE CONFIGURABLE FOR INSTANTANEOUS TRIPPING OF THE CIRCUIT BREAKER USING A 120V CIRCUIT.
19. FURNISH AND INSTALL CONDUIT AS NOTED ON SITE PLAN.



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Job Number 157132.000

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E03.00

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GENERAL NOTES:

1. REFER TO 260943 - NETWORK LIGHTING CONTROL SPECIFICATION.
2. LIGHTING CONTROL SYSTEM DESIGN BASIS IS LUTRON ATHENA. DESIGN ALTERNATES INCLUDE NLIGHT AND WATTSTOPPER.
3. VENDOR SHALL ENSURE THAT ALL NECESSARY COMPONENTS ARE PROVIDED TO FORM A COMPLETE LIGHTING CONTROL SYSTEM, AND THAT ALL SPECIFIC EQUIPMENT LIMITATIONS AND REQUIREMENTS ARE ACCOUNTED FOR IN THE SUBMITTAL.
4. WIRELESS OCCUPANCY SENSORS, DAYLIGHT SENSORS AND WALL SWITCHES SHALL BE INSTALLED IN THE DAY ROOM AND KITCHEN/DINING ROOMS ONLY. ALL OTHER SENSORS AND SWITCHES SHALL BE WIRED, UON.

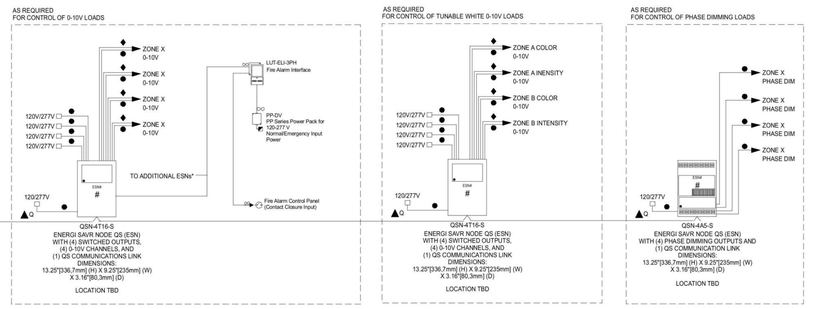
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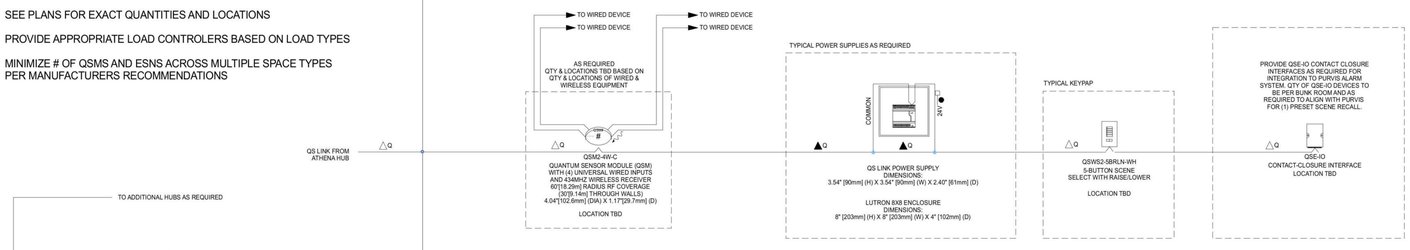
CONCEPT DRAWING NOTES:
CONTROL SYSTEM DRAWING IS PROVIDED FOR CONCEPTUAL PURPOSES ONLY AND IS NOT INTENDED FOR CONSTRUCTION. EXACT EQUIPMENT REQUIREMENTS, INCLUDING LOCATIONS AND QUANTITIES, SHOULD BE VERIFIED IN ACCORDANCE WITH THE MOST UP-TO-DATE LIGHTING/ELECTRICAL REFLECTED CEILING PLANS, LIGHTING FIXTURE SCHEDULES, PANEL SCHEDULES, CONTROL INTENT AND SPECIFICATIONS. SHADE EQUIPMENT SHOULD BE VERIFIED IN ACCORDANCE WITH ARCHITECTURAL PLANS, SPECIFICATIONS AND WINDOW SCHEDULES/DETAILS.

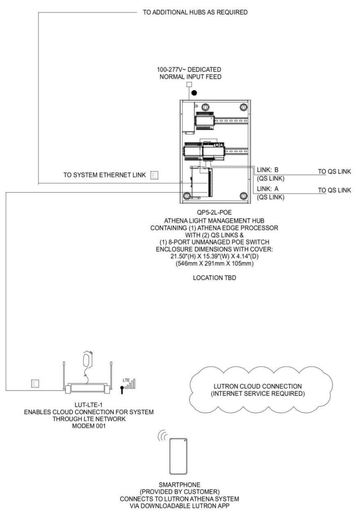
SEE PLANS FOR EXACT QUANTITIES AND LOCATIONS

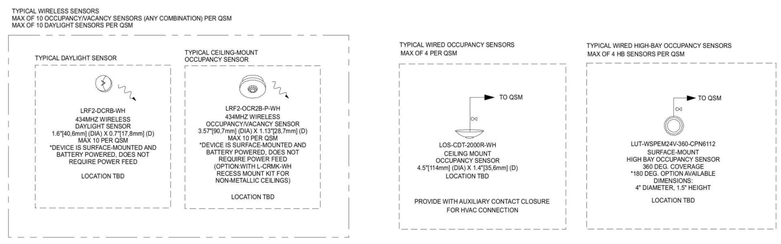
PROVIDE APPROPRIATE LOAD CONTROLERS BASED ON LOAD TYPES

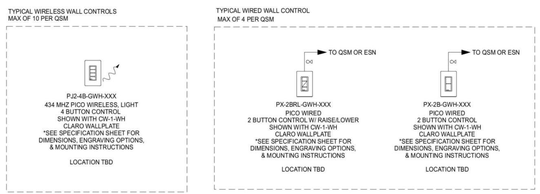
MINIMIZE # OF QSMS AND ESNS ACROSS MULTIPLE SPACE TYPES PER MANUFACTURERS RECOMMENDATIONS













TYPICAL LOAD SIDE TRANSFER RELAYS

PROVIDED BY LVS CONTROLS

WIRING LEGEND:

△Q QS CONTROL LINK. (SEE WIRE DESCRIPTION BELOW)
▲Q QS CONTROL LINK. (SEE WIRE DESCRIPTION BELOW)
(CONNECT WIRES 1, 3 AND 4. DO NOT CONNECT WIRE # 2)

QS WIRING AS REQUIRED BY CONTROL LINK LENGTH
(REFER TO QS SMART PANEL POWER SUPPLY WIRING GUIDE FOR SHADE WIRING NOTES):

TOTAL CONTROL LINK LENGTH	WIRE GAUGE	AVAILABLE FROM LUTRON IN ONE CABLE:
LESS THAN 500ft (152.4 m)	POWER (TERMINALS 1&2): 1 PAIR 18 AWG (1.0 mm²)	GRX-CBL-346S (NON-PLENUM) OR GRX-PCBL-346S (PLENUM)
	DATA (TERMINALS 3&4): 1 PAIR 22 AWG (0.5 mm²), TWISTED AND SHIELDED*	
500ft (152.4 m) TO 2,000ft (610 m)**	POWER (TERMINALS 1&2): 1 PAIR 12 AWG (4.0 mm²)	GRX-CBL-46L (NON-PLENUM) OR GRX-PCBL-46L (PLENUM)
	DATA (TERMINALS 3&4): 1 PAIR 22 AWG (0.5 mm²), TWISTED AND SHIELDED*	

*ALTERNATE DATA-ONLY CABLE: USE APPROVED DATA LINK CABLE (22 AWG [0.5 mm²] TWISTED/SHIELDED) FROM BELDEN (MODEL # 9451).
**TOTAL LENGTH OF THE QS LINK MUST NOT EXCEED 2,000 ft (600 m).

- INPUT POWER (NORMAL-EMERGENCY)
- INPUT POWER (NORMAL)
- 2 #12AWG (4 mm2)
- 3 #12AWG (4 mm2)
- 0-10V SIGNAL: 2 #18AWG (1.0 mm2)
- CONTACT CLOSURE SIGNAL: 2 #18AWG (1.0 mm2)
- CONTACT CLOSURE SIGNAL: 3 #18AWG (1.0 mm2)
- CLEAR CONNECT - TYPE A WIRELESS SIGNAL
- CLEAR CONNECT - TYPE X WIRELESS SIGNAL
- LUTRON SENSOR CABLE C-CBL-522S OTHERWISE USE 3 #22 AWG (1.0 mm2)
- LUTRON SENSOR CABLE C-CBL-522S OTHERWISE USE 4 #22 AWG (1.0 mm2)
- D DMX CONTROL
- E CAT5E OR BETTER CABLE FOR LUTRON NETWORK TERMINATED WITH RJ45 CONNECTORS. 328 ft (100 m) MAXIMUM RUN
- E POWER OVER ETHERNET (POE) ETHERNET LINK, CAT5E OR BETTER CABLE FOR LUTRON NETWORK TERMINATED WITH RJ45 CONNECTORS. 328 ft (100 m) MAXIMUM RUN

QS EQUIPMENT

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33 ARCH ST, BOSTON, MA 02110

ENERGY MODEL
ANDELMANLELEK
1408 PROVIDENCE HWY, NORWOOD, MA 02062

PROJECT

CONSTRUCTION DOCUMENTS 12/19/25

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER
455 MAIN STREET
WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

ELECTRICAL LIGHTING CONTROL DIAGRAM

SHEET NUMBER

E03.10

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GENERAL NOTES

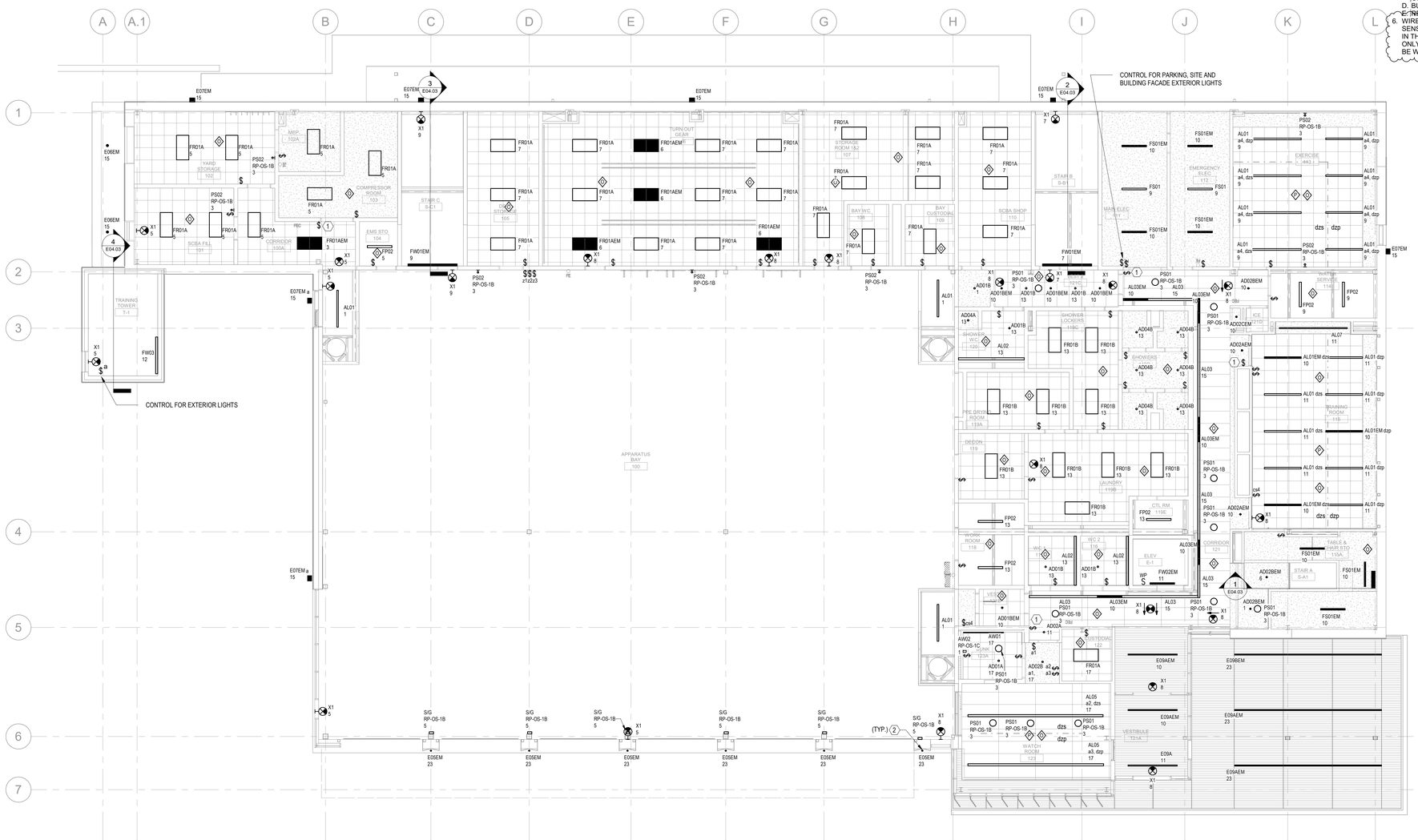
1. SEE DRAWING E00.00 FOR LEGENDS, NOTES, AND ABBREVIATIONS.
2. COORDINATE LOCATION OF ALL COMMON AREA LIGHTING CONTROL SWITCHES WITH ARCHITECT PRIOR TO INSTALLATION.
3. LIGHT FIXTURES DESIGNATED AS EMERGENCY SHALL BE PROVIDED WITH UL 924 BYPASS RELAY, AND FOLLOW SAME CONTROL SEQUENCE AS INDICATED IN CONTROL NARRATIVE. UPON LOSS OF NORMAL POWER, EMERGENCY FIXTURES SHALL TURN ON TO FULL BRIGHTNESS.
4. U.O.N. LIGHT FIXTURES TO BE FED FROM THE FOLLOWING PANELS.
   A. ALL NORMAL LIGHTING SHALL BE FED FROM LP-1A
   B. ALL EMERGENCY LIGHTING AND EXIT SIGNS SHALL BE FED FROM PP-EM-1.
5. TYPICAL CONTROL BY ROOM TYPE:
   A. OFFICES /STUDY: MANUAL ON/AUTOMATIC OFF
   B. CORRIDORS: FIXTURES DESIGNATED EMERGENCY ,SHALL REMAIN ON 24/7.
   C. STORAGE, IT, OTHER ROOMS: MANUAL ,ON/AUTOMATIC OFF
   D. BUNK ROOM: MANUAL ON/AUTOMATIC OFF
   ~~E. TRESTROOM: MANUAL ON/ AUTOMATIC OFF~~
6. WIRELESS OCCUPANCY SENSORS, DAYLIGHT SENSORS AND WALL SWITCHES SHALL BE INSTALLED IN THE DAY ROOM AND KITCHEN/DINING ROOMS ONLY. ALL OTHER SENSORS AND SWITCHES SHALL BE WIRED, UON.

1

KEY NOTES

1 MANUAL OVERRIDE SWITCH FOR CORRIDOR.

2 DRIVERS, BRANCH WIRING AND CONDUIT BETWEEN FIXTURES, AND REQUIRED JUNCTION BOXES FOR TYPE E05EM LUMINAIRES SHALL BE LOCATED INTERIOR TO THE APPARATUS BAY. CONTRACTOR TO LIMIT EXTERIOR EXPOSED BRANCH WIRING AND CONDUIT TO FIXTURE.



1 ELECTRICAL FIRST FLOOR LIGHTING RCP
1/8" = 1'-0"

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PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

ELECTRICAL FIRST FLOOR LIGHTING RCP

SHEET NUMBER

E04.01

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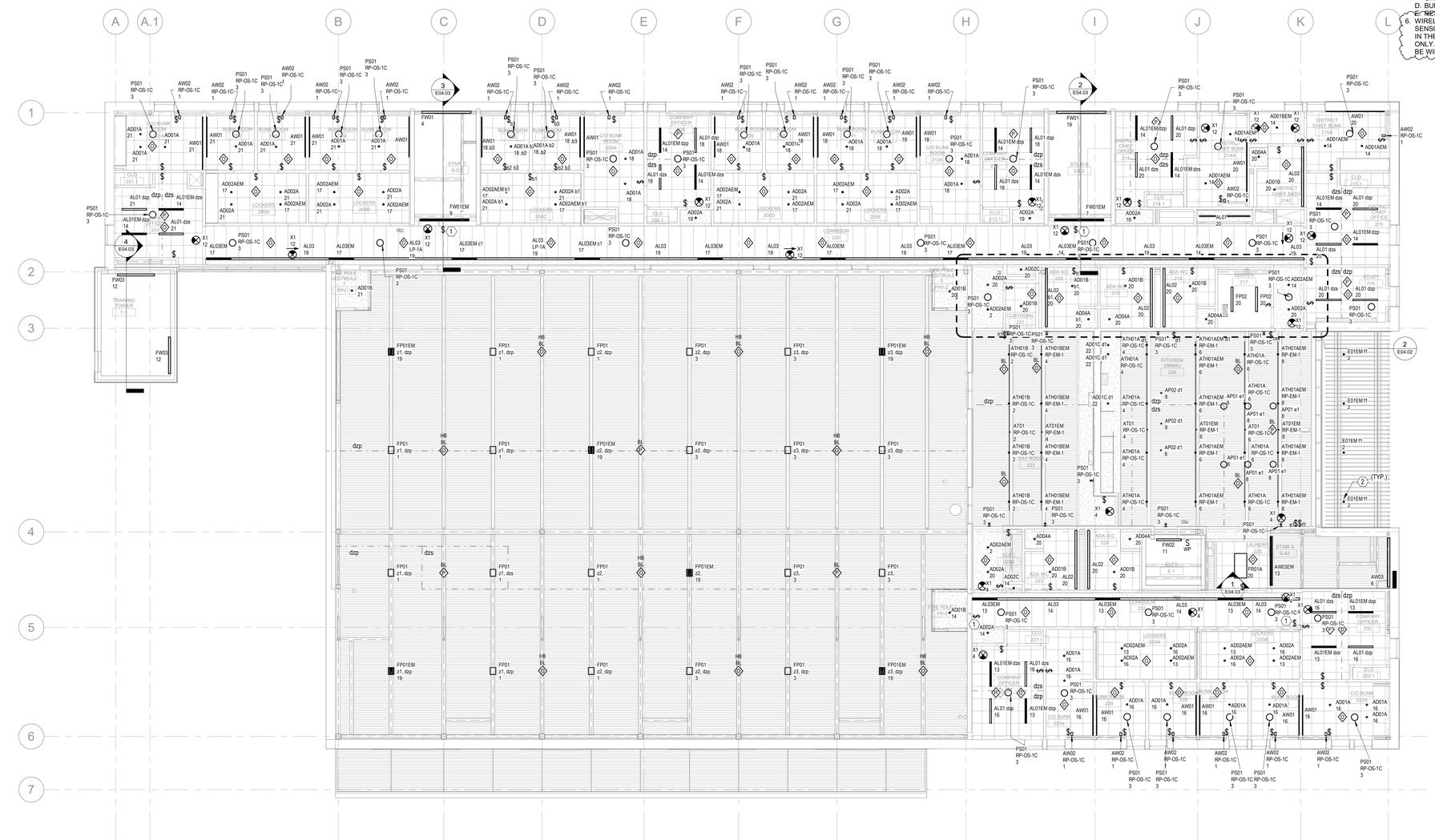
GENERAL NOTES

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   A. ALL NORMAL LIGHTING SHALL BE FED FROM LP-1A
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5. TYPICAL CONTROL BY ROOM TYPE:
   A. OFFICES /STUDY: MANUAL ON/AUTOMATIC OFF
   B. CORRIDORS: FIXTURES DESIGNATED EMERGENCY SHALL REMAIN ON 24/7.
   C. STORAGE, IT, OTHER ROOMS: MANUAL ON/AUTOMATIC OFF
   D. BUNK ROOM: MANUAL ON/AUTOMATIC OFF
   E. RESTROOM: MANUAL ON/AUTOMATIC OFF
6. WIRELESS OCCUPANCY SENSORS, DAYLIGHT SENSORS AND WALL SWITCHES SHALL BE INSTALLED IN THE DAY ROOM AND KITCHEN/DINING ROOMS ONLY. ALL OTHER SENSORS AND SWITCHES SHALL BE WIRED, UON.

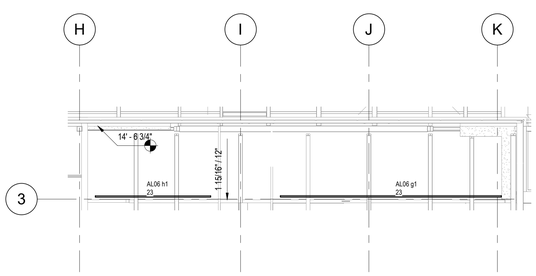
KEY NOTES

1 MANUAL OVERRIDE SWITCH FOR CORRIDOR.

2 BRANCH WIRING AND CONDUIT TO TERRACE LUMINAIRES SHALL BE ROUTED ALONG STRUCTURAL FRAME.



1 ELECTRICAL SECOND FLOOR LIGHTING RCP
1/8" = 1'-0"



2 ELECTRICAL SECOND FLOOR ENLARGED RCP
1/8" = 1'-0"

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ENERGY MODEL
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PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

ELECTRICAL SECOND FLOOR LIGHTING RCP

SHEET NUMBER

E04.02

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PANEL: PP-OS-1A

LOCATION: EMERGENCY ELEC 111
SUPPLY FROM: ATS-OS-1A
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 480/277 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 65 KAIC
BUS RATING: 600 A
MAIN CB: 600 A

CKT	CIRCUIT DESCRIPTION	LC	CT	TRIP	POLES	A	B	C	POLES	TRIP	CT	LC	CIRCUIT DESCRIPTION	CKT
1	ASHP-1 - EXTERIOR	HVAC	1	110 A	3	11584... 12714...			3	60 A	1	HVAC	DOAS-1 - ROOF	2
3	--	--	--	--	--		11584... 12714...		--	--	--	--	--	4
5	--	--	--	--	--			11584... 12714...	--	--	--	--	--	6
7	ASHP-1 - EXTERIOR	HVAC	1	110 A	3	11584... 18000...			3	100 A	1	HVAC	WH-2 - RM 114	8
9	--	--	--	--	--		11584... 18000...		--	--	--	--	--	10
11	--	--	--	--	--			11584... 18000...	--	--	--	--	--	12
13	VRF-1 - EXTERIOR	HVAC	1	30 A	3	3520... 53999...			3	300 A	1	HVAC...	TF-OS-1A	14
15	--	--	--	--	--		3520... 54818...		--	--	--	--	--	16
17	--	--	--	--	--			3520... 54892...	--	--	--	--	--	18
19	VRF-2 - EXTERIOR	HVAC	1	50 A	3	4960... 4062...			3	100 A	1	LIGH...	LP-1A	20
21	--	--	--	--	--		4960... 2679...		--	--	--	--	--	22
23	--	--	--	--	--			4960... 2917...	--	--	--	--	--	24
25	EUH-4 - APPARATUS BAY	HVAC	1	20 A	3	3324... 0 VA			3	110 A	--	--	SPARE	26
27	--	--	--	--	--		3324... 0 VA		--	--	--	--	--	28
29	--	--	--	--	--			3324... 0 VA	--	--	--	--	--	30
31	EUH-5 - APPARATUS BAY	HVAC	1	20 A	3	3324... 0 VA			3	20 A	--	--	SPARE	32
33	--	--	--	--	--		3324... 0 VA		--	--	--	--	--	34
35	--	--	--	--	--			3324... 0 VA	--	--	--	--	--	36
37	SPARE	--	--	20 A	3	0 VA 0 VA			3	20 A	--	--	SPARE	38
39	--	--	--	--	--		0 VA 0 VA		--	--	--	--	--	40
41	--	--	--	--	--			0 VA 0 VA	--	--	--	--	--	42
				TOTAL LOAD:		127050 VA	126482 VA	126783 VA						
				TOTAL AMPS:		459 A	457 A	458 A						

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	218757 VA	100.00%	218757 VA	
LIGHTING (LTG)	10587 VA	125.00%	13233 VA	**TOTAL CONN. LOAD:** 380314 VA
Motor	3000 VA	100.00%	3000 VA	**TOTAL EST. DEMAND:** 350736 VA
POWER	73195 VA	100.00%	73195 VA	**TOTAL CONN..:** 457 A
RECEPTACLE (R)	74460 VA	56.72%	42230 VA	**TOTAL EST. DEMAND:** 422 A
Spare	360 VA	100.00%	360 VA	

NOTES:

PANEL: PP-OS-2A

LOCATION:
SUPPLY FROM: PP-OS-1B-2
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 120/208 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 10 KAIC
BUS RATING: 100 A
MAIN CB: 100 A

CKT	CIRCUIT DESCRIPTION	Load Classification	TRIP	POLES	A	B	C	POLES	TRIP	Load Classification	CIRCUIT DESCRIPTION	CKT
1	VAV - 232	HVAC	20 A	1	0 VA 420 VA			1	20 A	HVAC	DSF 1,2,4,5 - APPARATUS BAY	2
3	TRAP PRIMER - LEVEL 2	POW...	20 A	1		480 VA 62 VA		2	20 A	POW...	SHUT OFF VALVE - VEST 2	4
5	DHU - PPE DRYING ROOM 119A	HVAC	20 A	1			750 VA 62 VA	--	--	--	--	6
7	C-1, C-2 - PPE DRYING ROOM 119A	HVAC	20 A	1	1770 VA 456 VA			2	20 A	HVAC	FCU 1-21, BS-8	8
9	EF-D1 - ROOF	HVAC	20 A	2		117 VA 456 VA		--	--	--	--	10
11	--	--	--	--			117 VA 117 VA	2	20 A	HVAC	EF-D2 - ROOF	12
13	FCU - LAV 120	HVAC	20 A	2	850 VA 117 VA			--	--	--	--	14
15	--	--	--	--		850 VA 1247 VA		2	20 A	HVAC	R-2 - RM 226	16
17	FCU - 230, 231, 232	HVAC	20 A	2			912 VA 1247 VA	--	--	--	--	18
19	--	--	--	--	912 VA 1247 VA			2	20 A	HVAC	R-1 - RM 226	20
21	FCU - WATCH ROOM 123	HVAC	20 A	2		788 VA 1247 VA		--	--	--	--	22
23	--	--	--	--			788 VA 788 VA	2	20 A	HVAC	FCU 118, 123	24
25	FCU - 229, 232A	HVAC	20 A	2	788 VA 788 VA			--	--	--	--	26
27	--	--	--	--		788 VA 1181 VA		2	20 A	HVAC	FCU 119B, 119A, 119	28
29	FCU- 227, 227a, 228	HVAC	20 A	2			1181 VA 1181 VA	--	--	--	--	30
31	--	--	--	--	1181 VA 1181 VA			2	20 A	HVAC	FCU - 232A, 232	32
33	SPARE	--	20 A	2		0 VA 1181 VA		--	--	--	--	34
35	--	--	--	--			0 VA 0 VA	1	20 A	--	SPARE	36
37	SPARE	--	20 A	2	0 VA 0 VA			1	20 A	--	SPARE	38
39	--	--	--	--		0 VA 0 VA		1	20 A	--	SPARE	40
41	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	42
			TOTAL LOAD:		9709 VA	8293 VA	7129 VA					
			TOTAL AMPS:		82 A	71 A	59 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	24641 VA	100.00%	24641 VA	
POWER	605 VA	100.00%	605 VA	**TOTAL CONN. LOAD:** 25128 VA
				TOTAL EST. DEMAND: 25128 VA
				TOTAL CONN..: 70 A
				TOTAL EST. DEMAND: 70 A

NOTES:

PANEL: PP-OS-1D

LOCATION: COMPRESSOR ROOM 103
SUPPLY FROM: DP-OS-1A
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 120/208 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 10 KAIC
BUS RATING: 100 A
MAIN CB: 100 A

CKT	CIRCUIT DESCRIPTION	LC	TRIP	POLES	A	B	C	POLES	TRIP	LC	CIRCUIT DESCRIPTION	CKT
1	FSD - RM 102A	POW...	20 A	1	500 VA 543 VA			1	20 A	HVAC	HHWP-2 - RM 102A	2
3	GF-1 - RM 102A	HVAC	20 A	1		864 VA 1181 VA		2	20 A	HVAC	FCU 202, 203, 204	4
5	MD-1 APPARATUS BAY 100	HVAC	20 A	1			500 VA 1181 VA	--	--	--	--	6
7	HHWP 1 - RM 102A	HVAC	20 A	2	272 VA 456 VA			2	20 A	HVAC	FCU 208A, 208, 200	8
9	--	--	--	--		272 VA 456 VA		--	--	--	--	10
11	FCU 101, 100A	HVAC	20 A	2			788 VA 1244 VA	2	20 A	HVAC	FCU 201A, 201, 200A, BS-2	12
13	--	--	--	--	788 VA 1244 VA			--	--	--	--	14
15	FCU 205, 207, 206	HVAC	20 A	2		1181 VA 500 VA		1	20 A	POW...	RTU - FUTURE POWER 1	16
17	--	--	--	--			1181 VA 0 VA	2	20 A	--	SPARE	18
19	FCU - RM 102, 103	HVAC	20 A	2	850 VA 0 VA			--	--	--	--	20
21	-- 1	--	--	--		850 VA 0 VA		2	20 A	--	SPARE	22
23	RTU TELECOMM - FUTURE POWER	POW...	20 A	1			500 VA 0 VA	--	--	--	--	24
25	SPARE	--	20 A	2	0 VA 0 VA			2	20 A	--	SPARE	26
27	--	--	--	--		0 VA 0 VA		--	--	--	--	28
29	SPARE	--	20 A	2			0 VA 0 VA	2	20 A	--	SPARE	30
31	--	--	--	--	0 VA 0 VA			--	--	--	--	32
33	SPARE	--	20 A	2		0 VA 0 VA		2	20 A	--	SPARE	34
35	--	--	--	--			0 VA 0 VA	--	--	--	--	36
37	SPARE	--	20 A	1	0 VA 0 VA			2	20 A	--	SPARE	38
39	SPARE	--	20 A	1		0 VA 0 VA		1	20 A	--	SPARE	40
41	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	42
			TOTAL LOAD:		4459 VA	5073 VA	5228 VA					
			TOTAL AMPS:		37 A	43 A	44 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	13440 VA	100.00%	13440 VA	
POWER	1500 VA	100.00%	1500 VA	**TOTAL CONN. LOAD:** 14751 VA
				TOTAL EST. DEMAND: 14751 VA
				TOTAL CONN..: 41 A
				TOTAL EST. DEMAND: 41 A

NOTES:

PANEL: PP-OS-1B

LOCATION: EMERGENCY ELEC 111
SUPPLY FROM: ATS-OS-1B
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 480/277 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 65 KAIC
BUS RATING: 600 A
MAIN CB: 600 A

CKT	CIRCUIT DESCRIPTION	LC	TRIP	POLES	A	B	C	POLES	TRIP	LC	CIRCUIT DESCRIPTION	CKT
1	EUH-1 - RM 114	HVAC	20 A	1	2493 VA 33156...			3	300 A	HVAC...	TF-OS-1B	2
3	EUH-2 - STAIR S-A1	HVAC	20 A	1		2493 VA 34308 VA		--	--	--	--	4
5	EUH-3 - STAIR S-C1	HVAC	20 A	1			2493 VA 35289 VA	--	--	--	--	6
7	EUH-8 - STAIR S-B1	HVAC	20 A	1	2493 VA 3520 VA			3	30 A	HVAC	VRF-3 - EXTERIOR	8
9	EUH-6 - APPARATUS BAY	HVAC	20 A	3		3324 VA 3520 VA		--	--	--	--	10
11	--	--	--	--			3324 VA 3520 VA	--	--	--	--	12
13	--	--	--	--	3324 VA 4320 VA			3	40 A	HVAC	VRF-4 - EXTERIOR	14
15	EF-3 - ROOF	HVAC	20 A	3		746 VA 4320 VA		--	--	--	--	16
17	--	--	--	--			746 VA 4320 VA	--	--	--	--	18
19	--	--	--	--	746 VA 6250 VA			3	40 A	POWER	COMPRESSOR - RM 103	20
21	EF-2 - ROOF	HVAC	30 A	3		3867 VA 6250 VA		--	--	--	--	22
23	--	--	--	--			3867 VA 6250 VA	--	--	--	--	24
25	--	--	--	--	3867 VA 3324 VA			3	20 A	HVAC	EUH-7 - APPARATUS BAY	26
27	WH-1 - RM 114	HVAC	100 A	3		18000 VA 3324 VA		--	--	--	--	28
29	--	--	--	--			18000... 3324 VA	--	--	--	--	30
31	--	--	--	--	18000 VA 0 VA			3	90 A	--	SPARE	32
33	DOAS-2 - ROOF	HVAC	125 A	3		27667 VA 0 VA		--	--	--	--	34
35	--	--	--	--			27667... 0 VA	--	--	--	--	36
37	--	--	--	--	27667 VA 0 VA			3	40 A	--	SPARE	38
39	HVAC MEP 102A	HVAC	20 A	1		2597 VA 0 VA		--	--	--	--	40
41	SPARE	--	125 A	3			0 VA 0 VA	--	--	--	--	42
43	--	--	--	--	0 VA 0 VA			3	30 A	--	SPARE	44
45	--	--	--	--		0 VA 0 VA		--	--	--	--	46
47	SPARE	--	20 A	3			0 VA 0 VA	--	--	--	--	48
49	--	--	--	--	0 VA 0 VA			3	20 A	--	SPARE	50
51	--	--	--	--		0 VA 0 VA		--	--	--	--	52
53	SPARE	--	20 A	1			0 VA 0 VA	--	--	--	--	54
55	SPARE	--	20 A	1	0 VA --			1	--	--	PREPARED SPACE	56
57	SPARE	--	20 A	1		0 VA --		1	--	--	PREPARED SPACE	58
59	SPARE	--	20 A	1			0 VA --	1	--	--	PREPARED SPACE	60
			TOTAL LOAD:		108109 VA	109152 VA	107897 VA					
			TOTAL AMPS:		390 A	394 A	390 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	268918 VA	100.00%	268918 VA	
KITCHEN (K)	9200 VA	80.00%	7360 VA	**TOTAL CONN. LOAD:** 325155 VA
POWER	29215 VA	100.00%	29215 VA	**TOTAL EST. DEMAND:** 319759 VA
RECEPTACLE (R)	17160 VA	79.14%	13580 VA	**TOTAL CONN..:** 391 A
APPLIANCE (APPL)	960 VA	100.00%	960 VA	**TOTAL EST. DEMAND:** 385 A

NOTES:

PANEL: PP-OS-1B-2

LOCATION: EMERGENCY ELEC 111
SUPPLY FROM: TF-OS-1B
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 120/208 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 10 KAIC
BUS RATING: 600 A
MAIN CB: 600 A

CKT	CIRCUIT DESCRIPTION	LC	TRIP	POLES	A	B	C	POLES	TRIP	LC	CIRCUIT DESCRIPTION	CKT
1	DSF-3 - RM 113	HVAC	20 A	1	0 VA 373 VA			1	20 A	HVAC	HWP 1&2 - RM 114	2
3	HRV-1 - ROOF	HVAC	20 A	1		1812 VA 93 VA		2	20 A	HVAC	EF-1 - ROOF	4
5	DRYING RACK - 119A	POWER	20 A	1			1980 VA 93 VA	--	--	--	--	6
7	FCU - 214, 214A	HVAC	20 A	2	788 VA 1244 VA			2	20 A	HVAC	FCU 107, 106, 105, BS-1	8
9	--	--	--	--		788 VA 1244 VA		--	--	--	--	10
11	FCU 209, 210, 200D	HVAC	20 A	2			1637 VA 0 VA	1	20 A	HVAC	VAV - 200	12
13	--	--	--	--	1637 VA 1637 VA			2	20 A	HVAC	FCU 112, 111, 110	14
15	FCU 121.13, 113, 121	HVAC	20 A	2		1244 VA 1637 VA		--	--	--	--	16
17	--	--	--	--			1244 VA 1306 VA	2	20 A	HVAC	BS-3,4 - RM 200	18
19	NG-1 - RM 114	HVAC	20 A	1	1200 VA 1306 VA			--	--	--	--	20
21	FCU - 216, 217	HVAC	20 A	2		914 VA 0 VA		1	20 A	HVAC	VAV - 200	22
23	--	--	--	--			914 VA 11040 VA	3	100 A	POWE...	RP-OS-2A	24
25	FCU - 215A, 215	HVAC	20 A	2	788 VA 9560 VA			--	--	--	--	26
27	--	--	--	--		788 VA 13380 VA		--	--	--	--	28
29	ACCU-1 - EXTERIOR	HVAC	90 A	3			5280 VA 788 VA	2	20 A	HVAC	HVAC BUNK ROOM 211	30
31	--	--	--	--	5280 VA 788 VA			--	--	--	--	32
33	--	--	--	--		5280 VA 777 VA		3	20 A	HVAC	ACCU-2 - EXTERIOR	34
35	ACCU-3 - EXTERIOR	HVAC	20 A	3			777 VA 777 VA	--	--	--	--	36
37	--	--	--	--	777 VA 777 VA			--	--	--	--	38
39	--	--	--	--		777 VA 250 VA		1	20 A	HVAC	VAV TURN OUT GEAR - 106	40
41	RP-OS-2A	HVAC...	100 A	3			9709 VA 1220 VA	1	20 A	POWER	TRAP PRIMER - ZONE 1A	42
43	--	--	--	--	8293 VA							44
45	--	--	--	--		7129 VA						46
47	HVAC SERVER 217	HVAC	20 A	2			394 VA 0 VA	2	20 A	--	SPARE	48
49	--	--	--	--	394 VA 0 VA			--	--	--	--	50
51	SPARE	--	20 A	2		0 VA 0 VA		2	20 A	--	SPARE	52
53	--	--	--	--			0 VA 0 VA	--	--	--	--	54
55	SPARE	--	20 A	1	0 VA 0 VA			2	20 A	--	SPARE	56
57	SPARE	--	20 A	1		0 VA 0 VA		--	--	--	--	58
59	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	60
			TOTAL LOAD:		33156 VA	34308 VA	35289 VA					
			TOTAL AMPS:		276 A	287 A	296 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	67306 VA	100.00%	67306 VA	
KITCHEN (K)	9200 VA	80.00%	7360 VA	**TOTAL CONN. LOAD:** 102744 VA
POWER	10465 VA	100.00%	10465 VA	**TOTAL EST. DEMAND:** 97552 VA
RECEPTACLE (R)	17160 VA	79.14%	13580 VA	**TOTAL CONN..:** 285 A
APPLIANCE (APPL)	960 VA	100.00%	960 VA	**TOTAL EST. DEMAND:** 271 A

NOTES:

PANEL: LP-1A

LOCATION: EMERGENCY ELEC 111
SUPPLY FROM: PP-OS-1A
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 480/277 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 22 KAIC
BUS RATING: 100 A
MAIN CB: 100 A

CKT	CIRCUIT DESCRIPTION	LC	TRIP	POLES	A	B	C	POLES	TRIP	LC	CIRCUIT DESCRIPTION	CKT
1	LTG - APPARATUS BAY 100	LTG	20 A	1	1211 VA 48 VA			1	20 A	LTG	LTG - STAIR C	2
3	LTG - APPARATUS BAY 100	LTG	20 A	1		1126 VA 46 VA		1	20 A	LTG	LTG - STAIR C	4
5	LTG - 100A, 103, 101, 102, 102A, 104	LTG	20 A	1			216 VA 83 VA	1	20 A	LTG	LTG- STAIR A	6
7	LTG - 106, 107, 110, 108, 109	LTG	20 A	1	525 VA 243 VA			1	20 A	LTG	LTG- KITCHEN	8
9	LTG - 113, 114	LTG	20 A	1		299 VA 93 VA		1	20 A	LTG	LTG - SITE (NOTE 1)	10
11	LTG - 121.13, 121, 115A, 121A	LTG	20 A	1			258 VA 1092 VA	1	20 A	LTG	LTG - TRAINING TOWER T-1	12
13	LTG - 119, 20D, 118, 117, 116, 120, 121C	LTG	20 A	1	520 VA 171 VA			1	20 A	LTG	LTG - CORRIDOR 232	14
15	LTG - CORRIDOR 121	LTG	20 A	1		239 VA 387 VA		1	20 A	LTG	LTG - 232A, 232B	16
17	LTG - 123, 122	LTG	20 A	1			491 VA 394 VA	1	20 A	LTG	LTG - 206, 207, 209, 211, 210, 212, 208A,...	18
19	LTG - CORRIDOR 200, STAIR B	LTG	20 A	1	572 VA 652 VA			1	20 A	LTG	LTG - 223, 224, 225, 220, 219, 218, 222,...	20
21	LTG - 200C, 200B, 204, 200A, 202, 203,...	LTG	20 A	1		341 VA 27 VA		1	20 A	LTG	LTG - 226	22
23	LTG - SECOND FLOOR AL6	LTG	20 A	1			263 VA 0 VA	1	20 A	--	SPARE	24
25	SPARE	--	20 A	1	0 VA 0 VA			1	20 A	--	SPARE	26
27	SPARE	--	20 A	1		0 VA 0 VA		1	20 A	--	SPARE	28
29	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	30
31	SPARE	--	20 A	1	0 VA 0 VA			1	20 A	--	SPARE	32
33	SPARE	--	20 A	1		0 VA 0 VA		1	20 A	--	SPARE	34
35	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	36
37	SPARE	--	20 A	1	0 VA 120 VA			3	20 A	-	LUTRON LUT-ELI EMERGENCY...	38
39	SPARE	--	20 A	1		0 VA 120 VA		--	--	--	--	40
41	SPARE	--	20 A	1			0 VA 120 VA	--	--	--	--	42
			TOTAL LOAD:		4062 VA	2679 VA	2917 VA					
			TOTAL AMPS:		15 A	10 A	11 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
LIGHTING (LTG)	9298 VA	125.00%	11622 VA	
Spare	360 VA	100.00%	360 VA	**TOTAL CONN. LOAD:** 9658 VA
				TOTAL EST. DEMAND: 11982 VA
				TOTAL CONN..: 12 A
				TOTAL EST. DEMAND: 14 A

NOTES:
NOTE 1: PROVIDE METERING FOR SITE LIGHTING CIRCUIT AND CONNECT TO THE POWER MONITORING SYSTEM.

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CONSULTANTS

FIREMATIC
WENDEL | MITCHELL ASSOCIATES
29 THATCHER PARK RD, VOORHEESVILLE, NY 12186

CIVIL/LANDSCAPE
WESTON & SAMPSON
1 WASHINGTON ST, 10TH FL, BOSTON, MA 02108

STRUCTURAL
RSE ASSOCIATES
63 PLEASANT ST, WATERTOWN, MA 02471

MEP/FP/LIGHTING
ARUP US, INC.
60 STATE ST, BOSTON, MA 02109

CODE
JENSEN HUGHES
33 ARCH ST, BOSTON, MA 02110

ENERGY MODEL
ANDELMANLELEK
1408 PROVIDENCE HWY, NORWOOD, MA 02062

PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
2	Addendum #7	1/23/26
1	Addendum #5	1/16/26

Job Number 157132.000

TITLE

ELECTRICAL PANEL SCHEDULES SHEET 1

SHEET NUMBER

E09.01

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SECTION 04 43 13.13

ANCHORED STONE MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Stone masonry anchored to concrete backup.
2. Stone masonry anchored to unit masonry backup.
3. Stone masonry anchored to cold-formed metal framing and sheathing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [Project site] .

1.3 ACTION SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and manufactured product.

B. Samples for Verification:
1. For each stone type indicated. Include at least ~~[two] [three] [four]~~ five Samples in each set and show the full range of color and other visual characteristics in completed Work.
2. For each color of mortar required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, supply sources, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.
1. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents contained in mockups unless Architect approves such deviations in writing.

C. Material Test Reports:
1. Stone Test Reports: For ~~[~~each~~]~~ stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous three ~~[five]~~ years.

2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.

B. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Protect accepted mockups from the elements with weather-resistant membrane.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for staining, compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 079200 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.

D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.

B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
1. Protect base of walls from rain-splashed mud and mortar splatter using coverings spread on the ground and over the wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1.9 COORDINATION

A. Advise installers of adjacent Work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.

B. Coordinate locations of dovetail slots installed in concrete that are to receive stone anchors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Stone: Obtain each variety of stone, from single quarry, whether specified in this Section or in another Section of the Specifications, with resources to provide materials of consistent quality in appearance and physical properties.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.

2.2 GRANITE

A. Material Standard: Comply with ASTM C615/C615M.

B. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
   1. Cambria Black, Flamed finish

2.3 MORTAR MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.
   1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in stone masonry mortar.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Davis Colors.
      b. Lanxess Corporation.
      c. Solomon Colors Inc.

D. Aggregate: ASTM C144 and as follows:
   1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   2. White Aggregates: Natural white sand or ground white stone.
   3. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
      a. Match Architect's sample.

E. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
      b. GCP Applied Technologies Inc.
      c. Sonneborn Products.

F. Water: Potable.

2.4 STONE ANCHORS

A. Stone Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Canaren Inc.
      b. Heckmann Building Products, Inc.
      c. Hohmann & Barnard, Inc.
      d. Meadow Burke.

B. Materials: Fabricate anchors from stainless steel, ASTM A240/A240M or ASTM A666, Type 304. Fabricate dowels from stainless steel, ASTM A276, Type 304.

C. Fasteners for Stone Trim Anchors: Annealed stainless steel bolts, nuts, and washers; ASTM F593 (ASTM F738M) for bolts and ASTM F594 (ASTM F836M) for nuts, Alloy Group 1 (A1).

2.5 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing[, where flashing is exposed or partly exposed and where indicated,] complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
   1. Stainless Steel: ASTM A240/A240M, Type 304, 0.016 inch (0.4 mm) thick.
   2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
   3. Fabricate through-wall flashing with drip edge [where] [unless otherwise] indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees[and hemmed].
   4. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees[and hemmed].

B. Flexible Flashing: For flashing unexposed to the exterior, use[one of] the following unless otherwise indicated:
   1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive, rubberized-asphalt compound, bonded to a high-density, cross-laminated, polyethylene film to produce an overall thickness of not less than [0.030 inch (0.76 mm)] [0.040 inch (1.0 mm)].
      a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
         1) Advanced Building Products Inc.
         2) Carlisle Coatings & Waterproofing Inc.
         3) Fiberweb, a brand of Clark/Hammerbeam Corp.

4) GCP Applied Technologies Inc.
5) Heckmann Building Products, Inc.
6) Hohmann & Barnard, Inc.
7) Polyguard Products, Inc.
8) Williams Products, Inc.
9) Wire-Bond.

C. Application: Unless otherwise indicated, use the following:
1. Where flashing is fully concealed, use [metal flashing] [or] [flexible flashing].

D. Solder and Sealants for Sheet Metal Flashings:
1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C920, chemically curing [urethane] [polysulfide] [silicone] sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Adhesives, Primers, and Seam Tapes for Flexible Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Weep/Vent Products: Use[one of] the following unless otherwise indicated:
1. Mesh Weep Holes/Vents: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches (50 mm) high by thickness of stone masonry; in color selected from manufacturer's standard.
a. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
1) CavClear; a division of Archovations, Inc.
2) Mortar Net Solutions.

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
a. Advanced Building Products Inc.
b. CavClear; a division of Archovations, Inc.
c. Mortar Net Solutions.
2. Provide one of the following configurations:

a. Strips, full depth of cavity and 10 inches (250 mm) wide, with dovetail-shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
b. Strips, not less than [3/4 inch (19 mm)] [1-1/2 inches (38 mm)] thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
c. Sheets or strips full depth of cavity and installed to full height of cavity.
d. Sheets or strips not less than [3/4 inch (19 mm)] [1 inch (25 mm)] thick and installed to full height of cavity with additional strips 4 inches (100 mm) high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from being clogged with mortar.

2.7 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
      b. EaCo Chem, Inc.
      c. Hydroclean; Hydrochemical Techniques, Inc.
      d. PROSOCO, Inc.

2.8 FABRICATION

A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.
   1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   2. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

B. Select stone to produce pieces of thickness, size, and shape indicated, including details on Drawings and pattern specified in "Setting Stone Masonry" Article.

C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.

D. Cut and drill sinkages and holes in stone for anchors and supports.

E. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
   1. Clean sawed backs of stone to remove rust stains and iron particles.

F. Thickness of Stone: Provide thickness indicated, but not less than the following:
   1. Thickness: As indicated.

G. Finish exposed stone faces and edges to comply with requirements indicated for finish and to match approved samples and mockups.
   1. Finish: Thermal finish.

2.9 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride.
   2. Use portland cement-lime mortar unless otherwise indicated.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
   4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Stone Masonry: Comply with ASTM C270, [Proportion] [Property] Specification.
   1. Mortar for Setting Stone: Type N.
   2. Mortar for Pointing Stone: Type N.

D. Pigmented Mortar: Use colored cement product[or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products].
   1. Pigments do not exceed 10 percent of portland cement by weight.
   2. Pigments do not exceed 5 percent of [masonry cement] [or] [mortar cement] by weight.
   3. Mix to match Architect's sample.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.

B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.

C. Examine wall framing, sheathing, and weather-resistant sheathing paper to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.

B. Coat concrete and unit masonry backup with asphalt dampproofing.

C. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION OF STONE MASONRY

A. Perform necessary field cutting and trimming as stone is set.
   1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.

B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.

C. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.

D. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place.

E. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

F. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 1/4 inch (6 mm) at narrowest points or more than 1/2 inch (13 mm) at widest points.

G. Provide sealant joints of widths and at locations indicated.
   1. Keep sealant joints free of mortar and other rigid materials.
   2. Sealant joints are specified in Section 079200 "Joint Sealants."

H. Install metal expansion strips in sealant joints at locations indicated. Build flanges of expansion strips into masonry by embedding in mortar between stone masonry and backup wythe. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.

I. Install embedded flashing and weep holes at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
   1. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of [4 inches (100 mm)] [8 inches (200 mm)] [12 inches (300 mm)] [16 inches (400 mm)], and extend into or through inner wythe to comply with requirements in Section 042000 "Unit Masonry."
   2. At concrete backing, extend flashing through stone masonry, turned up a minimum of 8 inches (200 mm), and insert in reglet.
   3. Install metal drip edges beneath flexible flashing at exterior wall face. Stop flexible flashing 1/2 inch (13 mm) back from exterior wall face and adhere flexible flashing to top of metal drip edge.

J. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
   1. Use mesh weep holes/vents] [aluminum weep holes/vents] [vinyl weep holes/vents to form weep holes.
   2. Space weep holes 24 inches (600 mm) o.c.
   3. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (13 mm in 12 m) or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.

B. Variation from Level: For[bed joints and] lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.

C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet (13 mm in 6 m) or 3/4 inch in 40 feet (19 mm in 12 m) or more.

D. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.

E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.

F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY

A. Anchor stone with stone anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.

B. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.

C. Provide 2-inch (50-mm) cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
   1. Slope beds toward cavity to minimize mortar protrusions into cavity.
   2. Do not attempt to trowel or remove mortar fins protruding into cavity.

3.6 ADJUSTING AND CLEANING

A. Remove and replace stone masonry of the following description:
   1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
   2. Defective joints.
   3. Stone masonry not matching approved samples and mockups.
   4. Stone masonry not complying with other requirements indicated.

B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
   5. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20, Revised II, using job-mixed detergent solution.
   6. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.

3.7 EXCESS MATERIALS AND WASTE

A. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 06 16 43

GYPSUM SHEATHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Gypsum wall sheathing.

B. Sheathing joint and penetration treatment.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review air-barrier and gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and gypsum sheathing.
   2. Refer to Section 05 40 00 - Cold-Formed Metal Framing for additional information.

1.3 SUBMITTALS

A. Action Submittals:
   1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   2. Shop Drawings: Comply with provisions of Section 05 40 00 - Cold-Formed Metal Framing.
      a. Shop Drawings that are required by that Section, indicate exterior sheathing screw fastener spacing to be utilized at interior zones and corner zones of building façade, as required to ensure sheathing installation will withstand negative wind pressures imposed by design wind speeds.

B. Informational Submittals:
   1. Qualification Data: For Installer.
   2. Field quality-control reports, if required.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to set quality standards for materials and execution.
   1. Provide mock-up in accordance with provisions of Section 01 43 39 - Mockup Requirements.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Testing Agency Qualifications (If Required):
1. For testing agency provide inspections that are acceptable to Owner that periodically performs inspections to verify that material are installed correctly.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Fire-Resistance Ratings: Indicated by design designations from UL (FRD) or from the listings of another qualified testing agency.

2.2 GYPSUM SHEATHING

A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
1. Manufacturers:
a. CertainTeed Corporation; GlasRoc.
b. Georgia-Pacific Building Products; Dens-Glass Exterior Sheathing.
c. National Gypsum Company; Gold Bond eXP.
d. United States Gypsum Co.; Securock.
2. Type and Thickness: Regular, 1/2 inch (13 mm) thick and Type X, 5/8 inch where required for fire resistance.
3. Permeance: Not less than 15 perms per ASTM E96/E96M.
4. Size: 48 by 96 inches (1219 by 2438 mm).
5. Mold Growth: 10, per ASTM D3273.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
   1. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, provide one of the following:
      a. Bugle-head screws complying with ASTM C954.
      b. Wafer-head screws complying with ASTM C1513.
   2. Minimum Fastener Head Diameter: Not less than 0.42 inch (10.7 mm), unless larger diameter is required by sheathing manufacturer.

2.4 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sheathing Sealant: Refer to Section 07 27 26 - Fluid-Applied Membrane Air Barriers. Sealant must be approved by Air-Barrier manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. ASTM C1280, unless closer spacing is required in order for sheathing to resist pressures imposed by design wind speeds.

D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to cold-formed metal framing with bugle-head or wafer-head screws, with minimum head diameter of 0.42 inch (10.7 mm) , unless larger diameter is required by sheathing manufacturer.

2. Install panels with a 3/8 inch (9.5 mm) gap where non-load-bearing construction abuts structural elements.
3. Install panels with a 1/4 inch (6.4 mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
   a. Decrease spacing between fasteners where required to ensure sheathing installation will withstand negative wind pressures imposed by design wind speeds, as indicated in Shop Drawings submitted under Section 05 40 00 - Cold-Formed Metal Framing.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
   a. Decrease spacing between fasteners where required to ensure sheathing installation will withstand negative wind pressures imposed by design wind speeds, as indicated in Shop Drawings submitted under Section 05 40 00 - Cold-Formed Metal Framing.

3.3 SHEATHING JOINT-AND-PENETRATION TREATMENT

A. Seal sheathing joints according to “Air-Barrier” manufacturer's written recommendations.
1. Apply sealant on joints and fasteners and trowel flat. Apply sufficient quantity of sealant to completely cover joints and fasteners after troweling, unless directed otherwise by “Air-Barrier” manufacturer’s written instructions. Seal other penetrations and openings.
   a. Utilize primers and tapes as recommended by sealant manufacturer at corners and joints at adjacent substrates.
2. Taping of joints will not be accepted as an alternative or substitute for application of joint sealant.
3. ~~Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip, so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.~~
4. ~~Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.~~

5. ~~Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.~~
6. ~~Seal top of through-wall flashings to sheathing with an additional 6 inch (150 mm) wide, transition strip.~~
7. ~~Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.~~
8. ~~Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.~~

3.4 FIELD QUALITY CONTROL

A. Testing: Owner reserves the right to engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. The following items will be subject to testing and inspecting:
   1. Attachment of sheathing to studs and other supplemental support framing.
   2. Type and size of fasteners.
   3. Spacing of fasteners.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION

SECTION 08 44 13

GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Conventionally glazed aluminum curtain walls.

B. Two-sided, structural-sealant-glazed aluminum curtain walls.

C. Insulated metal spandrel panels.

D. Vent windows.

E. Sun-control.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 SUBMITTALS

A. Action Submittals:
   1. Product Data: For each type of product.
      a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
      a. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
      b. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
         1) Joinery, including concealed welds.
         2) Anchorage.
         3) Expansion provisions.
         4) Glazing.
         5) Flashing and drainage.
         6) Window and door position switches and concealed wiring.
      c. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
   3. Delegated-Design Submittal: Glazed aluminum curtain wall systems, including support framing, connections, and related hardware shall be designed under the direct supervision of a Professional Structural Engineer experienced in the design of the work and licensed in the State of Massachusetts, using performance and design criteria, and requirements specified in this Section.

B. Informational Submittals:
   1. Qualification Data:
      a. For Installer.
      b. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the state in which Project is located.
   2. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.
      a. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
   3. Product Test Reports: For glazed aluminum curtain walls, for tests performed by manufacturer and witnessed by a qualified testing agency.
   4. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
   5. Source quality-control reports.
   6. Field quality-control reports.
   7. Sample Warranties: For special warranties.

C. Closeout Submittals:
   1. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.
   2. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

D. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain wall assemblies.

1.5 MOCKUPS

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Provide mock-up in accordance with provisions of Section 01 43 39
   2. Build mockup of typical wall area as shown on Drawings.
   3. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
   4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Special Assembly Warranty: Manufacturer and Installer agree(s) to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
      c. Deterioration of metals and other materials beyond normal weathering.
      d. Water penetration through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage Professional Structural Engineer licensed in the State of Massachusetts, as defined in Section 01 40 00 - Quality Requirements, to design glazed aluminum curtain walls.

B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:
   1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
      a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
   3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
      a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4-inch (6. 35-mm) for spans greater than 11 feet 8-1/4 inches (3.6 m) or 1/175 times span, for spans less than 11 feet 8-1/4 inches (3.6 m).

E. Structural: Test according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
   1. Fixed Framing and Glass Area:
      a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
   1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
   1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
   2. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

I. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
   1. Design Displacement: As indicated on Drawings.
   2. Test Performance: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.

J. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.
   2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.7 at design displacement and 1.5 times the design displacement.

K. Energy Performance: Certify and label energy performance according to NFRC as follows:
   1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.28, as determined according to NFRC 100.
   2. Thermal Transmittance (U-factor): Vent windows shall have U-factor of not more than 0.32, as determined according to NFRC 100.
   3. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.29 as determined according to NFRC 200.
   4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 65 as determined according to NFRC 500.

L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
   2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

M. Structural-Sealant Joints:
1. Designed to carry gravity loads of glazing.
2. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).

N. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 MANUFACTURERS

A. Arcadia, Inc.

B. Kawneer North America.

C. Oldcastle BuildingEnvelope.

D. Shuco US LP.

E. United States Aluminum.

F. YKK AP America Inc.

G. Basis of Design Products:
1. Oldcastle:
a. Reliance HTC 2-1/2” x 7-1/4” Curtainwall (with a System U-Value = 0.269)
b. Reliance HTC 2-1/2” X 10” Curtainwall (with a System U-Value = 0.27)
c. TCR-225 2-1/4” X 5” Window Wall, using SSG Mullions (available details provided show system use with 1-inch IGU’s, but it can accept 1-3/4”) (with a System U-Value = 0.279)
d. WS-500 TC Wide Stile Door (with a System U-Value = 0.431)
e. Signature Series 3375 3-3/4” Overall Sightline Casement Window (Not Zero-Sightline) (with a System U-Value = 0.32)

H. Source Limitations: Obtain all components of curtain wall system, including framing, entrances and accessories from single manufacturer.

2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides and Retained mechanically with gaskets on two sides and structural sealant on two sides.
3. Glazing Plane: Front.
4. Finish: High-performance organic finish.
5. Fabrication Method: Either factory- or field-fabricated system.

B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
1. Include snap-on aluminum trim that conceals fasteners.
2. Provied extended trim where indicated.

C. Extruded Aluminum Interior Stools: 0.90 inch thickness, finished to match curtain wall.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

E. Shadow box back pans: Provide 0.090-inch thickness back pans shadow box spandrel areas, both sides of insulation. At fire-rated construction provide steel backpan, instad of aluminum at fire-safing.
1. Color: As selected by Architect from Manufacturer’s standards.

2.4 INSULATED SPANDREL PANELS

A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
1. Overall Panel Thickness: As indicated.
2. Exterior Skin: Aluminum.
   a. Thickness: Manufacturer's standard for finish and texture indicated.
   b. Finish: Match framing system.
   c. Texture: Smooth.
   d. Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard.
3. Interior Skin: Aluminum.
   a. Thickness: Manufacturer's standard for finish and texture indicated.
   b. Finish: Matching curtain-wall framing.
   c. Texture: Smooth.
   d. Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard.
4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
5. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 or less.

B. Glazing: As specified in Section 08 80 00 "Glazing".

C. Finish: Match adjacent glazed aluminum curtain-wall finish.

2.5 ENTRANCES

A. Entrances: Comply with Section 08 41 13 - Aluminum-Framed Entrances And Storefronts.

2.6 VENT WINDOWS

A. Project out casement.

B. Minimum Performance Class: AW.

C. Minimum Performance Grade: 50.

D. Energy Performance: Certify and label energy performance according to NFRC as follows:
   1. Thermal Transmittance (U-factor): Operable whole-window U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) as determined according to NFRC 100.
   2. SHGC: Operable whole-window SHGC of no greater than 0.40 as determined according to NFRC 200.
   3. Condensation Resistance: Operable whole-window NFRC-certified condensation resistance rating of no less than 55 as determined according to NFRC 500.

E. Window Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, or bronze; including the following:

F. Glazing: Same as adjacent glazed aluminum curtain-wall glazing.

G. Finish: Match curtain wall framing.

2.7 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
   1. Type and Location: Full, inside for project-out sashes.

B. Aluminum Frames: Complying with SMA 1004 or SMA 1201.

C. Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.
   1. Mesh Color: Manufacturer's standard.

2.8 LOUVERS

A. See Section 08 91 21 - Wind-Driven Rain-Resistant Louvers.

2.9 SUN CONTROL

A. Sunshades: Assemblies consisting of manufacturer's standard or custom outrigger brackets, designed for attachment to curtain wall with mechanical fasteners.

1. Orientation: Vertical.
2. Projection from Wall: As indicated on Drawings.
3. Perforated aluminum plate fins:
   a. Thickness: 3/8 inch, unl;ess otherwise indicated.
   b. Perforation pattern: As indicated on the Drawings, or if not indicated, as selected by the Architect, with 1-inch perimeter margine.
4. Finish: Match adjacent glazed aluminum curtain wall.

2.10 GLAZING

A. Glazing: Comply with Section 08 80 00 - Glazing.

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: Comply with Section 08 80 00 - Glazing.
   1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less.
   2. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Structural Glazing Sealants: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
   1. Color: As selected by Architect from manufacturer's full range of colors.

E. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
   1. Color: Match structural sealant.

2.11 MATERIALS

A. Sheet and Plate: ASTM B209 (ASTM B209M).

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).

C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.

D. Structural Profiles: ASTM B308/B308M.

E. Steel Reinforcement:
   1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
   2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.12 ALUMINUM TRIM ACCESSORIES

A. Formed Closures Trim Pieces:
1. ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance requirements.
   a. Jambs / Brake Metal Closures.
      1) Thickness: 0.090 inches (2.38 mm).
      2) Finish: Matching framing system.
      3) Texture: Smooth.
   b. Interior trim at abutting partitions:
      1) Thickness: 0.090 inches (2.38 mm).
      2) Finish: Matching framing system.
      3) Texture: Smooth.
   c. Sills:
      1) Thickness: 0.090 inches
      2) Finish: Matching framing system.
      3) Texture: Smooth.
      4) Joint backing plate: Aluminum 0.040 inches thickness.
      5) Joint seal: Pre-cured silicone membrane.
      6) Keeper: Continuous; Aluminum 0.040 inches thickness.
      7) Dimensions: As indicated.

B. Extruded Aluminum Closures Trim Pieces:
1. ASTM B 221 (ASTM B 221M), alloy as standard with manufacturer for finish required, with temper as required to suit extruded operations and performance requirements.
   a. Interior Window Stools:
      1) Thickness: 0.090 inches (2.38 mm).
      2) Finish: Matching framing system.
      3) Texture: Smooth.
      4) End caps: To match stools.
   b. Interior Grille Stools:
      1) Thickness: 0.090 inches.
      2) Finish: Matching framing system.
      3) Texture: Smooth.
      4) End caps: To match stools.
   c. Corner bar at structural glazed corners:
      1) Thickness: 1-inch square bar
      2) Finish: Anodized.
      3) Color: Black.

2.13 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from 300 series stainless steel.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

C. Concealed Flashing: Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.

D. Wall Jamb Closure: 'F' – shaped, 0.125-inch- (3.175-mm-) thick by 4-inches long (100-mm) aluminum jamb closure designed to install in mullion glazing pocket.

E. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.14 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from exterior.
   6. Provisions for safety railings mounted on interior face of mullions.
   7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   8. Components curved to indicated radii.

D. Fabricate components to resist water penetration as follows:
   1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.

F. Factory-Assembled Frame Units:
1. Rigidly secure nonmovement joints.
2. Prepare surfaces that are in contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
3. Preparation includes, but is not limited to, cleaning and priming surfaces.
4. Seal joints watertight unless otherwise indicated.
5. Install glazing to comply with requirements in Section 08 80 00 - Glazing.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.15 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: ~~As selected by Architect from manufacturer's full range~~.
a. Match PPG Cafe Noir, with low gloss clear topcoat

2.16 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify locations possition switches and concealed witing connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:
1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
7. Seal joints watertight unless otherwise indicated.
8. Coordinate with _____for installation of possition switches and concealed wiring.

B. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

D. Install components plumb and true in alignment with established lines and grades.

3.4 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 08 80 00 - Glazing.
1. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.5 INSTALLATION OF WEATHERSEAL SEALANT

A. Install weatherseal sealant according to Section 07 92 00 - Joint Sealants and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.6 ERECTION TOLERANCES

A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).

2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
3. Alignment:
   a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
   b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
   c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Test Area: Perform tests on one bay at least 30 feet (9.1 m), by one story.

C. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.
   1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
      a. Perform a minimum of two tests in areas as directed by Architect.
      b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
   2. Air Infiltration: ASTM E 783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
      a. Perform a minimum of two tests in areas as directed by Architect.
      b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
   3. Water Penetration: ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.

D. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
   1. Test a minimum of two areas on each building facade.
   2. Repair installation areas damaged by testing.

E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 09 30 13

TILING

(PART OF TRADE-BID SECTION 09 00 01 - TILING)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Ceramic tile.

B. Porcelain tile.

C. Stone thresholds.

D. Waterproof / Crack isolation membrane.

E. Edge Protection / Metal edge strips.

1.2 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1a, ANSI A108.1b, ANSI A108.1c, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."

C. ISO 13007-2 Standards for Ceramic Tile Grouts and Adhesives.

D. Module Size: Actual tile size plus joint width indicated.

E. Face Size: Actual tile size, excluding spacer lugs.

1.3 SUBMITTALS

A. Action Submittals:
   1. Product Data: For each type of product.
   2. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
   3. Samples:
      a. Full-size units of each type and composition of tile and for each color and finish required.

b. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches (300 mm) square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
c. Stone thresholds in 6-inch (150-mm) lengths.
d. Metal edge strips in 6-inch (150-mm) lengths.

B. Informational Submittals:
1. Qualification Data: For Installer.
2. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
3. Product Certificates: For each type of product.
4. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

C. Maintenance Material Submittals:
1. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
a. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent or 2 cases, whichever is less of amount installed for each type, composition, color, pattern, and size indicated.
b. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer having a minimum of 5 years of experience on projects of comparable size and scope who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of each type of floor tile installation.
2. Build mockup of each type of wall tile installation.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dynamic Coefficient of Friction: For tiles installed on walkway surfaces, provide products with the followings values as determined by testing identical products per ANSI A137.1:
   1. Level Surfaces: Minimum > 0.42

2.2 MANUFACTURERS

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
   1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
   2. Obtain waterproofing membrane and waterproofing/crack isolation membrane , except for sheet products, from manufacturer of setting and grouting materials.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
   1. Stone thresholds.
   2. Waterproof membrane.
   3. Waterproofing / crack isolation membrane.
   4. Metal edge strips.

2.3 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
   1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.4 TILE PRODUCTS

A. Manufacturers:
   1. American Olean Tile Company.
   2. Dal-Tile Corporation.
   3. Global Tile Design.
   4. Stone Source.
   5. Tile Bar.
   6. Creative Materials Corporation
   7. Best Tile

B. Basis of Design Products:
   1. CT1 CERAMIC TILE- WALL (4"x16") BEST TILE VILLA HIJAU, GREEN, 4"X16"
   2. CT2 CERAMIC TILE- FLOOR (12"x24") CREATIVE MATERIALS CORP. HYANNIS ANTRACITE MATTE RECTIFIED, 12"X24"
   3. CT3 CERAMIC TILE- WALL (3"x12") CREATIVE MATERIALS CORP. METROPOLIS SUBWAY, WHITE GLOSSY, 3"X12"
   4. CT4 CERAMIC TILE- WALL (2"x6.5") BEST TILE WELLFLEET, EUCALYPTUS GLOSSY, 2"X6.5"

C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
   1. Provide as indicated in Interior Finish Legend, unless otherwise indicated.

D. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:
   1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
   2. Shapes: As follows, selected from manufacturer's standard shapes:
      a. Base for Thin-Set Mortar Installations: Straight.

b. Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose.
c. External Corners for Thin-Set Mortar Installations: Surface bullnose.
d. Internal Corners: Field-butted square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

2.5 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
2. Basis of Design Products: Refer to Interior Finish Legend on Drawings.

B. Marble Thresholds: ASTM C503/C503M, with a minimum abrasion resistance of 10 according to ASTM C1353/C1353M or ASTM C 241/C 241M and with honed finish.
1. Description: Uniform, fine- to medium-grained white stone with gray veining.
2. Description: Match Architect's sample.

2.6 EDGE PROTECTION / METAL EDGE STRIPS

A. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; nickel silver or stainless-steel, ASTM A666/A666M, 300 Series exposed-edge material.
1. Manufacturers:
a. Blanke Corporation.
b. Ceramic Tool Company, Inc.
c. Schluter Systems L.P.
2. Basis of Design Manufacturer: Schluter Systems.
a. Profiles:
1) Outside Corner Edge Protection, Tile-to-Tile: QUADEC.
2) Outside Corner Edge Protection, Tile-to-Gypsum Board: SCHIENE.
3) Finishing Edge Protection, Tile-to-Gypsum Board: SCHIENE.

B. Metal Edge Protection: Roll-formed Type 304 stainless steel, height as required to accept scheduled tile thickness.
1. Acceptable Products:
a. Tile-to-Concrete: "RENO-U", Model AEU as manufactured by Schluter Systems in height as required to accommodate scheduled tile and setting bed thickness.
b. Tile to Resilient Flooring: "RENO-U", Model AE as manufactured by Schluter Systems in height required to accommodate scheduled products and setting bed thickness.
c. Tile to Terrazzo: "SCHIENE", Model AE as manufactured by Schluter Systems, in height required to accommodate scheduled products and setting bed thickness.

d. Tile to Carpet: "SCHIENE", Model AE as manufactured by Schluter Systems, in height required to accommodate scheduled products and setting bed thickness.
e. Edge Protection at Wall: "JOLLY" for outside corners as manufactured by Schluter Systems, in size as required to accommodate scheduled tile and setting bed thickness.

2.7 WATERPROOFING / CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and ANSI A118.12 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
1. Manufacturers:
a. Laticrete International, Inc.; Laticrete Hydroban.
b. MAPEI Corporation; Mapelastic AquaDefense.
c. TEC; H.B. Fuller Construction Products Inc.; Hydra Flex Waterproofing Membrane.

2.8 SETTING MATERIALS

A. Modified Dry-Set Cement Mortar (Thinset): ANSI A118.4 and ISO 13007-2.
1. Manufacturers:
a. Wall Applications, non-large format tile:
1) Ardex Engineered Cements, "X5".
2) Custom Building Products, "MegaLite Rapid Set Crack Prevention Mortar."
3) Laticrete International, Inc., "253 Gold."
4) MAPEI Corporation, "Ultraflex 2."
b. Wall Applications, large format tile:
1) Ardex Engineered Cements, "X77".
2) Custom Building Products, "ProLite".
3) Laticrete International, Inc., Laticrete; 255 MultiMax.
4) MAPEI Corporation, "Ultralite Pro".
5) TEC; H.B. Fuller Construction Products Inc. "3N1 Performance Mortar.
2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4 and ISO 13007-2.

B. Medium-Bed, Modified Dry-Set Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 1/4 to 3/4-inch (6 to 19 mm).
1. Manufacturers:
a. Ardex Engineered Cements, "X32".

b. Custom Building Products, "Marble Granite & Travertine Fortified Premium Medium Bed Mortar".
c. Laticrete International, Inc., Laticrete; "4XLT".
d. MAPEI Corporation, "Ultraflex LFT".
e. TEC; H.B. Fuller Construction Products Inc. "Ultimate Large Tile Mortar".

2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.

2.9 GROUT MATERIALS (REFERENCE "TILE INSTALLATION SCHEDULE" AT END OF SECTION)

A. Water-Cleanable Epoxy Grout: ANSI A118.3 and ISO 13007; RG, with a VOC content of 65 g/L or less.
1. Manufacturers:
a. Ardex Engineered Cements, "WA 100 percent solids epoxy grout".
b. Custom Building Products, "100 percent Solids Epoxy Grout" or "Fusion".
c. Laticrete International, Inc., "SpectraLOCK Pro Premium Grout."
d. MAPEI Corporation, "Kerapoxy CQ" or "Flexcolor CQ".
2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F (60 and 100 deg C), respectively, and certified by manufacturer for intended use.

2.10 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
1. Manufacturers:
a. Ardex Engineered Cements, Feather Finish or K15.
b. Laticrete, "L&M Duracrete" or "L&M Durapatch Industrial"
c. MAPEI, "Mapecem Quickpatch."

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
1. Basis of Design Products, Laticrete, "Stonetech Professional Stone & Tile Cleaner".

2.11 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Section 07 92 00 - Joint Sealants.
1. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
2. Colors: Provide colors of exposed sealants to match colors of grout in tile.

2.12 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   2. Verify that concrete substrates for tile floors installed with bonded mortar bed or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
      a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
      b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
   3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
   4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable or self-leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1a and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA (HB) installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
   1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
      a. Exterior tile floors.
      b. Tile floors in wet areas.
      c. Tile swimming pool decks.
      d. Tile floors in laundries.
      e. Tile floors consisting of tiles 8 by 8 inches (200 by 200 mm) or larger.
      f. Tile floors consisting of rib-backed tiles.
   2. Follow procedures in the ANSI A108 Series of tile installation standards for tile layout including but not limited to:
      a. Center and balance areas.
      b. Excess amount of cuts.
      c. Smooth edge cuts.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
   1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
   2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.

3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
1. Wall tile joint maximum 1/8 inch (0.8 mm), adjust to smaller IF the floor calibration allows.
2. Floor tile joint maximum 3/16 inch (2.4 mm), adjust to smaller IF the wall calibration allows.
3. Align joints center to center.

H. At inside corners of tile floors, base and walls, provide sealant joint. Joint width to match specified joint widths. Color of exposed sealant to match color of grout in tile.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in improved modified dry-set mortar (thinset).
2. Do not extend waterproofing/crack isolation membrane under thresholds set in improved modified dry-set mortar. Fill joints between such thresholds and adjoining tile set on waterproofing/crack isolation membrane with elastomeric sealant.

K. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

L. Metal Edge Strips: Install at locations indicated.
1. Install metal edge strips in lengths as long as practical without gaps at seams. Do not use multiple strips where one continuous strip can be installed.

M. Grout Sealer: Apply floor sealer to grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 WATERPROOFING / CRACK ISOLATION MEMBRANE INSTALLATION

A. Install waterproofing / crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproofing / crack isolation membrane to cure before installing tile or setting materials over it.

3.5 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.6 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:
   1. Ceramic Tile Installation F125: TCNA F125-Full; thinset mortar on waterproof / crack isolation membrane.
      a. Ceramic Tile Type: Refer to Interior Finish Legend on Drawings.
      b. Thinset Mortar: Medium-bed, modified dry-set mortar.
      c. Grout: High-performance grout.
      d. Locations: Floors with floor tile over 14 by 14 inches (355 by 355 mm) in size or if one side is over 18-inches (457 mm) long.

B. Interior Wall Installations, Metal Studs or Furring:
   1. Ceramic Tile Installation W248: TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.
      a. Ceramic Tile Type: Refer to Interior Finish Legend on Drawings.
      b. Thinset Mortar: Medium-bed, modified dry-set mortar.
      c. Grout: Water-cleanable epoxy grout.
      d. Locations: Wet areas, wall tile over 14 by 14 inches (355 by 355 mm) in size or if one side is over 18-inches (457 mm) long.
   2. Ceramic Tile Installation W248: TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.
      a. Ceramic Tile Type: Refer to Interior Finish Legend on Drawings.
      b. Thinset Mortar: Modified dry-set mortar.
      c. Grout: Water-cleanable epoxy grout.
      d. Locations: Kitchens, bathrooms or public restrooms.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING AND SPECIALTIES

(Part of Work of Section 22 00 01 – PLUMBING, Trade Bid Required)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.
4. Backwater valves
5. Cleanouts.
6. Floor drains.
7. Trench drains.
8. Channel drainage systems.
9. Air-admittance valves.
10. Roof flashing assemblies.

11. Through-penetration fire-stop assemblies.

12. Miscellaneous sanitary drainage piping specialties.

13. Flashing materials.

14. Solids interceptors.

B. Related Sections:

1. Division 22 Section "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

2. Division 22 Section "Sanitary Sewerage Pumps" for effluent and sewage pumps.

3. Division 22 Section "Facility Storm Drainage Piping and Specialties" for storm drainage piping inside the building, drainage piping specialties and drains.

4. Division 22 Section "Plumbing Fixtures" for hair interceptors.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water

2. Waste, Force-Main Piping: 50 psig

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated Include rated capacities, operating characteristics, and accessories for the following:

1. Gas and Sand interceptors.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that piping, equipment, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Equipment Unit (where applicable): Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. 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.

C. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping and specialty components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

D. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

E. 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.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

1.10 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:

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

a. ANACO-Husky.

b. Clamp-All Corp.

c. Dallas Specialty & Mfg. Co.

d. MIFAB, Inc.

e. Mission Rubber Company; a division of MCP Industries, Inc.

f. Stant.

g. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.

3. Description: Stainless-steel shield with four (4) stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. MG Piping Products Company.

2. Standard: ASTM C 1277.

3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class. Marked with CISPI collective trademark and be listed by NSF International.

B. Gaskets: ASTM C 564 rubber.

~~2.3~~2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

3. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

~~2.4~~2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Unshielded, Non-pressure Transition Couplings:

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

      1) Dallas Specialty & Mfg. Co.

      2) Fernco Inc.

      3) Mission Rubber Company; a division of MCP Industries, Inc.

      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

   b. Standard: ASTM C 1173.

   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

   d. Sleeve Materials:

      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

      2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

      3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:

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

      1) Cascade Waterworks Mfg. Co.

      2) Mission Rubber Company; a division of MCP Industries, Inc.

   b. Standard: ASTM C 1460.

   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.

2) Dresser, Inc.

3) EBAA Iron, Inc.

4) JCM Industries, Inc.

5) Romac Industries, Inc.

6) Smith-Blair, Inc.; a Sensus company.

7) The Ford Meter Box Company, Inc.

8) Viking Johnson.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Manufacturer's standard.

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. Dielectric Unions:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Hart Industries International, Inc.

4) Jomar International Ltd.

5) Matco-Norca, Inc.

6) McDonald, A. Y. Mfg. Co.

7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Pressure Rating: 50 psig.

3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Matco-Norca, Inc.

4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Factory-fabricated, bolted, companion-flange assembly.

3) Pressure Rating: 50 psig.

4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

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

1) Advance Products & Systems, Inc.

2) Calpico, Inc.

3) Central Plastics Company.

4) Pipeline Seal and Insulator, Inc.

b. Description:

1) Non-conducting materials for field assembly of companion flanges.

2) Pressure Rating: 150 psig.

3) Gasket: Neoprene or phenolic.

4) Bolt Sleeves: Phenolic or polyethylene.

5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

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

1) Elster Perfection.

2) Grinnell Mechanical Products.

3) Matco-Norca, Inc.

4) Precision Plumbing Products, Inc.

5) Victaulic Company.

b. Description:

1) Standard: IAPMO PS 66

2) Electroplated steel nipple.

3) Pressure Rating: 300 psig at 225 deg F.

4) End Connections: Male threaded or grooved.

5) Lining: Inert and noncorrosive, propylene.

~~2.5~~2.6 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.

d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.14.1.

3. Size: Same as connected piping.

4. Body: Cast iron.

5. Cover: Cast iron with bolted or threaded access check valve.

6. End Connections: Hub and spigot or hubless.

7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.

8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

~~2.6~~2.7 CLEANOUTS

A. Exposed Metal Cleanouts:

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

g. Josam Company; Blucher-Josam Div.

2. Standard: ASME A112.36.2M for cast iron; ASME A112.3.1 for stainless steel

3. Size: Same as connected drainage piping

4. Body Material: Hubless, cast-iron soil pipe test tee or Stainless-steel tee with side cleanout as required to match connected piping.

5. Closure: Countersunk, brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

7. Closure for Stainless Steel cleanouts: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

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

   a. Josam Company; Josam Div.

   b. Oatey.

   c. Sioux Chief Manufacturing Company, Inc.

   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   e. Tyler Pipe; Wade Div.

   f. Watts Drainage Products Inc.

   g. Zurn Plumbing Products Group; Light Commercial Operation.

   h. Zurn Plumbing Products Group; Specification Drainage Operation.

   i. Josam Company; Josam Div.

   j. Kusel Equipment Co.

   k. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule heavy-duty, adjustable housing cleanout.

3. Size: Same as connected branch.

4. Type: Cast-iron soil pipe with cast-iron ferrule Heavy-duty, adjustable housing.

5. Body or Ferrule: Cast iron.

6. Clamping Device: Required.

7. Outlet Connection: Inside calk or Spigot.

8. Closure: Brass plug with straight threads and gasket, Cast-iron plug.

9. Adjustable Housing Material: Cast iron with threads.

10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.

11. Frame and Cover Shape: Round.

12. Top Loading Classification: Heavy Duty.

13. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

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

   a. Josam Company; Josam Div.

   b. MIFAB, Inc.

   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   d. Tyler Pipe; Wade Div.

   e. Watts Drainage Products Inc.

   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.

3. Size: Same as connected drainage piping.

4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk, drilled-and-threaded, brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

8. Wall Access: Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

~~2.7~~2.8 FLOOR DRAINS

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Provide with trap primer connection

~~2.8~~2.9 TRENCH DRAINS

A. Trench Drains:

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Scheir

e. Tyler Pipe; Wade Div.

f. Watts Drainage Products Inc.

g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3 for trench drains.

3. Material: Ductile or gray iron.

4. Outlet: Bottom or side

5. Grate Material: Stainless steel, heavy duty

~~2.9~~2.10 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company; Elmdor/Stoneman Div.

b. Thaler Metal Industries Ltd.

c. Oatey

B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counter-flashing fitting.

1. Open-Top Vent Cap: Without cap.

2. Low-Silhouette Vent Cap: With vandal-proof vent cap.

3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

~~2.10~~2.11 THROUGH-PENETRATION FIRE-STOP ASSEMBLIES

A. Through-Penetration Fire-stop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. ProSet Systems Inc.

b. 3M

c. Hilti

2. Standard: UL 1479 assembly of sleeve and stack fitting with fire-stopping plug.

3. Size: Same as connected soil, waste, or vent stack.

4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

6. Special Coating: Corrosion resistant on interior of fittings.

~~2.11~~2.12 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.

2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stacks piping.

E. Stack Flashing Fittings:

1. Description: Counter-flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. Size: Same as connected stack vent or vent stack.

G. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.

2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter-flashing.

H. Expansion Joints:

1. Standard: ASME A112.21.2M.

2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.

4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-

sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install steel piping according to applicable plumbing code.

P. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

R. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

S. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

T. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

U. Install force mains at elevations indicated.

V. Plumbing Specialties:

1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."

3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Z. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

AA. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

BB. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.

2. In Drainage Piping: Shielded, non-pressure transition couplings.

3. In Aboveground Force Main Piping: Fitting-type transition couplings.

4. In Underground Force Main Piping:

a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.

b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.

2. Install gate or full-port ball valve for piping NPS 2 and smaller.

3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.

2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.

3. Install backwater valves in accessible locations.

4. Comply with requirements for backwater valve specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.

3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42, clamps.

6. Install individual, straight, horizontal piping runs:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.

2. NPS 3: 60 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.

2. NPS 1-1/2: 108 inches with 3/8-inch rod.

3. NPS 2: 10 feet with 3/8-inch rod.

4. NPS 2-1/2: 11 feet with 1/2-inch rod.

5. NPS 3: 12 feet with 1/2-inch rod.

6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.

8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.

2. NPS 3: 96 inches with 1/2-inch rod.

3. NPS 4: 108 inches with 1/2-inch rod.

4. NPS 6: 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.

2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

3. NPS 2-1/2: 108 inches with 1/2-inch rod.

4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.

5. NPS 6: 10 feet with 5/8-inch rod.

6. NPS 8: 10 feet with 3/4-inch rod.

M. Install supports for vertical copper tubing every 10 feet.

N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 EQUIPMENT/SPECIALTY INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.

b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Assemble and install stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.

H. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

I. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

J. Install fixture air-admittance valves on fixture drain piping.

K. Install stack air-admittance valves at top of stack vent and vent stack piping.

L. Install air-admittance-valve wall boxes recessed in wall.

M. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

N. Install through-penetration fire-stop assemblies in plastic conductors and stacks at floor penetrations.

O. Assemble open drain fittings and install with top of hub 1 inch above floor.

P. Install deep-seal traps on floor drains and other waste outlets, if indicated.

Q. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.

R. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

S. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

T. Install vent caps on each vent pipe passing through roof.

U. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

V. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

W. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

X. Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.

Y. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

Z. Install wood-blocking reinforcement for wall-mounting-type specialties.

AA. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

D. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

4. Install horizontal backwater valves with cleanout cover flush with floor.

5. Comply with requirements for backwater valves, cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

E. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.

2. Sewage Pump: To sewage pump discharge.

F. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

G. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.9 LABELING AND IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Solids interceptors.

C. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL

A. During piping installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.11 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

F. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

2. Galvanized-steel pipe, drainage fittings, and threaded joints.

3. Copper DWV tube, copper drainage fittings, and soldered joints.

4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

2. Galvanized-steel pipe, drainage fittings, and threaded joints.

3. Copper DWV tube, copper drainage fittings, and soldered joints.

   a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

D. Aboveground, vent piping NPS 5 and larger shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

E. Underground, soil, waste, and vent piping shall be any of the following:

1. Service class, cast-iron soil piping; ~~calking materials; and calked joints.~~ gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.

4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

F. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:

1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.

2. Ductile-iron, mechanical-joint piping and mechanical joints.

3. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

END OF SECTION

SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING AND SPECIALTIES

(Part of Work of Section 22 00 01 – PLUMBING, Trade Bid Required)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.
4. Miscellaneous storm drainage piping specialties.
5. Cleanouts.
6. Backwater valves.
7. Through-penetration fire-stop assemblies.
8. Flashing materials.

B. Related Sections:

1. Division 33 Section "Storm Utility Drainage Piping" for storm drainage piping outside the building.
2. Division 22 Section “Sanitary Waste and Vent Piping and Specialties” for floor drains, area drains and all other drainage systems connected to sanitary sewer.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 15-foot head of water. Storm Drainage, Force-Main Piping 100 psig

B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures" and per authority having jurisdiction.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials and specialties shall bear label, stamp, or other markings of specified testing agency.

B. 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.

C. Product Data: For each type of product indicated.

1.7 COORDINATION

A. Coordinate size and location of all roof penetrations.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301. All pipe and fittings shall be marked with CISPI's collective trademark or receive prior approval by the engineer of record.

B. Heavy-Duty, Shielded Cast-Iron, Hubless Piping Couplings:

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

a. MG Piping Products Company.

b. Tyler Pipe

c. MIFAB, Inc.

2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class. Marked with CISPI collective trademark and be listed by NSF International.

B. Gaskets: ASTM C 564 rubber.

~~2.3~~2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.

3. Unshielded, Non-pressure Transition Couplings:

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

      1) Dallas Specialty & Mfg. Co.

      2) Fernco Inc.

      3) Mission Rubber Company; a division of MCP Industries, Inc.

      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

   b. Standard: ASTM C 1173.

   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

   d. Sleeve Materials:

      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

      2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:

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

      1) Cascade Waterworks Mfg. Co.

      2) Mission Rubber Company; a division of MCP Industries, Inc.

      3) Fernco

b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.

2) Dresser, Inc.

3) EBAA Iron, Inc.

4) Ford Meter Box Company, Inc. (The)

5) JCM Industries, Inc.

6) Romac Industries, Inc.

7) Smith-Blair, Inc.; a Sensus company.

8) Viking Johnson; c/o Mueller Co.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Manufacturer's standard.

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. Dielectric Unions:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Hart Industries International, Inc.

4) Jomar International Ltd.

5) Matco-Norca, Inc.

6) McDonald, A. Y. Mfg. Co.

7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Pressure Rating: 150 psig at 180 deg F.

3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Matco-Norca, Inc.

4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Factory-fabricated, bolted, companion-flange assembly.

3) Pressure Rating: 150 psig.

4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

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

1) Advance Products & Systems, Inc.

2) Calpico, Inc.

3) Central Plastics Company.

4) Pipeline Seal and Insulator, Inc.

b. Description:

1) Non-conducting materials for field assembly of companion flanges.

2) Pressure Rating: 150 psig.

3) Gasket: Neoprene or phenolic.

4) Bolt Sleeves: Phenolic or polyethylene.

5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

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

1) Elster Perfection.

2) Grinnell Mechanical Products.

3) Matco-Norca, Inc.

4) Precision Plumbing Products, Inc.

5) Victaulic Company.

b. Description:

1) Electroplated steel nipple complying with ASTM F 1545.

2) Pressure Rating: 300 psig at 225 deg F.

3) End Connections: Male threaded or grooved.

4) Lining: Inert and noncorrosive, propylene.

~~2.4~~2.5 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

D. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

~~2.5~~2.6 CLEANOUTS

A. Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.
   c. MIFAB, Inc.
   d. Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group.
2. Standard: ASME A112.36.2M

3. Size: Same as connected branch.
4. Type: Cast-iron soil pipe with cast-iron ferrule.
5. Body or Ferrule Material: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with set-screws or other device.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

~~2.6~~2.7 THROUGH-PENETRATION FIRE-STOP ASSEMBLIES

A. Through-Penetration Fire-stop Assemblies:

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

   a. ProSet Systems Inc.

   b. 3M

   c. Hilti

   d. Or approved equal

2. Standard: UL 1479 assembly of sleeve and stack fitting with fire-stopping plug.
3. Size: Same as connected pipe.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

~~2.7~~2.8 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Solder: ASTM B 32, lead-free alloy.

F. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90

degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: Slope downward in direction of flow for piping as required by code and per authority having jurisdiction.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

O. Install underground storm drainage piping according to ASTM D 2321.

P. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Storm Drainage Piping Specialties."
2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Storm Drainage Piping Specialties."
3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Storm Drainage Piping Specialties."

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

U. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

V. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

X. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.

Y. Provide insulation on all storm drainage piping and fittings below roof.

3.3 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.4 PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, non-pressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:

a. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
3. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3 : 60 inches with 1/2-inch rod.
2. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
3. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
4. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
5. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet .

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2: 108 inches with 3/8-inch rod.

2. NPS 2: 10 feet with 3/8-inch rod.
3. NPS 2-1/2: 11 feet with 1/2-inch rod.
4. NPS 3: 12 feet with 1/2-inch rod.
5. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
6. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
7. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.9 STORM DRAINAGE SPECIALTY INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 Sections.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 6 inches above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at base of each vertical soil and waste stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install drain-outlet backwater valves in outlet of drains.

J. Install test tees in vertical conductors and near floor.

K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

M. Install through-penetration fire-stop assemblies in plastic conductors at concrete floor penetrations.

N. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

3.10 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.11 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 15-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.12 PIPE CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.13 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.14 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

C. Underground storm drainage piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.

~~1.~~2. Service class, cast-iron soil piping and fittings; gaskets; and gasketed joints.

~~2.~~3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

D. Aboveground storm drainage force mains shall be following:

1. Galvanized-steel pipe, pressure fittings, and threaded joints.
2. Fitting-type transition couplings if dissimilar pipe materials.

E. Underground storm drainage force mains shall be the following:

1. Ductile-iron, mechanical-joint piping and mechanical joints.
2. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

END OF SECTION

SECTION 23 09 23

DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

(Part of Work of Section 23 00 01 – MECHANICAL, Trade Bid Required)

PART 1 - GENERAL

1.1 CONDITIONS & REQUIREMENTS

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

B. All work shall comply with the requirements of the Conditions of the Contract (General and Special), with the Contract Drawings, and with all other contract documents.

C. Any deviations from the requirements of the Contract Documents must be submitted in writing along with bid documents.

1.2 RELATED DOCUMENTS

A. In case there is a discrepancy between this specification and Division 21, Division 22, Division 23, Division 26 and Division 28 specifications and their associated drawings, then the Bidder shall assume the more stringent requirement for his bid.

1.3 SUMMARY

A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

1.4 SCOPE OF WORK

A. Control Contractor shall:

1. Provide installations of controllers and instruments provided by system and device manufacturers for equipment monitoring and control as herein specified. The scope shall include controllers, microprocessor-based controller unit panels, instrumentation, end control devices, wiring, conduit, and related systems integration as follows:
   a. Dedicated Outside Air Units

b. Supply / Exhaust Fans
c. Electric Unit Heaters
d. DX Split Systems
e. Air Handling Units (AHU)
f. Exhaust Fans
g. Roof Mounted Water Tank System
h. Heating Hot Water System
i. Water Meters
j. Programmed Start-Stop of Systems
k. Monitoring and controlling of Space Conditions
l. Alarm Annunciation.

2. Provide a required DDC control system hardware along with sensing devices, control valves, dampers and actuators as specified herein.
3. Provide a complete operational system including all work specified herein, specified in associated specifications for mechanical and electrical work and shown on all contract drawings.
4. The Contractor shall assume all control points referred to in this specification as well as the specifications in Division 23 and Division 26. The contractor is also responsible for all instrumentation and controls shown on the controls drawings, Division 23 and Division 26 drawings.
5. The BMS system shall provide equipment supervision and control, alarm management, energy management, information management, historical data collection and archiving and be capable of integrating multiple building functions.
6. The system shall employ standard networking practices and conventions, co-exist with existing Ethernet networks, and manage system data using generally accepted database storage and retrieval methods and standards.
7. Provide all wiring, raceways and electrical work associated with the BMS. This shall include and to be limited to the following:
   a. Controls wiring and conduit between control panels.
   b. Controls wiring and conduit between control panels and field instrumentation, external equipment control systems
   c. Wiring and conduit for the BMS communication networks.
8. Provide all electrical work associated with the BMS.
9. Provide all wiring in accordance with the latest editions of the local electrical code and the NEC.
10. Divisions 26 to provide dedicated circuits as required, refer to Division 26 drawings for junction box locations. Controls contractor to provide transformers and field terminations.
11. Incorporate surge transient protection into the design of the system to protect the electrical components in all DDC controllers, TECs, panels and workstations.
12. Provide control power transformers for valve actuators, damper actuators and all instruments and devices provided under this contract for low voltage operation.
13. Provide all wells for water monitoring devices, temperature sensors, flow switches and alarms, as required.
14. Furnish control dampers actuators not integral to damper factory assemblies. Furnish damper actuators meeting or exceeding the specifications, listed in the associated sections and located as shown on all drawings. Coordination is

required with Division 23, regarding the installation, final sizing and method of fixing and delivery of the dampers.

15. Provide system graphics for each system. See section herein for requirement.
16. Provide engineering and shop drawings as specified herein.
17. Provide field supervision of the associated elements of work as specified herein.
18. Provide mechanical installation of all control instrumentation etc. as specified herein.
19. Provide testing, calibration and commissioning as specified herein.
20. Provide demonstration of operation and system performance testing as specified herein.
21. Provide as-built drawings as specified herein.
22. Provide Operation and Maintenance manuals as specified herein.
23. Provide Personnel Training as specified herein.
24. Provide attendance and support during the commissioning of the project to Divisions 23 and 26, as required by the coordinated commissioning program.
25. With commencement of the project provide test procedure documents (TPD) describing the testing of all interfaces between the BMS and other systems for approval by the Owner, the Engineer and the Management Contractor.

1.5 DEFINITIONS

A. Explanations of terms utilized in this Specification:

1. Provide: Furnish and install, complete, the specified material, equipment or other item and perform all required labor to make a finished and acceptable installation.
2. Furnish: Purchase, store and deliver the specified material, equipment or other item to the project site complete with all necessary appurtenances, supports, etc.
3. Install: Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.
4. By others: By persons or parties responsible for work at the project other than the party or parties who have been awarded the contract for the work of this trade. In the event that this document is used to acquire work as part of a general construction contract, the words "by others" or "by other trades" shall mean by persons or parties who are not anticipated to be the Contractor for this trade working together with the Construction Manager (CM). In this context, the words "by others" or "by other trades" shall not be interpreted to mean not included in the overall contract.
5. Ductwork: Ductwork, volume dampers, motorized dampers, fire and smoke dampers, diffusers, registers, supports and all other items required for a complete functional system.
6. Piping: Piping, valves, strainers, supports and all other items required for the circulation of water to and from HVAC equipment.
7. Concealed: Embedded in masonry or other construction, installed behind wall furring, within double partitions, above inaccessible ceilings, in crawl spaces, in shafts, etc.
8. Exposed: Not concealed.

1.6 RELATED WORK

A. Related Documents and Sections: Examine Contract Documents for requirements that directly affect or are affected by Work of this Section. A list of those Documents and Sections include, but is not limited to the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 General Requirements Specification Sections, apply to this Section.
2. Other Related Sections:
   a. All Division 21 Equipment Sections
   b. All Division 22 Equipment Sections
   c. All Division 23 Equipment Sections
   d. All Division 26 Equipment Sections
   e. All Division 28 Equipment Sections

1.7 COORDINATION

A. Coordinate work under provisions of Division 1 as applicable.

B. Ensure installation of components is complementary to installation of similar components in other systems.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

D. Contractor to coordinate all BMS integrations, inputs and outputs to systems and equipment with final approved submittals. Integration to devices, controllers and systems requiring special programming, hardware, network switches, gateways and wiring to perform interface or integration shall be provided by the controls contractor. All IP based equipment, including network switches, shall be submitted for review and coordinated with owner’s IT for approval.

E. Ensure system is completed and commissioned.

F. Division 23 - BMS Contractor shall be responsible for all electrical work associated with the BMS control system as detailed below.

1. Perform all wiring in accordance with all local and national codes. Refer to Division 26, Electrical Specifications for areas requiring more stringent installation procedures.
2. Provide 120-volt branch circuits from junction boxes to DDC panels.
3. Provide 120VAC for all instruments, valves, dampers, and control devices requiring 120VAC supply. All work shall be installed in accordance with Division 26.
4. Provide 24-volt power, control and network interface wiring from network DDC controllers and panels to all application specific controllers (VAVs, TECs etc.), local display devices through end control devices, complying with requirements of Division 26.

5. BMS shall monitor fire alarm system control relays responsible for equipment shutdowns and stop normal operations in order to prevent the potential of nuisance alarms during fire related events. Provide BMS internal logic to parallel to fire alarm system smoke shutdown for variable frequency drive and motor starters related to emergencies as well as fire alarm system duct mounted smoke detectors according to local code requirements.
6. Provide transformers, where required, to match control voltage with actuator or sensor voltage.

G. The Division 23, Mechanical Contractor shall provide the following:

1. All openings and pressure taps for water monitoring devices, flow switches, control valves and wells furnished by the BMS Contractor.
2. Installation of all dampers and measuring devices. All control dampers shall be furnished by BMS Contractor where not specified as an integral component of a packaged unit.
3. Furnish and install all access doors.
4. Items furnished by BMS Contractor but installed by Sections of Division 23, Mechanical Contractor:
   a. Flow elements directly installed in the piping or ductwork, such as airflow measuring inlet probes, magmeters, pressure switches and thermowells.
   b. Automatic control valves.
   c. Control dampers.

H. The Division 26, Electrical Contractor shall provide the following.

1. Wiring of power feeds through all disconnects, starters, and to electric motors.
2. Division 26 contractor to provide all line voltage 120 VAC power wiring from electrical panels to junction boxes for the purpose of powering control panels. Junction boxes to be provided by Division 26 and shall be wired in conduit from dedicated circuits. Division 26 shall provide circuit breakers at all electrical panels for use by the BMS contractor.
3. Motor starters and motor feeder
4. If upon Div. 23 contractor's final sizing of control devices it has been determined that the power required for the assembly exceeds the power available from the BMS control panel, the Div.23 contractor shall coordinate with the Div. 26 contractor for additional power.

I. The Division 28, Fire Alarm System Contractor shall provide the following.

1. Wiring of power feeds through all smoke detectors.
2. Smoke detectors shall be furnished by Division 28 and installed by Division 23.
3. All necessary monitored relays and outputs to BMS for the purposes of alarming and smoke control functions and pressurization as required by BMS and described herein and on contract drawings.

1.8 REFERENCE STANDARDS

A. All work shall conform to the following Codes and Standards, where applicable:

1. National Fire Protection Association (NFPA) Standards, as specified.

2. National Electrical Code (NEC) and applicable local Electrical Code.
3. Underwriters' Laboratories (UL) listing and labels, as specified.
4. Factory Mutual (FM).
5. American National Standards Institute (ANSI).
6. National Electric Manufacturers' Association (NEMA).
7. American Society of Mechanical Engineers (ASME).
8. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
9. Air Movement and Control Association (AMCA).
10. Institute of Electrical and Electronic Engineers (IEEE).
11. American Standard Code for Information Interchange (ASCII).
12. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS).
13. Electronics Industries Association (EIA).
14. Occupational Safety and Health Administration (OSHA).
15. American Society for Testing and Materials (ASTM).
16. NFPA 92A and 92B
17. NFPA 101, 2002

1.9 GENERAL PRODUCT DESCRIPTION:

A. The building management system provided and installed shall be a distributed logic control system complete with all software and hardware functions.

1. The controllers shall be direct digital control (DDC) type and based on ANSI/ASHRAE Standard 135, BACnet controlling all mechanical equipment using BTL (BACNET Testing Labs) Certified native BACnet-compliant components.

B. The building management system shall consist of the following:

1. BMS Server (Existing Virtual)
2. Stand-alone DDC Controllers (32 bit processors) provided for each piece of main equipment. The intent of this specification is that the loss of any one DDC controller shall not affect the operation of more than one piece of main equipment while minimizing the impact on other equipment and HVAC systems. It shall only affect the points connected to the failed DDC controller. It is not acceptable that any control loops are split across two or more DDC control panels.
3. Stand-alone Terminal Equipment Controllers (TECs), otherwise referred to as Application-Specific Controllers (ASCs), shall only be used for terminal equipment.
4. One (1) Operator workstation comprises of a laptop serving as the operator's terminal to be connected and communicating simultaneously with the entire BMS. The operator terminal shall be able to monitor, adjust, trend, edit, modify, add, delete, backup the entire BMS system (including Terminal Equipment Controllers, DDC controllers, etc.) point database and all programs, provided the operator has the appropriate password access.

C. The system shall be modular in nature and permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.

D. Controllers shall assign password access and control priorities to either fully assignable point groups or each point individually. The logon password (at PC workstation) shall enable the operator to monitor, adjust and/or control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation. (E.g. all base points shall be accessible to any base building operators, but only electrical points shall be accessible to house electricians). Passwords and priority levels for every point shall be fully programmable and adjustable.

E. The BMS system shall operate with an input voltage rated at 120 Volts, 1 phase, 60 Hertz. All units shall be grounded in accordance with the local Electrical Code and the NEC. All units shall be supplied with filtered power, if required, to preclude noise generation. Signal range shall be 4-20 mA or 0-10 VDC.

F. The BMS shall be programmed to automatically detect critical alarms that require notification, create an action statement for each alarm, and select the person to receive the notification via e-mail or SMS text message. Software shall transmit email via Owner's existing SMTP server. SMS messages shall operate with any mobile phone carrier.

G. The control system shall be a high speed, peer to peer BACnet network of DDC controllers and a web based operator interface. All schedules, setpoints, trends, and alarms shall be BACnet objects.

H. Workstation information access shall be BACnet protocol. Communications shall use ISO 8802-3 (Ethernet) Data Link/ Physical layer protocol.

1.10 SUBMITTALS

A. Submissions Requirements:

1. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
2. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.
3. The following table defines the required submittals and hierarchy for time of submission:

Action Submittals		
Submittal #	**Submittal Name**	**Pre-requisite for Review**
1	Submittal Schedule	None
2	Qualification Data	None
3	Specification Compliance Submittal	1
4	Product Data for DDC system	3
5	Individual sensor/device product data	3
6	BTL listing submittal	3
7	Software submittal	3

8	Valve, Damper, and Actuator Delegated Design	3
9	Shop Drawings	3
10	Interface Control Documents	4
11	System Description	4,5 and 10
12	Sample Package (graphics and visible sensors)	4 and 9
13	Closeout Submittal Package	10, 11, and 12

4. Multiple and large Submissions:
   a. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
   b. In instances when large or multiple submittals are provided with a single submission, the time period for review will be extended and the release of submittals will be coordinated based on contractors' priority for release of equipment. Allow 3 weeks for large submittals.
5. Submit under provisions of Section 01 3300 – SUBMITTAL PROCEDURES and Division 01 as applicable. Shop drawings to be provided in PDF Format.
6. All submittals to be digital and searchable. Scanned submittals are not acceptable.
7. General Contractor comments must be actioned on submittal before submitting to the engineer for review.
8. Submit shop drawings for each system automatically controlled and integrated. The submittals shall be provided with a comprehensive index and each page of the submittal shall be provided with a page number, drawings shall have a drawing / sheet number, date and revision. Revisions of submittals if required shall provide necessary revision clouding of affected areas on all drawings resubmitted. Drawing submittals shall comprise, at a minimum the following information:
9. Prepare Drawings using computer software, and provide digital copies to owner.
10. Scanned drawings are not acceptable.
11. Title page with submittal title, job name and address, date, contract drawing and specification information (i.e. latest bulletin number and date), and BMS contractor project manager name and phone number, at a minimum.
12. Include a drawing index sheet listing each drawing number and title that matches information in each title block. Include plans, elevations, sections, and mounting details where applicable.
13. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
14. Detail means of vibration isolation and show attachments to rotating equipment.

B. Compliance Review

1. Contractors will provide a Compliance Review of the Specifications, Drawings and Addenda (if any). The Compliance Review is a paragraph-by-paragraph (Drawing by Drawing) review of the Specifications and Drawings with the following information, "C", "D" or "E" marked in the margin of the original

Specifications and any subsequent Addenda. Narrative text shall accompany the Drawing Compliance Review.

a. "C": Comply with no exceptions.
b. "D": Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
c. "E": Exception, do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives.
d. Note: Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Bidder is in complete compliance with the plans and Specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the contractor from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review. The Bidder may submit the latest state-of-the-art components in lieu of specified items. The engineer and Owner will review deviations from the Specifications.

C. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:
   a. Loss of power.
   b. Loss of network communication signal.
   c. Loss of controller signals to inputs and outpoints.
   d. Operator workstation failure.
   e. Server failure.
   f. Gateway failure.
   g. Network failure
   h. Controller failure.
   i. Instrument failure.
   j. Control damper and valve actuator failure.
4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

D. Plan Drawings

1. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
2. Room names and numbers with coordinated placement to avoid interference with control products indicated.
3. Each desktop operator workstation, server, gateway, network switches, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.

4. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
5. Network communication cable and raceway routing.
6. Information, drawn to scale.
7. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.

E. Schematic drawings

1. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve.
2. I/O listed in table format showing point name, type of device, manufacturer, model number, point address, and cross-reference to product data sheet number. Table to clearly differentiate between analog and digital, input and output points as well as all serial integration (soft points). An allowance for future point integration shall be made to ensure any points found to be necessary during commissioning and start-up can be added.
3. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
4. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
5. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers. Indicate all required electrical wiring of connected data points, including connected control unit and input device, field control panel layout and locations, and parts list coordinated with power panel locations. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
6. A contractors written sequence of operation for all systems, with specific IO reference by name and number.

F. Control Panel Drawings

1. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
2. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
3. Unique drawing for each panel.

G. System Network Riser Diagram

1. Each device connected to network with unique identification for each.
2. Interconnection of each different network in DDC system.
3. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
4. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

H. Power Riser Diagram:

1. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
2. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
3. Each product requiring power with requirements (volts/phase/ hertz / amperes/ connection type) listed for each.
4. Power wiring type and size, race type, and size for each.
5. Descriptive data and sequence of operation of operating, user, and application software.

I. Valve and Actuator Schedule

1. Valve Schedule and design calculations for control valves, and actuators.
   a. Valve Tag.
   b. Valve Service.
   c. Line Size.
   d. Valve Type.
   e. Valve Size.
   f. Pipe connection style.
   g. Flow (with Units) at Project design and minimum flow conditions.
   h. Pressure-differential drop across valve at Project design flow condition.
   i. Valve authority at design conditions.
   j. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
   k. Design and minimum control valve coefficient with corresponding valve position.
   l. Coil Pressure Drop (approved equipment)
   m. Design Pressure
   n. Maximum close-off pressure.
   o. Leakage flow at maximum system pressure differential.
   p. Torque required at worst case condition for sizing actuator.
   q. Valve model and manufacturer.
   r. Actuator operating voltage.
   s. Actuator position feedback or end switches.
   t. Actuator selection indicating torque provided.
   u. Actuator signal to control damper (on, close or modulate).
   v. Actuator position on loss of power.
   w. Actuator position on loss of control signal.
   x. Actuator model and manufacturer

J. Damper and actuator schedule

1. Schedule and design calculations for control dampers, and actuators.
   a. Flow at Project design and minimum flow conditions.
   b. Pressure-differential drop across damper at Project design flow condition.
   c. Maximum close-off pressure.
   d. Leakage flow at maximum system pressure differential.
   e. Torque required at worst case condition for sizing actuator.
   f. Actuator operating voltage.
   g. Actuator selection indicating torque provided.

h. Actuator signal to control damper (on, close or modulate).
i. Actuator position feedback or end switches.
j. Actuator position on loss of power.
k. Actuator position on loss of control signal.
l. Actuator model and manufacturer

K. Interface Control Documents

1. For each subsystem being integrated into the BAS system (VFDs, lighting controls, chillers, etc.) the contractor shall submit a complete interface control document, coordinated with the approved 3rd party submittals, detailing at a minimum:
   a. Communication type
   b. Connection point
   c. All input and output capability between the two systems
   d. Connection coordination with 3rd party

L. Product Data

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Documentation on submitted BMS controllers that have been tested and listed by the BTL or a letter from manufacturer's indicating the anticipated date by which testing is expected to be complete. If for any reason, BTL testing and listing has not been completed, a written commitment shall be provided to upgrade installed controls to a version that meets BTL testing and listing requirements should deficiencies be found during BTL testing.
5. Installation, operation and maintenance instructions including factors effecting performance.
6. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product. A complete index shall be provided with page numbering included on each product sheet.
   a. Servers.
   b. Workstations.
   c. Gateways.
   d. Network Switches and Routers.
   e. Protocol analyzers.
   f. BMS controllers.
   g. Enclosures.
   h. Electrical power devices.
   i. UPS units.
   j. Accessories.
   k. Instruments.
   l. Control dampers and actuators.

m. Control valves and actuators.

7. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
8. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

M. Software Submittal

1. As part of the submittal package, the contractor shall include a complete copy of specifications, with confirmation of conformance to all specifications. In the case of non-conformance, the contractor shall specifically highlight the specification section of non-conformance.
2. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, network switches and DDC controller.
3. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
4. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
5. Description of operator interface to alphanumeric and graphic programming.
6. Description of each network communication protocol.
7. Description of system database, including all data included in database, database capacity and limitations to expand database.
8. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

N. Samples:

1. For each of the following exposed product, installed in finished space for approval of selection of aesthetic characteristics including all proposed space temperature, humidity, CO2, pressure, and occupancy sensors for review and written approval by owner’s representative.
2. Provide sample of label to be provided for each control device with setting or adjustable range of control for written approval by Owner’s Representative.
3. Provide sample(s) of proposed graphic for review and written approval by Owner’s Representatives. Graphic samples must be included as part of the original shop drawing submittal package for owner and engineer to review.

O. Color graphics

1. Itemized list of color graphic displays to be provided.
2. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
3. Intended operator access between related hierarchical display screens.
4. Graphical interface capability
5. System graphics and inclusive of a master organizational plan.

1.11 CLOSEOUT SUBMITTALS

A. Factory Testing Results

1. Submit for approval test reports from the factory program testing procedures.

B. Final Graphic Submittal

1. Submit for approval final graphic samples of all system types (AHU's,VAV's, energy management, integrated systems, etc.).

C. Sensor Calibration Report

1. Submit for approval, a detailed report of the sensor calibration process. The report shall consist of both testing procedures and testing results. Any sensor that has been factory calibrated shall have the factory calibration report included in the calibration submittal.

D. DDC System I/O Checkout Report

1. Submit for approval, a detailed report highlighting the process and results as described in section, "DDC SYSTEM I/O CHECKOUT PROCEDURES".

E. As-built documentation

1. Submit for approval, as-built versions of shop drawings and product data in electronic PDF format. The as-built drawings, drawings, sequences, and products shall accurately reflect every change made to the system operation since approval of the shop drawings. Accurately record actual location of control components, including panels, thermostats, and sensors

F. System readiness confirmation

1. Submit for approval written confirmation of system readiness for testing as defined in section "Final Review".

G. Validation test report

1. Submit for approval all procedures and results as described in section "DDC System Validation Tests".

H. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
   a. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
   b. As-built versions of submittal Product Data.
   c. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
   d. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports,

trending data, overriding computer control and changing set points and variables.

e. A complete alarm list, with criticality levels, and distribution assignment.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to:
   1) Design and install new points, panels, and other hardware.
   2) Perform preventive maintenance and calibration.
   3) Debug hardware problems.
   4) Repair or replace hardware.
h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Submission of actual programming language used for each system type.
j. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
k. List of recommended spare parts with part numbers and suppliers.
l. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
m. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
n. Licenses, guarantees, and warranty documents.
o. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
p. Owner training materials.

1.12 QUALIFICATIONS / QUALITY ASSURANCE

A. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the Specification requirements.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of DDC control equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 10 years. The manufacturer shall be ISO 9000 certified.

C. Installer's Qualifications: Company specializing in applying the work of this Section with minimum ten years documented experience and approved by manufacturer.

D. Install system using competent workmen who are fully trained in the installation of temperature control equipment, and are direct employees of the controls installer. Installing wholesalers, franchisers, dealers, distributors are not acceptable. Electrical subcontractors for the installation of distribution wiring and power are acceptable.

E. Single source responsibility of BMS Contractor to include complete software, graphics installation and proper operation of the control system, debugging, and proper calibration of each component in the entire system. Third party software/programming and graphics package is not acceptable.

F. BMS Contractor shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment for a period of not less than 10 years.

G. Manufacturers shall submit evidence of electric and DDC parts availability through authorized parts wholesaler at time of bid.

H. Commissioning of a system or systems specified in this section is part of the construction process which includes documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel.

I. Quality Assurance Program

1. The BMS Contractor shall implement a Quality Assurance Program. At minimum, this program shall consist of the following requirements.
   a. The BMS Contractor shall assign a single individual to serve as the Quality Assurance Manager, who is responsible for the management of the program.
   b. The Quality Assurance Manager shall provide or maintain
      1) Documentation of training for employees-including office, field, and subcontractors- on the Quality Assurance Program.
      2) Written verification that each worker on the project has read the Specification sections outlining the project requirements for his or her area of specialty. The initial project team shall be documented in the first project submittal.
      3) A detailed audit trail for all Quality Assurance issues, including: problem ID number, date of original problem report, name of individual initiating report, and individual assigned responsibility for resolving the problem.
   c. Each individual team member shall be responsible for identifying and reporting Quality Assurance problems and for assisting, as requested by the Quality Assurance Manager, in the resolution thereof.

1.13 PRE-INSTALLATION CONFERENCE

A. Convene a conference one week prior to commencing work of this Section, under provisions of General Conditions and Division 1 as applicable.

B. Require attendance of parties directly affecting the work of this Section.

1.14 EXTRA MATERIALS

A. Submit maintenance materials under provisions of General Conditions and Division 1 as applicable.

B. Provide spare parts list.

1.15 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.
5. Provided they are available at a cost satisfactory to the owner warranties of unlimited duration.

1.16 CODES AND APPROVALS

A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local and state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with current editions in effect 90 days prior to receipt of bids of the following codes. All products of the DDC system shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products shall be provided. Systems or products not currently offering the following approvals are not acceptable.

1. NEMA standards pertaining to components and devices for DDC control systems.
2. NEMA EMC1 - Energy Management Systems Definitions.
3. Requirements of NEC pertaining to installation of DDC control systems, including, but not limited to, remote-control, signaling and power-limited circuits.
4. Provide DDC control system components and ancillary equipment which are UL-listed and labeled.
5. The BMS system shall be UL916PAZX listed.
6. Federal Communications Commission (FCC) Rules, pertaining to components and devices for DDC control systems and Section 15 governing radio frequency electromagnetic interference and be so labeled
7. Electronic Industries Association (EIA) Std RS-232 pertaining to interfacing requirements for connecting data terminals and communication equipment.
8. IEEE Std 488, "Standard Digital Interface for Programmable Instrumentation", for interfacing instrumentation into system.
9. ANSI X3.4, "Code for Information Interchange", requirements for interfacing computer data processing with communication terminal equipment.
10. ASME MC85.1 - Terminology for Automatic Control

B. The following current NFPA and ASHRAE Standards and Guides are applicable.

1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences
2. NFPA 90B Warm Air Heating, Air Conditioning
3. NFPA 92A, Recommended Practice for Smoke-Control Systems
4. NFPA 92B, Guide for Smoke Management Systems in Malls, Atria, and Large Areas
5. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning
6. ASHRAE 135 - Building Automation and Control Networks (BACnet)

C. All system components are to be designed and built to be fault tolerant.

1. Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at +3 hertz variation in line frequency.
2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be AC. coupled, or equivalent so that any single failure will not disrupt or halt bus communication.

1.17 WARRANTY

A. The system, including all hardware, software and workmanship, shall be guaranteed for a period of one (1) year from the date of final acceptance. Any manufacturing defects arising during this warranty period shall be corrected at no cost to the Owner. Warranty shall include one complete heating and cooling season.

B. All applicable software, as detailed in this specification, shall be updated by the BMS contractor free of charge during the warranty period to insure that the system software is the most up-to-date software available, for the system hardware installed, at the end of the warranty.

C. The system shall be free from defects in installation workmanship for a period of one year from acceptance. The BMS Contractor shall, free of charge, correct any defects in workmanship within one week of notification in writing by the Owner.

D. All corrective software modifications made during the warranty service period shall be updated on all user documentation and on user and manufacturer archived software disks.

1.18 TRAINING

A. Provide five (5) full days of training on site.

B. The BMS Contractor shall provide instructors to give full instructions to designated personnel in the adjustment, operation and maintenance of the system installed. Instructors shall be thoroughly familiar with all the aspects of the subject matter they

are to teach. All training shall be held during the normal work hours of 8:00am to 4:30pm weekdays.

C. Training shall include but not limited to:

1. Explanation of drawings and operations and maintenance manuals.
2. Walk thru of the job to locate control components.
3. DDC Controller and TEC (ASC) operation.
4. Explanation of adjustment, calibration and replacement procedures.

D. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory, authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Construction Manager after submission and approval of formal training plans.

1.19 TECHNICAL PROPOSALS

A. Technical proposals shall be prepared in accordance with these specifications. Two (2) copies of the proposal shall be submitted to the owner, general contractor, and consulting engineer at time of bid. Proposals that are unbound, loose, in a file folder, stapled, stapled in a manila file folder, etc., will not be acceptable. The technical proposal shall include the following data/information as a minimum. The order of listing here is not intended to indicate, nor should it be construed to indicate, the relative importance of the data/information:

1. Information on organizational capability to handle this (project management, personnel, manufacturing, single source responsibility, etc). Including contact references.
2. Information on training program to demonstrate specification compliance.
3. System Configuration as proposed including technical data to support the information below:
    a. Describe system architecture including a schematic layout with location and type (model number) of all DDC control panels.
    b. Describe system operation, functions and control techniques.
    c. Modularity.
    d. Provisions against obsolescence due to technological advancement.
    e. Provide hardware and software data sheets on system interfaces and integration requirements.
4. Detailed description of all operating, command, application, and energy management control software provided for this project.
5. A written guarantee of how long the system proposed will be a standard product and backed by ongoing parts availability and factory trained field support.
6. A signed certificate stating the Contractor has read the performance and functional requirements, understands them and his technical proposal shall comply (line by line conformance) with all parts of the specification. (Concordance Summary-).

7. Supply with the proposal a recommended spare parts listing, which the Owner should maintain at the site, with the associated costs of each part. Contractor shall provide lists for both warranty period spare parts requirements as well as spare parts needed beyond the warranty period. Spare parts shall be made available for 10 years beyond warranty period.
8. Proposal will provide a Compliance Review of the Specifications, Drawings and Addenda (if any). The Compliance Review is a paragraph-by-paragraph (Drawing by Drawing) review of the Specifications and Drawings with the following information, "C", "D" or "E" marked in the margin of the original Specifications and any subsequent Addenda. Narrative text shall accompany the Drawing Compliance Review.
   a. "C": Comply with no exceptions.
   b. "D": Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
   c. "E": Exception, do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives.
   d. Note: Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Bidder is in complete compliance with the plans and Specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the contractor from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review. The Bidder may submit the latest state-of-the-art components in lieu of specified items. The engineer and Owner will review deviations from the Specifications.
9. Information on the maintenance during warranty period.
10. Information on service contract.

B. Submit technical proposals with pricing in accordance with the Instructions to Bidders.

PART 2 - PRODUCTS

2.1 ACCEPTABLE BMS MANUFACTURERS / PRODUCT LINE

A. Alerton - BACtalk

2.2 ACCEPTABLE INSTALLERS/INTEGRATORS

A. Installers/Integrators: Company specializing in applying the work of this section with minimum 10 years documented experience approved by the manufacturer and determined acceptable following a review of pre bid qualification package.

2.3 ENVIRONMENT

A. All equipment detailed in this specification or other equipment associated with the BMS shall be capable of operation in the following conditions without detriment to the equipment.

1. 0-45°C (32°F – 113°F)
2. 0-95% RH

2.4 NETWORKING COMMUNICATIONS:

A. The design of the BMS shall network the operator workstations, DDC and TEC Controllers all communicating via BACnet. The network architecture shall consist of two levels, a primary high performance Building Level Network (BLN) for all DDC controllers and operator workstations and a secondary, Floor Level Network (FLN) that connects TECs for terminal units.

B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.

C. Building Level Network

1. The operator workstation and DDC Controllers shall communicate on the BLN such that communications may be executed directly between DDC Controllers, directly between workstations and between DDC Controllers and workstations via a BACnet LAN.
2. All operator devices shall have access to all point status and application report data or execute control functions for any and all other devices via the BLN or FLN. Access to data shall be based upon logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to the network data.
3. BLN shall provide the following minimum performance:
   a. Provide high-speed data transfer rates for alarm reporting, report generation and upload/download network devices. System performance shall insure than an alarm occurring at any DDC Controller is displayed at the PC workstation or other DDC controllers or alarm printers within 5 seconds.
   b. Support of any combination of DDC Controllers and operator workstations directly connected to the BLN. A minimum of 30 devices shall be supported on a single BLN.
   c. Message and alarm buffering to prevent information from being lost.
   d. Error detection, correction and re-transmission to guarantee data integrity.
   e. Synchronization of real-time clocks between DDC Controllers, including automatic daylight savings time corrections.
   f. All network wiring between DDC Controllers and DDC Controllers and operator workstations shall be in conduit (as a minimum).

g. The BLN shall allow the DDC Controllers to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall send alarm reports to multiple operator workstations without dependence upon a control or intermediate processing device. The peer-to-peer network shall also allow any DDC controller to access, edit, modify, add, delete, back up, restore all system point database and all programs.

h. The BLN shall allow the operators to assign password access and control priorities to each point individually. The logon password (at any PC workstation) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation. (e.g. all base building points shall be accessible to any base building operators, but only electrical points shall be accessible to house electricians). Passwords and priorities for every point shall be fully programmable and adjustable.

D. Floor Level Network

1. This level communication shall support a family of Terminal Equipment Controllers and shall communicate be-directionally with the BLN through DDC Controllers for transmission of global data via a BACnet LAN.
2. Terminal Equipment Controllers shall be arranged on the FLN in a functional relationship manner with DDC Controllers.

E. Web Browser Interface

1. The web browser shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser. The web browser shall provide for Navigation and Action for display of animated colorgraphics, schedules, alarms/events, live graphic program, active graphic setpoint controls, configuration menus for operator access, reports, trends, reporting actions for events.
2. On launching the web browser and selection of appropriate domain name of IP address, the operator shall be presented with a login page that will require a login name and password. Navigation of the system shall dependent on the operator's security access privileges.
3. Provide remote alarm notification utilizing e-mail and SMS text messages.

2.5 DDC CONTROLLER

A. Controllers shall be complete with uninterruptible power supplies (1/2 hour rated), a real time clock, input and output modules, memory, processors and all other items necessary for proper and correct interfacing and operation of the control functions described in this Specification.

B. All controllers shall have peer-to-peer communications. All controllers shall have a standalone capability such that a failure of the operator's station shall still permit the

plant and controls associated with the controllers, to continue to operate normally with the controllers continuing to communicate with one another.

C. In the event of transmission failure in the controller network the controllers shall continue to operate with all sequence interlocks and control strategies operating normally except those that require global information. Either user adjustable default values or the last sensed value (user selectable) shall then be assumed for these global parameters.

D. Controllers shall be able to provide the operator's station with status information concerning their internal operations. This information shall include, but not be limited to:

1. Data transmission and verification.
2. Input/output point status (i.e. sensor fault, point forced, etc).
3. Program status (i.e. program error, program running, etc).
4. Internal battery condition.

E. All necessary interfacing equipment shall be provided so that the controllers are fully compatible with all items of plant and equipment.

F. The controller shall be capable of accepting binary, analog, pulsed inputs and providing binary and analog outputs as necessary to meet application requirements.

1. Binary input - Shall monitor the change of state of a dry contact.
2. Pulsed input - Pulses (dry contact closures i.e. binary type input) originating typically from flow meters, electrical kWh or kVA meters, etc. and shall be accumulated into registers. A register shall be resettable to zero either by software or operator command. The input must be able to accept pulses up to a frequency of 10Hz with a minimum duration of 50ms. All counts must be stored in a non-volatile register so the count value is not affected by a power failure.
3. Binary output - A dry contact. Contact ratings shall be coordinated with the equipment being controlled.
4. Analog inputs - Analog to digital conversion (ADC) with a minimum resolution of 1024 counts (10 Bit) over the input range (i.e. 0-10V, 2-10V, 0-20mA, 4-20mA etc.) of the sensor. The sensor range shall match the process control range. Any equipment necessary for the conversion of an input signal to the required input level shall be provided.
5. Analog outputs - Digital to analog conversion (DAC) shall be performed by the controllers with a minimum resolution of 256 counts (8 Bit) over the output range which shall also match the control range of the device and/or system being controlled. Any equipment necessary for the conversion of the output signal to the required process level (i.e. 0-10V, 2-10V, 0-20mA, 4-20mA etc.) shall be provided. Where analog outputs are specified driving damper and valve actuators, they shall not be used to drive raise/lower actuators through interface devices.
6. Universal inputs-Shall be configurable to either binary or analogue input and shall have the features defined above.

G. Hardware Override Switches: The operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, on-board hand/off/auto switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not. In lieu of onboard switches, switches may be flush mounted on a panel adjacent to the DDC panel.

H. Each controller or controller location shall be provided with spare hardware capacity for future additions of at least 15 percent of each type of point and 25% spare memory capacity for future connection. Universal inputs may be counted as either a spare digital or analog point, but not both. Note that this spare capacity may be accomplished by the addition of input/output modules. Memory shall also be sufficient to allow all programs associated with these points to be run in the controller. The Contractor shall state in his offer how many spare points are actually available on each controller or at each controller location and the expansion capability.

I. The controllers shall be provided with their own internal battery backup power supply, capable of maintaining all memory including the real time clock for not less than 72 hours. The battery shall be easily replaceable i.e. not soldered to the PCB. A capacitor-based alternate to maintaining memory and real time clock for not less than 72 hours shall also be acceptable.

J. Each analog input shall be calibrated (to compensate for non-linear characteristics of input devices, line resistance and similar items) to achieve an accuracy, of the displayed value on the operator's station, as detailed in this specification for each sensing device. Calibration and scaling data shall be retained in the controller memory. Open or closed circuits on sensor inputs shall be recognized by the controller and annunciated as alarms on the system operator's station(s).

K. It shall be possible to characteristics each analog output to an actuator in order to obtain a near-linear response from the device the actuator is controlling. This may take the form of a look up table with a minimum of 6 coordinates, such that the linear output from a control loop is converted into a non-linear control signal to the actuator.

L. The controllers shall be mounted in control panels, which shall meet the following environmental requirements:

1. Control panels located in heated areas shall be NEMA Type 1.
2. Control panels located in unheated areas or in areas subject to dust or oil shall be NEMA Type 12.
3. Control panels located in exterior areas or in areas subject to rain, dripping liquid, or hosing, including kitchen areas shall be NEMA Type 4X, stainless steel.
4. All installations shall provide necessary heating or cooling to support installed equipment based on local environmental conditions.

M. The controllers shall be constructed so that the control panels and internal terminal strips can be mounted, and electrical terminations made, with all electronics being added at a later date during the testing and commissioning.

N. DDC controllers shall be used for main HVAC equipment controls.

O. Power fail restart: In the event of a loss of normal power there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for critical control configuration data, including storage of controller firmware, controller application program, schedules, and the values of any setpoints, variables, constants, or other parameters which will not automatically be refreshed by the workstation or a peer device within 60 seconds of restoration of power. Battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual operation.

2.6 DDC CONTROLLER RESIDENT SOFTWARE FEATURES

A. All software relating to plant control and monitoring detailed in this Specification shall reside at controller or unitary controller level. Only management software shall reside at the operator station.

B. All programs shall be scanned every two seconds as a minimum.

C. Software shall include diagnostic routines that check hardware for correct operation. All hardware faults shall be annunciated on the operator’s station(s).

D. For further details see Device Schedule in this Specification.

2.7 TERMINAL EQUIPMENT CONTROLLERS (TEC)

A. Where a controller is used to monitor and control exhaust fans, FCUs, etc, they shall be classed as terminal equipment controllers (TECs).

B. TECs shall be either small freely programmable controllers or firmware application specific controllers, which shall be selected to meet the performance requirements of the Specification.

C. Each TEC shall meet the specified requirements of a controller except where specified to the contrary.

D. Each TEC shall have its application program, setpoints, limits and schedules etc., backed up on non-volatile memory or maintained via batter for a minimum of 2 years.

E. Real time clock functions are not essential where these commands are generated by other controllers, which shall also control the transfer of information to, from and between TECs on the same communications network.

F. Each TEC shall be interrogated and adjusted by an operator’s station that may plug into the network at any point.

G. Only input and output points necessary to meet the functional requirements of this specification are required to be supplied. The spare capacity requirement, as detailed in the section covering DDC Controllers, is not required.

2.8 Workstation / Laptop Computer

A. Provide a laptop computer and a full featured keyboard.

B. The laptop operator's terminal shall communicate to the Ethernet network or plug directly into individual DDC panels. Provide a user-friendly English language-prompted interface for quick access to system information.
   1. The Contractor shall supply the Notebook type PC computers, indicated on the Contract Drawings and as specified herein, that shall be capable of accessing all system data.
   2. Each laptop shall be purchased within 6 months of substantial completion of the Contract. Each notebook computer shall be Dell Precision 7680 or approved equal, with the following minimum requirements:
      a. CPU: Intel Core i9-13950HX, 24 Core / 32 Thread, 5.50 GHz, 36MB cache.
      b. Memory (RAM): 32GB 5600MT/s CAMM, non-ECC
      c. Graphics Card: NVIDIA RTX 2000 Ada, 8 GB GDDR6
      d. Hard Drive: 1TB Sold State Drive
      e. Wireless network card, Wi-Fi 6 compatible.
      f. Display: 16-inch display, FHD+, minimum 1920x1200 resolution.
      g. Integral touchpad, speakers, and webcam.
      h. External optical wireless mouse.
      i. Each notebook computer shall be supplied with a padded carrying case.
   3. Each notebook computer shall be equipped with the most recent issue of the following software:
      a. Microsoft Windows 11 operating system, latest version with latest service pack version.
      b. Microsoft Office, latest version.
      c. McAfee Antivirus, latest version
      d. DVD+RW and CD-RW "Roxio" editing software, latest version, and 10 blank DVD+RW DVDs.
      e. All software necessary for viewing CD-ROM O&M Manual.
      f. All utilities necessary for management of the network of controllers and devices.
      g. All BMS software and licenses necessary to perform all the all the monitoring, command and diagnostic functions required by a system operator or a service technician. Usage shall be controlled by License Keys installed on the notebook computer.
   4. Laptop is to be used for System Monitoring and System Maintenance shall be equipped with the latest version of the following software:
      a. All BMS software necessary to perform all the monitoring functions specified herein.
      b. All BMS software necessary to perform all the monitoring, command and data management functions required by the OWS.

c. All utilities necessary for management of the network of controllers and devices.

2.9 SECTION NOT USED. ~~Building Management System Server - Rack Mounted:~~

~~A. BMS server shall be provided for information management, network alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater fault tolerance and reliability.~~

~~B. Contractor shall provide a wall mounted or free standing rack for mounting server and install server according to server manufacturer's recommendations.~~

~~C. The Contractor shall supply the Server indicated on the Contract Drawings or specified herein. The Server shall be an IBM compatible, blade type computer no larger than 2U.~~

~~D. Each Server shall have Server a hard drive capacity sufficient to store all data collected by the system for one calendar year, and device for transferring data and programs onto an external hard drive or USB memory key.~~

~~E. Each Server shall be purchased within 6 months of substantial completion of the Contract. Each Server shall be Dell Precision Rack 7910 Workstation Series or approved equal, with the following minimum requirements (hardware shall be the latest version available at time of purchase):~~

~~1. Processor: Intel Xeon Gold 5218, 16 Core / 32 Thread, 2.30 GHz, 22MB Cache.~~
~~2. Memory (RAM): 32GB, DDR4-2666MHz.~~
~~3. Solid State Drive (Boot): 512GB Solid-State Drive.~~
~~4. Hard Drive (Storage): 10TB 7200 RPM SATA Hard Drive 6.0 Gb/s~~
~~5. Integrated Network Adapter: 10/100/1000 Ethernet.~~
~~6. Power Supply: 550W (minimum), 80 Plus Platinum.~~
~~7. Operating System Windows Server, 64Bit, English, or as required by BMS software packages.~~
~~8. Rack-mounted console with 19" LCD display, full 88-key keyboard and touch. Console shall be within 1U rack-mountable housing.~~
~~9. All necessary serial, parallel, and network communication ports and all cables for proper system operation.~~
~~10. Contractor shall supply two (2) 64 GB (minimum) USB 3.0 Flash Drives.~~

~~F. Each Server is to be used for System Monitoring and System Maintenance shall be equipped with the latest version of the following software:~~

~~1. All BMS software necessary to perform all the monitoring functions specified herein.~~
~~2. All BMS software necessary to perform all the monitoring, command and data management functions required by the Server.~~
~~3. All utilities necessary for management of the network of controllers and devices.~~

2.10 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire size shall be at least 14 AWG and meet all electrical local code requirements and in accordance with Div 26 requirements. AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
4. Conductor colors shall be black (hot), white (neutral), and green (ground).
5. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable 24 V and Less:

1. Wire size shall be a minimum No. 18 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

C. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Cable shall be plenum rated.
2. Cable shall comply with NFPA 70.
3. Cable shall have a unique color that is different from other cables used on Project.
4. Copper Cable for Ethernet Network:
   a. 100BASE-TX.
   b. TIA/EIA 586, Category 5e or Category 6.
   c. Minimum No. 22 AWG solid.
   d. Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP).
   e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

D. UNINTERRUPTABLE POWER SUPPLY

1. The following equipment shall be provided with uninterruptible power supplies:
   a. BMS Control Panels
   b. BMS Workstation.
   c. Servers
   d. Gateways and network switches

2. Uninterruptible power supply (UPS): provide a self-contained UPS designed for installation and operation sized for at least 125% of the peak demand, and to provide a minimum of 15 minutes of full operation of the controller and input/output expansion modules connected to that controller.
3. Equipment connected to the UPS shall not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS.
4. Each UPS shall be wired such that primary power to the controller will be maintained upon failure of the UPS, including either a relay switch upstream of the UPS or two UPSs in parallel.
5. UPS shall be complete with necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power.
6. UPS shall be provide an alarm contact for monitoring by the BAS of UPS general alarm inclusive On Battery, Low Battery and UPS Shutdown.
7. UPS shall be provided with means for integration for monitoring of general alarm including battery failure.
8. BMS workstation, UPS, and gateways/network switches shall be complete with uninterruptible power supply capable of running all hardware for a period of 1/2 hour.
9. Manufacturer
    a. Sola SDU Off-Line DIN Rail HeviDuty UPS Series
    b. Schneider Electric Smart-UPS SUA500PDR
    c. or equal

2.11 WORKSTATION OPERATOR INTERFACE

A. Basic Interface Description

1. Provide scaled floor plans (Auto Cad or approved equivalent) indicating equipment location, service, and system data as required by the Owner. Graphics to incorporate integrated points communicated via BMS. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
2. All graphics to include dynamic screen link points for the following as a minimum;
    a. Manufacturer cut sheets files, either in PDF or other file format for instrumentation and control device represented. All cut sheets to be provided with selection of model provided clearly identified by markings.
    b. Sequence of operations text file for the systems and devices represented.
    c. Control system As-Builts
3. Operator workstation interface software shall minimize operator training through the use of English language prompting, 30 character English language point identification, on line help and industry standard PC application software. The software shall provide, as a minimum, graphical viewing and control of environment, scheduling and override of building operations, collection and analysis of historical data, definition and construction of dynamic color graphic displays, editing, programming, storage and downloading of controller

databases, and the ability to export data with Microsoft Word for Windows and Excel for Windows.

4. Provide a graphical user interface which shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change set points from graphical displays through the use of a mouse or similar pointing device. Provide functionality such that all operations can also be performed using the keyboard as a backup interface device. Provide additional capability that allows at least 10 special function keys to perform often-used operations
5. The software shall provide a multi-tasking Microsoft Windows environment that allows the user to run several applications simultaneously. Other Windows applications shall run simultaneously with the BMS software including Word, Excel, Access, etc. Provide functionality such that any of the following may be performed simultaneously, and in any combination, via user-sized windows. The operator shall be able to drag and drop information between applications (e.g. click on any point in the alarm screen and drag it into the dynamic trend graph screen to initiate a dynamic trend).
    a. Dynamic color graphics and graphic control
    b. Alarm management coordinated with other specification sections
    c. Week or Month at a Glance with 365 day time-of-day scheduling
    d. Trend data definition and presentation
    e. Graphic definition
    f. Graphic construction
6. Operator specific password access protection shall allow the user to limit workstation control, display and data base manipulation capabilities for each object in the system. An object shall be defined as any input or output point, set point, system program, etc. The operator privileges shall "follow" the operator to the operator terminal or DDC controller that the operator logs on to. Provide a minimum of 200 passwords.
7. Operators will be able to perform only those commands on the objects available based on their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.
8. An audit trail report to track system object changes, accounting for operator initiated actions, change made by a particular person or changes made to a specific piece of equipment, designated time frame shall be printed out on command or automatically and archived for future reference. The operator activity tracking data shall be stored in a tamper proof buffer.
9. Software shall allow the operator to perform commands including, but not limited to start up or shutdown of equipment, adjust set points (including multiple TEC subpoints to new settings with one command), add/modify/delete time programming, enable/disable process execution, lock/unlock alarm reporting, enable/disable totalization, enable/disable trending, override PID loop set points, enter temporary override schedules, define holiday schedules, change time/date, automatic daylight savings time adjustments, enter/modify analog warning and alarm limits, View limits, Enable/disable demand limiting for each meter, Enable/disable duty cycle for each load. All values (including setpoints) indicated within specification sequences, including those labelled as adjustable (adj.), shall be modifiable, with the proper password level, from the

operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

10. Reports shall be generated and directed to either display or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
    a. A general listing of all points in the network
    b. List of all points currently in alarm.
    c. List of all points currently in override status.
    d. List of all disabled points.
    e. List of all points currently locked out.
    f. DDC Controller trend overflow warning.
    g. List all weekly schedules.
    h. A DDC controller point module status report.
    i. A change of value cross reference report indicating user defined limit changes.
    j. Summaries shall be provided for specific points, for a logical point group, for a user-selected group or groups or for the entire facility without restriction due to the hardware configuration of the building management system. Under no conditions shall the operator need to specify the address of the hardware controller to obtain system information.
    k. Provide a custom reporting package that allows the operator to select, modify, or create custom reports. Each report shall be definable as to data content, format, interval and date. Report data shall be capable of being archived on hard disk for historical reporting. Each physical point or pseudo point shall be assigned an English descriptor for use in reports. The integrated Custom Report Writer capability shall allow the user to format reports of any mix of text, points with status, value and descriptors. The user shall have the capability to modify the defined reports or design unique reports that collect and disperse different combinations of data from the system. A custom report drop down item under the report bar item displays a report dialog box that allows you to schedule, run and view these reports. Spreadsheet packages which require off-line execution or manual translation of date files from one program format to another are not acceptable.
11. User-definable, automatic log-off timers of from 5 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

B. Scheduling

1. Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide the following spreadsheet types: weekly, monthly and yearly schedules for a minimum of 365 days in advance.
2. Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Each schedule shall include columns for each day of the week as well as holiday and special day columns for alternate scheduling on user-defined days. Equipment scheduling shall be accomplished by simply inserting occupancy and vacancy times into appropriate information blocks on the graphic. In addition, temporary overrides and associated times

may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.

3. Zone schedules shall be provided for each building zone as previously described. Each schedule shall include all controllable points residing within the zone. Each point may have a unique schedule of operation relative to the zone's occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and rescheduling of points may be accomplished easily via the zone schedule graphic.
4. Monthly calendars for a 24-month period shall be provided which allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

C. Collection and Analysis of Historical Data

1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting.
2. Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 10 points. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package such as Microsoft Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.
3. Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both static and/or real-time dynamic point data. A minimum of 6 points may be viewed simultaneously on a single graph, with color selection and line type for each point being user-definable. Displays shall include an 'X' axis indicating elapsed time and a 'Y' axis indicating a range scale in engineering units for each point. The 'Y' axis shall be manually or automatically scalable at the user's option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the 'Y' axis. All 'Y' axis data shall be color-coded to match the line color for the corresponding point.
    a. Static graphs shall represent actual point data that has been trended and stored on disk. Exact point values may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a building management and diagnostics tool.
    b. Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future

recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.

D. Dynamic Color Graphic Displays:

1. Provide graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, supply and exhaust fans and condensate systems to optimize system performance analysis and speed alarm recognition.
2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
3. Dynamic point values (e.g. temperature values, humidity values, flow values and status indication) shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
4. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
5. Graphic generation software shall be provided to allow the user to add, modify or delete system graphic displays via an off the shelf graphics package.
    a. The BMS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems and electrical symbols.
    b. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.
    c. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC Controllers including Terminal Equipment Controllers or terminal units.
6. Provide an automatically updated, dynamic display of the site specific BMS architecture indicating the status of all controllers, PC workstations and networks.
7. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
    a. Define symbols.
    b. Position and size symbols.
    c. Define background screens.
    d. Define connecting lines and curves.
    e. Locate, orient and size descriptive text.
    f. Define and display colors for all elements.
    g. Establish correlation between symbols or text and associated system points or other displays.

8. For each air handling unit provide a tabular graphic summary of that unit and its associated air distribution system. Graphics shall contain, at a minimum, the following information:
   a. Supply fan's current operating speed and setpoint.
   b. Manual adjustment of supply fan speed.
   c. Supply air static pressure and temperature.
   d. Current damper position or command.
   e. Current associated space temperature.
   f. Current preheat, reheat, and cooling valve positions or commands.
   g. A commandable override point to place all associated terminal units at maximum airflow.
   h. A commandable override point to place all associated terminal units at minimum airflow.

E. System Configuration and Definition

1. All temperature and equipment 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.
2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add, delete or modify any system object including DDC controllers, operator workstations, equipment controllers, reporting definitions, control loops, energy management applications, time and calendar-based programming, totalization, historical data trending, custom control processes, graphic displays, operator passwords, alarm messages, dial up telecommunications definitions, points of any type, etc.
3. Definition of operator device characteristics for individual points, applications and control sequences shall be performed using instructive prompting software.
   a. Libraries of standard application modules such as temperature, humidity and static pressure control may be used as "building blocks" in defining or creating new control sequences. In addition, the user shall have the capability to easily create and archive new modules and control sequences as desired via a word processing type format. Provide a library of standard forms to facilitate definition of point characteristics. Forms shall be self-prompting and incorporate a fill-in-the-blank approach for definition of all parameters. The system shall immediately detect an improper entry and automatically display an error message explaining the nature of the mistake.
   b. Programming shall be performed with the BMS system online, and not interfere with BMS system operation.
   c. Inputs and outputs for any process shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of 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).
   d. Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Similarly, changes made

at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.

e. Provide a program testing utility which allows visual dynamic simulation capability of the symbolically displayed control programs provided. User shall be able to select any portions of inputs, outputs and intermediate program points for visual dynamic display of intermediate values and or results. Provide ports for symbolic engineering tool at each DDC Controller, and (for TECs) at space temperature sensors noted on the plans or as described herein. The symbolic engineering utility shall be self-documenting and shall generate a complete controller program including I/O definition and engineering unit processing requirements, alarm limits, DDC operational program, and English text for all data points. Engineering program documentation shall include computer-driven output of all program data.

f. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

2.12 ALARM PROCESSING

A. Alarms shall be classified by their alarm type. The means shall be provided for enabling and disabling each individual alarm on the system. The contractor is responsible for enabling and setting all alarms within the BMS.

B. Once generated, the alarm shall be processed by its associated Alarm Type and Alarm Level as defined in either the I/O Point Schedules or collaboration with the Owner/Facilities Manager.

C. The Alarm Types shall be as follows:

1. Mismatch Alarm Type- Mismatch: The alarm is associated with an output command point and its related input giving status feedback of the output command. The alarm is generated when the status feedback does not correspond with the output command status for longer than a defined time delay period, initially set to 1 minute(adjustable).
2. Binary Alarm Type - The alarm is associated directly with an external volt free contact (i.e. a digital input). The alarm may be generated by transitions from either open to closed status, closed to open status, or any change of state. A time delay shall be associated with the alarm such that the alarm does not occur until the required alarm state has existed for longer than the delay period, initially set to 15 seconds(adjustable).
3. Analog Alarm Type - The alarm is associated directly with an analog input. The alarm is generated by the BMS due to a measured variable exceeding specified limits. It shall be possible to define the limits in two ways:
   a. Fixed limits. The point has fixed upper and lower alarm limits. If the measured variable rises above the upper limit, or falls below the lower limit, then an alarm is generated. e.g. high alarm limit = 80°F, low alarm limit = 45°F.

b. Floating limits. The point has an associated setpoint, and an alarm is generated when the measured variable deviates either above or below the setpoint by more than a given alarm limit value. If the setpoint is changed, the alarm limits are automatically moved to suit, e.g. setpoint = 66°F, alarm limits = Setpoint ± 2°F.

4. Hand/Off/Auto (HOA) Type - The alarm is associated with the placement of the HOA switches in the Hand or Off position. HOA switches include but are not limited to controllers and variable frequency drives.

D. The Alarm Levels shall be as follows:

1. Level 1: Life Safety.
2. Level 2: Critical Equipment Message.
3. Level 3: Urgent Message.
4. Level 4: Normal / Maintenance Message.

E. Alarm Initiation - Entry delay:

1. All alarms have an adjustable delay time such that the alarm is not triggered unless the alarm condition exists for the delay time. Default entry delays are as follows:
   a. Level 1 alarms: 1 second
   b. Level 2 alarms: 10 seconds
   c. Level 3 alarms: 1 minute
   d. Level 4 alarms: 5 minutes

F. Alarm Exit Hysteresis:

1. Each alarm has an adjustable time-based hysteresis to exit the alarm. The default is 5 seconds for all alarms. Once set, the alarm does not return to normal until the alarm conditions have ceased for the duration of the hysteresis.
2. Each analog alarm additionally has an adjustable percent-of-limit-based hysteresis. The hysterias requires the alarmed variable to be a percentage above or below (as applicable) the triggering threshold before the alarm is cleared. The default value is 0% for all alarms.

G. Latching:

1. Any alarm can be configured as latching or non-latching. A latching alarm requires acknowledgement from the operators before it can return to normal, if the exit hysteresis has been met. A non-latching alarm does not require acknowledgement. Default latching status is as follows:
   a. Level 1 alarms: latching
   b. Level 2 alarms: latching
   c. Level 3 alarms: non-latching
   d. Level 4 alarms: non-latching

H. The operator’s station display shall have a dedicated area at the top or bottom of the screen for use as an alarm banner. The alarm banner shall display, as a minimum, the two latest unacknowledged alarms at the top of the current alarm list. Alarms shall be entered into the list according to their type and event order, with the most

recent alarm being at the top of the list. As new alarm events occur, the list shall be sorted to keep the list in the desired order.

I. On occurrence, all alarms shall be put in the alarm list. In addition, the following actions shall be taken dependent upon the alarm type.

J. Alarm Actions

1. Level 1: Life Safety.
   a. Initiate remote notification via email/text.
   b. The alarm printout shall be in bold text or color-coded to clearly differentiate it from Urgent or Normal / Maintenance alarms. It shall be possible to sort or filter the alarm printout by alarm level.
   c. The banner alarm message display shall be differentiated by means of text size or color from general alarms.
   d. Shall generate an audible alarm at the operator's station.
   e. Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.
2. Level 2: Critical Equipment Message.
   a. The alarm printout shall be in bold text or color-coded to clearly differentiate it from Urgent or Normal / Maintenance alarms. It shall be possible to sort or filter the alarm printout by alarm level.
   b. The banner alarm message display shall be differentiated by means of text size or color from general alarms.
   c. Shall generate an audible alarm at the operator's station.
   d. Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.
3. Level 3: Urgent Message.
   a. Shall generate a banner alarm message.
   b. Shall generate an audible alarm at the operator's station.
   c. Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.
4. Level 4: Normal / Maintenance Message.
   a. Shall generate a banner alarm message.
   b. Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.

K. It shall be possible, at the highest operator password level, to enable and disable the audible alarm feature of the operator's station for such reasons as maintenance . In addition the keyboard facility to mute the audible alarm shall be provided. Alarms that have been muted shall be re-annunciated if not acknowledged within a user specified time.

1. All alarms associated with a device in maintenance mode, except for level 1 alarms, are suppressed.
2. If a device is in maintenance mode, a daily level 3 alarm is issued at midnight indicating the devices is still in maintenance mode.

L. Alarms shall remain active until acknowledged by an operator logged on with the appropriate password level, even if the alarm has physically cleared. Upon acknowledgement, the alarm shall be moved to the appropriate place in the alarm list, the alarm banner shall be updated as necessary. When an alarm is acknowledged, the audible alarm, if enabled, shall be muted unless another unacknowledged critical or general alarm exists on the system.

M. The system shall be capable of alarm notification escalation during periods in which alarms go unacknowledged for a period of time. The escalation shall provide means to notify assigned individuals and/or groups via all means addressed within this specification. The escalation shall be tiered in a manner so that multiple stages of escalation are programmable. Escalation shall be developed by contractor in collaboration with the Owner/Facilities Manager

N. Post exit suppression period:

1. To limit alarms, any alarm may have an adjustable suppression period such that, if the alarm is triggered, its post-suppression timer is triggered and the alarm may not trigger again until the post-suppression time has expired. Default post suppression periods are as follows:
   a. Level 1 alarms: 0 minutes
   b. Level 2 alarms: 5 minutes
   c. Level 3 alarms: 24 hours
   d. Level 4 alarms: 7 days

O. It shall be possible to acknowledge alarms on both an individual and group basis.

P. Upon clearance of an alarm, it shall be removed from the alarm list.

Q. All alarm events shall be included in the historical data program.

1. All alarms in the alarm list.
2. Level 1: Life Safety alarms only.
3. Level 2: Critical Equipment Message. alarms only.
4. Level 3: Urgent Message alarms only.
5. Level 4: Normal Message alarms only.
6. Hand/Off/Auto alarms only.
7. Acknowledged alarms only.
8. Selection of alarms associated with an individual drive or plant equipment only.

2.13 CONFIGURATION

A. Configuration data shall be stored in the DDC Controllers or the Terminal Equipment Controllers. Configuration data shall include but not be limited to the following:

1. The point identifier (minimum of 12 characters).
2. The point descriptor (minimum of 32 characters).
3. The engineering unit applicable (°F, psi, gpm etc).
4. The point alarm message if applicable (minimum of 80 characters).

5. Other miscellaneous information necessary for the correct operation of the entire BMS (e.g. trending run hours, accumulation, access levels etc).

2.14 BMS INTEGRATION WITH OTHER SYSTEMS AND DEVICES

A. DX PACKAGED AIR HANDLING UNIT

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Allow for a minimum of 30 points	TBD	TBD	TBD	TBD	Yes

B. Energy Recovery System

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Allow for a minimum of 30 points	TBD	TBD	TBD	TBD	Yes

C. VFD(s)

1. The BMS shall be able to start and stop and control the VFD speed via a hardwired point based on the sequence of operations program.
2. The communication interface shall allow the BMS read capabilities.
3. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the VFD manufacturer for this integration. This integration shall be done via BACnet IP where available or BACnet MSTP if BACnet IP is not available.
4. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Start / Stop	DO	No	Yes	Yes	Yes
Speed Modulation	AO	No	Yes	Yes	Yes
Status (Current Sensor)	AI	Yes	Yes	Yes	Yes
VFD Fault	DI	Yes	Yes	Yes	Yes
HOA Not in Auto	DI	Yes	Yes	Yes	Yes
VFD in Bypass	DI	Yes	Yes	Yes	Yes
Forward / Reverse Status	SW	No	No	No	Yes
Drive Ready Status	SW	No	No	No	Yes
At Setpoint Status	SW	No	No	No	Yes
Resets Faults	SW	No	No	No	Yes
Output Speed min-1	SW	No	No	No	Yes
Output Frequency Hz	SW	No	No	No	Yes
DC Bus Voltage V	SW	No	No	No	Yes
Motor Voltage V	SW	No	No	No	Yes
Motor Current A	SW	No	No	No	Yes
Motor Torque %	SW	No	No	No	Yes
Motor Power %	SW	No	No	No	Yes
Drive Thermal State %	SW	No	No	No	Yes
Energy Counter kWh	SW	No	No	No	Yes
Run Time	SW	No	Yes	Yes	Yes
Last Error Code	SW	No	No	No	Yes

D. Split Air Conditioning Units /Computer Room Air Conditioning (CRAC) Units

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the CRAC manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Space Temperature	SW	Yes	Yes	Yes	Yes
Space Humidity	SW	Yes	Yes	Yes	Yes
Unit Status	SW	No	Yes	Yes	Yes
Unit Runtime	SW	No	Yes	Yes	Yes
General Alarm	SW	Yes	Yes	Yes	Yes

E. Packaged Air Handling Unit

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.

3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Allow for a minimum of 30 points	TBD	TBD	TBD	TBD	Yes

F. Fuel Oil System

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with the approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. Typical Software Points shall be as follows:

Point	Type	Alarm	Short Term Trend	Long Term Trend	On BMS Graphic
Allow for a minimum of 45 points	TBD	TBD	TBD	TBD	Yes

G. Electric Power Meters and EPMS

1. The communication interface shall allow the BMS read capabilities.
2. It shall be the responsibility of the BMS contractor to review requirements and coordinate with approved submittal from the equipment manufacturer for this integration. This integration shall be done via BACnet IP or BACnet MSTP if BACnet IP is not available.
3. BMS shall monitor and store both total production and power output data from meters at minimum 5-minute intervals.

2.15 INFORMATION REDIRECTION

A. It shall be possible for the system to redirect information to other locations and/or printers on a time schedule basis (including holiday programming) or manual command basis.

2.16 RESPONSE TIMES

A. The response times detailed below are the maximum acceptable response times.

B. Alarms: The time from activation of an alarm (at the source) to annunciation on an operator's station, printer or to another DDC controller shall not exceed 10 seconds.

C. Graphic Displays: A graphic display shall be displayed complete with updated information from the field for all points, within 15 seconds of the operator request.

D. Once displayed all point information will be updated from the field and displayed at intervals not exceeding 30 seconds.

E. Logical Groups: A logical group shall be displayed complete with updated information from the field for all points within 15 seconds of the operator's request. Once displayed the value shall be refreshed every 10 seconds.

F. Selected Points: The field value of a single input, output or virtual point shall be displayed on the operator's station screen within 5 seconds of a request.

G. Global Program: the time from occurrence of an event tom one controller or unitary controller to the activation of the output of another controller or unitary controller shall not exceed 10 seconds.

2.17 TRANSIENT/SPIKE PROTECTION

A. Suppressors shall be fitted to all controller input points for protection against voltage transients, spikes etc.

B. The communication network(s), the BLN and the FLN, shall be isolated against transient disturbances via optical couplers or other approved means. Where running between buildings, lightning protection devices shall be installed on the communications network at the point of entry to each building.

2.18 ELECTROMAGNETIC PROTECTION

A. All components of BMS and the entire BMS system shall comply with the requirements of the relevant Emission and Immunity Standards.

B. In order to avoid corruption of the BMS equipment operation by electrical interference, all wiring shall be installed to minimize coupling of electromagnetic and electrostatic interference on low voltage signals and data wiring. Where mixed wiring is unavoidable braided screen mains cable, dressed close to metalwork, is preferred, but the Tendered shall clearly specify the methods by which he intends to eliminate any such interference with his signal and data transmission.

C. The BMS shall be protected from interference by the operation of hand held radio transmitters, radio pagers, etc. within 1 meter of the equipment.

2.19 BMS STANDARD PROGRAMS

A. The device schedules included in this Specification provide details of inputs monitored and outputs controlled by the BMS. All point types are described in the section covering DDC Controllers in this Specification. The BMS system shall allow for the following point functionality and standard programs to be available:

1. Point Override
2. Manual Start/Stop
3. Fixed Time Program

4. Optimum Start/Stop – program shall calculate the optimum start time for plant systems, e.g. the AHU, based on occupancy time and on internal space and outside conditions.
5. Control Loops
6. Rotational Point
7. Run Time Totalization
8. Anti-short Cycling
9. Staggered Start
10. User Definable Software
11. General Control Requirements

2.20 FIELD DEVICES

A. General

1. All control signals shall be via 4-20 mA or 0-10 VDC loops.
2. It is the contractor's responsibility to properly select all instruments for process and application suitability, inclusive of materials and operating ranges.
3. Input/Output sensors and devices shall be closely matched to the requirements of the BMS for accurate, responsive, noise-free signal input/output. Control input response shall be highly sensitivity and matched to the loop gain requirements for precise and responsive control. Provide the following instrumentation as required by the monitoring, control and optimization functions.

B. Temperature Sensors/Transmitters/Thermowells

1. Thermistors based temperature sensors shall be paired with a 4 wire 4-20 mA output transmitter. Transmitter shall have built-in circuit protection against reverse polarity and supply voltage transients.
2. RTD based temperature sensors shall use platinum elements only, nickel or silicon RTDs are not acceptable.
3. Air stream averaging type
   a. The assembly shall consist of a capillary type element, housed in a flexible sheath contained in housing suitable for duct mounting.
   b. Probe length: 1 ft./4 square ft. of duct area
   c. All duct cross sections greater than 10 square feet to have serpentine-averaging element to adequately average stratified air temperature.
   d. Temperature Monitoring Range: +20 to +120°F
   e. Factory calibration point: 70°F.
   f. Accuracy: ± 0.5 °F.
4. Air stream insertion / non-averaging type.
   a. The assembly shall consist of an insertion type element contained in a housing suitable for duct mounting and mounted on probe whose maximum length shall be 12 inches or ½ duct diameter, whichever is smaller.
   b. Temperature Monitoring Range: +20 to +120°F
   c. Factory calibration point: 70°F.
   d. Accuracy: ± 0.5 °F.

e. For outside air applications, mount with weather protection and sun shield.

5. Space monitoring type - Traditional
   a. The assembly shall consist of an element contained in a ventilated enclosure.
   b. Temperature Monitoring Range: +20 to +120°F
   c. Factory calibration point: 70°F.
   d. Accuracy: ± 0.5 °F.
   e. Provide low profile combination temperature and humidity sensors for Gallery/Exhibit Areas as applicable
   f. Coordinate Temperature Sensor faceplate requirements with architect/ owner and engineer. Faceplates options shall include color, blank faceplate option, display faceplate option, setpoint adjustment option and occupied/unoccupied override option) Submit for approval.

6. Space monitoring type – Wall Mounted Button/Bullet Sensor
   a. Sensors are to provide space temperature via hardwired connection.
   b. The assembly shall consist of a stainless steel button wall mounted style sensor/element.
   c. Temperature Monitoring Range: +20 to +120°F
   d. Factory calibration point: 70°F.
   e. Accuracy: ± 0.5 °F.

7. Space monitoring type – Electric /Line Voltage Thermostats
   a. Furnish and install all line voltage thermostats for unit heaters.
   b. Thermostats contacts shall be rated for maximum heater amperage and shall be snap acting, SPDT.
   c. Thermostat cover shall provide exposed set point and key adjust.
   d. When used for unit heaters - Furnish and install strap on aquastats to prevent unit heaters from operating without hot water or steam

8. Liquid insertion type
   a. The assembly shall be provided with a housing suitable for pipe mounting.
   b. The transmitter shall be compatible with the temperature element and the DDCP.
   c. Transmitter shall have built-in circuit protection against reverse polarity and supply voltage transients.
   d. Include a stainless steel thermowell, maximum length shall be 6 inches or 3/4 of pipe diameter, whichever is smaller.
   e. Temperature Monitoring Range: The sensor range shall be suitable to the process being monitored.
   f. Factory calibration point: Middle of process range.
   g. Accuracy: ± 0.5 °F.

9. Outside Air Assembly
   a. The assembly shall be contained in an enclosure suitable for outdoor applications.
   b. Temperature Monitoring Range: -50 to +120°F
   c. Factory calibration point: 70°F.
   d. Accuracy: ± 0.5 °F.

10. Averaging Temperature RTD for Cooling tower basin

a. A multipoint RTD capable of monitoring a multitude of temperatures over a vertical length as specified to cover depth of cooling tower basins.
b. Sensor shall be paired with a transmitter capable of an averaging process and 4-20mA output to the BMS.
c. Include a stainless steel thermowell.
d. Transmitter shall have built-in circuit protection against reverse polarity and supply voltage transients. Transmitter shall be a two wire device, loop powered.
e. Assembly shall be coordinated with cooling tower basing manufacturer to allow for proper mounting hardware installation. All mounting hardware to be provided by Controls contractor.
f. Manufacturer – Moore Industries.

11. Freezestats
    a. Furnish and install for each air handling unit with outdoor air connections, a low temperature safety thermostat (freezestat) with 20 ft sensing element installed in a serpentine fashion across the inlet of the cooling coil (one freezestat per coil section) in the air stream arranged to stop the unit supply fan and its associated return air fan should the temperature at any point along the sensing element fall below 39°F (adjustable) for an adjustable time period.
    b. Low temperature detector shall be automatic reset, DPDT type unless specified in sequences within specification.
    c. Provide manufacturer specified / accept able clips for recommended support.

12. Thermowells
    a. Provide a Thermowell for every thermistor temperature sensing element installed in piping and equipment. Provide a separate calibration thermowell for every thermistor. Refer to installation detail shown on drawings.
    b. Thermowells shall be Type 304 stainless steel, or brass tapered pattern, 3/4 inch NPT external process connection, 1/2 inch NPT internal thread, with lagging extension, equal to insulation thickness, where installed in insulated piping. Thermowells shall have an insertion length of at least 1/3 of pipe diameter but in no case shall wells be less than 4-1/2 inch insertion length. Maximum immersion length shall be 6 inches or 3/4 of pipe diameter, whichever is smaller. Thermowells shall be rated for maximum system operating pressure, temperature and fluid velocity.
    c. Internal bore of Thermowells shall be sized to exactly fit the diameter of the sensing element to be installed.
    d. Provide necessary thermally conductive material for proper sensor to thermowell contact.

13. Smart Sensors (for Residences)
    a. The assembly shall consist of an element contained in a ventilated enclosure.
    b. Temperature Monitoring Range: +20 to +120°F
    c. Factory calibration point: 70°F.
    d. Accuracy: ± 0.5 °F.

e. Unit shall be capable of occupancy monitoring. Sensor shall use either passive infrared or ultrasonic technology with sensitivity adjustment
f. Unit shall be classified as a Terminal Equipment Controller, refer to specific section for additional requirements.
g. Provide functionality (inclusive of hard wired outputs) required to control residence unit heating and cooling valves. In accordance with design details and sequence of operations.
h. Coordinate Temperature Sensor faceplate requirements with architect/ owner and engineer. Faceplates options shall include color, blank faceplate option, display faceplate option, setpoint adjustment option and occupied/unoccupied override option) Submit for approval.

C. Pressure Sensors/Transmitters/Switches

1. Air Differential Pressure Switch
   a. Differential pressure switches shall be diaphragm type, with die-cast aluminum housing and an adjustable set point.
   b. Output: Switches contact shall be DPDT and rated a minimum of 5 amps at 120 VAC.
   c. Switch pressure range shall be suited for application (e.g. filter 0-2.0", fan status 0-5.0", etc.).
   d. Sensor shall be adjustable for zero and span.
   e. All exposed tubing shall be capped with static pressure tips.

2. Air Differential Pressure Transmitter
   a. Sensors shall be suitable for low pressures likely to be encountered and be selected for approximately 50% over range and have 4-20ma output.
   b. Connect to measuring points with valved lines for testing and calibration.
   c. Sensors shall be adjustable for zero and span.
   d. Sensors for VFD fan control shall be located 2/3rds downstream of fan.
   e. All exposed tubing shall be capped with static pressure tips.

3. Air Static Pressure Transmitter
   a. Sensors shall be suitable for low pressures likely to be encountered and be selected for approximately 50% over range and have
   b. Output: 4-20 mA
   c. Connect to measuring points with valved lines for testing and calibration.
   d. Sensors shall be adjustable for zero and span.
   e. Sensors shall be located 2/3rds downstream of index run.
   f. All exposed tubing shall be capped with static pressure tips.

4. Water Pressure / Differential Pressure Switch
   a. Switches shall be diaphragm actuator type, with epoxy coated aluminum housing and an adjustable set point.
   b. Output: Switch contact shall be SPDT, 15A 120VAC.
   c. Switch pressure range shall be suited for application
   d. Actuator seal to be compatible with process temperature limits
   e. Accuracy : 1% of nominal range
   f. Sensor shall be adjustable for zero and span.
   g. Manufacturer: Ashcroft

5. Water Pressure / Differential Pressure Transmitter

a. Provide a variable capacitance 2-wire, 4-20 mA differential pressure transmitter assembly. Differential pressure transmitters shall be enclosed in a gasketed, dust and watertight housing. All body cavities open to the process fluid shall be provided with drain ports at the cavity bottom and vent ports at the top of the cavity. Both drain and vent ports shall be minimum ¼ inch – 18 NPT.
b. The transmitter shall have continuously adjustable (externally) zero and span. These adjustments shall be made within the transmitter housing without a change of parts.
c. The transmitter shall be capable of sustaining differential pressures in either direction, up to the body rating without damage to the instrument or a loss of accuracy or zero shift.
d. The transmitter shall be fully compensated for both process and ambient temperature variations and a calibrated accuracy of ±0.25% of calibrated span.
e. Provide local LCD display and wire-on-tag with instrument service information.
f. Provide manufacturers standard 316 stainless steel, 5-valve manifold and pressure gauges for supply and return pressures.
g. Manufacturer: Rosemount 3051S, 316 stainless steel or approved equal.

6. Building Pressurization System
   a. System layout shall include: both indoor and outdoor sensor locations with mounting design; where fire-rated penetrations are required in walls or ceilings with reference to penetration details which describe material transitions as required; where plenum-rated tubing is required; locations of control panels; requirements for power provided under Division 26; zone pressure sensors shall not be located near mailroom exhaust, kitchen hood exhaust, AHU return ducts, medical lab exhaust hoods, or other sources of positive or negative pressure which will adversely affect the stability and accuracy of the sensor readings

7. Indoor Pressure Pickup Ports
   a. Wall mount: Plate compatible with J-box.
   b. Ceiling mount: Plate compatible with J-box or designed to fit a ¾” thick suspended ceiling tile.
   c. Brushed stainless steel with gasket seals.
   d. Brass fitting for standard 1/8” to 5/32” I.D. tubing.
   e. Equal to Building Automation Products, Inc. ZPS-ACC.

8. Outdoor Static Pressure Pickup Ports
   a. Wall or roof mount.
   b. UV resistant and flame retardant plastic housing.
   c. ½” EMT conduit connection.
   d. Barbed fitting for standard 1/8” to 5/32” I.D. tubing
   e. Rated for -40 to 212°F, 0-100% non-condensing.
   f. Equal to Building Automation Products, Inc. ZPS-ACC-10.

9. Outdoor Static Pressure Manifold Enclosure
   a. Wall mounted, weatherproof (NEMA 3 or 4), steel enclosure.
   b. Powder coated finish.
   c. Hinged door.

d. Oil resistant door gasket.
e. Accessories:
   1) Powder coated, heavy gauge steel louvers, one per side for minimum 2 inch by 1.75 inch panel opening.
   2) Lockable door latch.
   3) Insect screen on over louver openings inside of enclosure.

D. Flow Sensors/Transmitters/Switches

1. Through the wall Airflow Measurement Device:
   a. Provide through the wall airflow measuring device for the monitoring air flow between the Fan Rom #1 and the adjacent corridor and Fan Rom #2 and the adjacent corridor as shown on mechanical and controls drawings.
   b. Each measuring device shall consist of one sensor and one transmitter to maintain specified accuracy and performance.
   c. A single manufacturer shall provide both the airflow measuring sensor and transmitter.
   d. The operating airflow range shall be 0 fpm to 5,000 fpm. . The operating environmental range for the airflow probes shall be 20°F to 140°F, 99% R (non-condensing).
   e. The operating environmental range of the transmitter shall be 30°F to 120°F protected from the weather.
   f. The sensor shall have an accuracy of ± 2% of reading over the entire operating range and be fully temperature compensated.
   g. Provide a 4-20 ma transmitter for interface to the BMS system.
   h. Provide all necessary hardware including, stainless steel faceplate with protective mesh, hose barbs, extensions, copper tubing, bleed sensor assembly, fittings, transmitter and panel enclosure.
   i. Installation method shall be coordinated with device manufacturer and approved by Owner and Controls Engineer prior to any and all work.
   j. Acceptable manufacturers:
      1) Ebtron Inc (Gold Series)including GB1/SB1Bleed Sensors

2. Air Flow Measurement Stations - Fan Inlet and Outside Air Intake / Exhaust Air Flow
   a. General: The airflow measurement stations shall be capable of monitoring airflow and temperature rates at each measurement location. The system shall be factory tested prior to shipment and shall not require calibration or adjustment over the life of the equipment, when installed in accordance to manufacturer’s guidelines.
   b. Provide fan inlet and outdoor airflow measuring devices for air handling units as shown on drawings. Each airflow measuring device shall consist of multiple measuring probes.
   c. Installed accuracy shall be percent of reading and demonstrated at both maximum and minimum airflow rates for each measurement location..
   d. The operating airflow range shall be 0 fpm to 5,000 fpm. .
   e. A single manufacturer shall provide both the airflow measuring probe and transmitter.
   f. Sensor assembly
      1) Each sensing point shall independently measure airflow and temperature prior to averaging. Sensors shall be calibrated to

NIST-traceable standards for both airflow and temperature. Heated element, bead in glass hermetically sealed thermistor probes.

2) Provide quantity of probes to meet manufacturer's minimum installation requirements. Provide quantity of airflow measuring probes to maintain specified accuracy and performances.
3) Each airflow measuring device shall consist of multiple measuring probes. Provide quantity of airflow measuring probes to maintain specified accuracy and performances.
4) The operating environmental range for the airflow probes shall be -20 deg f to 160 deg f, 100% R (non-condensing).
5) The sensor shall have an accuracy ± 2% of reading over the entire operating range and be fully temperature compensated.

g. Transmitter and Electronics Enclosure
1) The transmitter shall operate on 24 VAC. The transmitter shall have a minimum 16 character alphanumeric LCD display for airflow, temperature, and system diagnostics. Analog output signals shall be user selectable (0-10 VDC or 4-20 mA). All inputs and outputs shall be fused, protected, and internally isolated from the 24 VAC power supply. The transmitter shall have a non-drifting adjustment for output signal offset/gain. The transmitter display shall be capable of being configured in either I.P. or S.I. units. The transmitter shall accept a user-defined area to display volumetric flow rates in CFM.
2) The enclosure shall be aluminum alloy for indoor use and capable of operating over a temperature range of -20° F to +120° F. The electronics shall be installed inside and protected from the weather. Exterior installation or areas acceptable to high levels of moisture use NEMA4 enclosure.

h. Temperature Output to BMS
1) Provide temperature monitoring output to BMS in accordance with mechanical drawings.

i. Acceptable manufacturers:
1) Ebtron, Inc (Gold Series)

j. BMS contractor shall employ or subcontract factory trained Ebtron technician as part of this contract to assist in design and to inspect all outside air measurement installations and assist in calibrating and adjusting the Ebtron outside air sensors as required to meet final balancing setting to provide accurate BMS monitoring and control.

3. Air Flow Measurement Stations - Fan Array
a. Probe and Sensor Node Configurations
1) Fan Arrays (less than or equal to 4 fans): 2 probes x 1 sensor node per probe or 1 probe x 1 sensor node per probe in each fan
2) Fan Arrays (greater than 4 fans): 1 probe x 1 sensor node per probe in each fan (8 probe maximum)

b. Installed Airflow Accuracy
1) ±(3% to 10%) of reading, depending on fan type and installation.

c. Sensor Node Averaging Method
1) Airflow: Independent, arithmetic average per fan
2) Temperature: Independent, velocity weighted average

d. Listings and Compliance
   1) UL: UL-873 and CSA C22.2 No. 24
   2) BACnet International: BTL Listed (GTC108 and GTM108 transmitters)
e. Environmental Limits
   1) Temperature:
      a) Probes: -20 to 160 ºF [-28.9 to 71.1 ºC]
      b) Transmitter: -20 to 120 ºF [-28.9 to 48.9 ºC]
   2) Humidity: (non-condensing)
   3) Probes: 0 to 100%
   4) Transmitter: 5 to 95%
f. Sensing Node Sensors
   1) Self-heated sensor: Precision, hermetically sealed, bead-in-glass thermistor
   2) Temperature sensor: Precision, hermetically sealed, bead-in-glass thermistor
g. Sensing Node Housing
   1) Material: Glass-filled Polypropylene
   2) Sensor Potting Materials: Waterproof marine epoxy
h. Airflow Measurement
   1) Accuracy: ±2% of reading to NIST-traceable airflow standards (includes transmitter uncertainty)
   2) Calibrated Range: 0 to 10,000 fpm [0. to 50.8 m/s]
   3) Calibration Points: 16
   4) Temperature Measurement
   5) Accuracy: ±0.15 ºF [0.08 ºC] to NIST-traceable temperature standards (includes transmitter uncertainty)
   6) Calibrated Range: -20 to 160 ºF [-28.9 to 71.1 ºC]
   7) Calibration Points: 3
i. Sensor Probe Assembly
   1) Mounting Rods
      a) Material: Zinc plated steel
   2) Mounting Brackets
      a) Material: 304 stainless steel
   3) Probe to Transmitter Cables
      a) Type: FEP jacket, plenum rated CMP/CL2P, UL/cUL listed, -67 to 302 ºF [-55 to 150 ºC], UV tolerant
      b) Standard Lengths: 10, 25, and 50 ft. [3.1, 7.6 and 15.2 m]
   4) Connecting Plug: 9/16” [14.29 mm] nominal diameter with gold-plated connector pins
j. Power Requirement:
   1) 24 VAC (22.8 to 26.4 under load) @16V-A
k. User Interface:
   1) 2 line x16-character backlit LCD display and 4 button interface

l. BMS Connectivity
   1) All Transmitter: Three field selectable (0-5/0-10 VDC or 4-20mA), scalable and isolated analog output signals (AO1=airflow,AO2=temperature or alarm, AO3=Not used.
   2) GTC108e Transmitter: One additional field selectable (BACnet MS/TP or Modbus RTU) and isolated RS-485 network connection - Individual sensor node airflow rates and temperatures are available via the network (as applicable)
   3) GTM108e Transmitter: One additional isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection – Individual sensor node airflow rates and temperatures are available via the network
m. Airflow Alarm
   1) Type: Low and/or high user defined setpoint alarm
n. Tolerance: User defined % of setpoint
o. Delay: User defined
p. Zero Disable: Alarm can be disabled when the airflow rate falls below the low limit cutoff value (unoccupied periods)
q. Reset Method: Manual or automatic
r. Visual Indication: Yes, LCD display
s. Network Indication: Yes (GTM108 and GTC108 only)
t. Analog Signal Indication: Yes, on AO2 assignment
u. Fan Alarm
v. Type: Minimum airflow, % deviation from median airflow, or % deviation from maximum airflow stored in memory
w. Tolerance: User defined % of setpoint
x. Delay: User defined
y. Zero Disable: Alarm can be disabled when the airflow rate falls below the low limit cutoff value (unoccupied periods)
z. Reset Method: Manual or automatic
aa. Visual Indication: Yes, LCD display
bb. Network Indication: Yes (GTM108 and GTC108 only)
cc. Analog Signal Indication: Yes, on AO2 assignment
dd. System Status Alarm
ee. Type: Sensor diagnostic system trouble indication
ff. Visual Indication: Yes, LCD display
gg. Network Indication: Yes
hh. Analog Signal Indication: Yes, on AO2 assignment
ii. EB-Link Bluetooth Interface for Android® and iPhone®:
jj. Download individual sensor node airflow/temperature data, settings and diagnostics

4. Airflow/Temperature Measurement Devices
   a. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans and/or schedule.
   b. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices unless an authorized EBTRON representative deems duct work to be too restrictive for probes. Written authorization is required by EBTRON and the specifying engineer.
   c. FLOW STATION CONSTRUCTION:

1) Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
2) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
3) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
4) The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.
5) The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.
6) Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.
7) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
8) Devices using less than two thermistors in each sensor assembly are not acceptable.
9) Devices using platinum wire RTDs are not acceptable.
10) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
11) Pitot tubes and arrays are not acceptable.
12) Vortex shedding devices are not acceptable.

d. ALL SENSOR PROBES
1) Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.
2) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
3) Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range.
4) Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
5) Temperature accuracy shall be +/-0.15° F over the entire operating temperature range of -20° F to 160° F.
6) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).
7) Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
8) Each sensor assembly shall not require matching to the transmitter in the field.
9) A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

e. DUCT AND PLENUM PROBES
1) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
2) Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
3) Insertion mounted through the side or top of the duct
4) Internally mounted inside the duct or plenum
5) Standoff mounted inside the plenum
6) The number of sensor housings provided for each location shall be as follows:

f. Duct or Plenum Area g. (sq.ft.)	h. Total # Sensors / Location
i. <2	j. 4
k. 2 to < 4	l. 6
m. 4 to < 8	n. 8
o. 8 to <16	p. 12
q. >=16	r. 16

1) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

s. TRANSMITTERS
1) The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor assembly.
2) The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.
3) The transmitter shall have a power switch and operate on 24 VAC (isolation not required).
4) The transmitter shall use a switching power supply fused and protected from transients and power surges.
5) The transmitter shall use "watch-dog" circuitry to assure reset after power disruption, transients and brown-outs.
6) All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
7) The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be installed at a location that is protected from weather and water.
8) The transmitter shall be capable of communicating with other devices using one of the following interface options:
9) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
10) RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus

11) BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
12) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP
13) Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.
14) LonWorks Free Topology
15) The transmitter shall be capable of accepting an infra-red interface card for downloading airflow and temperature data or uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).
16) Provide PDA upload/download software.
17) Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rate, individual sensor temperatures and the average temperature received from the transmitter.
18) Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.
19) Provide a Microsoft Excel file capable of creating balance reports from PDA data files transferred to a Windows 98 or higher based PC.
20) Provide a Microsoft Excel file to create configuration data files that can be transferred from a Windows 2000, Windows XP or higher based PC to a PDA for upload to one or more transmitters.
21) The ATMD shall be UL listed as an entire assembly.
22) The ATMD shall carry the CE Mark for European Union shipments.
23) The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.
24) A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

t. INSTALLATION
1) Install airflow / temperature measurement devices in accordance with manufacturer's instructions at the locations indicated on the plans.
2) A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.
3) Install labels and nameplates to identify control components according to Section 23 33 00 or 25 35 00.
4) Install electronic cables according to Section 25 05 00 "Common Work Results for Integrated Automation."
5) Install low-voltage power, signal and communication cable according to Sections 25 05 13 "Conductors and Cables for Integrated Automation," 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and/or 27 15 00 "Communications Horizontal Cabling."

u. ADJUSTING
   1) Duct and plenum devices shall not be adjusted without approval from the consulting mechanical engineer.

v. ACCEPTABLE MANUFACTURERS
   1) Subject to compliance with requirements of this Section, provide products that comply with this specification by one of the following vendors:
   2) EBTRON, Inc. Model GTx116-P (basis of design)
   3) Kurz Instruments
   4) Fluid Components International (FCI)
   5) Alternatives requesting acceptance as "equals" less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered. For any product to be considered for substitution a written section-by-section detailed exceptions/compliance document shall be submitted to the Engineer before any approval will be considered. Before a product can be considered as an equal to EBTRON for substitution to this specification, a "non-fan powered" working demo must be made available for a side by side evaluation to EBTRON in the specifying engineer's office. The products must demonstrate accurate airflow measurement, repeatability and response time as well as specification compliance. Providing a working demo in and of itself does not constitute the products approval.

5. Liquid Flow - Magnetic Flow Meter
   a. The flow transmitter shall be a full sized magnetic flow meter.
   b. The flow meter shall be field-programmable with all site criteria being capable of input or change on-site by the use of plug-in hand-held terminal. All programming will be menu-driven and input in plain English.
   c. System Requirements
      1) Intrinsic Accuracy: Within 1 percent of actual flow above 1 fps.
      2) Calibrated Accuracy: 0.5 percent of actual flow above 1 fps.
      3) Flow Range Ability: Bidirectional including active zero sensitivity.
      4) Sensitivity: 0.001 ft./sec.
      5) Respectability: High precision: 0.15%.
   d. Flow Transmitter
      1) The flow transmitter shall be solid state design utilizing high reliability circuit elements and compound shall be micro-computer controller. The transmitter shall be housed in a NEMA 4X enclosure suitable for remote mounting. The transmitter shall be furnished with built-in fault alarm, and self diagnostic program to accurately track the metering systems performance. The programming shall be battery backed in RAM.
      2) The transmitter shall be equipped with an isolated 4-20 ma output signal, proportioned to flow, and be able to drive a restive load of up to 800ohms.
   e. The flow meter shall be provided will flow sizing calculation data.
   f. Manufacturer / Model
      1) Rosemount / Sensor Model 8705, Transmitter Model 8732C

E. Energy Metering System

1. Water Metering System
   a. Liquid Flow - Magnetic Flow Meter
      1) The flow transmitter shall be a full sized magnetic flow meter.
      2) System Requirements

         a) Intrinsic Accuracy: Within +/-0.25 percent of actual flow 0.04 to 6 fps

         b) Flow Range Ability: Bidirectional including active zero sensitivity.

         c) Sensitivity: 0.001 ft./sec.

         d) Repeatability: High precision: 0.15%.
      3) Flow Transmitter

         a) The flow transmitter shall be solid state design utilizing high reliability circuit elements and compound shall be micro-computer controller. The transmitter shall be housed in a NEMA 4X enclosure suitable for remote mounting. The transmitter shall be furnished with built-in fault alarm, and self-diagnostic program to accurately track the metering systems performance. The programming shall be battery backed in RAM.

         b) The transmitter shall be equipped with an isolated 4-20 ma output signal, proportioned to flow, and be able to drive a restive load of up to 800ohms.
      4) The flow meter shall be provided will flow sizing calculation data.
      5) The flow meter shall be field-programmable with all site criteria being capable of input or change on-site by the use of plug-in hand-held terminal. All programming will be menu-driven and input in plain English.
      6) Manufacturer / Model

         a) Rosemount / Sensor Model 8705, Transmitter Model 8732C
   b. Precision matched RTDs: 1,000 ohm platinum
      1) Differential Temperature Accuracy: 0.2 Deg F (with ice bath calibration).
      2) Transducers: (High Temperature)
   c. Installation, programming and Start-Up
      1) The manufacturer and/or factory representative of the energy meter shall provide field supervision at the project site for the installation of the metering equipment. The manufacturer and/or factory representative of the meter shall provide on-site programming of the meter, installation check and commissioning of the meter.
   d. Energy Meter

1) Provide a Kessler Ellis Products Supertroll II energy flow meter (with matched supply and return temperature sensors) for hot and chilled water BTU measurement applications.
2) Provide local LCD display and wire-on-tag with instrument service information.
3) NEMA 4X front.
4) The computer shall have on board self-diagnostics, and ROM based stored fluid properties for water.
5) The computer shall be capable of a Modbus RTU output for all the device parameters monitored including, but not limited to instantaneous flow.
6) Energy meter shall be provided with manufacturer's gateway to convert meter data from Modbus/RTU to BACnet/MSTP for compatibility with BMS.

e. Training
1) The manufacturer and factory representative of the flow-meter shall provide a minimum of one half-day of operation orientation and instruction on the operation of the flow-meter consecutive with the installation of the flow meter.

F. Miscellaneous Sensors

1. Humidity Sensors
a. The assembly shall consist of a humidity sensor utilizing a resistance change bulk polymer sensing element mounted in a housing suitable for the following applications – Outdoor, Return, and Space.
b. Sensor Humidity Operating Range: 0 to 100%.
c. Accuracy: ±2.5% RH between 50 and 104 DegF.
d. Repeatability: 0.5% RH/year
e. Sensitivity: 0.4%RH
f. Hysteresis: Less than 1%.
g. Stability: Better than 1.0% RH over a year. (Long term stability)
h. Temperature effect: Temperature compensated with less than 0.06% per °F.
i. Supply voltage: 18-38 VDC
j. Output: Two-wire loop-powered, 4-20 ma, %0 to 100% linear
k. Adjustments: One point with calibrator (duct mounted applications).
l. Operating temperature: -40°F to 130°F
m. Storage temperature: -85°F to 158°F
n. Max load: (Supply voltage 10VDC)/0.02, 700Ohms@ 24VDC
o. Connections screw terminals for loop terminations.
p. Provide 2 years warranty.
q. Sensor manufacturer shall send samples, mounting options and appearance to architect for approval prior to shipment.
r. Manufacturer - Vaisala

2. Combination Temperature and Humidity Sensors
a. The assembly shall consist of a temperature and humidity sensor mounted in a ventilated housing suitable for wall mounting.
b. Coordinate Temperature Sensor faceplate requirements with architect/ owner and engineer.

c. Faceplates options shall include color, blank faceplate option, display faceplate option, setpoint adjustment option and occupied/unoccupied override option) Submit for approval.
d. Humidity Sensor
   1) Sensor Humidity Operating Range: 0 to 100%.
   2) Accuracy: ±2.5% RH between 50 and 104 DegF.
   3) Repeatability: 0.5% RH/year
   4) Sensitivity: 0.4%RH
   5) Hysteresis: Less than 1%.
   6) Stability: Better than 1.0% RH over a year. (Long term stability)
   7) Temperature effect: Temperature compensated with less than 0.06% per °F.
e. Temperature Sensor
   1) Sensor Operating Range: 20 DegF to 120 DegF
   2) Accuracy: ±1 DegF.
   3) Repeatability: 0.5% RH/year
   4) Sensitivity: 0.4%RH
   5) Hysteresis: Less than 1%.
   6) Stability: Better then 1.0% RH over a year. (Long term stability)
f. Output: Two - Two-wire loop-powered, 4-20 ma, %0 to 100% linear
g. Adjustments: One point with calibrator (duct mounted applications).
h. Operating temperature: -40°F to 130°F
i. Storage temperature: -85°F to 158°F
j. Max load: (Supply voltage 10VDC)/0.02, 700Ohms@ 24VDC
k. Connections screw terminals for loop terminations.
l. Provide 2 years warranty.
m. Manufacturer - Vaisala

3. Carbon Dioxide Sensor – Duct Mounted
   a. Provide duct mounted carbon dioxide infrared microprocessor based sensor.
   b. Measurement range of 0 to 2000 PPM; accuracy +/-40 ppm (+/- 3% of reading)
   c. Analog Output: 4-20mA or 0-10VDC and Modbus proportional output signal, temperature compensated Maximum drift of ±100 PPM per year.
   d. Relay Output: 1 DPDT contact 5A, 30 VDC or 250VAC, Alarm contacts to close when user defined setpoint is reached. Adjustable alarm limit of 0 to 2000 PPM, factory set at 1000 PPM of carbon dioxide.
   e. Microprocessor based offset algorithm to automatically compensate for drift.
   f. Maximum response time: < 60 sec.
   g. Power requirements: 24VAC/VDC 200mA
   h. Manufacturer / Model
      1) Vulcain / 90DM3A

4. Carbon Dioxide Sensor– Wall / Surface Mounted
   a. The carbon dioxide sensor shall provide an output signal correspondence linearly to 0-2000 ppm/0-5000 ppm (user adjustable) of CO2 using Non-dispersive Infrared (NDIR) technology.
   b. The CO2 concentration shall be determined by measuring the attenuation of a specific wavelength of infrared light travels from its source to a

detector along a defined optical path. The sensor shall detect the amount of attenuation and convert it into a 0 to 10 VDC analog output signal, which corresponds linearly to 0 to 2000 ppm sensed concentration of CO2.

c. The sensor features shall have a membrane filter to help prevent contaminants from entering the sensing chamber and yet remain permeable to CO2.
d. A microprocessor-based offset compensation algorithm shall automatically compensate for drift. The compensation algorithm shall include a self-test that can detect problems (such as excessive drift) and initiate an alarm signal.
e. In addition to compensating for drift, the microprocessor shall speed the full calibration process by automatically adjusting the span (of the 0 to 2000 ppm output range). One easy accessed button shall complete this process.
f. Provide a separate 24 VAC transformer and power and control wiring.
g. The sensor shall be suitable for duct and space mounting as shown on the drawings. Provide carbon dioxide sensors as quantified in device schedule and shown mechanical drawings.
h. Sensor minimum requirements:
    1) Accuracy ±30 ppm + 2 % of reading (at room conditions).
    2) Repeatability ±10ppm CO2
    3) Maximum Drift ±50ppm CO2 per year
    4) Output Signal 0 to 10 VDC/4-20 mA proportional over the 0 to 2000 ppm/0-5000ppm CO2 range
i. Alarm Relay: SPST normally open dry rated for 10W maximum, 100 or 500 mA DC maximum with adjustable limit (0-2000 CO2 factory set at 1000ppm ±50ppm CO2)
j. Alarm Set Resolution ±20ppm CO2 minimum
k. Alarm Hysteresis 50ppm CO2
l. Calibration Adjustments Automatic zero compensation and span calibrations; uses calibrated span and zero.
m. Calibration interval – greater than two (2) years
n. Adjustment Resolution 20ppm CO2 minimum
o. Response Time: <30 seconds to 63 percent of step change, <60 seconds to 100 percent of step change
p. Warm up time: 5 minutes
q. Ambient Operating Conditions 32 to 122°F
r. 5 to 95 percent RH, non-condensing
s. Provide a calibration kit (flow system type) including zero gas and test carbon dioxide gas. Turn over complete kit to owner at warranty start date
t. Provide weatherproof enclosure for outdoor air mounting
u. Manufacturer / Model
    1) Vaisala / GMW90.

5. Gas Detection System – Garage CO & NO2
    a. Gas detection system shall be designed to alarm and initiate ventilation via the BMS upon the presence of Carbon Monoxide (CO) and Nitrous Oxide (NO2) generated by the operation of vehicles within the garage,

loading dock areas and similar spaces. The system shall consist of the following:

b. Controller
   1) Controller shall be a microprocessor based system, complete with power supplies, input and output modules, real time clock, memory, processors and all other items necessary for proper and correct interfacing with the gas monitoring system devices, operation of the control functions as described in the sequence of operations and the BACnet network communications capabilities as required by the BACnet building management system (BMS). The BACnet communication feature shall allow the BMS the capability of remote monitoring of the sensors as well as the status of the system.
   2) The controller shall be provided with additional expansion I/O modules as required capable of accepting binary, analog, and providing binary and analog outputs. The controller shall be modular and be capable of future field upgrades to include additional modules and sensors.
   3) The system controller shall be capable of communicating digitally with networked gas sensors and annunciator assemblies through three RS485 communication busses. Each bus shall be capable of accepting 32 devices including sensors, relay modules, annunciator panels, and horn/strobe modules.
   4) Each controller shall have an indicator which shows each sensors gas value as it sequences through the sensors. It shall immediately terminate the sequence and display any sensor in alarm and its location. The panel shall have a minimum 65 dB audible alarm and a silence switch. The panel will have a real time clock and shall be capable of timed operation of external devices such as fans should the application warrant it.
   5) The controller shall operate from a 120VAC/24VAC low voltage supply as provided by the manufacturer.
   6) The controller(s) shall be wall mounted in NEMA 4X enclosures.
c. Central Control Panel shall meet the following requirements:
   1) Each channel shall have 3 concentration levels and a fault alarm.
   2) Internal battery backup for complete operation of system for up to ½ hour of power loss.
   3) Digital display of concentration and alarm condition
   4) Event data logger
   5) Manual reset pushbutton
d. Sensors
   1) CO and NO2 sensors shall be of the electrochemical type. Each sensor shall be addressable over the RS485 bus. Each sensor shall include a local DPDT relay. All sensors shall be installed per manufacturer’s recommended installation. Sensors shall have a minimum radius of coverage of 50ft.
   2) Sensors shall be powered by low voltage as provided by the system controller.
   3) Sensors shall operate and report to the controller continuously. Sample draw type systems shall not be permitted.
   4) Gas sensor shall meet the following requirements

a) Loop powered

b) Local Display and keypad.(model dependent)

c) Display concentration, output and fault condition

d) NEMA 4x Enclosure.

e) Automatic Temperature Compensation

e. Warning /Activation Assemblies
   1) Warning /activation assemblies shall be provided and located by the main exits.
   2) The assemblies shall be comprised of a beacon, strobe and pushbutton/reset pull station.
f. Startup service shall be provided by a factory trained technician
g. Test and Calibration Equipment
   1) All necessary calibration and testing equipment shall be provided to perform the testing, commissioning and acceptance testing as part of the deliverable.
h. Test and Calibration Equipment
i. All necessary calibration and testing equipment shall be provided to perform the testing, commissioning and acceptance testing as part of the deliverable
j. Manufacturer:
   1) Sensidyne
   2) MSA
   3) Or Approved Equal.

6. Carbon Monoxide Detection System
   a. Provide a UL listed gas semiconductor or electrochemical sensors in an enclosure suitable for loading dock applications networked to a gas detection controller.
   b. BMS Contractor to provide wiring, conduit, relays, etc., for a complete system.
   c. Controller
      1) Fully programmable with up to 2 levels of alarm plus system fault relay to initiate the area exhaust fans and notification devices
      2) Controller shall be Modbus or BACnet compatible with capability to manage the total number of sensors required or a maximum of 96 transmitter inputs
      3) Back lit Alphanumeric or LED display
      4) Relay Outputs: a minimum of 4 DPDT contacts 5A, 30 VDC or 250VAC rated, shall be supplied in order to notify alarm status to the BMS
      5) Audible Output: minimum 65dBA Alarm with local reset button
      6) Enclosure shall be designed for use in NEMA 4X installations
      7) Controller shall be design to communicate with a network of sensors (RS-485 Modbus) and include the capability to provide digital communication output of BACnet or Modbus.
   d. Warning /Activation Assemblies

1) Warning /activation assemblies shall be provided and located by the main exits.
2) The assemblies shall be comprised of a beacon, strobe and pushbutton/reset pull station.

e. Manufacturer:
1) Sensidyne
2) MSA

7. Current Transducers - Analog Output
a. Provide and install split core current sensors to interface with the DDC system as described in Sequence of Operations and as shown on Control Drawings.
b. Units shall be UL listed.
c. Each sensor shall be two wire, loop powered and sized for expected amperage.
d. Analog Output Current Transducer
e. Typical installations used for the determination of current consumption of fan and pump motor in remote starter enclosures.
f. Power requirements: Self powered, 0-60 Amp rating
g. Output: 0-5 VDC
h. Accuracy +/-2.0% Full scale
i. Manufacturer: Veris - Hawkeye H922

8. Current Transducers - Analog Output - Variable Frequency Drive Applications
a. Typical installations used for the determination of VFD driven fan and pump motor status points in remote starter enclosures.
b. Self-adjusting setpoint, automatic compensation for effects of frequency and amperage changes related to VFD (insensitive to frequencies 10-80 hz)
c. Current sensor 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. Power requirements: Self powered induced from line
e. Accurate to 0.5% full scale
f. Output: 4-20mA
g. Manufacturer: Veris - Hawkeye H720

9. Digital Output Current Switch
a. Typical installations used for the determination of fan and pump motor status points in remote starter enclosures.
b. 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.
c. Power requirements: Self powered induced from line
d. Adjustable setpoint 2.5-135A
e. Output: One normally open contact; 1 A rating at 30VAC/VDC
f. Manufacturer: Veris - Hawkeye H908

10. Digital Output Current Switch (Variable Frequency Drive Applications)
a. Typical installations used for the determination of VFD driven fan and pump motor status points in remote starter enclosures.

b. Self-adjusting setpoint, automatic compensation for effects of frequency and amperage changes related to VFD
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. Power requirements: Self powered induced from line
e. Output: One normally open contact; 0.1 A rating at 30VAC/VDC
f. Manufacturer: Veris - Hawkeye H904

11. Digital Output Current Switch (Electronically Commutated Moter (ECM) Applications)
    a. Typical installations used for the determination of ECM controlled fan and pump motor status points in remote starter enclosures.
    b. Adjustable minimum turn-on to prevent false trip due to ECM stand-by current
    c. Current sensing switches shall be split core.
    d. 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.
    e. Power requirements: Self powered induced from line
    f. Output: One normally open contact; 1.0 A rating at 30VAC/VDC
    g. Manufacturer: Senva C-2320-L-ECM

12. Occupancy Sensors
    a. Occupancy sensors shall be provided to interface with the DDC system as described in Sequence of Operations.
    b. Occupancy Switch can be combined with space temperature sensor. Sensor shall use either passive infrared or ultrasonic technology with sensitivity adjustment
    c. Power requirements: 24 VDC
    d. Output: 2 Form C contacts; 1 A rating at 24VDC
    e. Manufacturer:

13. Water Leak Detection Sensors - Point
    a. Water leak detection sensors shall be provided to interface with the DDC system as shown on Control Drawings.
    b. Sensors: Shall be comprised of two gold-plated sensing probes for corrosion resistance and microchip technology for dependable and accurate detection of conductive liquids. Supervised operation—signals on leak detected, circuit failure or power loss
    c. Power requirements: 24 VAC/VDC, 100mA, 50/60Hz, 3 VA (max)
    d. NEMA 1 Enclosure
    e. Output: 2 Form C contacts; 3 A rating at 24VAC
    f. Manufacturer: Emerson, Liqui-tect

14. Water Leak Detection System - Areas
    a. Provide advanced system water leak detection system for detecting water in individual area and area floor drain as reflected in drawings.
    b. The liquid sensing cable shall detect the presence of water and other conductive liquids. The cable shall consist of four wires: two wires serve as liquid sensors and two other wires serve as continuity and alarm signal links. All four wires shall be helically winded around a central core

(function as carrier) and away from the surface area of this core (to protect the four wires physically). The cable shall be made of material which is non-flame propagating and self-extinguishing.

c. The sensing cables shall be of such construction that no metallic parts shall be exposed to the environment. The system shall be provided with the flexibility of custom "cut-to-length" sensing cable to meet the exact length requirement at each AHU gallery and with pre-connectors sensing cable components. The cable shall be UL listed and FM approved.

d. Provide all mounting clips and accessories for a complete system.

e. Sensing cable in each area shall be connected to its independent detection system via leader cable. System shall consist of a main control panel and interface modules. Each main panel system (mounted on wall) shall provide a dry contact upon detection of water in floor drain to BMS. Each main panel system shall be capable of monitoring up to 5000 ft of sensing cable.

f. Main Panel:
   1) Summary relay contacts, LED status lights, LCD information display at the panel.
   2) Standard external interface modes include:
      a) dry contacts
      b) BACnet MSTP communication.
   3) Event history accessible from the front panel or via serial port to identify type of event, time, location, and other parameters for all sensor events or user adjustments and interventions.
   4) Layered password protection for setup changes.
   5) Adjustable sensitivity and selectable measurement units.
   6) Universal power supply for 120/240 Vac 50/60 Hz.
   7) Non-volatile memory for event history, setup and network configuration.
   8) Precision to locate leak: ± 0.5% maximum of circuit length.

g. Interface / Auxiliary Module:
   1) Monitor up to 500 feet (150 meters) of sensing cable.
   2) Precision: 0.5% of sensor length ±2 ft (0.6m).
   3) Voltage-free contact for alarm signaling.
   4) LED indicators.
   5) Serial connection between modules and main panel up to 4000 feet witout amplification.
   6) Power supplied by Main panel.
   7) Provide with NEMA 4 enclosure.

h. Leak detection system panel shall be able to operate between within 32 deg F (0 deg C) to 122 deg F (50 deg C) and 5 to 95% RH. Provide laminated or framed (glass or plastic protective cover) leak detection identification map indicating the leak detection system layout with reference points. Install a map in each associated area.

i. Approved Manufacturers
   1) Trace Tek (Raychem)
   2) ELSA
   3) Liebert

4) Pentair
5) Approved equal

15. Window Position Switches
    a. Provide and install window switches according to design drawings and manufacturer installation requirements.
    b. Coordinated installation with Architect
    c. Get written approval of final selection and installation method of devices with architect
    d. Manufacturer - Sentrol
    e. Model- Guardswitch Series 100

16. Door Switches
    a. Provide and install door switches according to design drawings and manufacturer installation requirements.
    b. Coordinated installation with Architect
    c. Get written approval of final selection and installation method of devices with architect
    d. Manufacturer – United Security
    e. Model- SP3000A

G. Automatic Control Valves

1. Control valves assemblies shall be provided and delivered from a single manufacturer as a complete assembly.
2. The manufacturer shall warrant all components for a period of 5 years from the date of production with the first two years unconditional.
3. Characterized Control Valves - Modulating
    a. Control valves shall be globe or characterized ball valves.
    b. A TEFZEL flow-characterizing disc shall be installed in the inlet of two-way characterized control valves and in the control port of three-way valves. The valve trim shall utilize a stainless steel ball and stem for all water or glycol solutions up to 60%. For water applications, an optional chrome plated brass ball and brass stem may be used for sizes ¾” and smaller.
    c. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1 ¼” shall be rated at 600 psi and sizes 1 ½” to 3” at 400 psi.
    d. Characterized Control Valves shall have a self-aligning, blowout proof, brass stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon seats shall be used.
    e. The valves shall have a four bolt mounting flange to provide a 4 position, field changeable, electronic actuator mounting arrangement.
    f. A non-metallic coupling, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

4. Two Position Control Valves
    a. Control valves shall be globe or ball valves.
    b. Line size full ported valves shall be used to minimize pressure drop.

c. The valve trim shall utilize a stainless steel ball and stem for all water or glycol solutions up to 60%. For water applications, an optional chrome plated brass ball and brass stem may be used for sizes ¾" and smaller.
d. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1 ¼" shall be rated at 600 psi and sizes 1 ½" to 3" at 400 psi.
e. Valves shall have a self-aligning, blowout proof, brass stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon seats shall be used.
f. The valves shall have a four bolt mounting flange to provide a 4 position, field changeable, electronic actuator mounting arrangement.
g. A non-metallic coupling, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

5. Valve Actuators:
a. Valve actuators shall be electric, and properly selected for the valve body and service. Actuators shall be fully proportioning and be fail in place, spring return for fail open or fail closed operation as specified. Floating control actuators shall not be acceptable.
b. The controls contractor shall provide control power transformers for valve actuators for low voltage operation as required.
c. If upon contractor's final sizing of valve and actuators it has been determined that the power required for the assembly exceeds the power available from the BMS control panel, the contractor shall coordinate with the Div. 26 contractor for additional power.
d. Manufacturer:
1) Belimo

6. Thermostatic radiator valve
a. Assembly shall be selected to maintain room temperature within ±1°F.
b. The operator shall be of a bellows design with a vapor or liquid charge and shall be connected to the valve via a snap-on fast mounting system or secured by an Allen screw.
c. The thermostatic operator shall be capable of temperature adjustment between 45° and 86°F (7 and 30°C) and be locked and limited by the use of limiting pins or internal mechanism.
d. The valve shall be of nickel plated brass construction with a fully replaceable packing gland capable of replacement while the system is in operation. The valve disc shall be constructed of EPDM, capable of withstanding 250°F (121°C).
e. Provide a separate remote wall mounted dial and remote sensor (as applicable).
f. The thermostatic radiator valve and accessories shall be Danfoss or an approved equal.

H. Dampers

1. Motorized Control Dampers

a. Motorized Control Dampers shall have 13 gauge galvanized frames of not less than 3" in width and blades of 16 gauge, or double 22 gauge, galvanized steel and shall be adequately braced to from a rigid assembly where required in galvanized ductwork. Dampers shall have blades not more 8" wide. Linkage and hardware shall be zinc plated steel. Damper blades and rods shall be installed in horizontal position.
b. All dampers shall be of the opposed blade type, and shall be electric motor operated. Dampers shall have continuous elastomer or stainless steel stops to avoid leakage. Bearings shall be oil tight non-ferrous sleeve type. All dampers shall be provided with continuous 3/16" x 1/2" closed cell neoprene gasketing around perimeter of the frame and at interlocking blade edges to form an airtight seal.
c. All dampers shall be constructed to provide a maximum leakage in accordance with ASHRAE/IES 90.1 and tested to ANSI /AMCA Std 500. Submit leakage and flow characteristic data for all dampers.
d. All outside air dampers shall automatically close in the event of a loss of power, unless otherwise noted.
e. Outdoor air applications in costal environments shall be provided with TAMCO SW (saltwater), Ruskin CE or approved equal, construction features
f. Dampers shall be Imperial, Ruskin or approved equal.

2. Damper Operators:
   a. Damper operators shall be electric, spring return or fail in place, and shall be properly sized so as to stroke the damper smoothly and efficiently throughout its range. Actuator response shall be linear in response to sensed load.
   b. The controls contractor shall provide control power transformers for damper actuators for low voltage operation as required.

3. Damper End Switches
   a. Damper end switches shall comprise of high temperature micro switches, mercury switches are not acceptable.
   b. Damper end switch shall comprise of one switch which closes when the blades are fully open and the second switch closes when the blades are fully closed
   c. Damper end switches shall be provided for each actuator controlled damper section. If more than one end switch is provided for a damper assembly, the wiring of damper section end switches in parallel is acceptable.
   d. Manufacturer: Ruskin

I. Electrical metering devices

1. Division 26 shall provide electrical meters which shall provide inputs to the BMS via a Modbus or BACNET communications protocol. Refer to Division 26 specifications for additional details as to the data being monitored. The interface shall allow for full monitoring of the device encompassing multiple inputs to the BMS.

J. Field Equipment Cabinets:

1. All indoor control cabinets shall be fully enclosed NEMA 1 (minimum, see NEMA rating for enclosures within this specification) construction with (hinged door) key-lock latch and removable sub panels. A single key shall be common to all field panels and sub panels. All transformers, electric relays, manual override switches, etc., shall be mounted within the enclosure and factory wired to terminal strips.
2. Interconnections between internal and face mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service (or in accordance with line voltage), individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.
4. Provide 6" x 6"trough the width of the control panel, minimum 24" in length, above the control panel to provide an entrance for cabling and tubing into the panel, with 50% spare nipple capacity.
5. Panels shall be located to avoid conflicts with ductwork, piping, equipment, the work of other trades, and building conditions. Panel locations indicated on the Drawings shall be coordinated prior to installation and adjusted to avoid conflicts.

K. Test and Calibration Equipment

1. All necessary calibration and testing equipment shall be provided to perform the testing, commissioning and acceptance testing as part of the deliverable.

L. Component Tags

1. Valve Tags:
   a. All automatic and manual valves provided by this contractor, shall be identified with 2" diameter brass tags and brass chains. Lettering shall be 1/2" high, stamped and painted black. Automatic valve tags shall be stamped with the letters "AV" and sequentially numbered. Provide valve schedule and sample tags for approval.
2. Sensor Tags:
   a. All sensors/instruments shall be identified with 1"x 3" black lamacoid labels with engraved white lettering. Lettering shall be 1/4" high. Provide sensor number, Air handling unit number/pump/source equipment (as relevant), part number and sensor range on tag.

PART 3 - EXECUTION

3.1 Building MANAGEMENT SYSTEM - GENERAL

A. Space mounted devices are to be identical in appearance. All devices shall be mounted under the same style cover.

B. Provide all relays, switches, sources of electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified.

C. Install controls so that adjustments and calibrations can be readily made.

D. Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.

E. Conceal control conduit and wiring in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install control conduit and wiring in parallel banks with all changes in directions made at 90 degree angles.

F. Install control valves horizontally with the power unit up. Installation of control valves will be by the Division 23 Contractor.

G. Unless otherwise noted, install wall mounted sensors, thermostats and humidistats at 5'-0" above the finished floor measured to the centerline of the instrument. Submit device locations, mounting heights and details for approval.

H. Install outdoor thermostats in perforated tube and sun shield or engineer approved installation assembly designed for application.

3.2 PNEUMATIC TUBING & INSTALLATION

A. Concealed spaces: Pneumatic tubing shall be polyethylene tubing.

B. Exposed: Where pneumatic tubing is installed in exposed areas susceptible to damage (i.e., located outdoors, exposed to heavy pedestrian or maintenance traffic), tubing shall be polyethylene tubing installed in conduit.

C. Splicing of pneumatic tubing is not acceptable.

3.3 SENSOR TUBING & INSTALLATION

A. Concealed spaces: Tubing shall be copper tubing.

B. Exposed: Where tubing is installed in exposed areas susceptible to damage (i.e., located outdoors, exposed to heavy pedestrian or maintenance traffic), tubing shall be installed in conduit.

3.4 ELECTRICAL INSTALLATION

A. General

1. For conduit support and installation of wires and cables see applicable paragraphs of the latest edition of the NEC.

B. Raceways and Conduit

1. All conduit/cable entry to control panels shall be from the bottom or sides to prevent condensation from draining into electronic equipment contained within.
2. Conduit / EMT percent fill shall not exceed maximum NEC allowable fill.
3. Use liquid tight flexible metal conduit for making connections at instruments and devices mounted on piping or vessels or on equipment subject to vibration.

C. Wiring

1. Line voltage wiring, concealed or exposed, shall be installed in accordance with Division 26, local electrical code and the NEC.
2. Low voltage data transmission wiring, except the primary peer-to-peer communications trunk,
   a. installed in concealed, accessible areas shall be plenum rated cable
   b. installed in concealed, non-accessible areas shall be installed in EMT(metal).
   c. installed in exposed areas, such as mechanical equipment rooms, shall be installed in EMT(metal).
3. Peer-to-peer communications including trunk low voltage data transmission and wiring between controllers shall be installed in EMT(metal).
4. Cables for 120/24 VAC wiring and low level signal wiring shall always be run in separate raceways.
5. Wire splices within conduit are prohibited under any circumstances.
6. All smoke control wiring including Fire Alarm System Relay and Monitoring Modules shall be in accordance with Division 26.
7. All wiring shall be in accordance with this specification and Division 26, including tagging, labeling and identification.
8. Controllers shall be provided with an independent terminal strip for field wiring. All control wiring internal to the panel landing direct on I/O will be done through a terminal strip. Under no circumstances will field wiring be terminated from inputs or outputs direct to the I/O controllers.

D. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements.

3.5 SEQUENCE OF OPERATIONS

A. Initial Space Setpoints – Unless otherwise noted in Sequence of Operations.

	COOLING	**HEATING**

Room Type	Temperature Setpoint (Cooling) Deg F		Temperature Setpoint (Heating) Deg F	
	Occupied	Vacancy Setback (if applicable)	Occupied	Vacancy Setback (if applicable)
Garages	N/A	N/A	60	N/A
MEP	75	80	68	60
Closets/Storage Rooms	75	80	68	60
Health Club/waiting room	72	80	68	60
Conference/meeting rooms	72	80	68	60
Office Spaces	72	80	68	60
Corridors	75	80	68	60
Locker/Dressing Rooms	75	80	68	60
Dormitory/Sleeping Areas	72	80	68	60

B. ASP and Slab Heating Radiant System
   1. General:
      a. The Heating Hot Water System is comprised of a modular ASHP, capable of providing heating hot water (HHW) to the slab. The system is arranged in a variable primary / variable secondary system.
      b. The ASHP system shall be provided with a master controller capable of staging the heat pump modules and the production of the HHW at setpoint. The BMS shall enable/disable the ASHP based on the required operation.
      c. The system shall monitor space temperatures.
      d. The system shall include both BMS and OEM Slab Temperature Controller (Tekmar or equal) to provide the functions depicted on the mechanical and control design drawings.
      e. The OEM controller shall be integrated to the BMS, contractor to coordinate with approved submittals and provide all necessary hardware, and programming to integrate.
   2. System Equipment
      a. Packaged 2 pipe Air Source Heat Pump modular system with OEM master controller and two modules.
      b. HHW Pump 1, Duty, ECM, 0% speed output - ASHP.
      c. HHW Pump 2, Duty, ECM, 0% speed output - Slab.
      d. 3 Way Blending Temperature Control valve, modulating type, fail in place, normally open to HHW recirculation.
   3. System off:
      a. When the system is off all valves, pumps, and control devices shall be in their normal positions.
   4. System on:

a. The system shall be started based on a call for space heating or manually via the BMS.
b. Once the system is started, the BMS shall
   1) Start HHWP 1 and ramp pump to minimum speed
   2) Start HHWP 2 and ramp pump to minimum speed
   3) Send an enable signal to the ASHP.
c. Once complete the BMS shall initiate HHW differential pressure, flow and temperature control sequences.

5. HHW Differential Pressure Control - ASHP HHW
   a. The HHWP 1 shall ramp up to speed and modulate to meet the ASHP water differential pressure setpoint (adj.). DP setpoint to be coordinated with the ASHP approved submittal manufacturer specific requirements, initially set to 2 psi(adj.).
6. HHW Flow Control - Slab
   a. The HHWP 2 shall ramp up to speed setpoint, setpoint to be coordinated with testing and balancing contractor.
7. HHW Temperature Control – Space Temperature
   a. The BMS shall upon proof of HHWP 2 flow, modulate the three way temperature control blending valve to meet the HHW supply temperature as measured upstream of the slab manifolds. The HHW setpoint shall be set initially to 100.
8. Alarms
   a. Space temperature is below 50 DegF (Adj.)
   b. The system pressure monitored at expansion tank shall be monitored by the BMS. On indication of a low or high pressure condition 10% deviation from setpoint an alarm will be generated on the bms workstation.
   c. The BMS shall monitor the ASHP common alarm.
   d. The BMS shall monitor the Glycol Feeder common alarm.

C. DX Packaged Air Handling Unit (DOAS-X) (OEM Controller)
1. General
   a. Packaged unit, normally off.
   b. System shall be controlled via manufacturer provided controller.
   c. BMS shall integrate to controller via BACnet or Modbus, final protocol to be determined based on approved shop drawings.
2. System Off
   a. When the system is off, all devices shall be in their normal position as stated above.
3. System Start Up
   a. The system shall be enabled via the BMS based on a time of day schedule or manual command from the BMS workstation.
   b. Whenever the system is called to run, a request to run signal (unique to system) shall be sent to the FAS. the FAS shall then command all associated FSD'S to their open position.
   c. The manufacturer provided controller shall operate the unit to meet the supply air temperature setpoints (adj – provided via the BMS) and humidity setpoints (adj – provided via the BMS) and supply and exhaust duct static pressure (adj – determined during testing and balancing).

d. The manufacturer provided controller shall include programming for fire alarm system request to run, morning warmup, and morning cooldown modes.

4. Alarms
   a. The BMS shall monitor the unit status and common alarms, in addition to any alarms provided via integration.

D. Energy Recovery Ventilator (ERV-X) (OEM Controller)
1. General
   a. Packaged unit, normally off.
   b. System shall be controlled via manufacturer provided controller.
   c. BMS shall start and stop the ERV via hardwired control to the OEM controller.
2. System Off
   a. When the system is off, all devices shall be in their normal position as stated above.
3. System Start Up
   a. The system shall be enabled via the BMS, based on a time of day schedule or manual command from the BMS workstation.
   b. The manufacturer provided controller shall operate the unit to meet the supply and return constant air flow control.
4. Alarm
   a. Status mismatch –
      1) Fan is commanded on and the fan status is off as determined by the current sensor.

E. VRF FCU SERVING BOH SPACES TYPICAL
1. The system shall be controlled via manufacturer provided thermostats, occupancy sensor (As Applicable), gas detection, leak sensor and controllers furnished with the unit.
2. BMS integration:
   a. The unit controller shall be integrated with the BMS
   b. The following points shall be provided with direct control from the BMS over the integration
      1) System enable
      2) Cooling setpoint and setback
      3) Heating setpoint and setback (If applicable)
   c. The BMS shall be programmed for occupied and unoccupied time determination of the spaces served. The schedule is to be initially set for the following;
      1) Occupied - Monday through Friday (6am to 6-pm)
      2) Unoccupied - at all other times.
   d. Temperature setpoints are to be as follows;
      1) Scheduled Occupied cooling: 75 °F(adj.)
      2) As- Applicable - Standby cooling: 77 °F(adj.) (Occupancy Sensor Based)
      3) Scheduled Unoccupied cooling: 80°F(adj.)
      4) Scheduled Occupied heating: 70 °F(adj.) (If applicable)
      5) As- Applicable - Standby heating: 67 °F(adj.) (Occupancy Sensor Based)

6) Scheduled Unoccupied heating: 60 °F(adj.) (If applicable)

e. Temperature control:
1) On a call for cooling, the manufacturer's controller shall begin to modulate fan speed and refrigerant flow to the DX coil unit in order to control to the cooling setpoint.
2) On a call for heating, the manufacturer's controller shall begin to modulate fan speed and refrigerant flow to the DX coil unit in order to control to the heating setpoint. (If applicable)
3) The mfr controller shall automatically energize the outdoor condensing unit to accommodate the temperature control requirements.

3. The BMS shall be monitor space temperature via space thermostat
4. The zone shall be monitored by OEM provided occupancy sensors (As- Applicable - refer to mechanical plans for applicability). The zone shall be indexed to the standby setpoint during scheduled occupied mode if occupancy is not detected for a period of 30 minutes (adjustable).
5. The BMS shall be monitor space temperature via space thermostat
6. Each unit shall be equipped with a high-level water sensor in the condensate pan Leak detection shall be provided by the manufacturer. If the sensor is tripped the unit shall automatically shut down.
7. Additional monitoring and alarms:
a. Normal Alarms:
1) Space temperature is {5°F} lower than the setpoint for {15 consecutive minutes}.
2) Space temperature is {5°F} higher than the setpoint for {15 consecutive minutes}.

F. VAV AND EVAV SERVING VRF TYPICAL

1. For operation of VRF refer to VRF FCU SERVING BOH SPACES TYPICAL sequence.
2. VAV - Exhaust VAV With VAV Flow Offset
a. SUMMARY
1) Variable air volume (EVAV), modulating type, fail last position.
2) The VAV consists of an exhaust air volume damper and pressure pick-up probes for airflow measurement.
b. The local VAV controller shall control the airflow to each CAV terminal box. Each terminal box shall be programmed for a design flow setpoint as measured by a flow sensor.
c. Provide a time of day schedule for each CAV. Initially set each schedule for Occupied during building business hours and Unoccupied at all other times and coordimnate with VRF schedule.
d. The terminal box flow shall be indexed to the unoccupied flow setpoint during unoccupied hours in accordance with the mechanical schedule.
e. The terminal box flow shall be indexed to the occupied flow setpoint during occupied hours in accordance with the mechanical schedule.
f. Demand Control Ventilation – Applicable to zones with CO2 Sensors
1) During Occupied mode, BMS will generate Demand Control ventilation signal based on current zone CO2 level and zone CO2

setpoint. Zone CO2 setpoint will be equal to 600 PPM plus the outdoor air CO2 concentration.

2) As DCV control signal increases from 0% to 100%, BMS will reset active zone minimum supply air CFM limit from scheduled minimum to scheduled maximum CFM.

g. ALARMS

1) Space CO2 level, if monitored, is higher than {1000 PPM} for {15 consecutive minutes}.
2) Supply Air temperature is {5°F} lower than the setpoint for {10 consecutive minutes}.
3) Supply Air CFM is {10%} higher than the setpoint for {15 consecutive minutes}.
4) Supply Air CFM is {10%} lower than the setpoint for {15 consecutive minutes}.

3. EVAV - Exhaust VAV With VAV Flow Offset

a. SUMMARY

1) Exhaust variable air volume (EVAV), modulating type, fail last position.
2) The EVAV consists of an exhaust air volume damper and pressure pick-up probes for airflow measurement.

b. OPERATION

1) BMS shall modulate the airflow from each EVAV. Each EVAV shall be programmed for design flow setpoint as measured by a flow sensor.
2) The EVAV operating schedule is to be coordinated with the VAV serving the space.
3) When the VAV is in operation, the EVAV box shall index to the VAV airflow minus a scheduled offset. Offset shall initially be set to 50CFM (adj.) Final value to be coordinated with TAB contractor to provide slight negative pressurization to the space.
4) When the VAV is closed, the exhaust VAV box shall be closed.

c. ALARMS

1) Exhaust Air CFM is {10%} higher than the setpoint for {15 consecutive minutes}.
2) Exhaust Air CFM is {10%} lower than the setpoint for {15 consecutive minutes}.

G. VAV and EVAV serving VRF, And Window/Door Switches Typical

1. For operation of system see VRF FCU SERVING BOH SPACES and VAV AND EVAV SERVING VRF sequence.
2. Window and door switches have been provided as noted on design drawings. Upon window or door switch proving open the associated VRF serving the space shall be disabled. VRF to be reenabled upon space temperature falls below low temperature setpoint, initially set to 50 Deg F (adj.).
3. Alarm

1) Space air temperature is at low temperature setpoint for {5 consecutive minutes}.

H. Exhaust Fan (Starter) – EF-01
   1. This sequence of operations applies to each of the following exhaust fans:
      a. EF-01
   2. General
      a. Exhaust Fan, constant speed, off.
      b. Exhaust air isolation damper, two position type, normally closed, fail closed (Only if damp applicable)
   3. System Off:
      a. When the system is off, the exhaust fan and damper shall be in the normal position as stated above.
   4. System On:
      a. Exhaust fan shall be started based on a time-schedule program resident in the BMS, or manually by an operator. The time-schedule program shall be adjustable at the operator workstation. Time schedule shall be as coordinated with the owner.
      b. When the exhaust fan is enabled, its exhaust air isolation damper shall open. Once the damper proves open, the fan shall be permitted to start.
      c. Exhaust fan shall operate at a constant speed.
   5. Fan status shall be monitored at the BMS via a current sensor.
   6. Maintenance alarms are generated at the operator workstation when:
      a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor
      b. Damper Mismatch (isolation dampers):
         1) Position feedback and damper command disagree for more than 120 seconds (adj).

I. Diesel Exhaust Extraction System (Exhaust Fan (Starter) – EF-02
   1. This sequence of operations applies to each of the following exhaust fans:
      a. EF-02
   2. General
      a. Exhaust Fan, constant speed, off.
      b. Exhaust air isolation damper, two position type, normally closed, fail closed (If applicable)
   3. System Off:
      a. When the system is off, the exhaust fan and damper shall be in the normal position as stated above.
   4. System On:
      a. Exhaust fan shall be started by an OEM controller/starter serving the vehicle exhaust extraction system.
      b. Exhaust fan shall operate at a constant speed.
   5. Fan status shall be monitored at the BMS via a current sensor.
   6. Maintenance alarms are generated at the operator workstation when:
      a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor
      b. Damper Mismatch (isolation dampers):
         1) Position feedback and damper command disagree for more than 120 seconds (adj).

J. Motorized Modulating Dampers
   1. Motorized modulating dampers shall be controlled by the BMS.

2. Damper position shall be monitored by the BMS.
3. Alarms & Additional Monitoring:
    a. Damper Position Deviation:
        1) Difference between damper command and position feedback deviates beyond ±10% (adj) for 10 minutes (Adj)
        2) Generate Alarm to BMS

K. Motorized Isolation Dampers
1. Motorized isolation dampers shall be controlled by the BMS.
2. Damper end switches shall be monitored by the BMS.
3. Alarms & Additional Monitoring:
        1) Damper Mismatch (isolation dampers):
            a) Position feedback and damper command disagree for more than 120 seconds (adj).
            b) Generate Alarm to BMS

L. Kitchen System

1. For operation of system see VRF FCU SERVING BOH SPACES and VAV AND EVAV SERVING VRF sequence.
2. Space includes a kitchen exhaust hood.
3. The BMS shall monitor operation of kitchen exhaust hood via a current switch. Upon the hood proving operational via the current sensor status the VAV shall be ramped to 600 cfm (Adj.) and the EVAV shall be closed.
4. Upon the kitchen hood being off, the VAV and EVAV shall return to normal operation.
5. The space shall also be provided with a self-controlled space heater, the BMS shall monitor the status of the heater via a current sensor.

M. Laundry Room Controls

1. For operation of system see VRF FCU SERVING BOH SPACES and VAV AND EVAV SERVING VRF sequence. No EVAV is provided as part of this system, sequences relating to EVAV are to be ignored.
2. Space includes a dryer.
3. The BMS shall monitor operation of dryer via a current switch. Upon the dryer proving operational via the current sensor status the BMS shall initiate the following;
    a. The exhaust fan shall be turned on.
    b. The VAV shall be ramped to 400 cfm (Adj.).
4. Upon the dryer being off, the exhaust fan shall be turned off and the VAV shall return to normal operation.
5. The space shall also be provided with a self-controlled space heater, the BMS shall monitor the status of the heater via a current sensor.
6. Maintenance alarms are generated at the operator workstation when:
    a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor

N. PPE Drying Room Controls

1. For operation of system see VRF FCU SERVING BOH SPACES and VAV AND EVAV SERVING VRF sequence.
2. Space includes a dehumidifier and a recirculation fan.
3. The dehumidifier system is enabled by the BMS and operates on a single interlocked "Drying Mode."
4. Upon the space dewpoint exceeding setpoint: 55 Deg F Dewpoint (Adj.) the BMS shall initiate the following.
   a. Circulator Fan is turned on.
   b. Exhaust Fan is turned on.
   c. Dehumidifier is turned on (enabled).
   d. VRF system Room temperature setpoint changed to 80F
   e. VAV flow setpoint changed to 300 CFM
   f. EVAV flow setpoint changed to 0 CFM
5. Upon the space dewpoint less than setpoint: 52 Deg F Dewpoint (Adj.) for 5 minutes the BMS shall initiate the following.
   a. Circulator Fan is turned off.
   b. Exhaust Fan is turned off.
   c. Dehumidifier is turned off (disabled).
   d. VRF system Room temperature setpoint changed to back to 75F in summer, 68F in winter.
   e. VAV flow setpoint changed to 110 CFM
   f. EVAV flow setpoint changed to 160 CFM
6. The Dehumidifier shall be provided with a Condensate Pump High-Level Switch, upon activation the dehumidifier shall be turned off. The BMS shall monitor the alarm and announce at the BMS.
7. Maintenance alarms are generated at the operator workstation when:
   a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor

O. Gas Detection System and Exhaust Fan (EF-3)
   a. System Equipment
      1) Gas Detection system, comprising of sensors and horn strobes.
      2) Exhaust Fan EF-3, VFD, 0% speed output.
      3) Makeup air isolation damper, two position type, normally closed, fail closed
   b. System Operation
      1) The Gas Detection System (GDS) shall continuously monitor carbon monoxide (CO) and nitrogen dioxide (NO_2) levels in the garage areas. It shall control the operation of the exhaust system fan based on gas concentration thresholds.
      2) The Gas Detection System (GDS) system shall sense for high levels of CO and NO2 gases from the cars and trucks in the garage areas.
      3) The system shall for a high level detection alarm activate the exhaust system and high level detection alarm which shall alarm locally and generate a BMS alarm at the BMS workstations.
      4) The CO and NO2 ppm settings for the level alarms shall be programmable.
      5) In the event of a high level alarm, makeup isolation air damper shall be opened, the exhaust system (EF-3) shall be ramped up to

setpoint to achieve design flow, contractor to coordinate with testing and balancing contractor to determine proper VFD setting.

6) The BMS shall monitor the running status of the exhaust system via a current sensing relays and damper end switches.
7) In the event of a high high level alarm, the exhaust system shall continue to run at 100% and the horn / strobe shall be activated. The system shall not be re-set until the system is re-set and the BMS operator has and cleared the alarm event.
8) The system shall not be reset until the system is reset and the BMS operator has acknowledged and cleared the alarm event.

c. Maintenance alarms are generated at the operator workstation when:
1) Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor
2) Damper Mismatch (isolation dampers):

a) Position feedback and damper command disagree for more than 120 seconds (adj).

P. Destratification Fan – (Wall Switch)
1. General
a. Fan, normally off.
b. Wall mounted switch.
2. System Off:
a. When the system is off, fan shall be in its normal position as stated above.
3. System Operation:
a. The fan shall be started/ stopped by manual operation of the wall mounted switch.
4. Monitoring
a. BMS shall monitor fan status
5. Maintenance alarms are generated at the operator workstation when:
a. Fan Status mismatch – Fan is commanded on and the fan status is off as determined by the current sensor

Q. Electric Unit Heater
1. General
a. BMS shall monitor space temperature and heater status.
b. Wall mounted or integral space thermostat shall control the unit heater by either cycling on/off or modulating the heater SCR (Silicon-controlled Rectifier) to maintain the zone temperature at setpoint (adjustable), initially set to {55 deg F}.
2. ALARMS
a. The BMS shall generate an alarm if the space temperature is below {50 deg F} for {10 minutes}.

R. Emergency Generator
1. Generator control

a. Emergency Generators shall be controlled by the Generator Control System (GCS) provided under Division 26. The BMS shall not issue control commands to the generator.

2. BMS Monitoring
   a. The controls contractor shall coordinate with approved manufacturer shop drawings to identify available monitoring points. The BMS shall monitor and annunciate the following critical generator alarms as a minimum, refer to detail for additional requirements:
      1) Generator status (Running, Stopped, Fault)
      2) Engine alarms (Overtemperature, Low Oil Pressure, Overspeed, etc.)
      3) Battery status
      4) Fuel level
   b. All alarms shall be displayed on the BMS graphical interface and logged per the BMS alarm protocol.

S. Automatic Transfer Switch (ATS) Monitoring
1. ATS Control
   a. The Automatic Transfer Switch shall be provided under Division 26 and shall be controlled by the ATS manufacturer's control system. The BMS shall not issue control commands to the ATS.
2. BMS Monitoring
   a. The BMS shall monitor ATS status and alarms via available outputs provided by the ATS control panel. Monitoring points may include:
      1) Source availability (Normal/Standby)
      2) Transfer status (Source 1/Source 2)
      3) ATS position
      4) Alarm or fault conditions
3. The controls contractor shall coordinate with:
   a. Electrical design drawings for ATS quantities and locations
   b. Approved manufacturer shop drawings for available monitoring signals and interface requirements
4. Alarm Handling
   a. All ATS alarms shall be displayed on the BMS graphical interface and logged per the BMS alarm protocol. Alarm priorities shall reflect the critical nature of emergency power systems.

T. Outdoor Weather Station Monitoring
1. Sensor Integration.
   a. The BMS shall monitor the following environmental parameters via hardwired outputs from the outdoor weather station:
      1) Outdoor Air Dry Bulb Temperature
      2) Outdoor Air Relative Humidity
      3) Outdoor Air Carbon Dioxide (CO_2) Concentration
   b. The weather station shall be furnished and installed by the controls contractor. All sensor outputs shall be connected to the BMS for real-time monitoring and trending.
2. Installation Requirements
   a. The outdoor weather station shall be installed on the north side of the building, at a location free from direct sunlight, localized heat sources,

and obstructions to ensure accurate readings. Mounting height and shielding shall comply with manufacturer recommendations and industry best practices.

3. Data Utilization
    a. BMS shall use weather station data for:
        1) Economizer control logic
        2) Demand-controlled ventilation strategies
        3) Outdoor air quality monitoring
        4) Trending and diagnostics
4. Alarms
    a. Sensor failures or out-of-range values shall generate alarms per the BMS alarm protocol.

U. Fire Smoke Damper (FSD) Control and Monitoring Sequence
1. FSD Control
    a. Fire Smoke Dampers shall be controlled by the Fire Alarm System (FAS) in accordance with local code and life safety requirements. The BMS shall not override or interfere with FAS control logic.
2. FSD Monitoring
    a. The BMS shall monitor the status of each FSD via two discrete end switches:
        1) Open Position Switch
        2) Closed Position Switch
    b. The controls contractor shall provide wiring from each FSD to the BMS for status indication.
    c. Refer to contract drawings for quantities and locations.
3. Status Display and Alarming
    a. FSD status shall be displayed on the BMS graphical interface, showing:
        1) Damper position (Open/Closed)
        2) Fault condition (if applicable)
    b. Alarms
        1) The BMS shall generate an alarm if both switches indicate open and closed simultaneously (fault condition).
        2) The BMS shall generate an alarm if neither switch is active for more than 120 seconds.
    c. Alarms shall be logged and annunciated per the BMS alarm handling protocol.

V. Electrical Power Monitoring System
1. The systems shall be provided by Div 26 and monitored by the BMS:
    a. BMS shall monitor electrical power consumption at each electrical power meter.
    b. BMS shall integrate to meter via BACnet or Modbus, final protocol to be determined based on approved shop drawings.

W. Plumbing Water Meter - Typical
1. The systems shall be provided by Div 22 and monitored by the BMS:
    a. Water Meter – BMS shall monitor domestic water via pulsed input or analog input. To be determined based on final approved water meter shop drawings.

X. Fuel Oil System
   1. The Fuel Oil System shall be controlled by the dedicated Fuel Oil Control System (FOCS).
   2. The BMS shall not issue control commands to fuel oil pumps, valves, or tank level systems.
   3. BMS shall integrate to the fuel oil system via BACnet or Modbus, final protocol to be determined based on approved shop drawings.
   4. BMS Monitoring and Alarming
      a. The BMS shall monitor and annunciate the alarms from the Fuel Oil System components, refer to approved submittal for quantities and types of available alarms.

Y. Sump Pump (Plumbing)
   1. The Sump system shall be provided under Div 22 and monitored for alarms by the BMS.
   2. Controls contractor to coordinate with approved manufacturer shop drawings for available alarms.

Z. Recirculation Pump (Plumbing)
   1. The Recirculation Pump system shall be provided under Div 22 and monitored by the BMS.
   2. Controls contractor to coordinate with approved manufacturer shop drawings.
   3. Refer to contract drawings for quantities and locations.

AA. Hot box temperature monitoring
   1. General
      a. BMS shall monitor hot box temperature.
   2. Alarms:
      a. The BMS shall generate an alarm if the hot box temperature is below 40 Deg F (adj.) for 10 mins (adj.)

3.6 COMMISSIONING, TESTING AND ACCEPTANCE

A. Refer to Section 230593 for requirements of controls system testing and balancing to be carried out by an independent contractor.

B. The installation contractor shall perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets as contained in this specification or alternatively on commissioning data sheets as provided by the independent controls testing contractor and submitted for review prior to the work being carried out. Commissioning work, which requires shutdown of system or deviation from normal function, shall be performed when the operation of the system is not required. The commissioning must be coordinated with the Owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the Owner and construction manager are present throughout the commissioning procedure.

C. Field I/O Calibration and Commissioning

1. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications and approved shop drawings. Test, calibrate and bring on line each control sensor and device. Commissioning to include, but not be limited to:
   a. Sensor accuracy at 10, 50 and 90% of range.
   b. Sensor range.
   c. Verify analog limit and binary alarm reporting.
   d. Point value reporting.
   e. Binary alarm and switch settings.
   f. Actuator and positioner spring ranges.
   g. Fail safe operation on loss of control signal, electric power, network communications, etc.
2. Record calibration and test data on commissioning data sheets. Sufficient space should be provided near each point name for sign off.

D. System Program Commissioning

1. After control devices have been commissioned (i.e. calibrated, tested and signed off), each DDC program shall be put on line and commissioned. The contractor shall, in the presence of the Owner demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracies. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and retested.

E. Loop Tuning

1. The BMS contractor shall tune each control loop per ASHRAE Fundamentals IP. Tuning shall consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. The derivative portion of loops shall not be used unless field tuning is not possible without it.
2. For all control loops, the BMS contractor shall tune the loops to ensure the fastest stable response without hunting, offset, or overshoot with the tolerances defined below. Except from a startup, maximum allowable variance from setpoint for controlled variables under normal load fluctuations shall be as follows:
   a. Duct air temperature: ±1°F.
   b. Space temperature: +/- 3°F within 3 minutes and control within +/- 2°F.
   c. Chilled water temperature: +/- 1°F.
   d. Hot water temperature: +/- 2°F.
   e. Duct pressure: +/- 0.25" w.g.
   f. Water pressure: +/- 1 psid.
   g. Duct humidity: +/- 3 percent when adding humidity.
   h. Space humidity: +/- 5 percent when adding humidity to control.
   i. Terminal air flow control: +/- 5 percent of setpoint.

j. Space Pressurization: +/- 0.03" w.g. with no door or window movements.
k. Steam Pressure: +/- 3 psig.
l. Water Level: +/- 5 percent tank height.

3. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, the tolerances shall be maintained with exceptions as noted.
4. Loop tuning shall take place during periods of high gain.
5. Maintain a record of control loops that require tuning at alternate times of year.
6. Document all loop tuning by capturing text, short interval trends, or screen shots of trend graphs documenting the final response.
   a. Trend Logs:
      1) Trends logs are historical archives stored in the BMS that document the operation of the systems and equipment. Trends can be interval recordings of system I/O parameters or Change of Value based trends that record when a system value changes by more than a specified threshold.
      2) Sample times indicated as COV (±) or change of value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record.
      3) Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals.
      4) Trending Requirements: As described in previous sections
      5) Trending to document Sequence of Operation Tests may require a more frequent interval than final trending requirements. Coordinate with the CxA to determine the correct intervals to prove operational testing and modify intervals as required.
      6) The BMS contractor shall set up the trends logs, ensure they are being stored properly, and then, if requested by the CxA, forward the data in electronic format to the CxA. Data shall be forwarded in one of the following formats:
         a) Microsoft EXCEL Spreadsheet (.xls)
         b) Comma Separated Value (.csv or .txt) preferably with quotes delimiting text fields and # delimiting date/time fields
      7) The CxA shall analyze trend logs of the system operating parameters to evaluate normal system functionality.
      8) The BMS contractor shall allow the CxA BMS access to view the trend log data and allow downloading to a remote location. The BMS contractor shall also provide instruction for accessing the trend logs.
   b. Trend Graphs:
      1) Trend graphs are generally used to facilitate and document testing. The BMS contractor shall prepare controller and workstation software to display graphical trends.

2) On the trend graphs, lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.
3) Indicate engineering units of the y-axis values; e.g. °F, inches w.g., Btu/lb, percent wide open, etc. The y-axis scale shall beset such that all trended values are in a readable range.
4) Trend outside air temperature, humidity, and enthalpy during each period in which any other points impacted by these parameters are trended.
5) All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend interval. On renovation projects with existing to remain controls on air or water generation equipment, these trend graphs need only address the new BMS renovation work.
6) Each graph shall be clearly labeled with HVAC subsystem title, date, and times.
7) The BMS contractor shall forward the trend graphs as part of the CxA BMS Pre-Requisite Package to the CxA for review.

F. Integrated System Commissioning:

1. After all DDC programs have been commissioned, the contractor shall verify the overall system performance as specified. Tests shall include, but not be limited to the following:
2. Data communication, both normal and failure modes.
3. Fully loaded system response time.
4. Impact of component failures on system performance and system operation.
5. Time/Date changes.
6. End of month/ end of year operation.
7. Season changeover.
8. Global application programs and point sharing.
9. System backup and reloading.
10. System status displays.
11. Diagnostic functions.
12. Power failure routines.
13. Battery backup.

G. Acceptance Testing

1. Submit for approval, a detailed acceptance test procedure designed to demonstrate step by step testing of all BMS related sequences, systems and equipment, integration with external systems and compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure, in addition to the testing described above the testing will verify that sensors and control devices maintain specified accuracies and the system performance does not degrade over time.
2. Using the commissioning test data sheets, the contractor shall demonstrate all point types as required by Owner/engineer. The contractor shall supply all instruments for testing and turn over same to the Owner after acceptance testing.
   a. All test instruments shall be submitted for approval.

H. Test instrument accuracy

Temperature:	1/4°F or 1/2% full scale, whichever is less.
High Pressure (psi):	1/2 psi or 1/2% full scale, whichever is less.
Low Pressure (in w.c.):	1/2% of full scale
Humidity:	2% RH
Electrical:	1/4% full scale

1. Test instruments to be factory calibrated with calibration certificates provided valid at least 6 months from installation.

I. Commissioning Testing Support

1. System verification testing is part of the Commissioning Process.
2. Verification testing shall be performed by the contractor and witnessed and documented by the Engineer.
3. The commissioning process requires detailed O&M documentation.
4. The controls contractor shall assist the commissioning authority with performing verification and performance testing. This includes the following:
   a. Attend Commissioning (Cx) progress and coordination meetings.
   b. Prepare and submit required draft forms and systems information.
   c. Establish trend logs of system operation as specified herein.
   d. Demonstrate system operation.
   e. Manipulate systems and equipment to facilitate testing.
   f. Provide instrumentation necessary for verification and performance testing.
   g. Manipulate control systems to facilitate verification and performance testing.
   h. Provide a BMS technician(s) to work at the direction of the commissioning authority for software optimization assistance.
5. Software Optimization Assistance
   a. At no additional cost to owner, controls contractor will provide the services of a BMS technician as specified above at the project site and at the disposal of the commissioning authority and owner. The purpose of this requirement is to make changes, enhancements, and additions to the control unit and/or workstation software that have been identified during the construction and commissioning of the project in order to complete functional testing and the integrated systems test.
   b. The BMS technician will be thoroughly trained in the programming and operation of the controller and workstation software. If the BMS technician provided cannot perform every software task requested by the commissioning authority and owner in a timely fashion, the controls contractor will provide additional qualified personnel at the project site in order to meet the total specified requirements on-site.

J. Verification Testing

1. System verification testing is part of the Commissioning Process. Verification testing shall be performed by the contractor and witnessed and documented by

the Engineer. The commissioning process requires detailed O&M documentation.

3.7 CLOSEOUT

A. Substantial completion requirements:

1. Provide final cleaning immediately prior to substantial completion inspection.
2. Corrective work:
   a. Remove, repair and reinstall, or restore in place damaged items.
   b. Replace damaged materials or items with new if repair not acceptable to Architect.
3. Provide product data to complete operation & maintenance manuals.
4. Submit executed warranties.

3.8 DEVICE AND INPUT/OUTPUT SCHEDULE

A. Refer to design drawings for device and input/output schedules.

END OF SECTION 230923

SECTION 23 35 33

LISTED KITCHEN VENTILATION SYSTEM EXHAUST DUCTS

(Part of Work of Section 23 00 01 – MECHANICAL, Trade Bid Required)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Listed grease ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for listed grease ducts.

B. Shop Drawings: For listed grease ducts.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in listed grease ducts and field-fabricated grease ducts.

1.6 WARRANTY

A. Listed grease duct shall have a limited lifetime warranty to begin at the date of installation when installed in accordance with the manufacturer’s published installation instructions.

PART 2 - PRODUCTS

2.1 LISTED GREASE DUCTS (ZERO-CLEARANCE TO COMBUSTIBLES)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Duravent
2. CaptiveAire
3. Metal-Fab, Inc.
4. Schebler Co.
5. Selkirk Corporation
6. Or equal

B. Description: Factory-fabricated, -listed, and -labeled, double-wall ducts tested according to UL 1978 and UL 2221 classified for zero clearance to combustibles with a 2-hour fire rating. Duct systems shall be rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

C. Construction: Inner shell and outer jacket, fully welded at seams, and separated by at least a 3-inch annular space filled with high-temperature, ceramic-fiber insulation.

1. Inner Shell: ASTM A666, Type 304 stainless steel. 20 ga. Minimum.
2. Outer Jacket: Aluminized steel where concealed. Stainless steel where exposed. 24 ga. Minimum.

D. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at 1500 deg F minimum.

E. Hood Connectors: Constructed from the same material as grease duct with internal or external continuously welded or brazed joints.

F. Accessories: Tees, elbows, increasers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 (or governing code of local jurisdiction) including cleanouts, transitions, adapters, and drain fittings.

G. Grease Duct Supports: Construct duct bracing and supports from non-combustible material.

1. Design bracing and supports to carry static and seismic loads within stress limitations of the International Building Code.
2. Ensure that bolts, screws, rivets and other mechanical fasteners do not penetrate duct walls.

H. Comply with ASTM E2336.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install ducts in accordance with NFPA 96,"Ventilation Control and Fire Protection of Commercial Cooking Operation"; Internation Mechanical Code; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines" unless otherwise indicated.

B. Install all ducts without dips and traps that may hold grease and sloped a minimum of 2 percent to drain grease back to the hood.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Comply with requirements in Section 077200 "Roof Accessories."

D. Coordinate connections to kitchen exhaust hoods.

E. Coordinate firestopping where grease ducts penetrate fire separations with requirements in Section 078413 "Penetration Firestopping."

F. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211 and UL 2221, whichever is most stringent.

G. Seal between sections of grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

H. Connections: Make grease duct connections according to the International Mechanical Code.

1. Grease duct to exhaust fan connections: Connect grease ducts to inlet side of fan using flanges, gaskets, and bolts.

2. Grease duct to hood connections:

a. Make grease duct to hood joints connections using internal or external continuously welded or brazed joints.

I. Support ducts at intervals recommended by manufacturer to support weight of ducts and accessories, without applying loading on kitchen hoods.

1. Securely attach supports and bracing to structure.

J. Grease Duct Enclosures: Comply with requirements of the International Building Code and ASTM E2336.

K. Coordinate fire-rated enclosure construction with Section 092116.23 "Gypsum Board Shaft Wall Assemblies."

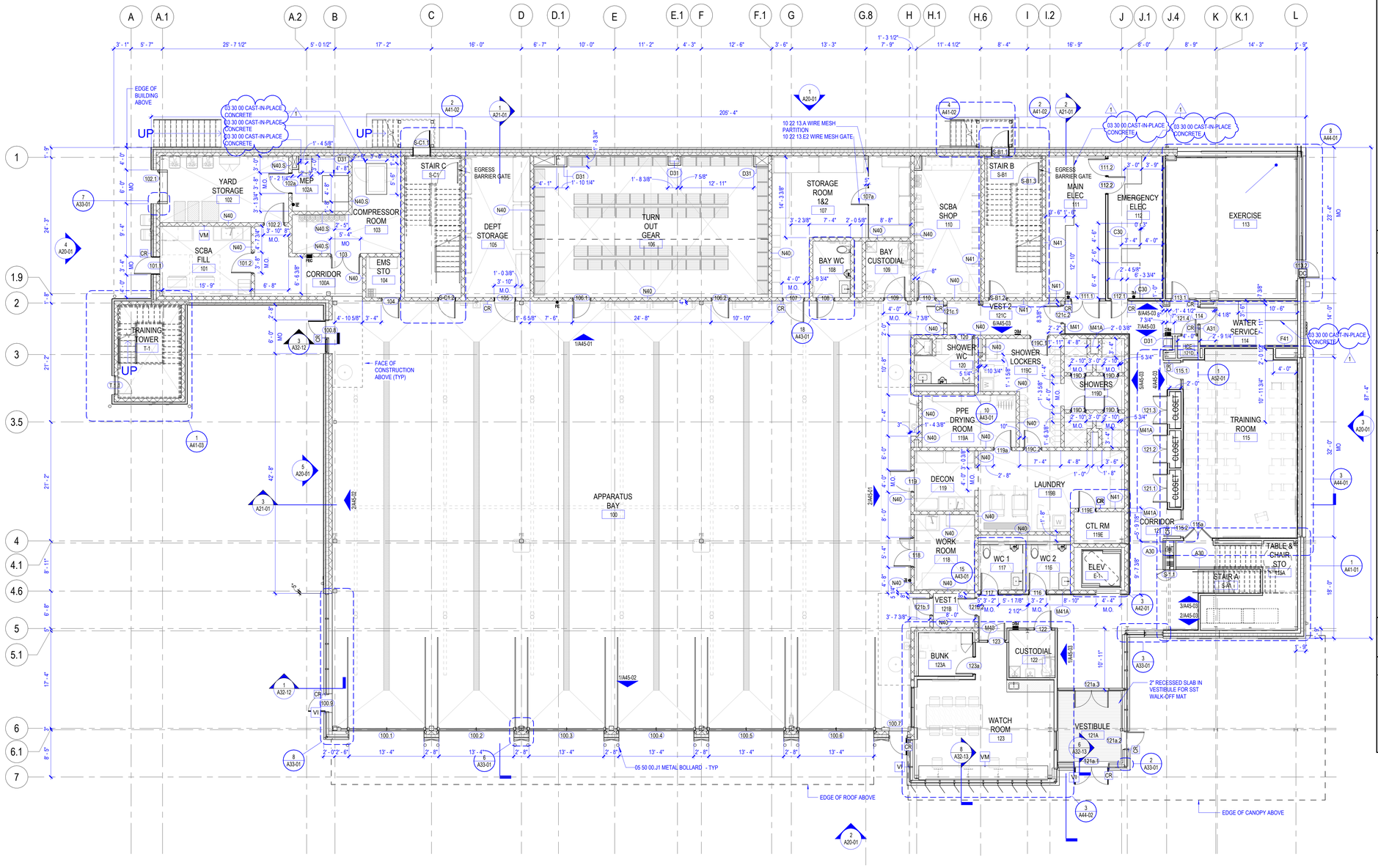
L. Repair damage to adjacent materials caused by listed kitchen ventilation system exhaust ducts installation.

3.3 FIELD QUALITY CONTROL

A. Perform air leakage test in presence of Owner before concealment of any portion of the grease duct system.

1. Notify Owner a minimum of seven- days before test is performed.

END OF SECTION 233533



1 LEVEL 01 FLOOR PLAN
SCALE 1/8" = 1'-0"

FLOOR PLAN GENERAL NOTES

1. SEE THE A61 SERIES FOR PARTITION TYPES
2. ALL PARTITIONS ARE TYPE A31 UNLESS NOTED OTHERWISE
3. DOOR DIMENSIONS ARE TO EDGE OF DOOR LEAF UNLESS NOTED OTHERWISE.
4. FOR SWINGING DOORS, THE HINGE SIDE OF OF THE DOOR JAMB SHALL BE LOCATED 4" FROM THE ADJACENT PERPENDICULAR WALL, UNLESS NOTED OTHERWISE
5. REFER TO A32-01 AND A32-02 FOR EXTERIOR ASSEMBLIES
6. PROVIDE 3" (EQUAL TO R-15) UNDERSLAB INSULATION UNDER APPARATUS BAY AND WEST OF STAIR C BETWEEN GRIDLINES 1 AND 2 ON LEVEL 1.
7. INTERIOR MASONRY OPENINGS TO BE 3'-4" UNLESS NOTED OTHERWISE.
8. REFER TO STRUCTURAL FOR SHEAR WALLS LOCATIONS AND REQUIREMENTS.
9. WALL TYPE N40.S IS A FULLY GROUTED MASONRY WALL PROVIDED FOR ACOUSTICS ONLY, REFER TO 04 20 00
10. WALL TYPES M41A & N41A CONTAIN AN ADDITIONAL LAYER OF 5/8" GYPSUM WALL BOARD.
11. ROLLER SHADES, "R" INDICATE RECESSED OR "S" FOR SURFACE MOUNTED

FLOOR PLAN LEGEND

- 270 DEGREE IP SECURITY CAMERA
- FIXED IP SECURITY CAMERA
- VI — VIDEO INTERCOM SUBSTATION
- VM — VIDEO INTERCOM SUBSTATION
- DC — DOOR CONTACT / POSITION SWITCH
- CR — ACCESS CONTROL CARDR READER
- COMMUNICATION OUTLET
- W — WALL PHONE COMMUNICATION OUTLET
- TV — IN-WALL BOX TELEVISION COMMUNICATIONS OUTLET WITH AV INFRASTRUCTURE
- STATUS — STATUS BOARD DATA OUTLET
- DIS — IN-WALL BOX DISPLAY COMMUNICATIONS OUTLET WITH AV INFRASTRUCTURE

FLOOR PLAN KEYNOTES

<<< Indicates Sheet Keynote on Plan

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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

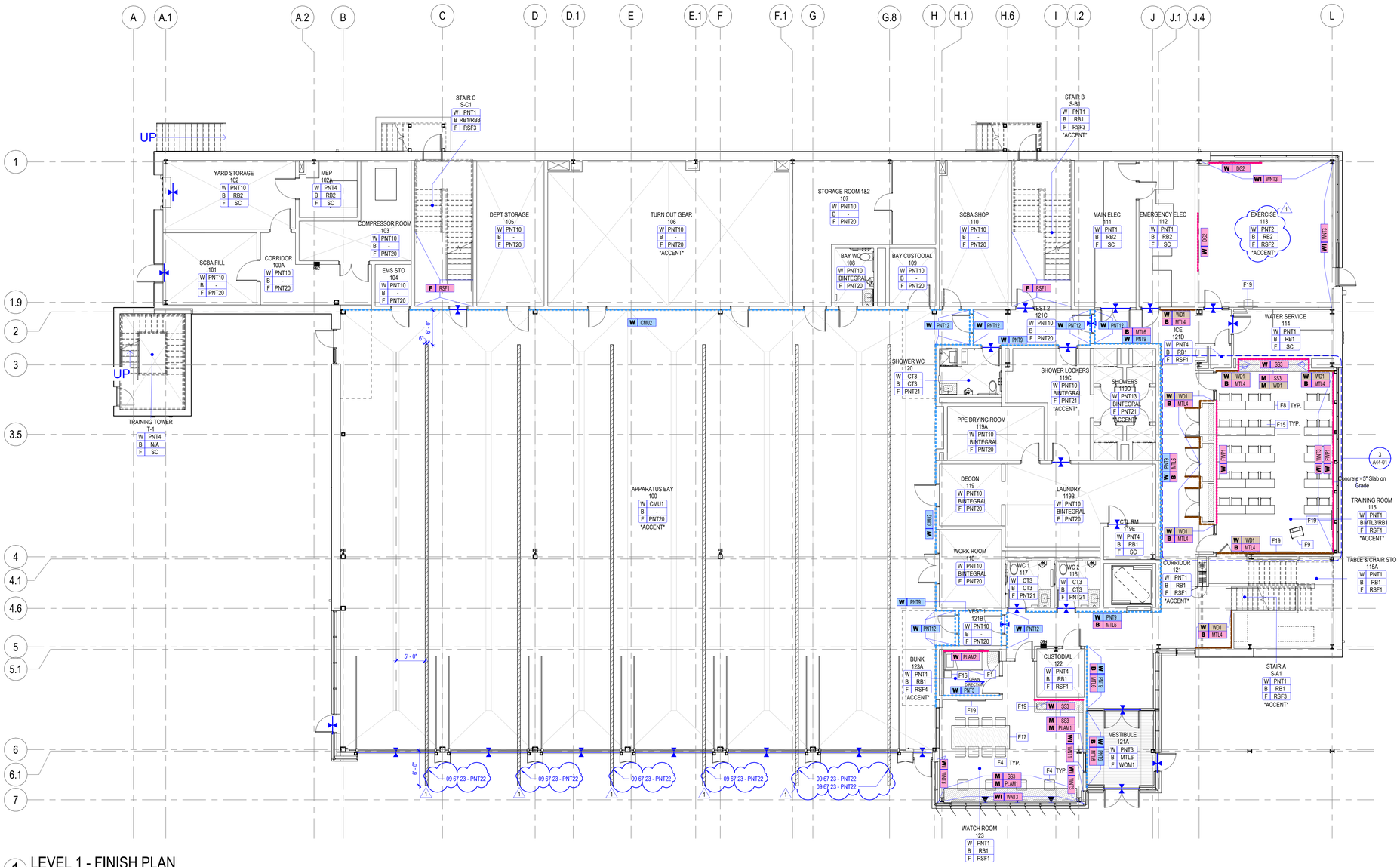
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SHEET NUMBER

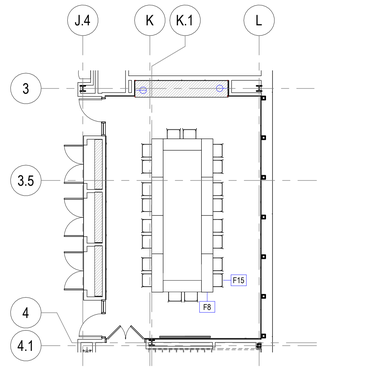
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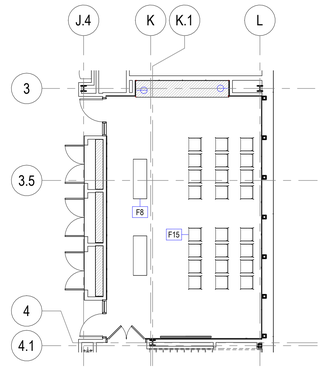
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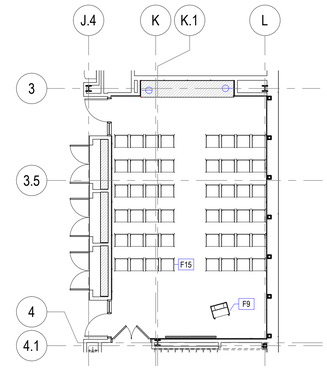
1 LEVEL 1 - FINISH PLAN
SCALE 1/8" = 1'-0"



2 LEVEL 1 - "AFTER ACTION" LAYOUT
SCALE 1/8" = 1'-0"



3 LEVEL 1 - "CPR TRAINING" LAYOUT
SCALE 1/8" = 1'-0"



4 LEVEL 1 - "LECTURE" LAYOUT
SCALE 1/8" = 1'-0"

INTERIOR FINISH PLAN GENERAL NOTES

1. REFER TO INTERIOR FINISH LEGEND IN A60 SERIES FOR INFORMATION.
2. SEE A50 SERIES FOR CASEWORK INFORMATION
3. TYPICAL FLOOR FINISH TO BE RSF1, UNO.
4. TYPICAL WALL FINISH TO BE PNT1, UNO.
5. TYPICAL WALL BASE TO BE RB1, UNO.
6. ALL FINISHES INSIDE COAT AND STORAGE CLOSETS SHALL BE CONSISTENT WITH THE ADJACENT ROOM FINISHES, UNO. FLOOR COVERINGS SHALL CONTINUE FROM ADJACENT ROOM INTO CLOSETS
7. PROVIDE A FINISH AT ALL AREAS THAT ARE EXPOSED BEHIND MILLWORK, FILE CABINETS, PANELING, ETC. DUE TO REVEALS, JOINTS, END CONDITIONS, ETC.
8. SEE ELEVATIONS ON A40 SERIES FOR ADDITIONAL FINISH INFORMATION.

BASE:

9. NEW WALL BASE SHALL BE INSTALLED ON ALL NEW AND EXISTING WALLS AND COLUMNS, UNO.
10. RESILIENT WALL BASE AT ALL HARD SURFACE FLOORS SHALL BE COVED BASE, UNO.

PAINT:

11. PAINT REVEALS AND FILER PANELS TO MATCH ADJACENT FINISHES, UNO.
12. PAINT EXPOSED ELECTRICAL RACEWAYS TO MATCH THE ADJACENT WALL SURFACE. PAINT ALL EXPOSED MISC METAL AND STRUCTURAL STEEL WITH PNT7
13. PROVIDE A PRIME PAINT COAT IN UNEXPOSED AREAS COVERED BY MILLWORK, PANELING, AND OTHER FIXED ARCHITECTURAL ELEMENTS UNO.
14. DOORS TO RECEIVE PAINT SHALL BE PAINTED PNT1, UNO.
15. HOLLOW METAL FRAMES SHALL BE PAINTED PNT1, UNO.
16. FIRE EXTINGUISHER CABINETS SHALL BE PAINTED TO MATCH ADJACENT WALL, UNO.
17. ACCESS PANELS SHALL BE PAINTED TO MATCH ADJACENT SURFACE.
18. GYPSUM BOARD SOFFITS ABUTTING A WALL SHALL BE PAINTED TO MATCH THE WALL. GYPSUM BOARD SOFFITS NOT ABUTTING A WALL SHALL BE PAINTED TO MATCH ADJACENT GYPSUM BOARD CEILING, IF APPLICABLE. GYPSUM BOARD SOFFITS ADJACENT TO ONLY ACOUSTICAL PANEL CEILINGS SHALL BE PAINTED FLAT WHITE.

FLOORING:

19. FLOORING TRANSITIONS AT DOORWAYS SHALL BE ALIGNED WITH THE FACE OF THE FRAME'S STOP FACING THE DOOR.
20. REFER TO SHEET A60 SERIES FOR ADDITIONAL INFORMATION ON FLOORING TRANSITIONS.

WINDOW TREATMENT:

1. ALL BUNK ROOMS TO RECEIVE WNT2 , PRIVATE BATH ROOM AND OFFICES ON L2 TO RECEIVE WNT1, CLERESTORY AT EXERCISE AND TRAINING ROOM TO RECEIVE WNT3, CLERESTORY AT DAY ROOM TO RECEIVE WNT4.
2. WATCH ROOM TO RECEIVE WNT1 AND WNT 3, SEE PLANS.

LEGEND

- DENOTES AREA "NOT IN CONTRACT"
- MILLWORK

ROOM FINISH TAG

Name
101

W XXX	WALL FINISH
B XXX	WALL BASE FINISH
F XXX	FLOOR FINISH
ACCENT	IF ACCENT IS PRESENT

FINISH TAG LEGEND

W PNT1 — MATERIAL APPLICATION / FINISH KEY

W WALL	M MILLWORK
B BASE	WI WINDOW
F FLOOR	P PARTITION
C CEILING (RCP ONLY)	EX EXISTING TO REMAIN

ACCENT FINISHES

W ELEV	SEE ELEVATION
	OTHER
	PAINT
	CERAMIC TILE
	WOOD

FINISH SYMBOLS

- FLOOR FINISH TRANSITION
- WP1 — CORNER GUARD TAG. REFER TO A** SERIES FOR INFORMATION.
- WPX — WALL PROTECTION TAG. REFER TO A** SERIES FOR INFORMATION.
- MATERIAL SEAM
- GRAIN DIRECTION — MATERIAL PATTERN DIRECTION
- PATTERN START POINT

FINISH PLAN KEYNOTES

<<< Indicates Sheet Keynote on Plan

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CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

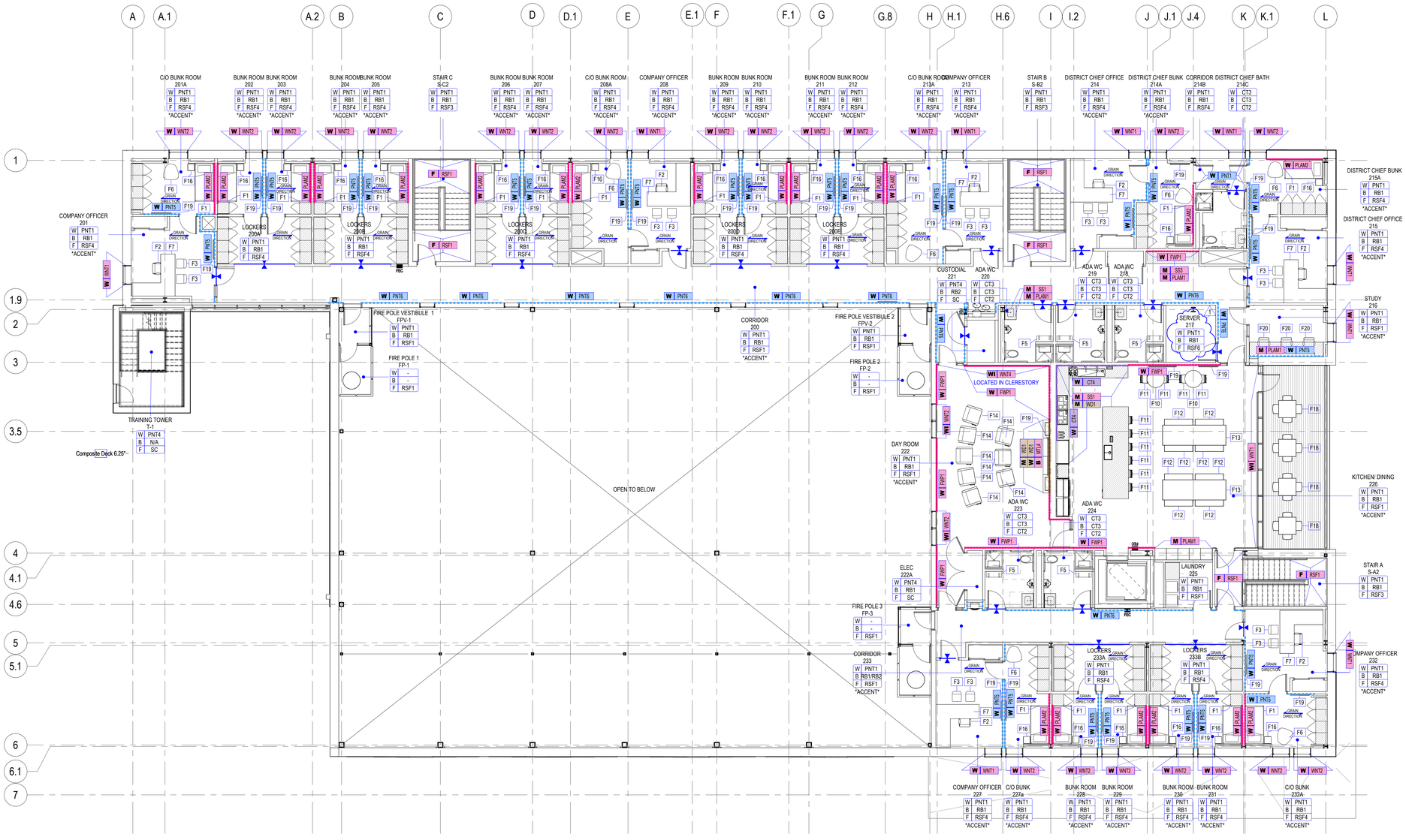
ARCHITECTURAL FURNITURE, EQ. & FINISHES PLAN - LEVEL 1

SHEET NUMBER

A13-01

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1 LEVEL 2 - FINISH PLAN
SCALE 1/8" = 1'-0"

INTERIOR FINISH PLAN GENERAL NOTES

1. REFER TO INTERIOR FINISH LEGEND IN A60 SERIES FOR INFORMATION.
2. SEE A50 SERIES FOR CASEWORK INFORMATION
3. TYPICAL FLOOR FINISH TO BE RSF1, UNO.
4. TYPICAL WALL FINISH TO BE PNT1, UNO.
5. TYPICAL WALL BASE TO BE RB1, UNO.
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8. SEE ELEVATIONS ON A40 SERIES FOR ADDITIONAL FINISH INFORMATION.

BASE:

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WINDOW TREATMENT:

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2. WATCH ROOM TO RECEIVE WNT1 AND WNT 3, SEE PLANS.

LEGEND

- DENOTES AREA "NOT IN CONTRACT"
- MILLWORK

ROOM FINISH TAG

Name
101

W	XXX	WALL FINISH
B	XXX	WALL BASE FINISH
F	XXX	FLOOR FINISH

"ACCENT" — IF ACCENT IS PRESENT

FINISH TAG LEGEND

W PNT1 — MATERIAL APPLICATION; FINISH KEY

W	WALL	M	MILLWORK
B	BASE	WI	WINDOW
F	FLOOR	P	PARTITION
C	CEILING (RCP ONLY)	EX	EXISTING TO REMAIN

ACCENT FINISHES

W	ELEV	SEE ELEVATION
		OTHER
		PAINT
		CERAMIC TILE
		WOOD

FINISH SYMBOLS

- FLOOR FINISH TRANSITION
- WP1 — CORNER GUARD TAG. REFER TO A** SERIES FOR INFORMATION.
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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

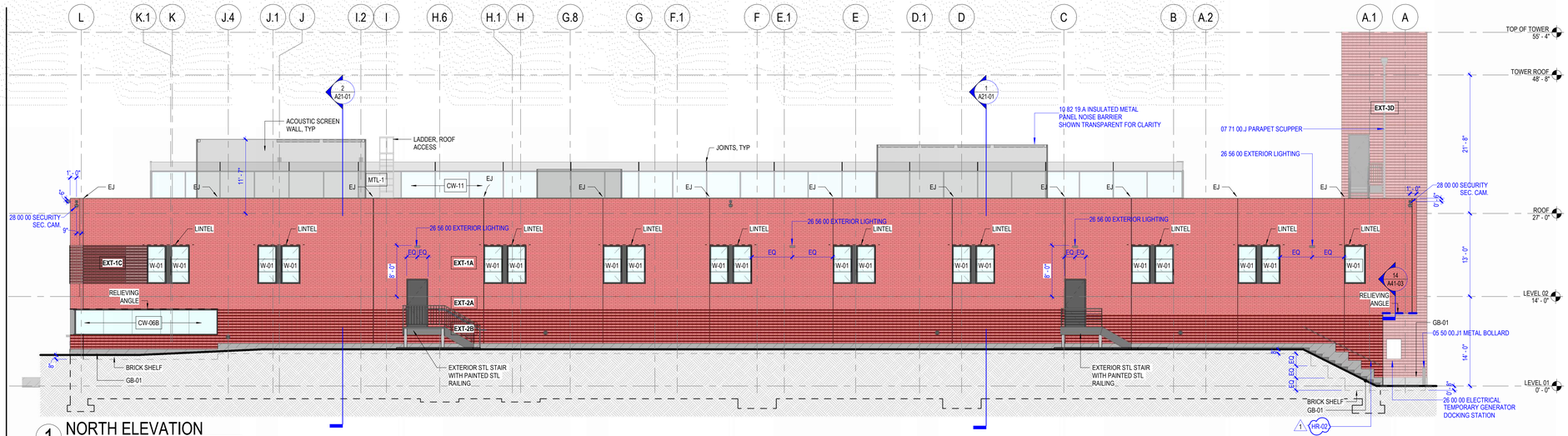
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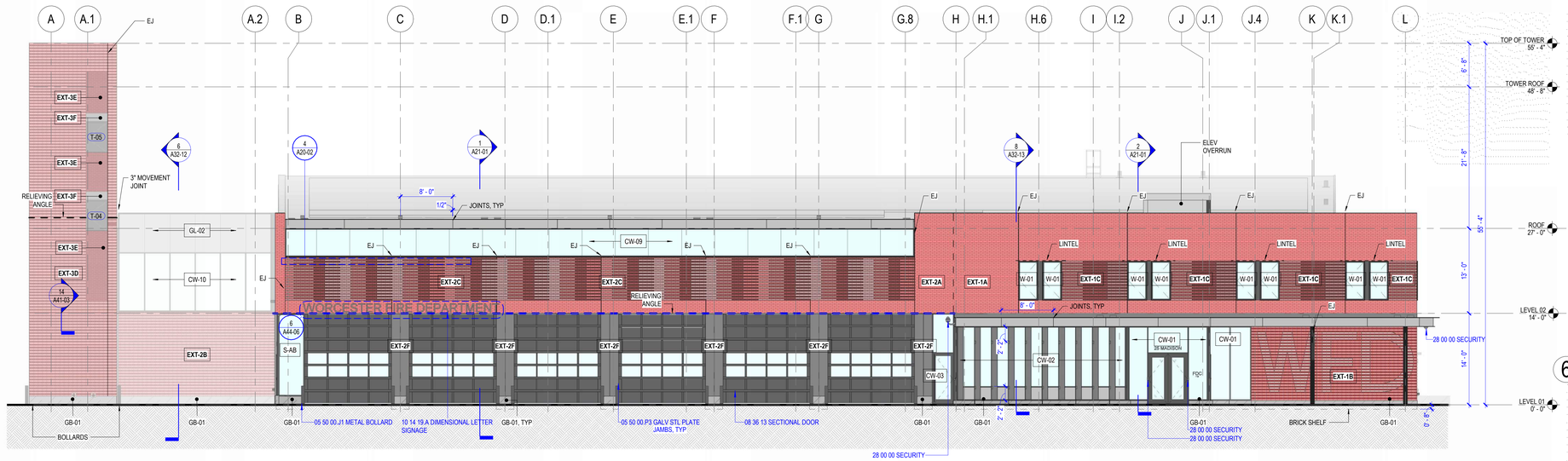
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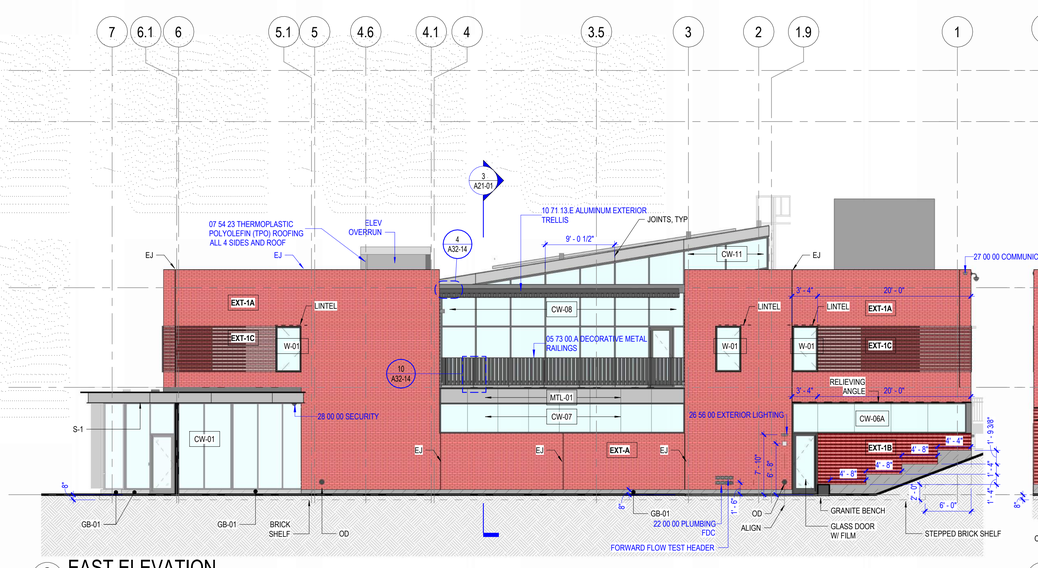
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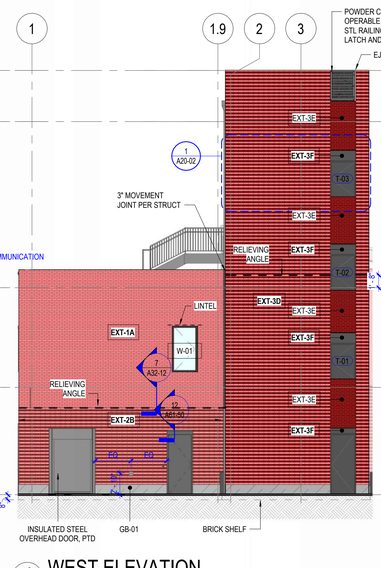
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SCALE 1/8" = 1'-0"



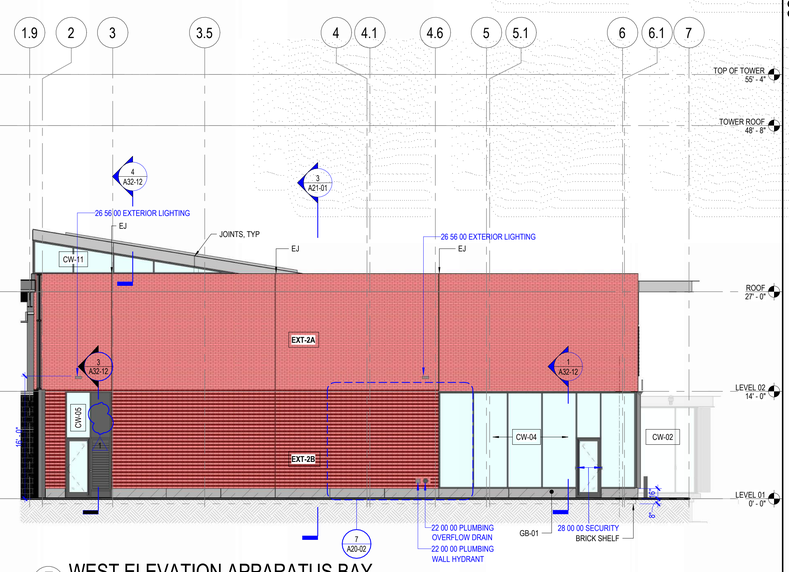
2 SOUTH ELEVATION
SCALE 1/8" = 1'-0"



3 EAST ELEVATION
SCALE 1/8" = 1'-0"



4 WEST ELEVATION
SCALE 1/8" = 1'-0"



5 WEST ELEVATION APPARATUS BAY
SCALE 1/8" = 1'-0"

6 NORTH DECK
SCALE 1/8" = 1'-0"

7 SOUTH DECK
SCALE 1/8" = 1'-0"

EXTERIOR ELEVATION GENERAL NOTES

1. MATERIAL SYMBOLS ON ELEVATIONS ARE TO DISPLAY THE EXTENT OF THE MATERIAL ONLY. THEY ARE NOT TO SCALE.
2. FINISH GRADE ELEVATIONS AND TAKEOFFS MAY VARY BASED ON GRADE COORDINATION
3. SEE A32-01 AND A32-02 FOR EXTERIOR WALL & ROOF ASSEMBLIES

EXTERIOR ELEVATION LEGEND

- SMOOTH FACE BRICK
- TEXTURED FACE BRICK
- MTL -01 - METAL PANEL
- GB-01 - GRANITE BASE
- GL-01 - WINDOW GLAZED ASSEMBLY
- GL-02 - SHADOWBOX GLAZED ASSEMBLY

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1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

EXTERIOR ELEVATIONS

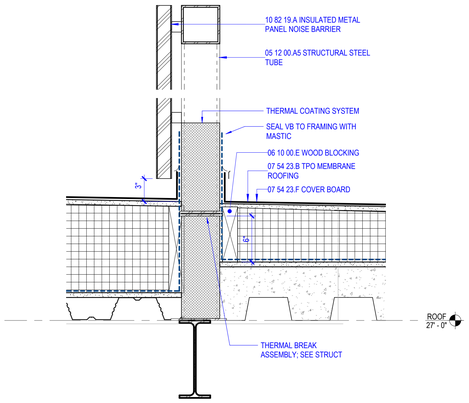
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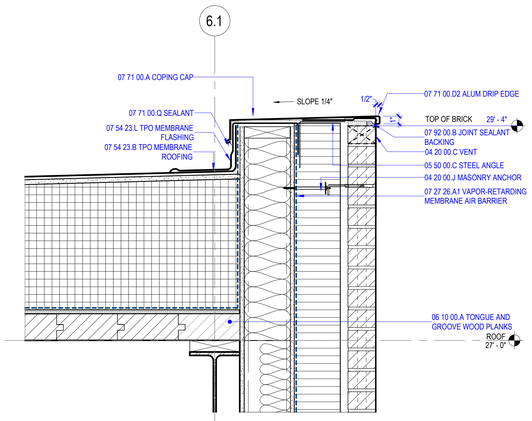
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CONSTRUCTION DOCUMENTS 12/19/25

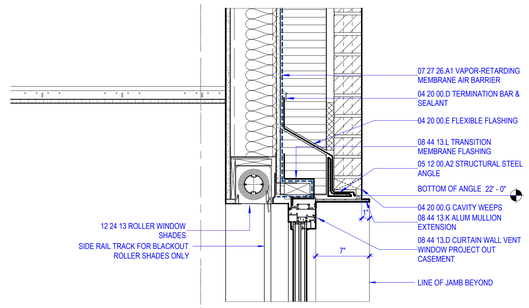
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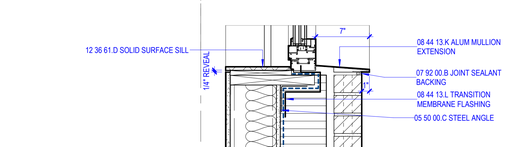
7 ACOUSTICAL SCREEN WALL
SCALE 1 1/2" = 1'-0"



5 TYP PARAPET @ STUD BACK UP
SCALE 1 1/2" = 1'-0"

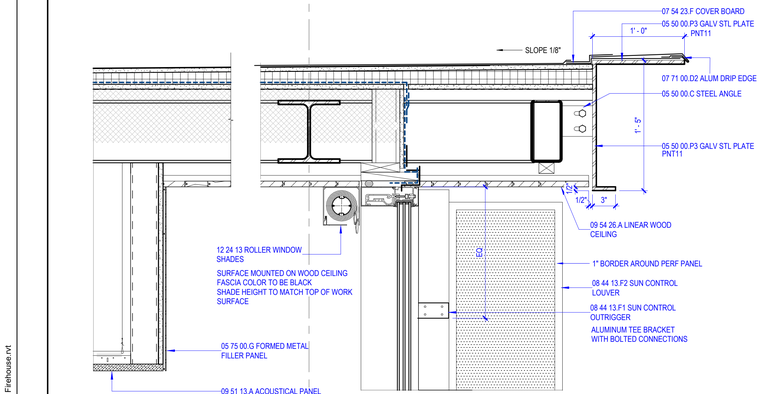


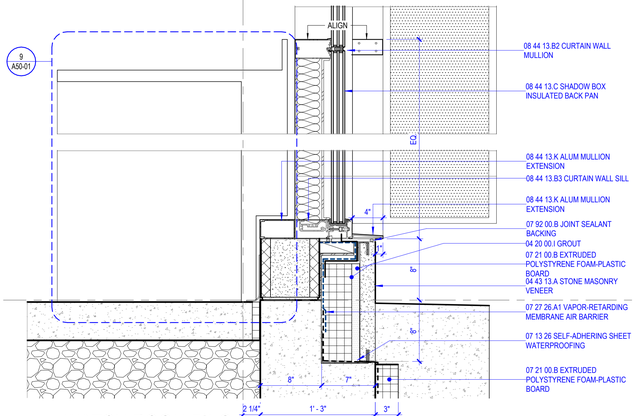
4 TYP WINDOW HEAD
SCALE 1 1/2" = 1'-0"



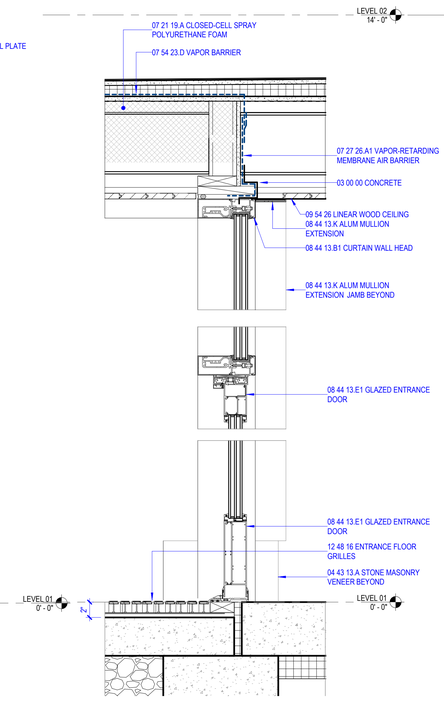
3 TYP WINDOW SILL
SCALE 1 1/2" = 1'-0"

2 ENTRY CANOPY
SCALE 1 1/2" = 1'-0"

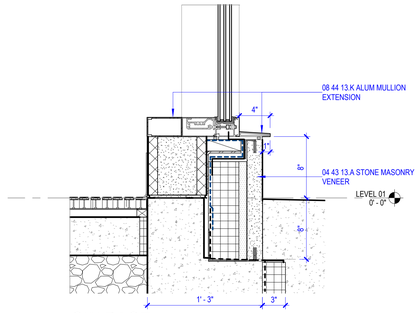




8 WATCH ROOM FINS
SCALE 1 1/2" = 1'-0"



6 ENTRY VESTIBULE DOOR
SCALE 1 1/2" = 1'-0"



1 CW BASE
SCALE 1 1/2" = 1'-0"

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1408 PROVIDENCE HWY, NORWOOD, MA 02062

PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

BUILDING ENCLOSURE SECTION DETAILS - BUNKS & ENTRY

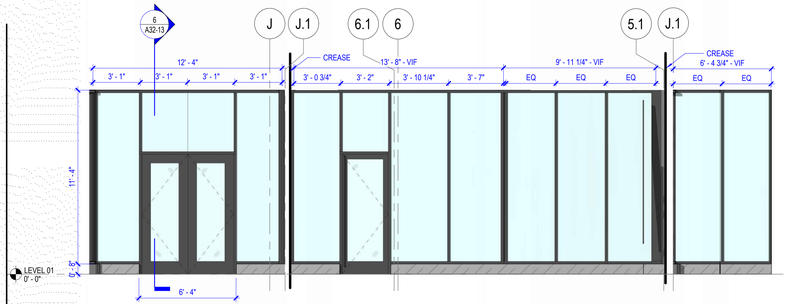
SHEET NUMBER

A32-13

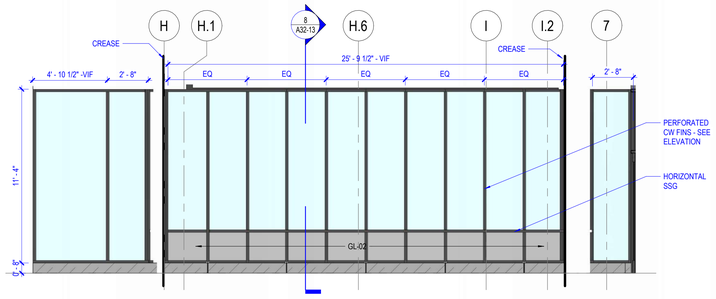
CONSTRUCTION DOCUMENTS 12/19/25

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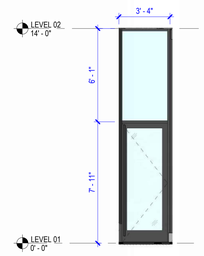
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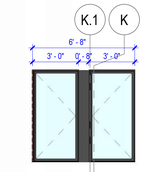
1 CW-01 - ENTRY - UNFOLDED (EGA-1.2)
SCALE 1/4" = 1'-0"



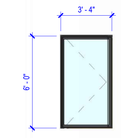
2 CW-02 - WATCH ROOM - UNFOLDED (EGA-1.2)
SCALE 1/4" = 1'-0"



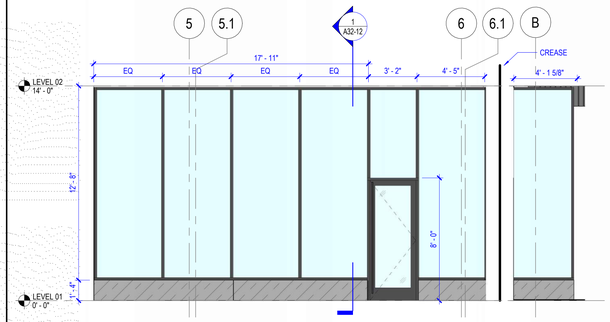
3 CW-03 - APPARATUS BAY ENTRY (EGA-1.2)
SCALE 1/4" = 1'-0"



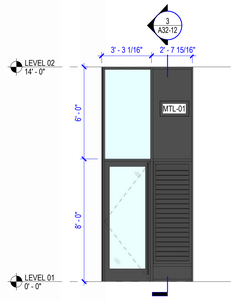
21 CW-21
SCALE 1/4" = 1'-0"



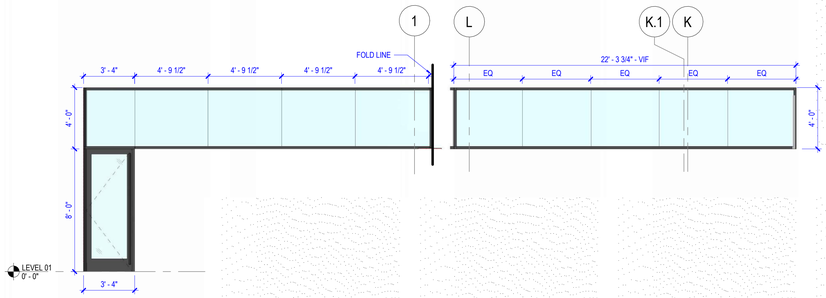
22 CW-22
SCALE 1/4" = 1'-0"



4 CW-04 - APPARATUS BAY - WEST ENTRY (EGA-1.2)
SCALE 1/4" = 1'-0"

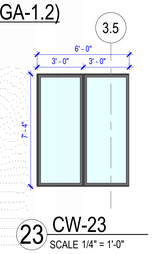


5 CW-05 - NORTH WEST ENTRY (EGA-1.2)
SCALE 1/4" = 1'-0"

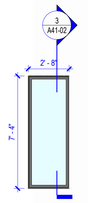


6A CW-06A - FITNESS EAST (EGA-1.1)
SCALE 1/4" = 1'-0"

6B CW-06B - FITNESS NORTH (EGA-1.1)
SCALE 1/4" = 1'-0"

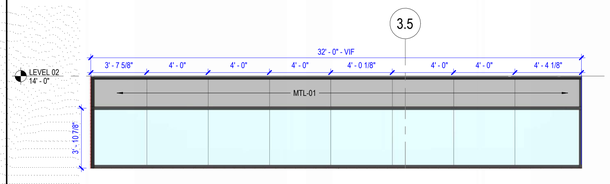


23 CW-23
SCALE 1/4" = 1'-0"

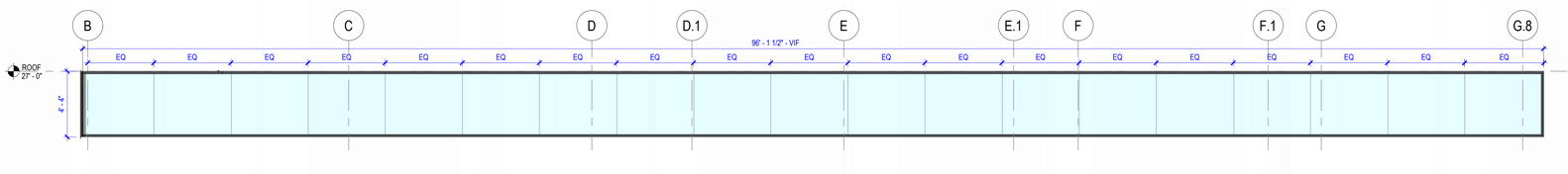


24 CW-24
SCALE 1/4" = 1'-0"

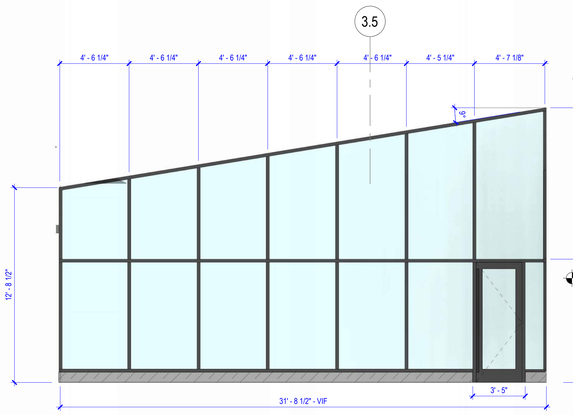
NOTE:
1. SEE A32-01 FOR EXTERIOR GLAZING INFORMATION
2. SEE A45-03 FOR SF-07
3. ALL CW FRAMES TO HAVE PERIMETER EXTENDED SNAP COVER, UNLESS SHOWN OTHERWISE. SEE 3/A34-11 FOR SILL AND HEAD DETAIL. SEE 8/33-01 FOR JAMB DETAIL



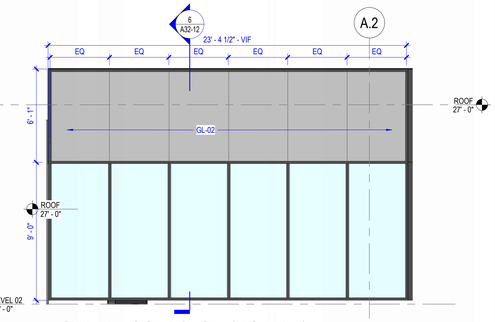
7 CW-07 - TRAINING ROOM (EGA-1.1)
SCALE 1/4" = 1'-0"



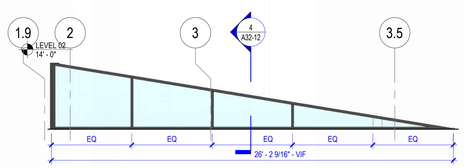
9 CW-09 - SOUTH CLERESTORY (EGA-1.1)
SCALE 1/4" = 1'-0"



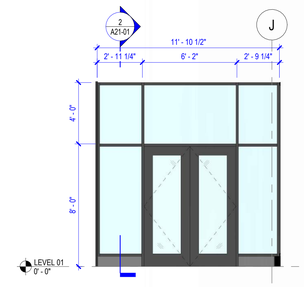
8 CW-08 - KITCHEN (EGA-1.3)
SCALE 1/4" = 1'-0"



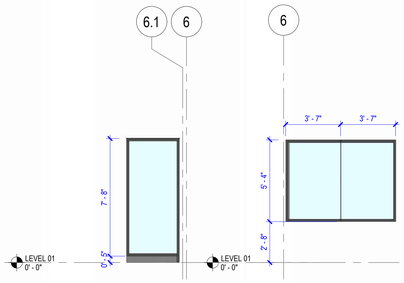
10 CW-10 - CORRIDOR (EGA-1.2)
SCALE 1/4" = 1'-0"



11B CW-11B - CLERESTORY WEST (EGA-1.1)
SCALE 1/4" = 1'-0"

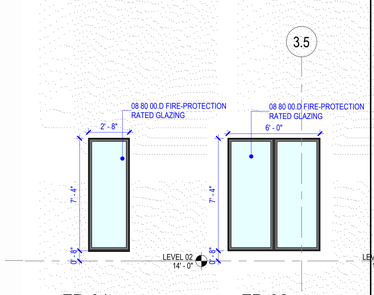


12 SF-01 (ENTRY VESTIBULE)
SCALE 1/4" = 1'-0"



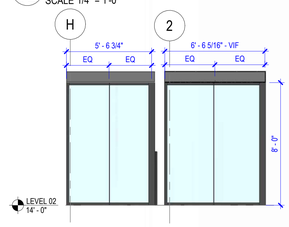
13 SF-02
SCALE 1/4" = 1'-0"

14 SF-03
SCALE 1/4" = 1'-0"

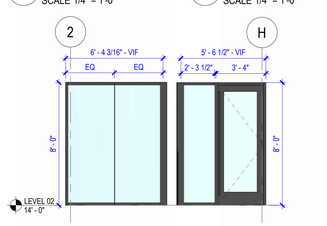


18 FP-01
SCALE 1/4" = 1'-0"

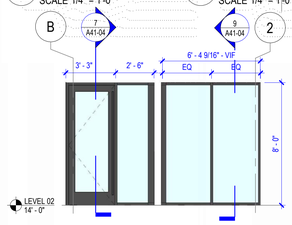
19 FP-02
SCALE 1/4" = 1'-0"



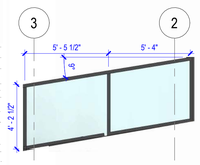
15 SF-04 - UNFOLDED
SCALE 1/4" = 1'-0"



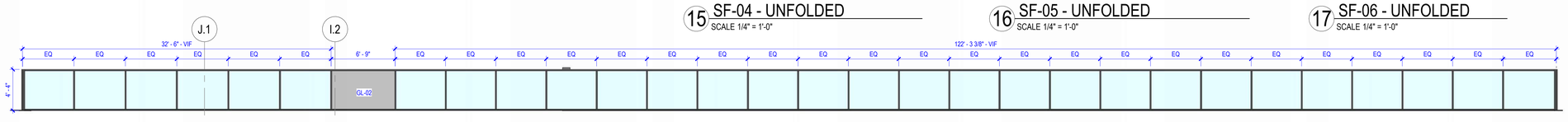
16 SF-05 - UNFOLDED
SCALE 1/4" = 1'-0"



17 SF-06 - UNFOLDED
SCALE 1/4" = 1'-0"



11A CW-11A - CLERESTORY EAST (EGA-1.1)
SCALE 1/4" = 1'-0"



11 CW-11 - CLERESTORY NORTH (EGA-1.1)
SCALE 3/16" = 1'-0"

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PROJECT

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CITY OF WORCESTER

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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

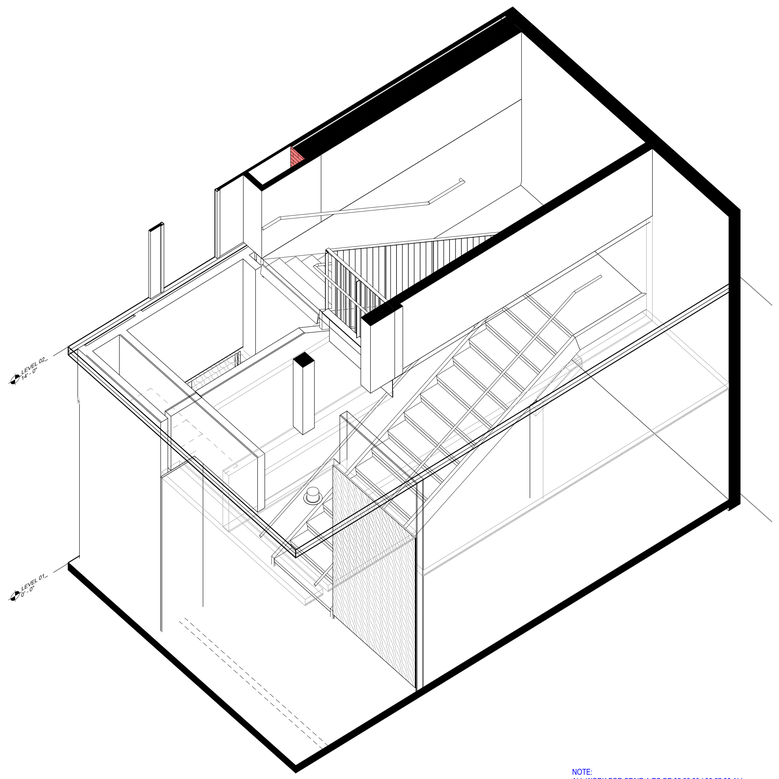
EXTERIOR GLAZING ELEVATIONS

SHEET NUMBER

A34-01

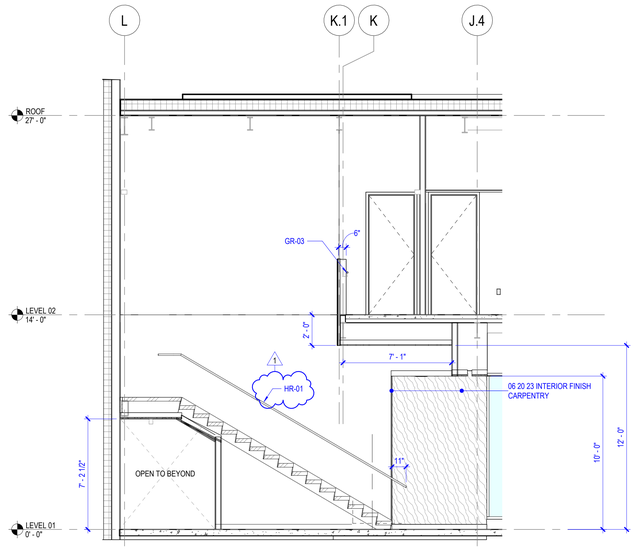
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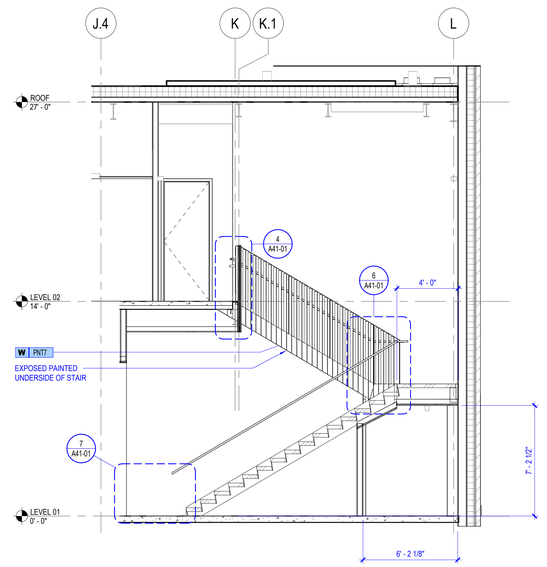


NOTE:
ALL WORK FOR STAIR A TO BE 05 50 00 / 05 57 00 ALL EXPOSED STEEL TO BE PAINTED WITH PNT7

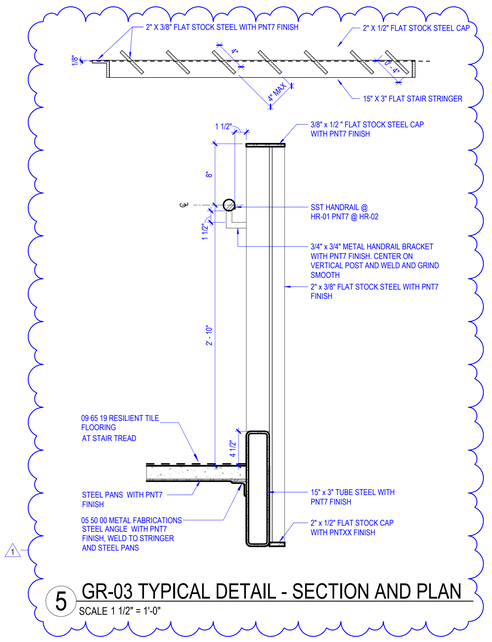
9 STAIR A - AXON
SCALE



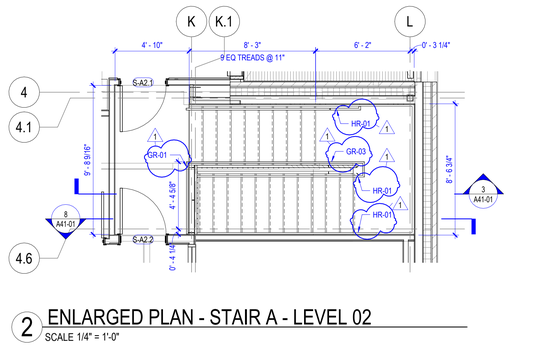
8 ENLARGED STAIR PLAN NORTH SECTION - STAIR A
SCALE 1/4" = 1'-0"



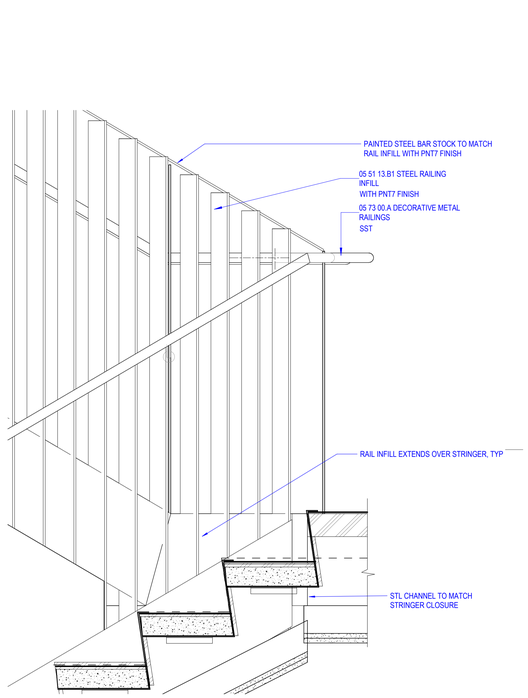
3 ENLARGED STAIR SECTION - STAIR A
SCALE 1/4" = 1'-0"



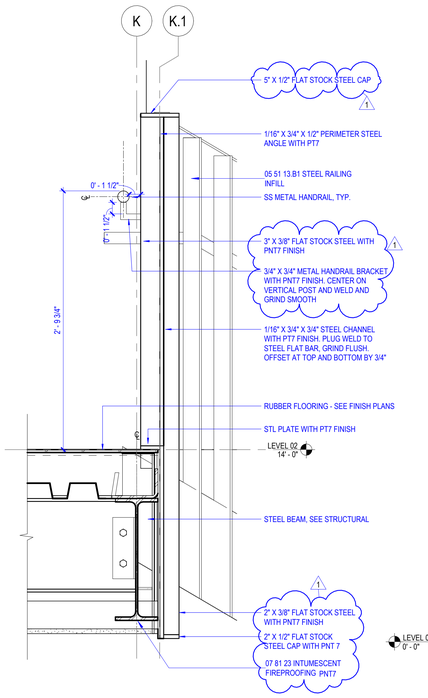
5 GR-03 TYPICAL DETAIL - SECTION AND PLAN
SCALE 1 1/2" = 1'-0"



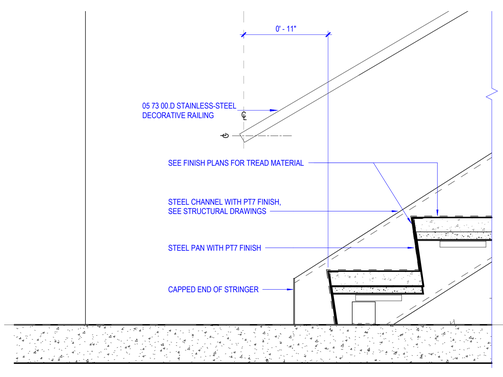
2 ENLARGED PLAN - STAIR A - LEVEL 02
SCALE 1/4" = 1'-0"



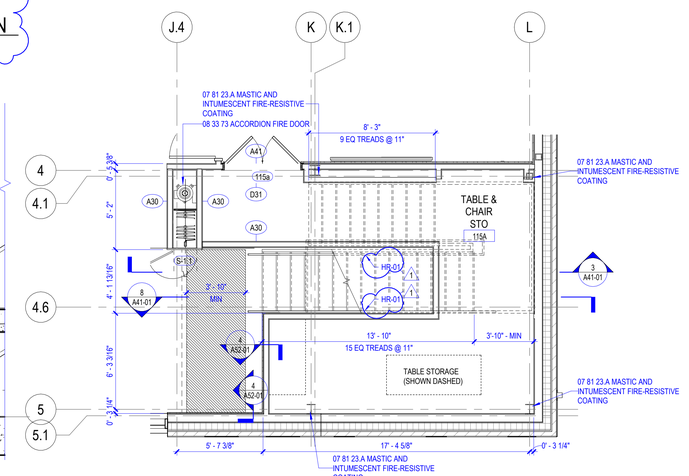
6 STAIR A - MID-LANDING GUARDRAIL
SCALE 1 1/2" = 1'-0"



4 STAIR A - LEVEL 2 LANDING GUARDRAIL GR-03
SCALE 1 1/2" = 1'-0"



7 STAIR A - BOTTOM LANDING
SCALE 1 1/2" = 1'-0"



1 ENLARGED PLAN - STAIR A - LEVEL 01
SCALE 1/4" = 1'-0"

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KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

ENLARGED STAIR A PLANS AND SECTIONS

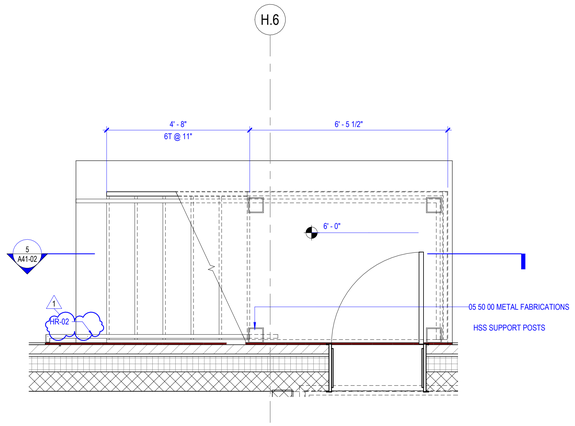
SHEET NUMBER

A41-01

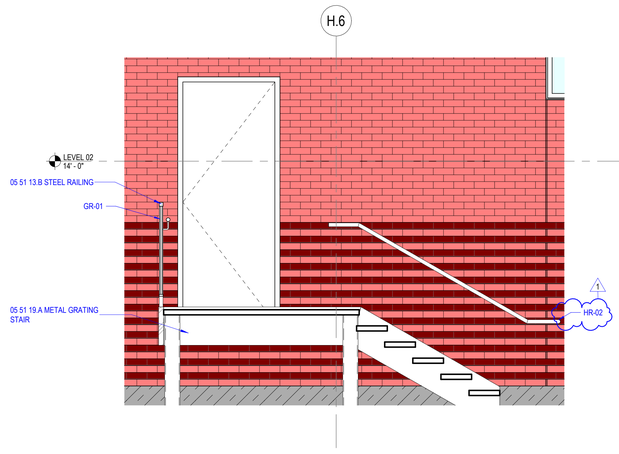
CONSTRUCTION DOCUMENTS 12/19/25

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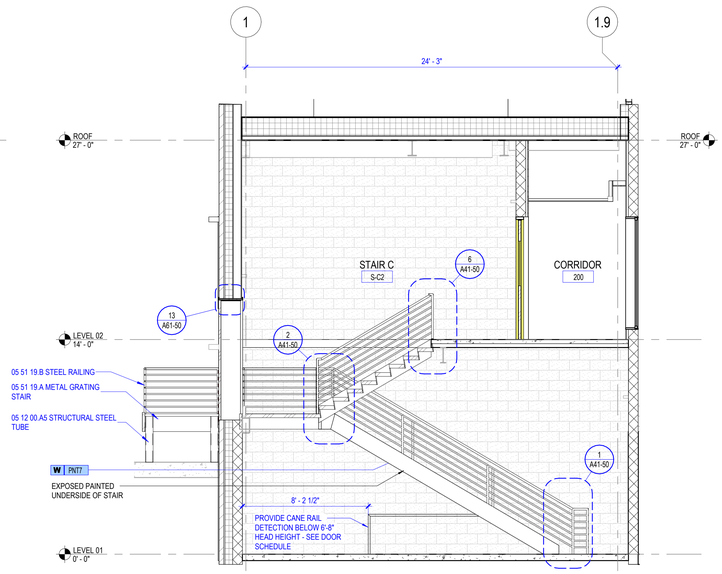
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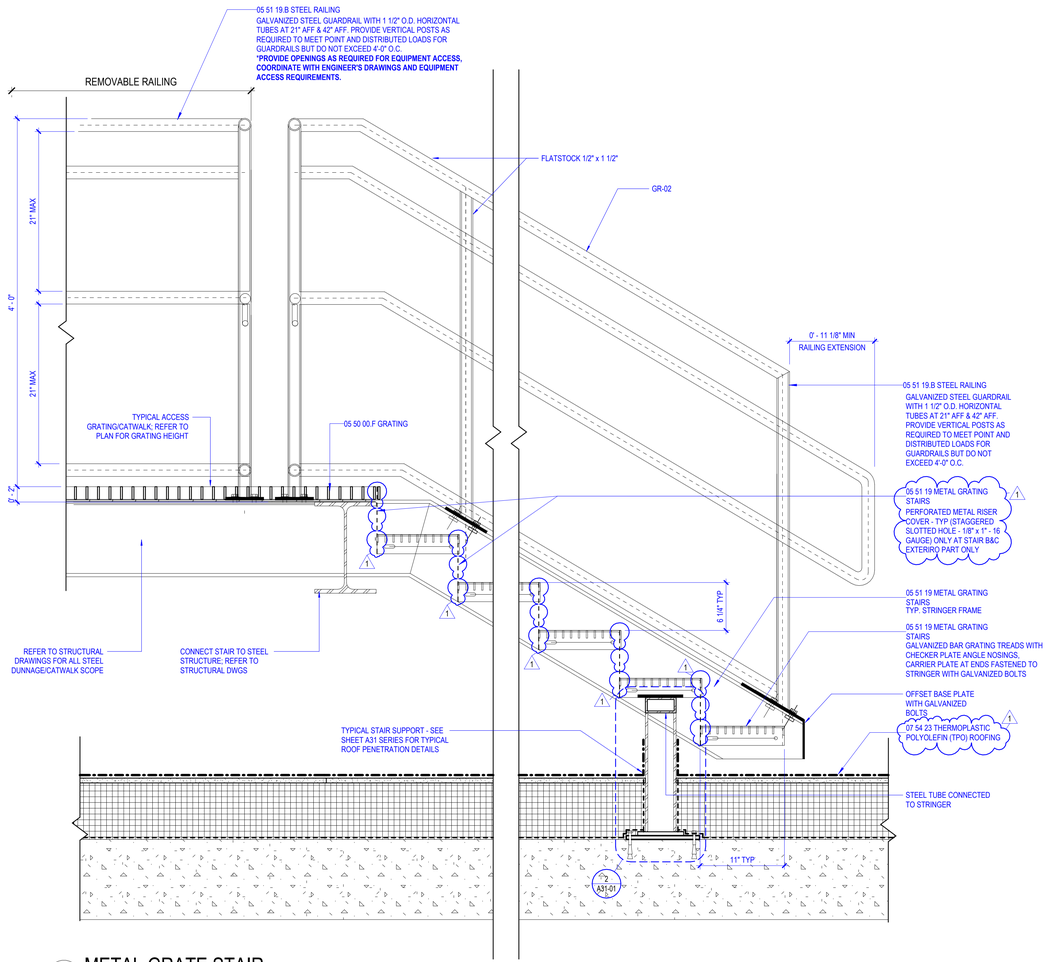
4 LEVEL 01 - TYP. EXTERIOR STAIR
SCALE 1/2" = 1'-0"



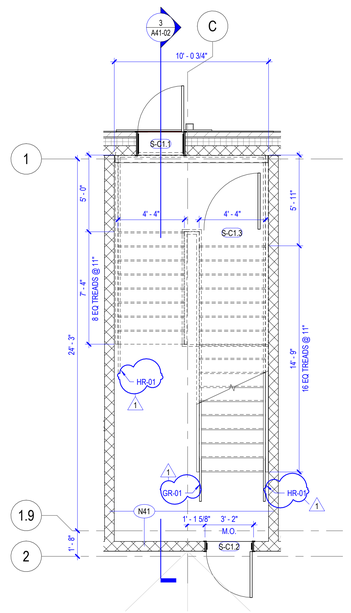
5 ENLARGED TYP. EXTERIOR STAIR SECTION
SCALE 1/2" = 1'-0"



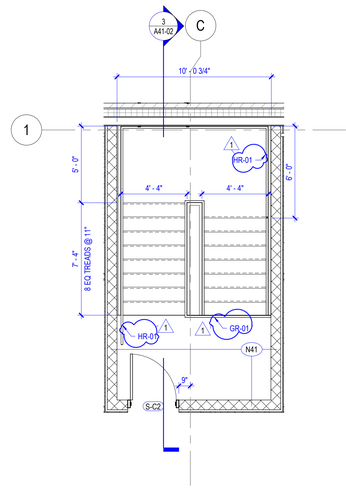
3 ENLARGED STAIR SECTION - STAIR B/C
SCALE 1/4" = 1'-0"



6 METAL GRATE STAIR
SCALE 1 1/2" = 1'-0"



2 ENLARGED PLAN - STAIR B/C - LEVEL 01
SCALE 1/4" = 1'-0"



1 ENLARGED PLAN - STAIR B/C - LEVEL 02
SCALE 1/4" = 1'-0"

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PROJECT

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CITY OF WORCESTER

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WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

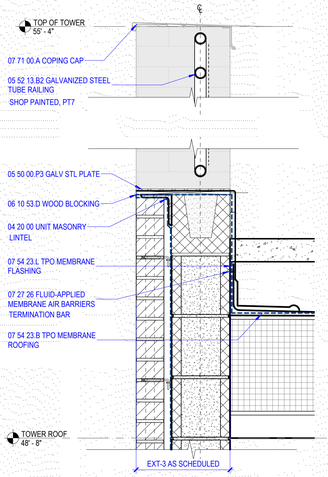
ENLARGED STAIR B,C,D,E, AND F PLANS AND SECTIONS

SHEET NUMBER

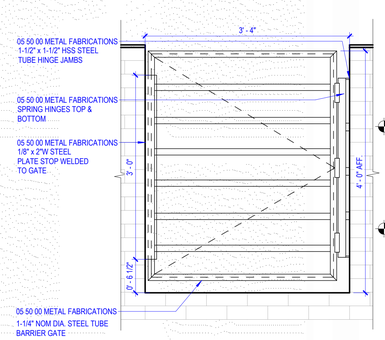
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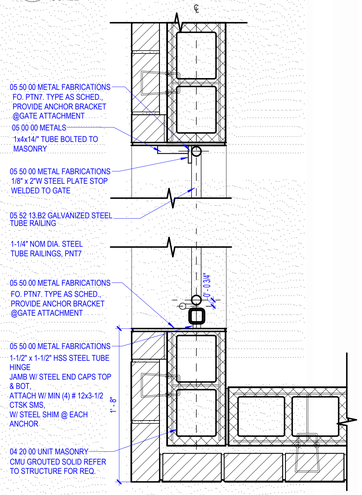
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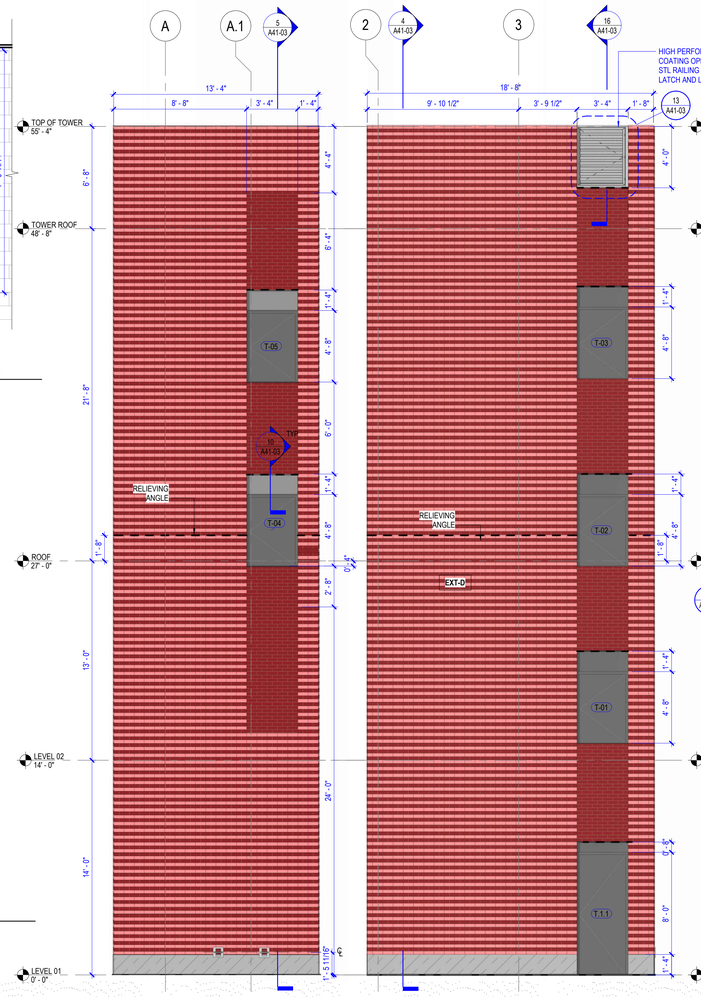
16 TRAINING TOWER GATE SECTION
SCALE 1 1/2" = 1'-0"



13 TRAINING TOWER GATE ELEVATION
SCALE 1" = 1'-0"

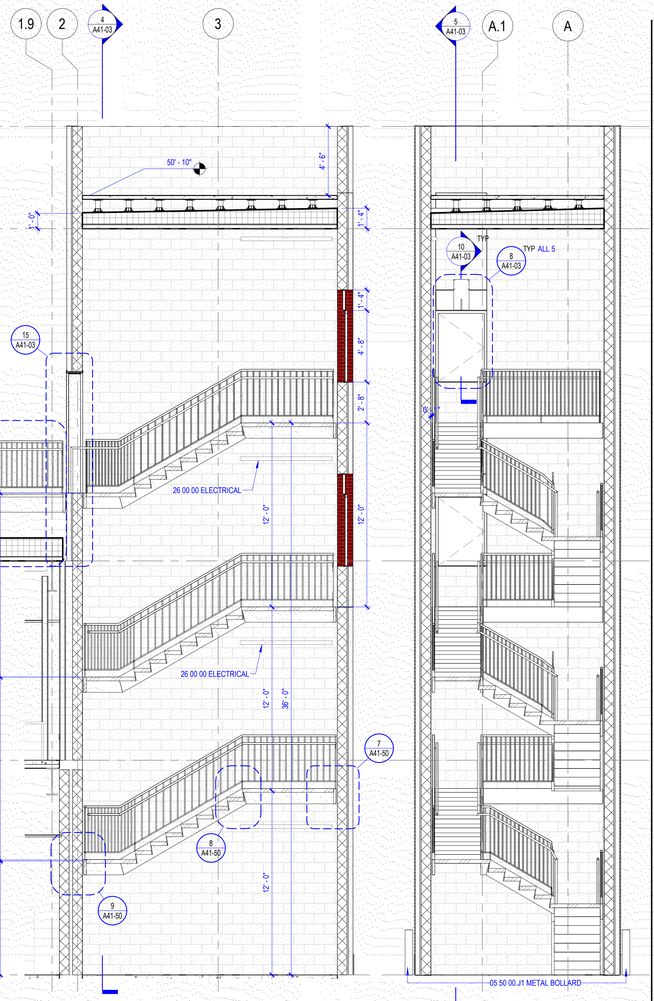


12 TRAINING GATE PLAN DETAIL
SCALE 1 1/2" = 1'-0"



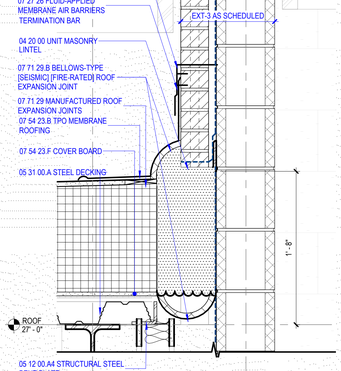
7 TOWER SOUTH ELEVATION
SCALE 1/4" = 1'-0"

6 TOWER WEST ELEVATION
SCALE 1/4" = 1'-0"

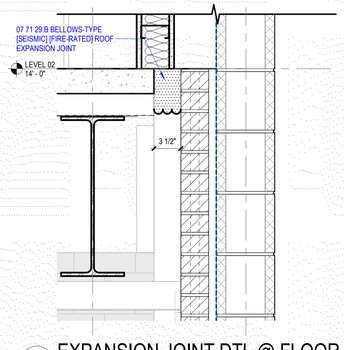


5 TRAINING TOWER SECTION - WEST
SCALE 1/4" = 1'-0"

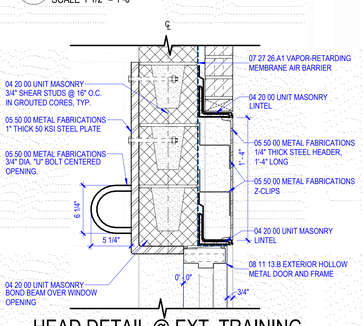
4 TRAINING TOWER SECTION - SOUTH
SCALE 1/4" = 1'-0"



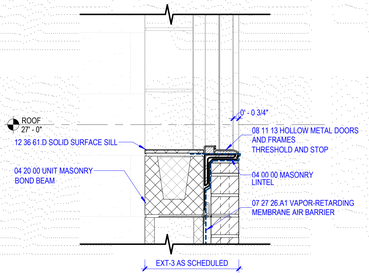
15 DOOR FRAME - TOWER ROOF
SCALE 1 1/2" = 1'-0"



14 EXPANSION JOINT DTL @ FLOOR
SCALE 1 1/2" = 1'-0"

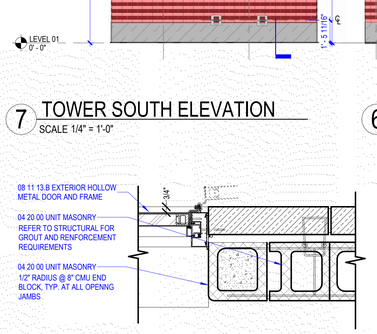


11 HEAD DETAIL @ EXT. TRAINING WINDOW
SCALE 1 1/2" = 1'-0"

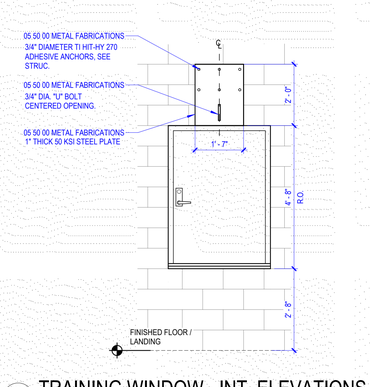


NOTES:
1. U BOLT ANCHOR POINT DESIGNED FOR 10,000# MAXIMUM ULTIMATE LOAD PER NFPA 1402 SECTION 11.2.1.
2. INDICATOR OF ALLOWABLE LOAD REQUIRED.
3. REFER TO STRUCTURAL FOR REINFORCEMENT.
4. DO NOT PAINT "U" BOLT TO ALLOW FOR INSPECTION.

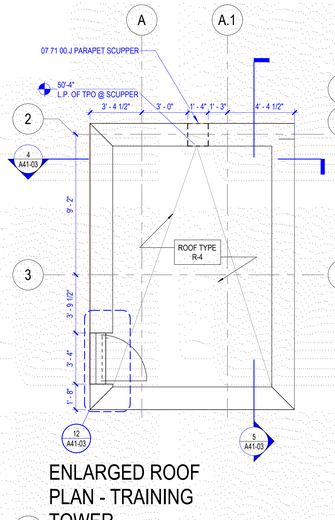
10 FRAME @ EXTERIOR TRAINING WINDOW
SCALE 1 1/2" = 1'-0"



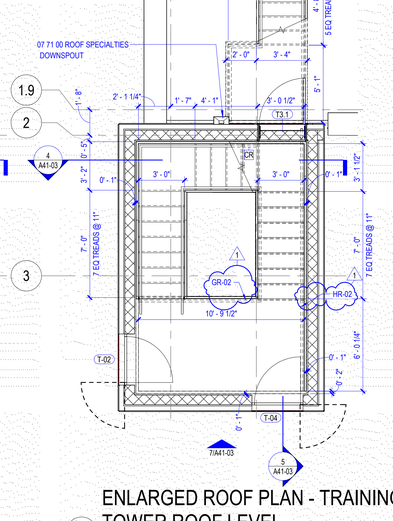
9 TRAINING WINDOW JAMB
SCALE 1 1/2" = 1'-0"



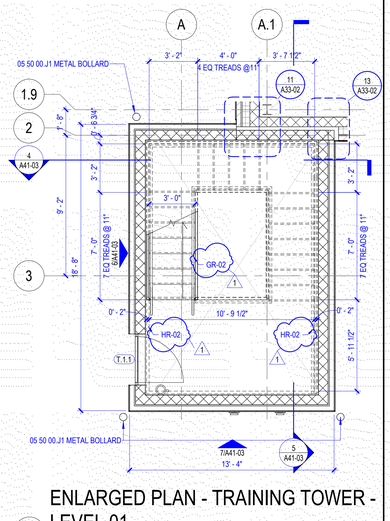
8 TRAINING WINDOW - INT. ELEVATIONS
SCALE 1/2" = 1'-0"



3 ENLARGED ROOF PLAN - TRAINING TOWER
SCALE 1/4" = 1'-0"



2 ENLARGED ROOF PLAN - TRAINING TOWER ROOF LEVEL
SCALE 1/4" = 1'-0"



1 ENLARGED PLAN - TRAINING TOWER - LEVEL 01
SCALE 1/4" = 1'-0"

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KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

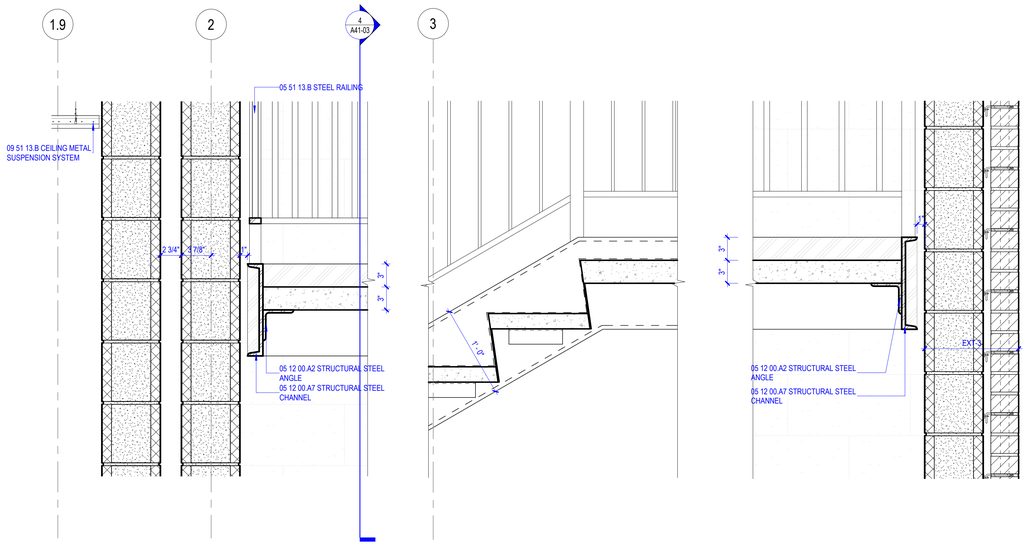
TRAINING TOWER PLANS & SECTION

SHEET NUMBER

A41-03

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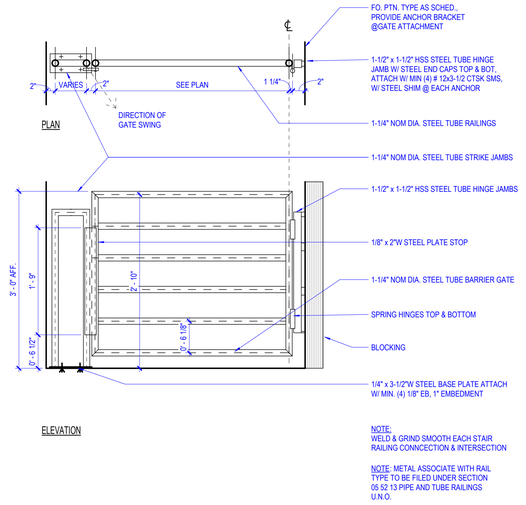
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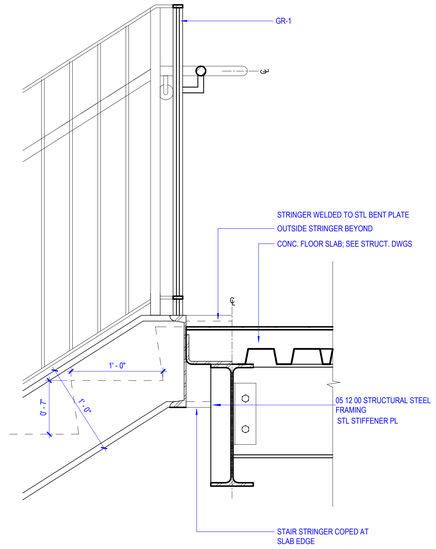
9 TOWER STAIR - TRAINING PLATFORM AT MID LANDING
SCALE 1 1/2" = 1'-0"

8 TOWER STAIR - TRAINING PLATFORM
SCALE 1 1/2" = 1'-0"

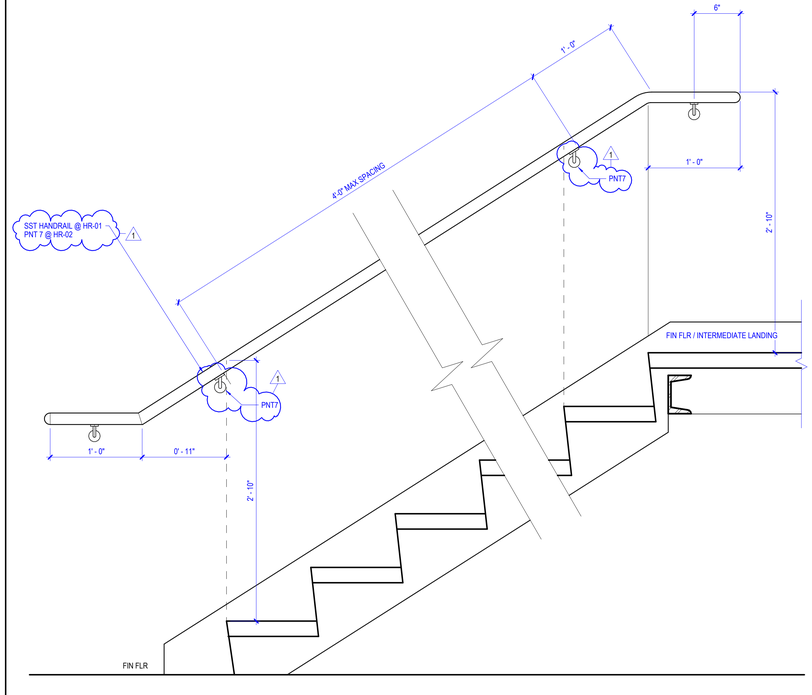
7 TOWER STAIR SECTION DETAIL - EXTERIOR WALL
SCALE 1 1/2" = 1'-0"



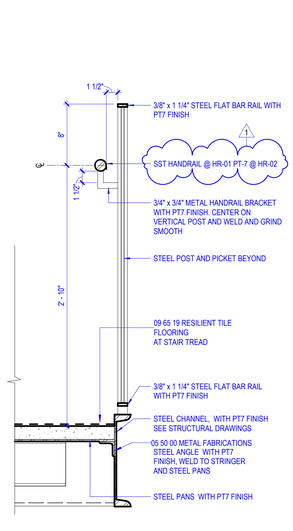
5 STAIR BARRIER GATE EXIT LANDING
SCALE 1" = 1'-0"



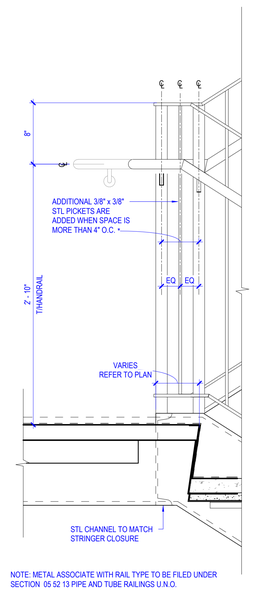
6 STAIR B/C - LEVEL 2 TOP OF LANDING
SCALE 1 1/2" = 1'-0"



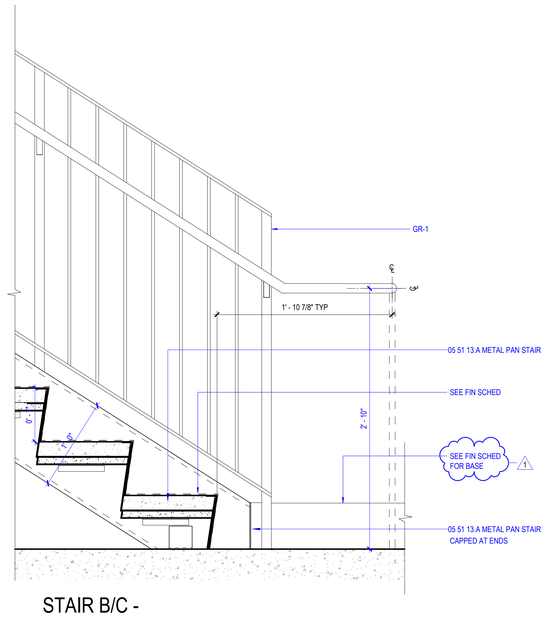
4 HR-01 & HR-02 - TYP HANDRAIL DETAIL
SCALE 1 1/2" = 1'-0"



3 GR-01 & GR-02 - TYP. GUARDRAIL DETAIL
SCALE 1 1/2" = 1'-0"



2 STAIR B/C - MID-LANDING GUARDRAIL
SCALE 1 1/2" = 1'-0"



1 STAIR B/C - BOTTOM LANDING
SCALE 1 1/2" = 1'-0"

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Job Number 157132.000

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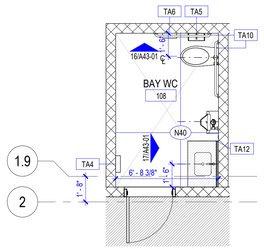
STAIR DETAILS

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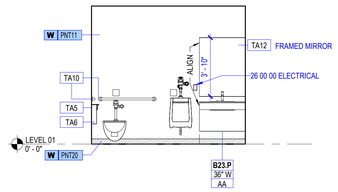
A41-50

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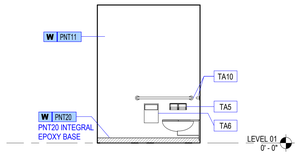
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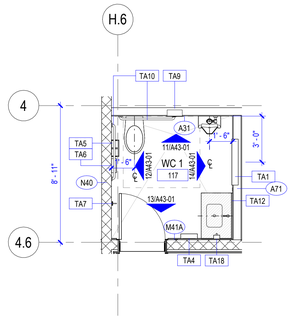
18 ENLARGED PLAN - BAY LAVATORY
SCALE 1/4" = 1'-0"



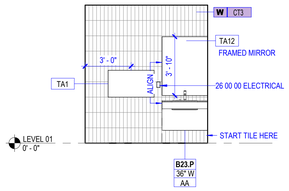
17 ENLARGED ELEVATION - BAY LAVATORY (EAST)
SCALE 1/4" = 1'-0"



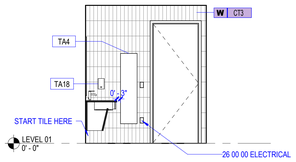
16 ENLARGED ELEVATION - BAY LAVATORY (NORTH)
SCALE 1/4" = 1'-0"



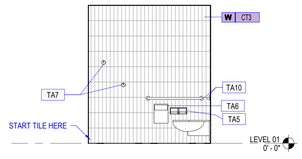
15 ENLARGED PLAN - LAVATORY
SCALE 1/4" = 1'-0"



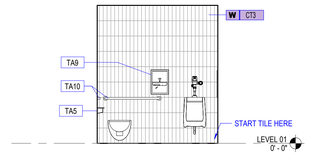
14 ENLARGED ELEVATION - LAVATORY (EAST)
SCALE 1/4" = 1'-0"



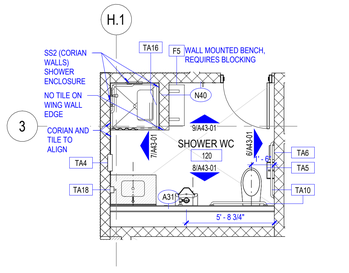
13 ENLARGED ELEVATION - LAVATORY (SOUTH)
SCALE 1/4" = 1'-0"



12 ENLARGED ELEVATION - LAVATORY (WEST)
SCALE 1/4" = 1'-0"



11 ENLARGED ELEVATION - LAVATORY (NORTH)
SCALE 1/4" = 1'-0"

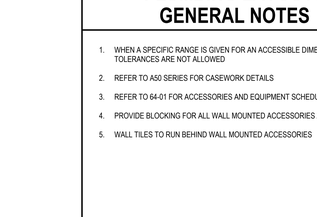


10 ENLARGED PLAN - SHOWER/LAVATORY
SCALE 1/4" = 1'-0"

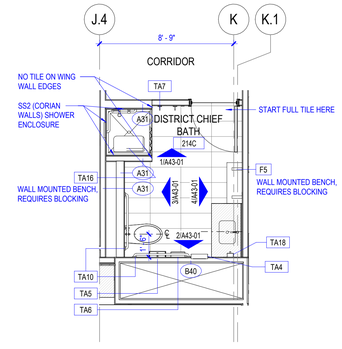
9 ENLARGED ELEVATION - SHOWER LAVATORY (NORTH)
SCALE 1/4" = 1'-0"

8 ENLARGED ELEVATION - SHOWER LAVATORY (SOUTH)
SCALE 1/4" = 1'-0"

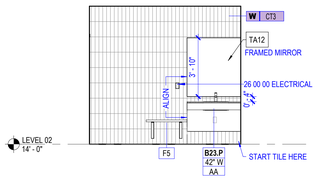
7 ENLARGED ELEVATION - SHOWER LAVATORY (WEST)
SCALE 1/4" = 1'-0"



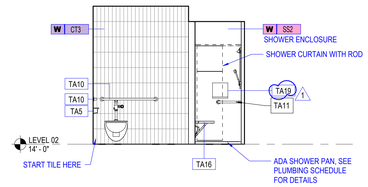
6 ENLARGED ELEVATION - SHOWER LAVATORY (EAST)
SCALE 1/4" = 1'-0"



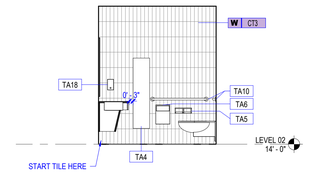
5 ENLARGED PLAN - DISTRICT CHIEF BATHROOM
SCALE 1/4" = 1'-0"



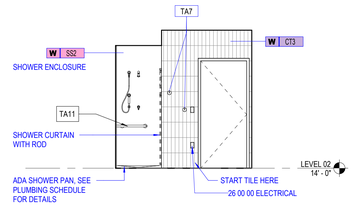
4 ENLARGED ELEVATION - DISTRICT CHIEF BATHROOM (EAST)
SCALE 1/4" = 1'-0"



3 ENLARGED ELEVATION - DISTRICT CHIEF BATHROOM (WEST)
SCALE 1/4" = 1'-0"



2 ENLARGED ELEVATION - DISTRICT CHIEF BATHROOM (SOUTH)
SCALE 1/4" = 1'-0"



1 ENLARGED ELEVATION - DISTRICT CHIEF BATHROOM (NORTH)
SCALE 1/4" = 1'-0"

PLUMBING LAYOUTS GENERAL NOTES

1. WHEN A SPECIFIC RANGE IS GIVEN FOR AN ACCESSIBLE DIMENSION, TOLERANCES ARE NOT ALLOWED
2. REFER TO A50 SERIES FOR CASEWORK DETAILS
3. REFER TO 64-01 FOR ACCESSORIES AND EQUIPMENT SCHEDULE
4. PROVIDE BLOCKING FOR ALL WALL MOUNTED ACCESSORIES AND EQUIPMENT
5. WALL TILES TO RUN BEHIND WALL MOUNTED ACCESSORIES

Perkins&Will

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CIVIL/LANDSCAPE
WESTON & SAMPSON
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STRUCTURAL
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ARUP
60 STATE ST, BOSTON, MA 02109

CODE
JENSEN HUGHES
33 ARCH ST, BOSTON, MA 02110

ENERGY MODEL
ANDELMANLELEK
1408 PROVIDENCE HWY, NORWOOD, MA 02062

PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

ENLARGED TOILET PLANS AND ELEVATIONS

SHEET NUMBER

A43-01

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1/27/2026 4:47:04 PM Autodesk Docs://City of Worcester - South Division Firehouse/ARCH_City of Worcester_South Division Firehouse.rvt

DOOR SCHEDULE

MARK	To Room: Number	MARK		DOOR						FRAME						HARDWARE SET NUMBER	REMARKS
			FIRE	SIZE									DETAILS				
DOOR NO		ROOM NAME	RATING	W	HT	THK	TYPE	MATERIAL	FINISH	TYPE	MATERIAL	FINISH	HEAD	JAMB			
LEVEL 01																	
101.2	101	SCBA FILL	-	3' - 6"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
102.2	102	YARD STORAGE	-	3' - 6"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
102a	102	YARD STORAGE	-	3' - 6"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	19.0		
103	103	COMPRESSOR ROOM	-	5' - 0"	7' - 10"	0' - 1 3/4"	FF	HM	PNT3	D	HM	PNT3	12/A61-50	15/A61-50	25.0		STC 35-40
104	104	EMS STO	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
105	105	DEPT STORAGE	-	3' - 8"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
106.1	106	TURN OUT GEAR	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
106.2	106	TURN OUT GEAR	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
107	107	STORAGE ROOM 1&2	-	3' - 8"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	10.0		
107a	107	STORAGE ROOM 1&2	-	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	19.0		
108	108	BAY WC	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	10.0		
109	109	BAY CUSTODIAL	-	3' - 8"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	21.0		
110	110	SCBA SHOP	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
111.1	121	CORRIDOR	60	5' - 0"	7' - 10"	0' - 1 3/4"	FF	HM	PNT1	D	HM	PNT1	10/A61-50	9/A61-50	23.0		STC 35-40
111.2	111	MAIN ELEC	90	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	22.0		
112.1	121	CORRIDOR	90	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	22.0		STC 35-40
112.2	112	EMERGENCY ELEC	90	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	22.0		
113.1	113	EXERCISE	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	20.0		STC 35-40
114	114	WATER SERVICE	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	19.0		STC 35-40
115.1	115	TRAINING ROOM	-	3' - 0"	8' - 0"	0' - 1 3/4"	FG	AL	PNT11	S1L1	AL	PNT11	10&11/A61-50	8&9/A61-50	20.0		STC 35-40
115.2	115	TRAINING ROOM	-	3' - 0"	8' - 0"	0' - 1 3/4"	FG	AL	PNT11	S1L1	AL	PNT11	10&11/A61-50	8&9/A61-50	20.0		STC 35-40
115a	115	TRAINING ROOM	60	5' - 0"	7' - 8"	0' - 1 3/4"	FF	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	18.0		
116	116	WC 2	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	7/A41-04	16/A61-50	10.0		
117	117	WC 1	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	7/A41-04	16/A61-50	10.0		
118	118	WORK ROOM	-	5' - 0"	7' - 10"	0' - 1 3/4"	FF	HM	PNT3	D	HM	PNT3	12/A61-50	15/A61-50	25.0		
119	119	DECON	20	3' - 8"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	7.0		
119a	119A	PPE DRYING ROOM	20	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	20.0		
119C.1	119C	SHOWER LOCKERS	-	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	15.0		
119C.2	119C	SHOWER LOCKERS	20	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	15.0		
119D.1	119D	SHOWERS	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	FB	-	S	FB	-	12/A61-50	15/A61-50	24.0		
119D.2	119D	SHOWERS	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	FB	-	S	FB	-	12/A61-50	15/A61-50	24.0		
119D.3	119D	SHOWERS	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	FB	-	S	FB	-	12/A61-50	15/A61-50	24.0		
119D.4	119D	SHOWERS	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	FB	-	S	FB	-	12/A61-50	15/A61-50	24.0		
119E	119E	CTL RM	60	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	19.0		
120	120	SHOWER WC	-	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	12/A61-50	15/A61-50	10.0		
121.1	121.1	CLOSET	-	5' - 0"	7' - 8"	0' - 1 3/4"	FF	WD	SEAL	S	MW	PNT3	7/A52-01	12/A52-01	18.0		BLIND CUT DOORS - REFER TO A52-01
121.2	215.4	CLOSET	-	5' - 0"	7' - 8"	0' - 1 3/4"	FF	WD	SEAL	S	MW	PNT3	7/A52-01	12/A52-01	18.0		BLIND CUT DOORS - REFER TO A52-01
121.3	121.2	CLOSET	-	5' - 0"	7' - 8"	0' - 1 3/4"	FF	WD	SEAL	S	MW	PNT3	7/A52-01	12/A52-01	18.0		BLIND CUT DOORS - REFER TO A52-01
121.4	121D	ICE	-	2' - 6"	7' - 0"	0' - 1 3/4"	F	HM	PNT1	D	HM	PNT1	10/A61-50	9/A61-50	18.0		
121a.3	121A	VESTIBULE	-	6' - 0"	7' - 10"	0' - 1 3/4"	FGFG	AL	PNT11		AL	PNT11		16/A61-50	3.0		
121b.1	121B	VEST 1	-	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT1	S	HM	PNT1	12/A61-50	15/A61-50	7.0		
121b.2	121B	VEST 1	-	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	8.0		
121c.1	121C	VEST 2	-	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PTD	S	HM	PNT1	12/A61-50	15/A61-50	7.0		
121c.2	121C	VEST 2	-	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	8.0		
122	122	CUSTODIAL	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	21.0		
123	123	WATCH ROOM	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	20.0		
123a	123A	BUNK	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
S-1.1	S-A1	STAIR A	60	1' - 6"	10' - 6"	0' - 3"	AC	HM	PNT1	S	HM	PNT8	1/A41-01	1/A41-01	-		ACCORDION FIRE DOOR - POCKET OPENING
S-B1.2	S-B1	STAIR B	60	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	12/A61-50	15/A61-50	16.0		
S-B1.3			-	3' - 8"	3' - 0"	0' - 1 3/4"	BG	-	-	-	-	-			-		EGRESS BARRIER GATE
S-C1.2	S-C1	STAIR C	60	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	12/A61-50	15/A61-50	7.0		
S-C1.3			-	3' - 8"	3' - 0"	0' - 1 3/4"	BG	-	-	-	-	-			-		EGRESS BARRIER GATE
LEVEL 02																	
200F	200	CORRIDOR	-	6' - 0"	7' - 10"	0' - 1 3/4"	FF	HM	PNT3	D	HM	PNT3	10/A61-50	9/A61-50			
201	201	COMPANY OFFICER	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	SEAL	S1L1	HM	PNT3	10&11/A61-50	8&9/A61-50	9.0		STC 35-40
201.1	201.1	CLO	-	5' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		
201a	201	COMPANY OFFICER		3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	SEAL	S	HM	PNT3	10/A61-50	9/A61-50	11.0		
202	202	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	PNT1	SEAL	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
203	203	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
204	204	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
205	205	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
206	206	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
207	207	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
208.1	208	COMPANY OFFICER		3' - 0"	7' - 10"	0' - 1 3/4"	FG	WD	PNT7	S	HM	PNT7	10/A61-50	9/A61-50	9.0		STC 35-40
208.2	208.1	CLO	-	4' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		
208a	208A	C/O BUNK ROOM		3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		
209	209	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
210	210	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
211	211	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
212	212	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
213.1	213	COMPANY OFFICER		3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S	HM	PNT7	10&11/A61-50	8&9/A61-50	9.0		STC 35-40
213.2	213.1	CLO	-	4' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		STC 35-40
213A.1	213	COMPANY OFFICER	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		
214.1	214	DISTRICT CHIEF OFFICE		3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S	HM	PNT7	10/A61-50	9/A61-50	9.0		
214.2	214.1	CLO	-	5' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	S	HM	PNT3	10/A61-50	9/A61-50	13.0		
214A.1	214	DISTRICT CHIEF OFFICE	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	9.0		STC 35-40
214B.1	214B	CORRIDOR	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	12.0		
214B.2	214B	CORRIDOR	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	12.0		
214C	214B	CORRIDOR	-	3' - 0"	7' - 0"	0' - 1 3/4"	F	HM	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	10.0		
215.1	215	DISTRICT CHIEF OFFICE	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT7	S1L1	HM	PNT7	10&11/A61-50	8&9/A61-50	9.0		STC 35-40
215.2	215.1	CLO	-	6' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		
215a	215	DISTRICT CHIEF OFFICE	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
216	216	STUDY	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	9.0		STC 35-40
217	217	SERVER	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	14.0		
218	218	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
219	219	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
220	220	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
221	221	CUSTODIAL	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	21.0		
222.1	222	DAY ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	16.0		STC 35-40
222.2	222	DAY ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	16.0		STC 35-40
222a	222A	ELEC	-	6' - 4"	7' - 10"	0' - 1 3/4"	FF	HM	PNT3	D	HM	PNT3	10/A61-50	9/A61-50	17.0		
223	223	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
224	224	ADA WC	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	10.0		
225	225	LAUNDRY	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	10/A61-50	9/A61-50	20.0		STC 35-40
226.2	226	KITCHEN/ DINING	20	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L1	HM	PNT7	10&11/A61-50	8&9/A61-50	20.0		
226.3	226	KITCHEN/ DINING	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S1L2	HM	PNT7	10&11/A61-50	8&9/A61-50	20.0		STC 35-40
227.1	227	COMPANY OFFICER		3' - 0"	7' - 10"	0' - 1 3/4"	FG	HM	PNT7	S	HM	PNT7	10/A61-50	9/A61-50	9.0		STC 35-40
227.2	227.1	CLO	-	5' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10/A61-50	9/A61-50	13.0		
227A.1	227	COMPANY OFFICER	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		
228	228	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
229	229	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
230	230	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
231	231	BUNK ROOM	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	10/A61-50	9/A61-50	11.0		STC 35-40
232.1	232	COMPANY OFFICER	20	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT7	S1L1	HM	PNT7	10/A61-50	9/A61-50	9.0		STC 35-40
232.2	232.1	CLO	-	5' - 0"	7' - 10"	0' - 1 3/4"	S	WD	SEAL	D	HM	PNT3	10&11/A61-50	8&9/A61-50	13.0		
232A.1	232	COMPANY OFFICER	-	3' - 0"	7' - 10"	0' - 1 3/4"	F	WD	PNT1	S	HM	PNT1	7/A41-04	16/A61-50	11.0		
FP-1.1	100	APPARATUS BAY	20	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
FP-1.2	100	APPARATUS BAY	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	AL	PNT8	S	AL	PNT8	7/A41-04	16/A61-50	8.0		
FP-2.1	100	APPARATUS BAY	20	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
FP-2.2	100	APPARATUS BAY	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	AL	PNT8	S	AL	PNT8	7/A41-04	16/A61-50	8.0		
FP-3.1	100	APPARATUS BAY	20	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
FP-3.2	100	APPARATUS BAY	-	3' - 0"	7' - 10"	0' - 1 3/4"	FG	AL	PNT8	S	AL	PNT8	7/A41-04	16/A61-50	8.0		
S-A2.1	226	KITCHEN/ DINING	60	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT7	S	HM	PNT7	10/A61-50	9/A61-50	16.0		
S-A2.2	S-A2	STAIR A	60	3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
S-B2	S-B2	STAIR B	60	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		
S-C2	S-C2	STAIR C	60	3' - 0"	7' - 10"	0' - 1 3/4"	N	HM	PNT8	S	HM	PNT8	7/A41-04	16/A61-50	16.0		

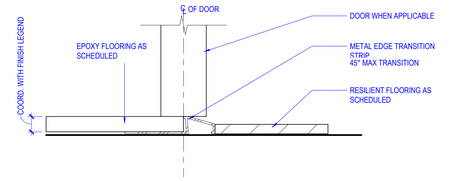
DOOR SCHEDULE - EXTERIOR

MARK	To Room: Number	MARK		DOOR						FRAME						HARDWARE SET NUMBER	REMARKS
			FIRE	SIZE									DETAILS				
DOOR NO		ROOM NAME	RATING	W	HT	THK	TYPE	MATERIAL	FINISH	TYPE	MATERIAL	FINISH	HEAD	JAMB			
LEVEL 01																	
100.1	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.2	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.3	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.4	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.5	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.6	100	APPARATUS BAY		13' - 4"	14' - 0"	0' - 3"	OH1	STEEL	PNT11	-	STEEL	PNT11	2/A32-11	6&8/A33-01			EXTERIOR
100.7	100	APPARATUS BAY		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	-	ALUM	PNT11	13/A61-50	5/A33-01	6.0		EXTERIOR
100.8	100	APPARATUS BAY		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	-	ALUM	PNT11	6/A32-13	SIM 10/A33-02	6.0		EXTERIOR
100.9	100	APPARATUS BAY		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	-	ALUM	PNT11	6/A32-13	8/A33-01	4.0		EXTERIOR
101.1	101	SCBA FILL		3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	SIM 13/A61-50	14/A61-50	6.0		EXTERIOR; SEE 4/A20-01
102.1	102	YARD STORAGE		6' - 0"	8' - 8"	0' - 3"	OH2	HM	PNT3	-	HM	PNT3	13/A61-50	7/A33-01			EXTERIOR
113.2	113	EXERCISE	-	3' - 0"	8' - 0"	0' - 1 3/4"	FG	AL	PNT11	S	AL	PNT11	6/A32-13	8/A33-01	4.0		POSITIONING SENSOR, EXTERIOR
121a.1	121A	VESTIBULE		6' - 0"	7' - 10"	0' - 1 3/4"	FGFG	ALUM	PNT11	-	ALUM	PNT11	6/A32-13	8/A33-01	1.0		EXTERIOR
121a.2	121A	VESTIBULE		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	-	ALUM	PNT11	6/A32-13	8/A33-01	2.0		EXTERIOR
S-B1.1	SB-1	STAIR B		3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	13/A61-50	14/A61-50	4.0		EXTERIOR
S-C1.1	SC-1	STAIR C		3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	13/A61-50	14/A61-50	4.0		EXTERIOR
T-01	T-1	TRAINING TOWER		3' - 4"	4' - 7 3/4"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT1	11/A41-03	7/A41-03			EXTERIOR
T-02	T-1	TRAINING TOWER		3' - 4"	4' - 7 3/4"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
T-03	T-1	TRAINING TOWER		3' - 4"	4' - 7 3/4"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
T-04	T-1	TRAINING TOWER		3' - 4"	4' - 7 1/2"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
T-05	T-1	TRAINING TOWER		3' - 4"	4' - 7 1/2"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
T-1.1	T-1	TRAINING TOWER		3' - 4"	8' - 0"	0' - 1 3/4"	F	HM	PNT3	S	HM	PNT3	11/A41-03	7/A41-03			EXTERIOR
LEVEL 02																	
226.1	226	KITCHEN/ DINING		3' - 0"	7' - 10"	0' - 1 3/4"	FG	ALUM	PNT11	S	ALUM	PNT11	6/A32-13	10/A33-02	27.0		EXTERIOR
ROOF																	
T3.1	T-1	TRAINING TOWER		3' - 0"	7' - 10"	0' - 1 3/4"	F	HM	PNT3	-	HM	PNT3	15/A61-03	7/A41-03	27.0		EXTERIOR

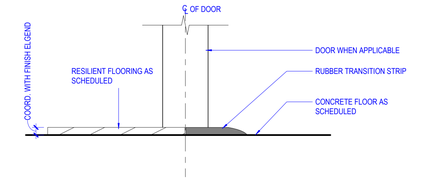
FLOOR TRANSITION GENERAL NOTES

HEIGHT CHANGE RULES
1. UP TO 1/4 INCH: NO ADDITIONAL TREATMENT IS REQUIRED FOR A VERTICAL CHANGE.
2. 1/4 TO 1/2 INCH: THE EDGE MUST BE BEVELED AT A SLOPE NOT STEEPER THAN 1:2 (A 1-TO-2 SLOPE MEANS FOR EVERY 1 INCH OF VERTICAL RISE, THERE IS 2 INCHES OF HORIZONTAL RUN).
3. OVER 1/2 INCH: THE CHANGE MUST BE HANDLED AS A RAMP, FOLLOWING ALL APPLICABLE RAMP SLOPE AND LANDING REGULATIONS.

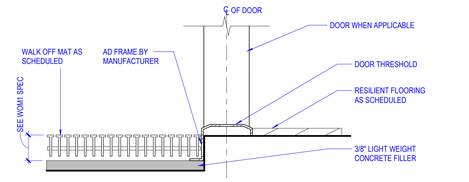
FLOOR TRANSITION DETAILS



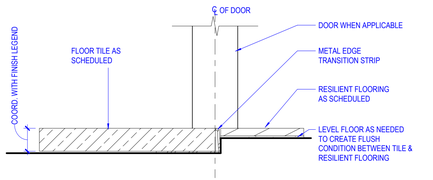
4 EPOXY TO RESILIENT TRANSITION DETAIL
SCALE 12" = 1'-0"



3 RESILIENT TO CONCRETE TRANSITION DETAIL
SCALE 12" = 1'-0"



2 WOM TO RESILIENT TRANSITION DETAIL
SCALE 12" = 1'-0"


℄ OF DOOR
DOOR WHEN APPLICABLE
FLOOR TILE AS SCHEDULED
METAL EDGE TRANSITION STRIP
RESILIENT FLOORING AS SCHEDULED
LEVEL FLOOR AS NEED

EQUIPMENT SCHEDULE

TAG	DESCRIPTION	MODEL	FINISH	COMMENTS	Install Code
E1	30" COOKTOP	RECESSED, COUNTER DEPTH		8 COOKING ZONE IN TOTAL, ADA COMPLIANT	1
E2	60" WALL RANGE HOOD	WALL MOUNTED	STAINLESS STEEL	ADA COMPLIANT	1
E3	30" ELECTRIC OVEN	RECESSED, COUNTER DEPTH	STAINLESS STEEL	ADA COMPLIANT	1
E4	FRENCH DOOR REFRIGERATOR, BOTTOM FREEZER	FREE STANDING, COUNTER DEPTH	STAINLESS STEEL		3
E5	ELECTRIC TOASTER	COUNTERTOP	STAINLESS STEEL		3
E6	MICROWAVE	RECESSED DRAWER	STAINLESS STEEL		1
E7	DISHWASHER	RECESSED, COUNTER DEPTH	STAINLESS STEEL	ADA COMPLIANT, QUIET OPERATION	1
E8	COFFEE BREWERS	COUNTERTOP			3
E9	WASHING MACHINE	FREE STANDING			3
E10	DRYER	FREE STANDING			3

FURNITURE SCHEDULE

TAG	DESCRIPTION	INSTALL CODE	COMMENTS
F1	BUNK BED, 39" X 80"	3	METAL FRAME
F2	EXECUTIVE TASK CHAIR - ARMS	3	5-STAR CASTORS BASE, FOR RESILIENT FLOOR
F3	GUEST CHAIR - NO ARM	3	SLED BASE
F4	TASK CHAIR - NO ARM	3	SLED BASE
F5	BATHROOM SEATING 36" x 16"	2	WALL MOUNTED BENCH, STAINLES STEEL BRACKETS, PLAM2 FINISH SEAT
F6	LOUNGE CHAIR	3	
F7	OFFICE DESK WITH RETURN	3	7'-6" x 5'-6"
F8	DESK, 20" x 48"	3	
F10	HIGH TOP TABLE - 36" DIAMETER	3	34" H
F11	COUNTER HEIGHT STOOL	3	
F12	KITCHEN BENCH, 18" x 60"	3	
F13	KITCHEN TABLE, 42" x 132"	3	
F14	RECLINER CHAIR	3	
F15	STACKING TRAINING CHAIR	3	CASTORS OR SLED BASE
F16	BED SIDE TABLE, 30"x30"	3	
F17	CONFERENCE TABLE, 48" x 120"	3	
F18	OUTDOOR TABLE SET WITH (4) CHAIRS,TABLE SIZE 36" x 36"	3	
F19	WALL MOUNTED TV/DISPLAY	3	
F20	TASK CHAIR - ARMS	3	CASTORS OR SLED BASE

ACCESSORY SCHEDULE

TAG	DESCRIPTION	INSTALL CODE	COMMENTS
TA1	WALL MOUNTED BABY CHANGING STATION	1	SEMI-RECESSED, STAINLESS STEEL
TA4	WALL PAPER TOWEL DISPENSER AND WASTE RECEPTACLE	1	SEMI-RECESSED, STAINLESS STEEL
TA5	WALL MOUNTED TOILET TISSUE DISPENSER AND UTILITY SHELF	1	SURFACE-MOUNTED, STAINLESS STEEL
TA6	WALL MOUNTED SANITARY NAPKIN DISPOSAL	1	SURFACE-MOUNTED, STAINLESS STEEL
TA7	COAT HOOK	1	STAINLESS STEEL
TA9	RECESSED SHARP DISPOSAL	1	STAINLESS STEEL
TA10	1-1/2" GRAB BARS WITH SNAP FLANGE, 42" long	1	STAINLESS STEEL
TA11	HORIZONTAL TWO-WALL BAR for Shower Stall	1	STAINLESS STEEL
TA12	MIRROR	1	FRAMED - BRUSHED NICKEL 1/4" DEEP NOSE ALUMINUM J-CHANNEL
TA16	ADA FOLDING SHOWER SEAT	1	PADDED SEAT, WALL MOUNTED REQUIRES WALL BLOCKING
TA17	COUNTER PAPER TOWEL DISPENSER, C-FOLD	1	RECESSED, STAINLESS STEEL
TA18	SOAP DISPENSER	3	WALL MOUNTED, BY OWNER
TA19	SOAP AND SHAMPOO DISPENSER	3	WALL MOUNTED, BY OWNER

EQUIPMENT / FURNITURE NOTES :

1. REFER TO A13 SERIES FOR FURNITURE/EQUIP. LOCATIONS
2. FOR FIREMATIC FURNITURE, SEE A17 DRAWING SERIES.

INSTALL CODE KEY

1: FURNISHED & INSTALLED BY CONTRACTOR (CF/CI)
2: FURNISHED BY OWNER; INSTALLED BY CONTRACTOR (OF/CI)
3: FURNISHED & INSTALLED BY OWNER (OF/OI)
4: FURNISHED BY CONTRACTOR & INSTALLED BY OWNER (CF/OI)

FINISH LEGEND

SPEC	TAG	TYPE	MFR	STYLE	COLOR/FINISH	SIZE	COMMENTS
ALUMINUM PANEL/WALL							
07 42 13	MTL1	ALUMINUM PANEL/WALL		WALL ALUMINUM PANEL	TO MATCH PPG - BLACK NOIR		ALUMINUM PANEL
ALUMINUM TRIM/BASE							
05 75 03	MTL2	ALUMINUM TRIM/BASE		ALUMINUM BASE, FLUSH	BLACK MATTE	4"H	ANODIZED ALUMINUM METAL BASE C, 4" H (POWDER COAT FINISH)
05 75 03	MTL3	ALUMINUM TRIM/BASE		ALUMINUM BASE	ALUMINUM, BLACK COLOR	4"H	ANODIZED ALUMINUM METAL BASE A, 4" H (POWDER COAT FINISH)
05 75 03	MTL4	ALUMINUM TRIM/BASE		ALUMINUM BASE	ALUMINUM, BLACK COLOR	4"H	ANODIZED ALUMINUM METAL BASE B, 4" H (POWDER COAT FINISH)
05 75 03	MTL5	ALUMINUM TRIM/BASE		ALUMINUM TRIM / REVEAL / CORNER	ALUMINUM, BLACK COLOR	1/4"	ANODIZED ALUMINUM CORNER (POWDER COAT FINISH)
05 75 03	MTL6	ALUMINUM TRIM/BASE		ALUMINUM TRIM / REVEAL / CORNER	ALUMINUM, BLACK COLOR	1/2"	ANODIZED ALUMINUM CORNER (POWDER COAT FINISH)
05 75 03	MTL7	ALUMINUM TRIM/BASE		ALUMINUM TRIM / REVEAL / CORNER	ALUMINUM, BLACK COLOR	1/4" x 1/2"	ANODIZED ALUMINUM REVEAL MOLDING (POWDER COAT FINISH)
CEILING							
09 51 13	APC1	CEILING		ACOUSTIC PANEL CEILING, 2X6	WHITE	2x6	HIGH NRC, LAY-IN TILE, T GRID, 9/16"
09 51 13	APC2	CEILING		ACOUSTIC PANEL CEILING, 2X2	WHITE	2x2	HIGH NRC, LAY-IN TILE, T GRID, 9/16"
09 51 13	APC3	CEILING		MOISTURE RESISTANT PANEL CEILING, 2X2	WHITE	2x2	HIGH NRC, LAY-IN TILE, T GRID, 9/16"
09 54 26	AWC1	CEILING		LINEAR WOOD CEILING	HEMLOCK, SOLID WOOD CORE	3"x5/8"	TONGUE & GROOVE LINEAR CEILING
CERAMIC TILE							
09 30 13	CT2	CERAMIC TILE		FLOOR TILE	MATTE CERAMIC/PORCELAIN	12"x24"	FOR LAYOUT INSTALLATION SEE ELEVATION. GROUT COLOR TO MATCH TILE
09 30 13	CT3	CERAMIC TILE		WALL TILE	GLOSSY GLAZED CERAMIC	3"x12"	FOR LAYOUT INSTALLATION SEE ELEVATION. GROUT COLOR TO MATCH TILE
09 30 13	CT4	CERAMIC TILE		WALL TILE	GLOSSY GLAZED CERAMIC	2"x6.5"	FOR LAYOUT INSTALLATION SEE ELEVATION. GROUT COLOR: OFF-WHITE
EPOXY							
09 67 23	INTEGRAL BASE	EPOXY		INTEGRAL COVE AT EPOXY FLOORING			SEE DETAIL FOR WALL TRANSITION
FABRIC WRAPPED PANEL							
09 84 33	FWP1	FABRIC WRAPPED PANEL			XOREL, WINDSOR 6131 - COLOR 36		UNBACKED TEXTILE, 56 INCH WIDE, 1" MINERAL FIBER CORE
MIRROR							
08 81 13	DG2	MIRROR		MIRROR		7'-8"H	EXERCISE ROOM WALLS
PAINT							
09 91 23	PNT1	PAINT		GENERAL PAINT	BM_OC-57 White Heron		EGGSHELL FOR WALLS AND METAL PAINT FOR DOORS
09 91 23	PNT2	PAINT		ACCENT	BM_HC-151 Whipple Blue		
09 91 23	PNT3	PAINT		METAL PAINT	BM_2121-20 STEEL WOOL		DOORS
09 91 23	PNT4	PAINT		ACCENT	BM_2125-40 Shadow Gray		
09 91 23	PNT5	PAINT		ACCENT	BM_2127-60 Feather Gray		
09 91 23	PNT6	PAINT		ACCENT	BM_2121-30 Pewter		
09 91 23	PNT7	PAINT		STEEL/METAL/MEP/FP PAINT	BM_2126-10 Black Tar		METAL STRUCTURE / STAIRS / RAILINGS/ EXPOSED MEPFP
09 91 23	PNT8	PAINT		METAL PAINT	SW 6905-GOLDFINCH		"YELLOW ZONE" DOOR
09 96 13.13	PNT9	PAINT		HIGH PERFORMANCE, TEXTURED	GOH 34806376		HIGH PERFORMANCE PAINT, TEXTURED. TO MATCH BM_2121-20 Steel Wool
09 91 23	PNT10	PAINT		EPOXY	SW_7671 On he Rocks		CMU WALLS IN LOCKERS ROOMS AND BAY SUPPORT SPACES
08 41 13	PNT11	PAINT		SHOP APPLIED 3-COAT FINISH	TO MATCH PPG - BLACK NOIR		ALUMINUM FRAME, CURTAIN WALL
09 91 23	PNT12	PAINT		EPOXY	TO MATCH SW 6905-GOLDFINCH		CMU - PORTAL ACCENT EPOXY
09 96 56	PNT13	PAINT		EPOXY	LIGHT GREY WITH SMALL CHIPS		MICROFLAKES 1/16"
09 67 23	PNT20	PAINT		EPOXY FLOORING	Medium/Dark Grey		TEXTURED FINISH, HIGH TRAFFIC, APARATUS BAY AREA AND FIREMATIC SPACES
09 67 23	PNT21	PAINT		EPOXY FLOORING W/ INTEGRAL COVE	MEDIUM GREY W/ GREY SPECKLES		LOCKERS AND TOILETS IN FIREMATIC SPACES
09 67 23	PNT22	PAINT		EPOXY PAINT	BRIGTH YELLOW		FLOOR STRIPES AT APARATUS BAY AREA
PLASTIC LAMINATE							
06 41 16	PLAM1	PLASTIC LAMINATE		SOLID COLOR, MATTE	LIGTH GRAY		
06 41 16	PLAM2	PLASTIC LAMINATE		WOOD TEXTURE, WOODBRUSH FINISH	WOOD PATTERN		
PREFACED CMU							
04 20 00	CMU1	PREFACED CMU		PREFACED	WHITE WITH SMALL CHIPS		CMU AT BAY
04 20 00	CMU2	PREFACED CMU		PREFACED	LIGHT GREY WITH SMALL CHIPS		CMU AT BAY
RESILIENT TILE FLOORING							
09 65 19	RSF1	RESILIENT TILE FLOORING		LARGE FORMAT TILE, NO WELDING	MEDIUM GREY W/ GREY SPECKLES	39.45"X39.45"	
09 65 19	RSF4	RESILIENT TILE FLOORING		RESILIENT PLANK	WOOD PATTERN		STAGGERED LAYOUT INSTALLATION
RUBBER ATHLETIC FLOOR							
09 65 66	RSF2	RUBBER ATHLETIC FLOOR		RUBBER TILE, FITNESS	BLACK W/ IVORY SPECKLES		
RUBBER BASE							
09 65 13	RB1	RUBBER BASE		GENERAL BASE	CHARCOAL GREY	4"H, COVE	
RUBBER SHEET FLOORING							
09 65 19	RSF5	RUBBER SHEET FLOORING		LARGE FORMAT TILE, NO WELDING	DARK GREY W/ GREY SPECKLES	39.45"X39.45"	ED
RUBBER TREAD/RISER FLOORING							
09 65 66	RSF3	RUBBER TREAD/RISER FLOORING		RUBBER STAIR TREAD/RISER	TO MATCH RSF1 COLOR		
SEALED CONCRETE							
09 61 61	SC	SEALED CONCRETE					
SOLID QUARTZ							
06 61 19	SS1	SOLID QUARTZ		JUMBO SLAB	POLISHED, SMALL WHITE-CHIP PATTERN		3CM
SOLID SURFACE							
09 75 23	SS2	SOLID SURFACE		SHOWER CLADDING, WINDOW SILL	MODERN WHITE		1/2" THICK, WIDESHEET FOR SHOWER CLADDING
09 75 23	SS3	SOLID SURFACE		TRAINING CREDENZA, WATCH ROOM	LIGHT MEDIUM GREY, LEATHER FINISH		1/2" AND 3/4" THICKNESS
09 75 23	SS4	SOLID SURFACE		BUNK NICHE	DARK CHARCOAL/BLACK COLOR		1/2" THICK
STATIC-CONTROL RESILIENT FLOORING							
09 65 36	RSF6	STATIC-CONTROL RESILIENT FLOORING		RUBBER FLOOR TILE	SMOOTH	24" x 24"	WELDED SEAMS
WALK OFF MAT							
12 48 13	WOM1	WALK OFF MAT		RECESSED ENTRANCE GRILLE	STAINLESS STEEL		
WINDOW TREATMENT							
12 24 13	WNT1	WINDOW TREATMENT		MANUAL ROLLER WINDOW SHADE - 5%	WHITE/LIGHT GREY		REFER TO DETAIL SHEETS FOR MOUNTING TYPE
12 24 13	WNT2	WINDOW TREATMENT		MANUAL ROLLER WINDOW SHADE - BLACKOUT	WHITE/LIGHT GREY		REFER TO DETAIL SHEETS FOR MOUNTING TYPE
12 24 13	WNT3	WINDOW TREATMENT		MOTORIZED ROLLER WINDOW SHADE - 5%	WHITE/LIGHT GREY		REFER TO DETAIL SHEETS FOR MOUNTING TYPE
12 24 13	WNT4	WINDOW TREATMENT		MOTORIZED ROLLER WINDOW SHADE - BLACKOUT	WHITE/LIGHT GREY		REFER TO DETAIL SHEETS FOR MOUNTING TYPE
WOOD PLANKS							
06 20 23	WD1	WOOD PLANKS		SOLID RUSTIC, RECLAIMED DOUGLAS FIR SPECIES, TONGUE & GROVE	STAINED AND SEALED, LOW SHEEN FINISHED	7" WIDE	REFER TO DETAIL SHEETS FOR PLANK THICKNESS, LENGTH AND PANEL SIZES

PAINT & WALL COVERING NOTES

1. GYPSUM BOARD WALLS SHALL HAVE EGGSHELL FINISH, UNLESS NOTED OTHERWISE.
2. GYPUSM BOARD CEILINGS SHALL HAVE FLAT FINISH, UNLESS NOTED OTHERWISE.
3. ALL DOORS AND FRAMES SCHEDULED TO RECEIVE PAINT SHALL HAVE SATIN FINISH, UNLESS NOTED OTHERWISE.

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CITY OF WORCESTER

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KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #6	1/23/26

Job Number 157132.000

TITLE

ARCHITECTURAL EQ., FURNITURE & FINISHES SCHEDULES AND LEGENDS

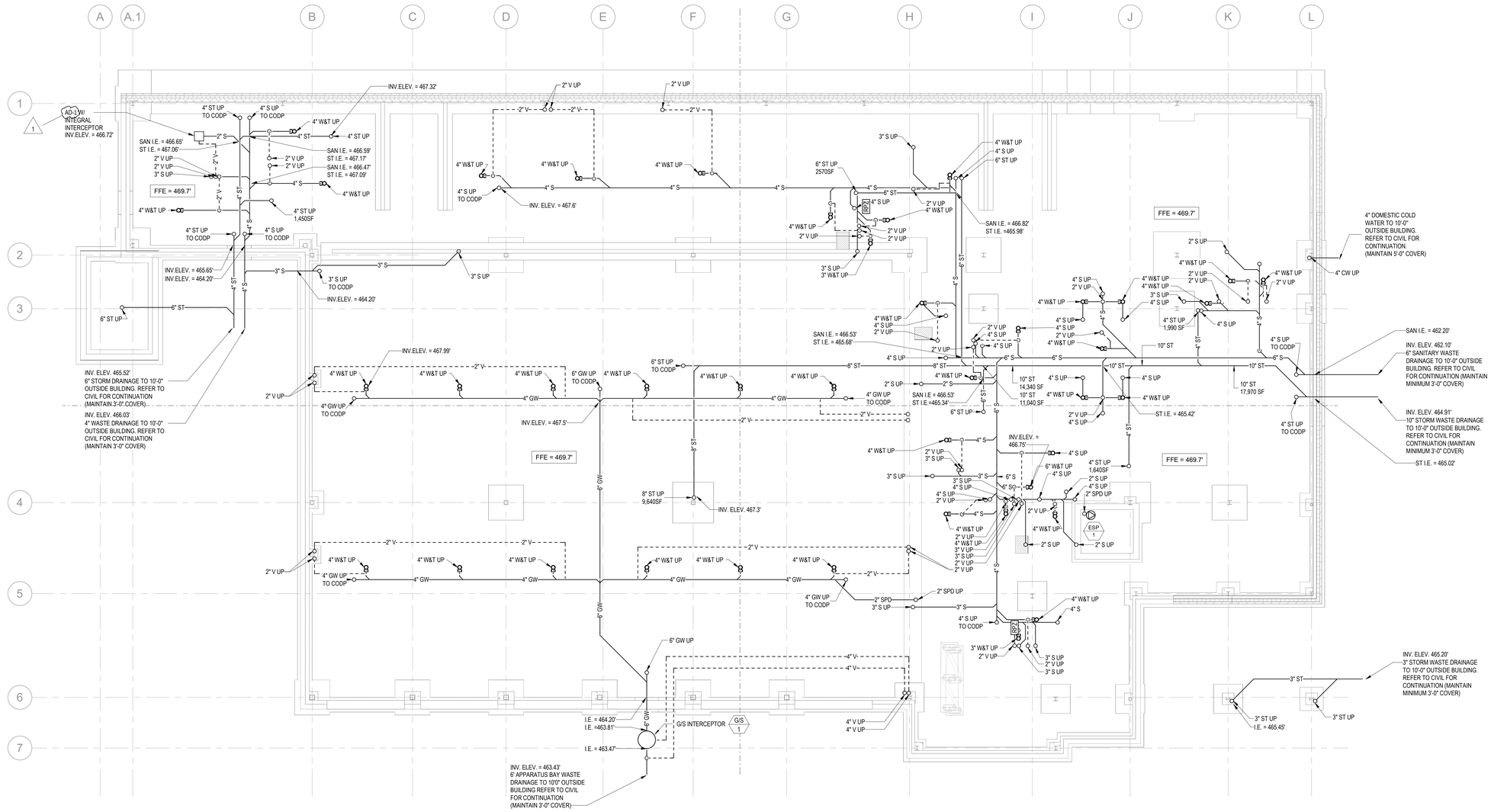
SHEET NUMBER

A64-01

CONSTRUCTION DOCUMENTS 12/19/25

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1 PLUMBING FIRST FLOOR UNDERSLAB PLAN
1/8" = 1'-0"

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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

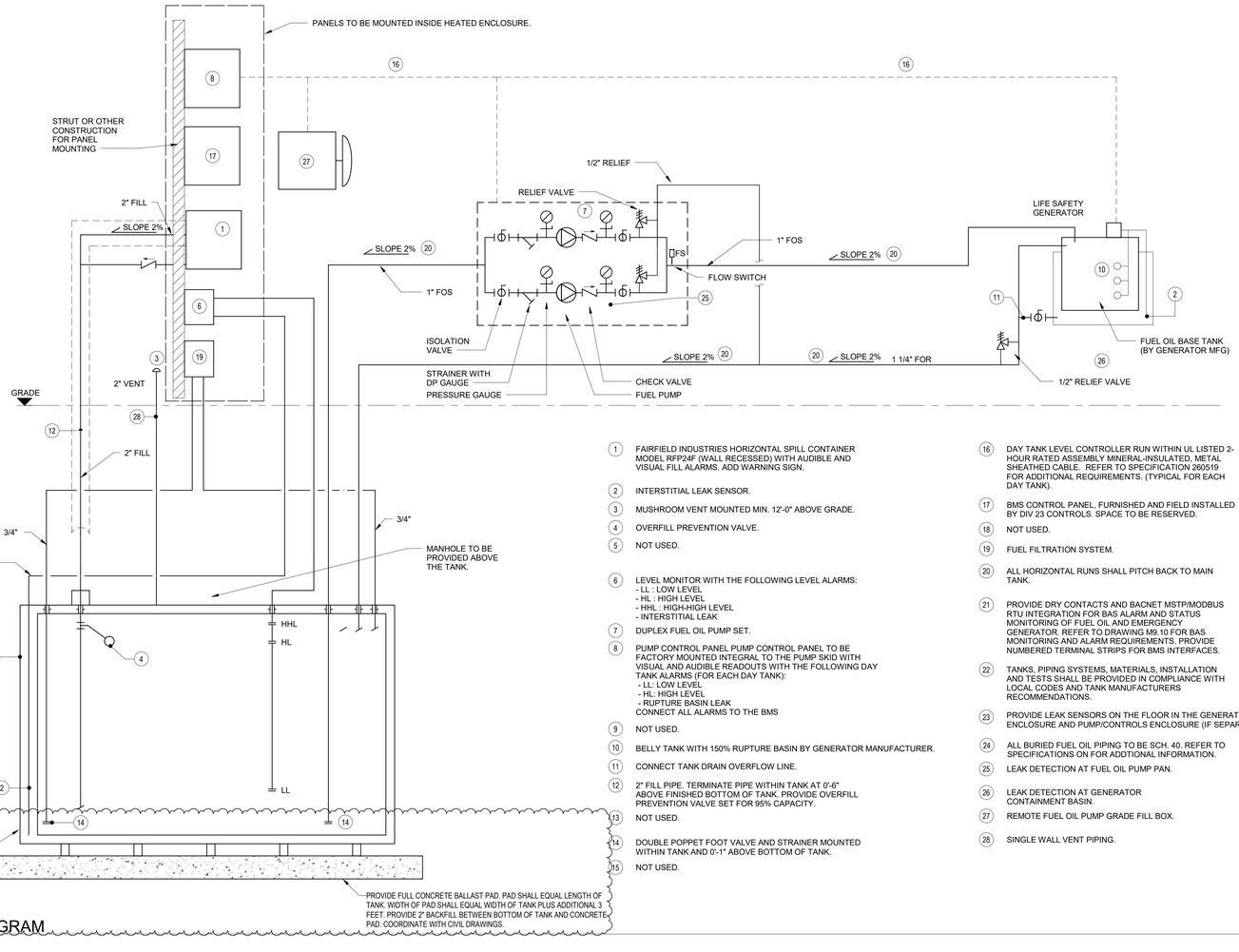
PLUMBING UNDERGROUND PLAN

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FUEL OIL LINE DIAGRAM
NTS

1. FAIRFIELD INDUSTRIES HORIZONTAL SPILL CONTAINER MODEL RFP24F (WALL RECESSED) WITH AUDIBLE AND VISUAL FILL ALARMS. ADD WARNING SIGN.
2. INTERSTITIAL LEAK SENSOR.
3. MUSHROOM VENT MOUNTED MIN. 12'-0" ABOVE GRADE.
4. OVERFILL PREVENTION VALVE.
5. NOT USED.
6. LEVEL MONITOR WITH THE FOLLOWING LEVEL ALARMS:
   - LL : LOW LEVEL
   - HL : HIGH LEVEL
   - HHL : HIGH-HIGH LEVEL
   - INTERSTITIAL LEAK
7. DUPLEX FUEL OIL PUMP SET.
8. PUMP CONTROL PANEL PUMP CONTROL PANEL TO BE FACTORY MOUNTED INTEGRAL TO THE PUMP SKID WITH VISUAL AND AUDIBLE READOUTS WITH THE FOLLOWING DAY TANK ALARMS (FOR EACH DAY TANK):
   - LL: LOW LEVEL
   - HL: HIGH LEVEL
   - RUPTURE BASIN LEAK

   CONNECT ALL ALARMS TO THE BMS
9. NOT USED.
10. BELLY TANK WITH 150% RUPTURE BASIN BY GENERATOR MANUFACTURER.
11. CONNECT TANK DRAIN OVERFLOW LINE.
12. 2" FILL PIPE. TERMINATE PIPE WITHIN TANK AT 0'-6" ABOVE FINISHED BOTTOM OF TANK. PROVIDE OVERFILL PREVENTION VALVE SET FOR 95% CAPACITY.
13. NOT USED.
14. DOUBLE POPPET FOOT VALVE AND STRAINER MOUNTED WITHIN TANK AND 0'-1" ABOVE BOTTOM OF TANK.
15. NOT USED.
16. DAY TANK LEVEL CONTROLLER RUN WITHIN UL LISTED 2-HOUR RATED ASSEMBLY MINERAL-INSULATED, METAL SHEATHED CABLE. REFER TO SPECIFICATION 260519 FOR ADDITIONAL REQUIREMENTS. (TYPICAL FOR EACH DAY TANK).
17. BMS CONTROL PANEL, FURNISHED AND FIELD INSTALLED BY DIV 23 CONTROLS. SPACE TO BE RESERVED.
18. NOT USED.
19. FUEL FILTRATION SYSTEM.
20. ALL HORIZONTAL RUNS SHALL PITCH BACK TO MAIN TANK.
21. PROVIDE DRY CONTACTS AND BACNET MSTP/MODBUS RTU INTEGRATION FOR BAS ALARM AND STATUS MONITORING OF FUEL OIL AND EMERGENCY GENERATOR. REFER TO DRAWING M9.10 FOR BAS MONITORING AND ALARM REQUIREMENTS. PROVIDE NUMBERED TERMINAL STRIPS FOR BMS INTERFACES.
22. TANKS, PIPING SYSTEMS, MATERIALS, INSTALLATION AND TESTS SHALL BE PROVIDED IN COMPLIANCE WITH LOCAL CODES AND TANK MANUFACTURERS RECOMMENDATIONS.
23. PROVIDE LEAK SENSORS ON THE FLOOR IN THE GENERATOR ROOM ENCLOSURE AND PUMP/CONTROLS ENCLOSURE (IF SEPARATE).
24. ALL BURIED FUEL OIL PIPING TO BE SCH. 40. REFER TO SPECIFICATIONS ON FOR ADDTIONAL INFORMATION.
25. LEAK DETECTION AT FUEL OIL PUMP PAN.
26. LEAK DETECTION AT GENERATOR CONTAINMENT BASIN.
27. REMOTE FUEL OIL PUMP GRADE FILL BOX.
28. SINGLE WALL VENT PIPING.

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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

MECHANICAL SINGLE LINE DIAGRAMS

SHEET NUMBER

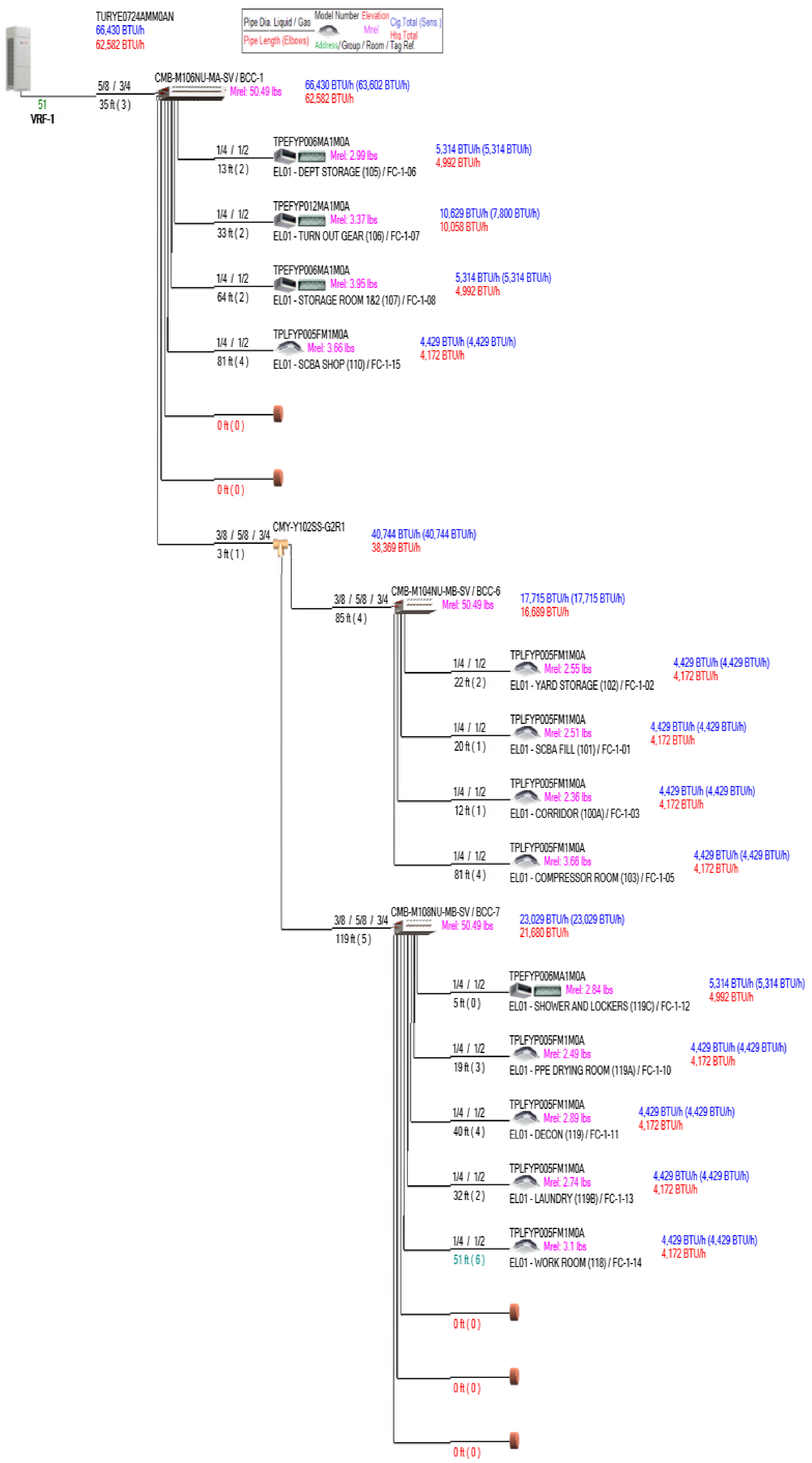
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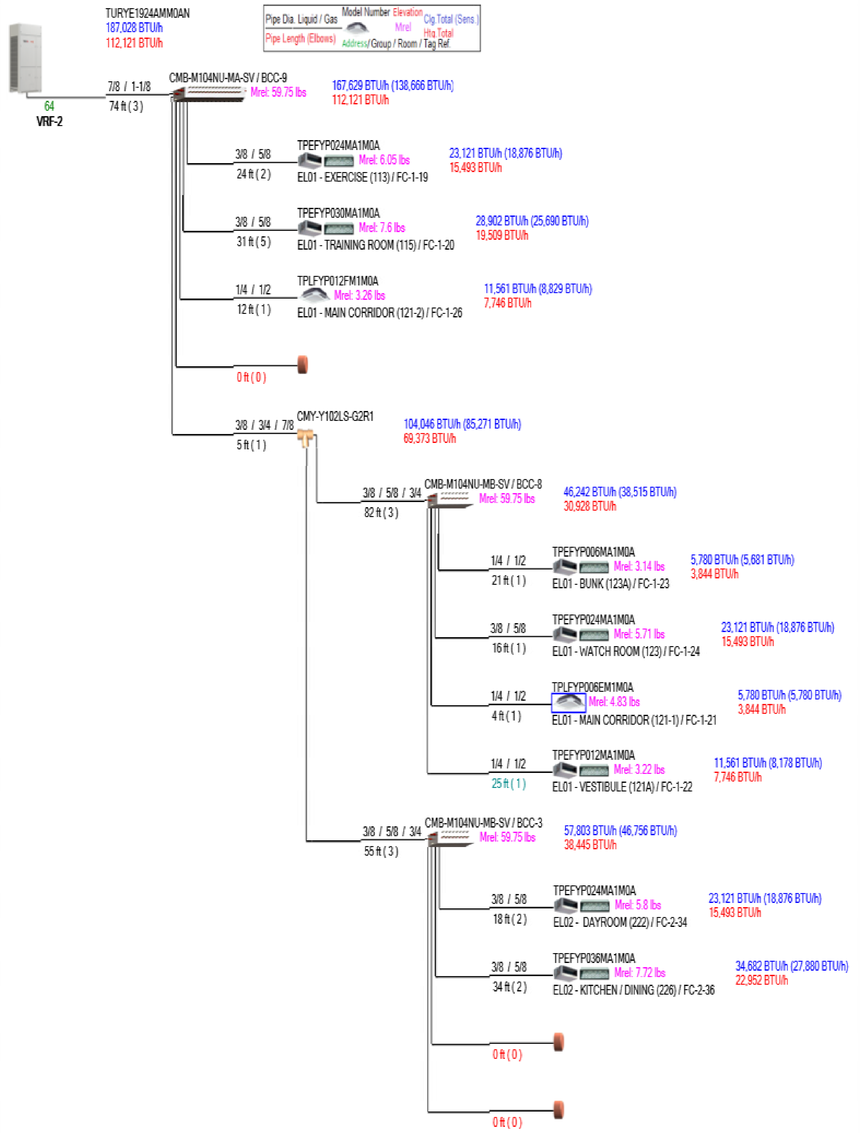
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KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

MECHANICAL VRF SINGLE LINE DIAGRAMS

SHEET NUMBER

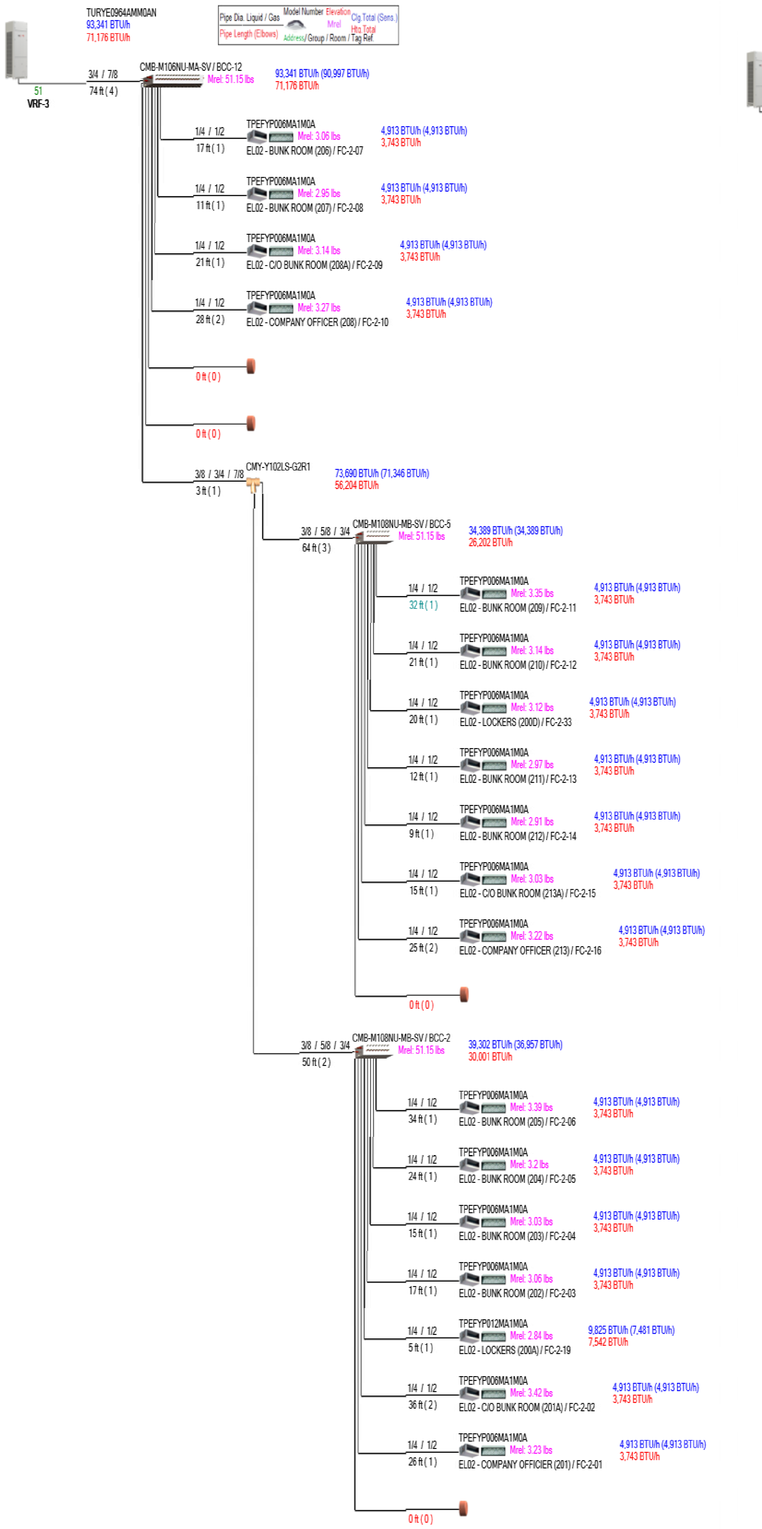
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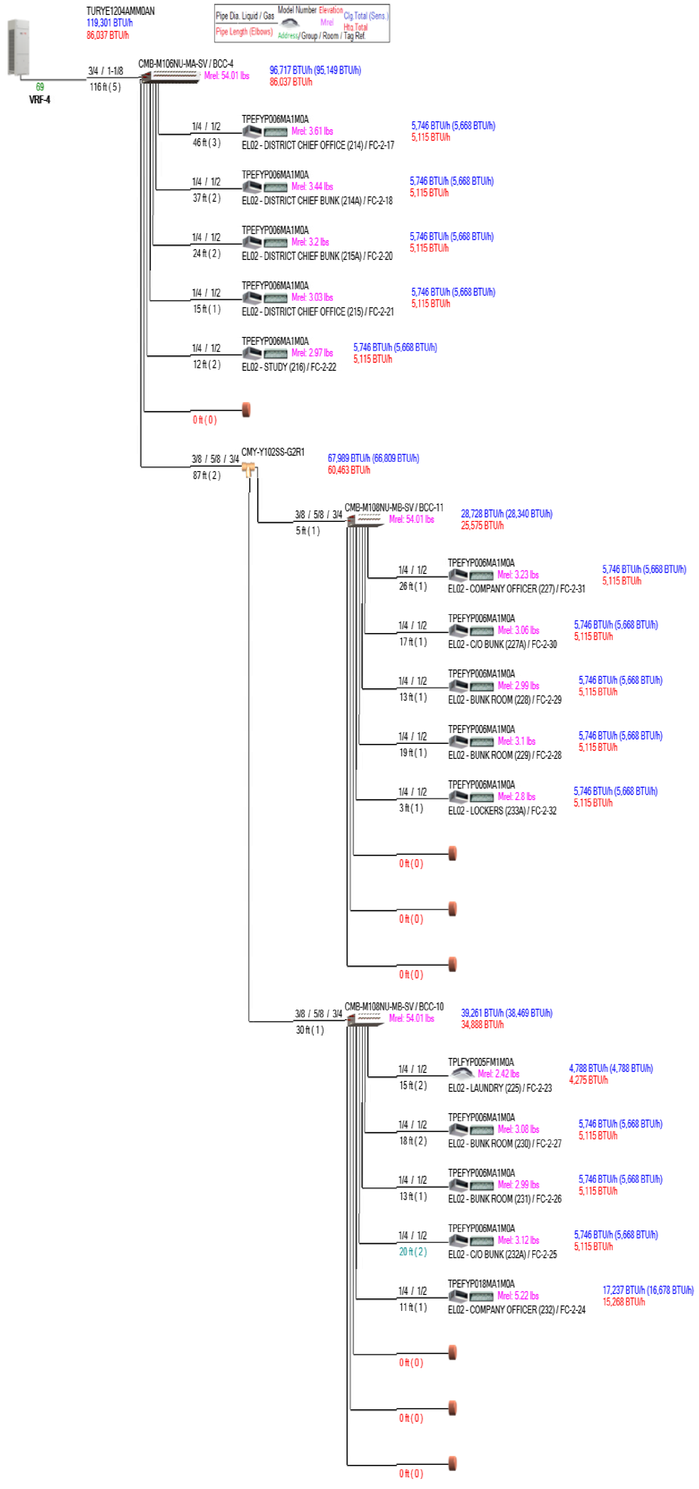
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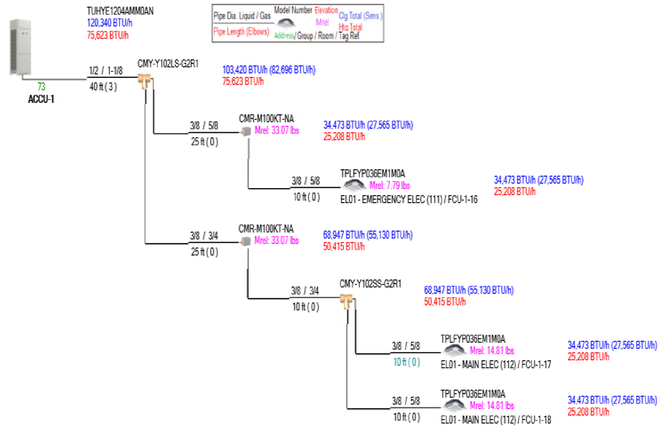
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CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

MECHANICAL VRF SINGLE LINE DIAGRAMS

SHEET NUMBER

M03.04

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SYMBOLS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	FAN - CENTRIFUGAL		THERMOWELL
	FAN - AXIAL		AVERAGING ELEMENT
	FAN - PLENUM / PLUG		VALVE - 2 WAY
	PUMP		VALVE - 3 WAY
	FILTER - PLEATED		ACTUATOR - MOTOR
	FILTER - BAG		ACTUATOR - DIAPHRARM
	FILTER - CARBON		ACTUATOR - PISTON
	COIL - HEATING		DAMPER
	COIL - COOLING		DAMPER - FIRE/SMOKE
	COIL - PREHEATING		MANUAL SWITCH
	COIL - REHEATING		HORN / STROBE
	HUMIDIFIER		STROBE
VFD	VARIABLE FROQUENCY DRIVE		PANIC BUTTON
	MOTOR STARTER		UNDERFLOOR TEMPERATURE SENSOR
XXX	PANEL (SEE ABBREVIATIONS)	AA YY	EQUIPMENT TAG XX - DEVICE TYPE YY - DEVICE NUMBER
		TT 01	BMS DEVICE TT - DEVICE TYPE 01 - DEVICE NUMBER
		PT 02	NON-BMS DEVICE PT - DEVICE TYPE 02 - DEVICE NUMBER
			LOCAL HARD WIRED CONNECTION
			IP COMMUNICATIONS CAT-5E/6/6A IN SUPPORT OF BACNET / IP, BACNET SC, MODBUS / TCPIP
			SERIAL COMMUNICATIONS RS-485, RS-232 IN SUPPORT OF BACNET / MSTP, MODBUS / RTU
			IP COMMUNICATIONS FIBER IN SUPPORT OF BACNET / IP, BACNET SC, MODBUS / TCP

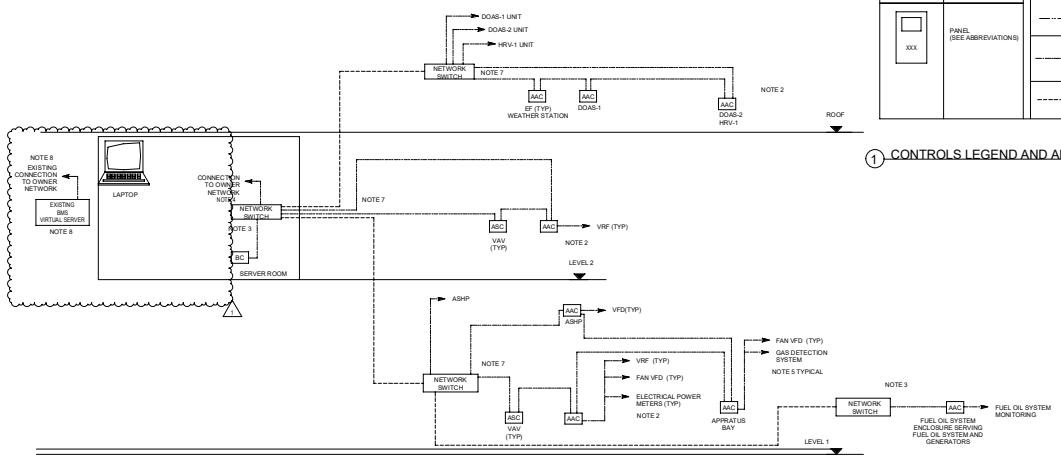
ABBREVIATIONS

SYMBOL	DESCRIPTION
A	AQUASTAT
AAC	ADVANCED APPLICATION CONTROLLER
AC	ALARM CONTACT
AFS	AIR FLOW SWITCH
AFT	AIR FLOW TRANSMITTER
AHU	AIR-HANDLING UNIT
AI	ANALOG INPUT
AO	ANALOG OUTPUT
AS	AIR SEPERATOR
ASC	APPLICATION SPECIFIC CONTROLLER
BC	BUILDING CONTROLLER
BCP	BOILER CONTROL PANEL
BMS	BUILDING MANAGEMENT SYSTEM
CA	COMMON ALARM
CCP	CHILLER CONTROL PANEL
CHWR	CHILLED WATER RETURN
CHWS	CHILLED WATER SUPPLY
CO2	CARBON DIOXIDE
CP	CONTROL PANEL
CPF	CHEMICAL POT FEEDER
CRAC	COMPUTER ROOM A/C UNIT
CS	CURRENT SENSOR
DC	DRY COOLER
DDCP	DIRECT DIGITAL CONTROL PANEL
DES	DAMPER END SWITCH
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
DRS	DAMPER RESET SWITCH
EF	EXHAUST FAN
EFSO	EMERGENCY FUEL SHUT OFF SYSTEM
EGCP	EMERGENCY GENERATOR CONTROL PANEL
ET	EXPANSION TANK
FAS	FIRE ALARM SYSTEM
FBK	FEEDBACK
FCU	FAN COIL UNIT
FLP	FAIL LAST POSITION
FLSS	FIRE AND LIFE SAFETY STSTEM
FLT	FAULT
FMS	FACILITY MANAGEMENT SYSTEM
FMS	FLOW MEASURING STATION
FS	FLOW SWITCH
FSC	FAN START CIRCUIT
FSD	FIRE SMOKE DAMPER
FT	FLOW TRANSMITTER
FOCP	FUEL OIL CONTROL PANEL
FZ	FREEZE PROTECTION DEVICE (FREEZESTAT)
GCP	GENERATOR CONTROL PANEL
GWR	GLYCOL WATER RETURN
GWS	GLYCOL WATER SUPPLY
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
HT	HUMIDITY TRANSMITTER
HX	HEAT EXCHANGER
IMH	IMMERSION HEATER
IP	INTERNET PROTOCOL
LS	LEAK SENSOR
MIV	MOTORIZED ISOLATION VALVE
NIC	NETWORK INTERFACE CONTROLLER
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
P	PUMP
PCD	PRESSURE CONTROL DAMPER
PCV	PRESSURE CONTROL VALVE
PDS	PRESSURE DIFFERENTIAL SWITCH

ABBREVIATIONS

SYMBOL	DESCRIPTION
PI	PRESSURE INDICATOR
PSH	PRESSURE SWITCH HIGH
PSL	PRESSURE SWITCH LOW
PT	PRESSURE TRANSMITTER
RFL	RESETTABLE FUSIBLE LINK
SCD	SMOKE CONTROL DAMPER
SD	SMOKE DETECTOR
ST	STATUS
SW	SWITCH
TCD	TEMPERATURE CONTROL DAMPER
TCV	TEMPERATURE CONTROL VALVE
TF	TRANSFER FAN
THL	TEMPERATURE HIGH LIMIT
TSD	TOUCH SCREEN DISPLAY
TT	TEMPERATURE TRANSMITTER
UPS	UNINTERRUPTIBLE POWER SUPPLY
UH	UNIT HEATER
VAV	VARIABLE AIR VOLUME
VES	VALVE END SWITCH
VFD	VARIABLE FREQUENCY DRIVE

1 CONTROLS LEGEND AND ABBREVIATIONS



2 CONTROLS SYSTEM ARCHITECTURE

NOTES:
1. CONTRACTOR TO PROVIDE ALL WIRING INCLUSIVE OF NETWORK SWITCHES.
2. EQUIPMENT INTEGRATION TYPICAL - COORDINATE INTEGRATION PROTOCOLS WITH APPROVED EQUIPMENT SUBMITTALS.
3. LOCATE NETWORK SWITCH WITHIN NEAREST BMS PANEL.
4. COORDINATE WITH OWNER'S IT.
5. REFER TO MECHANICAL AND ELECTRICAL PLANS FOR PANEL LOCATIONS.
6. N/A
7. CONTRACTOR TO IMPLEMENT LOOP NETWORK ARCHITECTURE WITH RAPID SPANNING TREE PROTOCOL (RSTP). CONTRACTOR TO CONFIGURE ALL NETWORK SWITCHES IN SUPPORT OF THIS TOPOLOGY.
8. EXISTING BMS VIRTUAL SERVER TO BE UTILIZED. CONTRACTOR TO COORDINATE WITH OWNER'S IT OPERATIONS AND THE CONTROLS VENDOR AS REQUIRED.

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CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

1	Addendum #1	12/2/25
DESC	DESC	DATE

Job Number 157132.000

TITLE

MECHANICAL CONTROLS

SHEET NUMBER

M09.00

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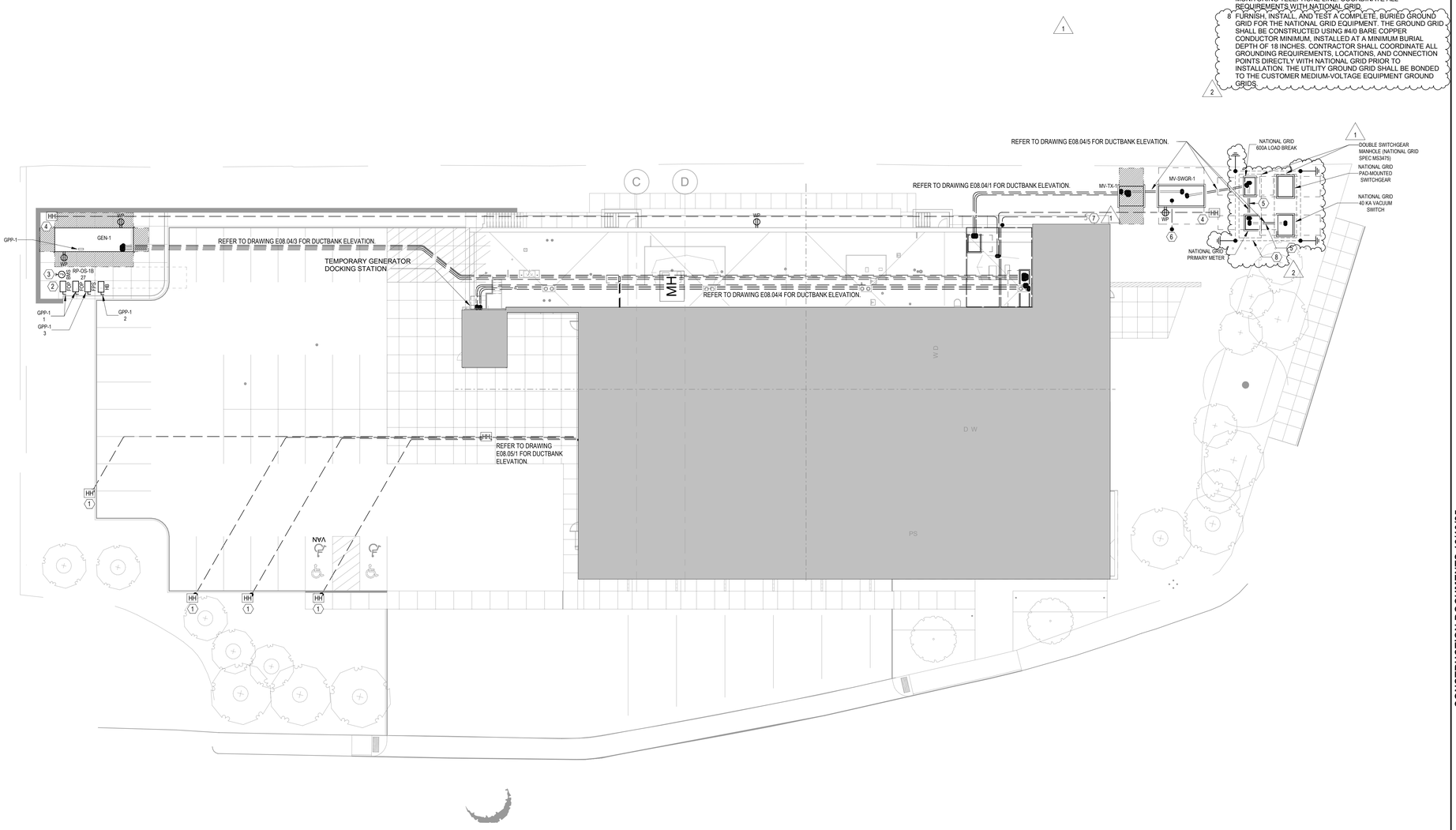
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GENERAL NOTES

1. SEE DRAWING E00.00 FOR LEGENDS, NOTES, AND ABBREVIATIONS.
2. UNDERGROUND CONDUIT ROUTING IS DIAGRAMMATIC AND INTENDED TO CONVEY CONNECTIVITY RATHER THAN ACTUAL CONDUIT ROUTINGS. CONDUIT RUNS, WHERE SHOWN, ARE INTENDED TO REPRESENT THE GENERAL CONDUIT ROUTING ONLY. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXACT QUANTITY, CONFIGURATION AND ROUTING IN THE FIELD. NOT ALL CONDUIT RUNS ARE SHOWN.

KEY NOTES

1. CONDUIT AND WIRE SHALL BE FURNISHED AND ROUTED FROM PANEL PP-EV TO FUTURE EV CHARGER HANDHOLES.
2. FUEL OIL PUMPS, FUEL POLISHING SYSTEM, BMS AND HOTBOX SYSTEM SHALL BE LOCATED WITHIN THE ENCLOSURE PROVIDED BY DIVISION 23.
3. POWER CONNECTION FOR BMS PANEL. COORDINATE EXACT LOCATION WITH MECHANICAL CONTRACTOR. BMS POWER LOCATED INSIDE FUEL PUMP ENCLOSURE.
4. FURNISH AND INSTALL HANDHOLE FOR FUTURE EXTERIOR LIGHTING. PROVIDE 1" EMPTY CONDUIT WITH PULLSTRING FROM HANDHOLE TO PANEL LP-1A.
5. FURNISH AND INSTALL (2) 4" EMPTY CONDUIT WITH PULLSTRING BETWEEN NATIONAL GRID EQUIPMENT.
6. PROVIDE SPARE CONDUIT FROM SWITCHGEAR AND STUB OUT UNDERGROUND 5 FEET BEYOND CONCRETE PAD FOR FUTURE USE. CONDUIT SHALL BE CAPPED AND SEALED UNDERGROUND.
7. FURNISH AND INSTALL CONDUIT UNDERGROUND FROM FUTURE RTU LOCATION TO SITE PROPERTY LINE FOR RTU MONITORING TELEPHONE LINE. COORDINATE ALL REQUIREMENTS WITH NATIONAL GRID.
8. FURNISH, INSTALL, AND TEST A COMPLETE, BURIED GROUND GRID FOR THE NATIONAL GRID EQUIPMENT. THE GROUND GRID SHALL BE CONSTRUCTED USING #4/0 BARE COPPER CONDUCTOR MINIMUM, INSTALLED AT A MINIMUM BURIAL DEPTH OF 18 INCHES. CONTRACTOR SHALL COORDINATE ALL GROUNDING REQUIREMENTS, LOCATIONS, AND CONNECTION POINTS DIRECTLY WITH NATIONAL GRID PRIOR TO INSTALLATION. THE UTILITY GROUND GRID SHALL BE BONDED TO THE CUSTOMER MEDIUM-VOLTAGE EQUIPMENT GROUND GRIDS.



1 ELECTRICAL SITE PLAN
1/16" = 1'-0"

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PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
2	Addendum #7	1/23/26
1	Addendum #5	1/16/26

Job Number 157132.000

TITLE

ELECTRICAL SITE POWER PLAN

SHEET NUMBER

E01.01

CONSTRUCTION DOCUMENTS 12/19/25

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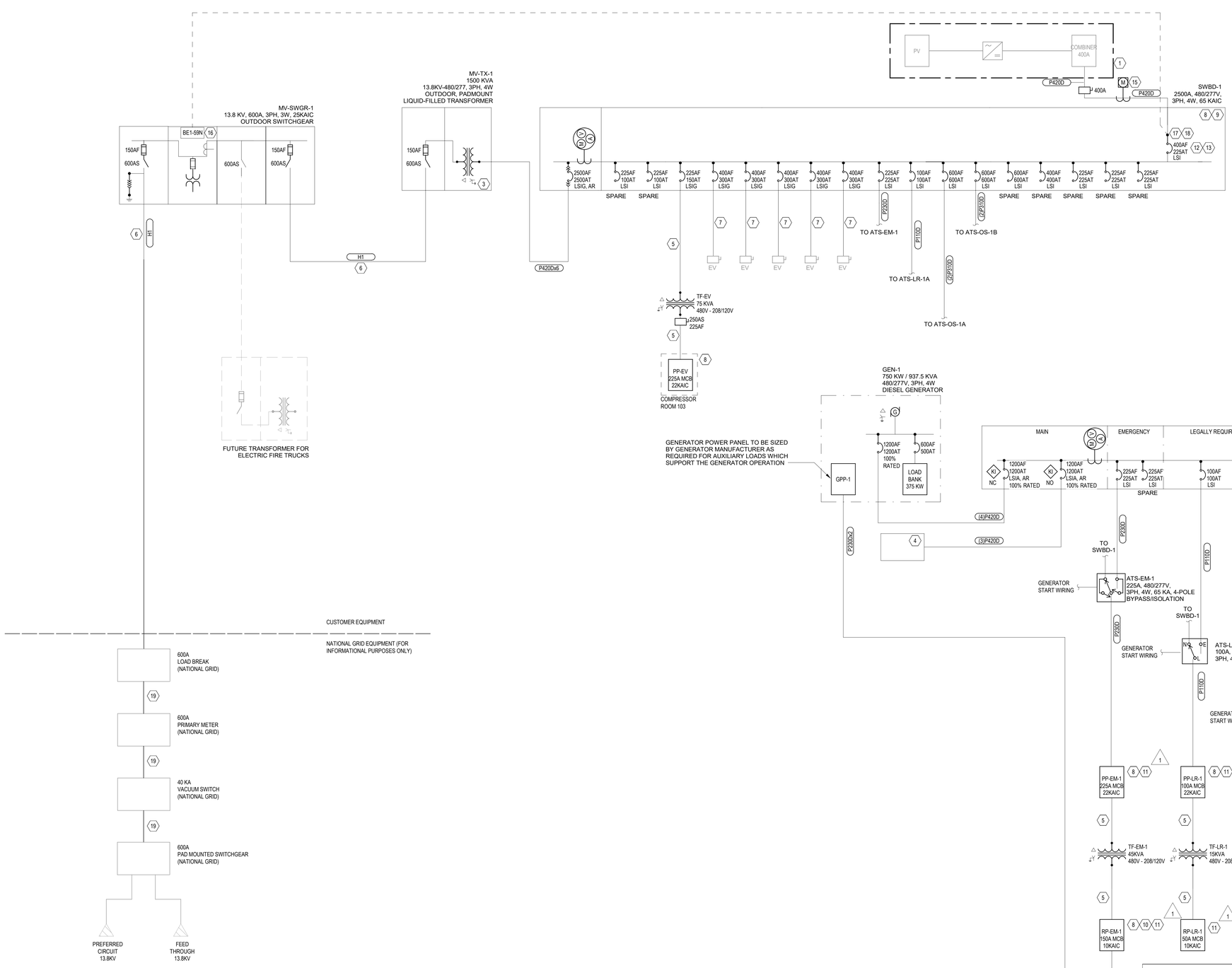
1/27/2026 4:37:02 PM Autodesk Docs://City of Worcester - South Division Firehouse/MEP_City of Worcester_South Division Firehouse r14

GENERAL NOTES:

1. SEE DRAWING E00.00 FOR LEGENDS, NOTES, AND ABBREVIATIONS.
2. SEE DRAWING E00.01 FOR DRY TYPE TRANSFORMER WIRING SCHEDULE.
3. HALFTONE DASH INDICATES FUTURE SCOPE.

KEY NOTES: (XX)

1. PV SYSTEM EQUIPMENT PROVIDED BY OTHERS. REFER TO PV DRAWINGS FOR MORE INFORMATION.
2. EMERGENCY SWITCHBOARD SHALL BE CONSTRUCTED WITH BARRIERED, VERTICAL SECTIONS TO SEPARATE THE EMERGENCY BRANCH FROM ALL OTHER LOADS.
3. ROUTE CONDUITS IN AN UNDERGROUND CONCRETE-ENCASED DUCTBANK FROM THE PADMOUNTED TRANSFORMER TO THE MAIN ELECTRICAL ROOM. REFER TO DETAIL 1 AND 2 ON DRAWING E08.04.
4. TEMPORARY GENERATOR CONNECTION BOX AS PER NEC 700.3. LOCATED OUTDOORS ON BUILDING EXTERIOR WALL. TYPE 4X ENCLOSURE, PHASE ROTATION MONITOR, 1200A LSIA/AR 100% RATED INTERNAL BREAKER, 16-SERIES CAM-TYPE CONNECTOR RATED 480V, 1200A. REFER TO DETAIL 1 AND 4 ON DRAWING E08.04 FOR CONDUIT ROUTING.
5. REFER TO TRANSFORMER SCHEDULE.
6. ELEC CONTRACTOR TO FURNISH AND INSTALL CONDUIT AND WIRING. PROVIDE (1) SPARE 5" CONDUIT.
7. FURNISH AND INSTALL EMPTY 3.5"C CONDUIT WITH PULL STRING.
8. PROVIDE SURGE PROTECTIVE DEVICE.
9. ALL FEEDER CIRCUIT BREAKERS SHALL HAVE INTEGRAL METERING TRIP UNITS.
10. PROVIDE MAIN CIRCUIT BREAKER WITH ELECTRONIC TRIP UNIT WITH INTEGRAL METERING FUNCTION.
11. PROVIDE BRANCH CIRCUIT MCNIT MONITORING FOR ALL POLES.
12. BREAKER SHALL BE FURNISHED WITH WARNING LABEL STATING "POWER SOURCE OUTPUT CONNECTION - DO NOT RELOCATE THIS OVERCURRRENT DEVICE.
13. PV BREAKER SHALL BE LOCATED IN POSITION FURTHEST FROM SWITCHBOARD MAIN BREAKER.
14. PROVIDE 2-POLE AND 3-POLE FEEDER BREAKERS WITH INTEGRAL METERING TRIP UNITS.
15. PV SYSTEM TO BE PROVIDED WITH BIDIRECTIONAL REVENUE UTILITY METER MEETING NATIONAL GRID REQUIREMENTS.
16. PROVIDE BASLER BE1-59N RELAY. PART NUMBER SHALL BE A6F-A1J-C2N0F. RELAY TO BE MOUNTED IN MV-SWGR-1 AND CONNECTED ON THE LOAD SIDE OF THE DISCONNECT. PROVIDE (3) PTs CONNECTED WYE-PRIMARY AND BROKEN DELTA-SECONDARY. PTs SHALL PROVIDE RESISTOR ACROSS THE BROKEN DELTA SECONDARY TO MITIGATE FERRORESONANCE.
17. FOR PV POI CIRCUIT BREAKER, PROVIDE REMOTE TRIP CONTACT TO ACCOMODATE SIGNALS FROM THE BE1-59N RELAY IN MV-SWGR-1. PROVIDE PRE-CLOSE AND POST-CLOSE BREAKER TRIP CIRCUIT HEALTHY SUPERVISION.
18. PROVIDE CIRCUIT BREAKER WITH UNDERVOLTAGE RELEASE (UVR). UVR SHALL BE CONFIGURABLE FOR INSTANTANEOUS TRIPPING OF THE CIRCUIT BREAKER USING A 120V CIRCUIT.
19. FURNISH AND INSTALL CONDUIT AS NOTED ON SITE PLAN.



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CITY OF WORCESTER

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KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
2	Addendum #7	1/23/26
1	Addendum #5	1/16/26

Job Number 157132.000

TITLE

ELECTRICAL SINGLE LINE DIAGRAM

SHEET NUMBER

E03.00

CONSTRUCTION DOCUMENTS 12/19/25

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GENERAL NOTES:

1. REFER TO 260943 - NETWORK LIGHTING CONTROL SPECIFICATION.
2. LIGHTING CONTROL SYSTEM DESIGN BASIS IS LUTRON ATHENA. DESIGN ALTERNATES INCLUDE NLIGHT AND WATTSTOPPER.
3. VENDOR SHALL ENSURE THAT ALL NECESSARY COMPONENTS ARE PROVIDED TO FORM A COMPLETE LIGHTING CONTROL SYSTEM, AND THAT ALL SPECIFIC EQUIPMENT LIMITATIONS AND REQUIREMENTS ARE ACCOUNTED FOR IN THE SUBMITTAL.
4. WIRELESS OCCUPANCY SENSORS, DAYLIGHT SENSORS AND WALL SWITCHES SHALL BE INSTALLED IN THE DAY ROOM AND KITCHEN/DINING ROOMS ONLY. ALL OTHER SENSORS AND SWITCHES SHALL BE WIRED, UON.

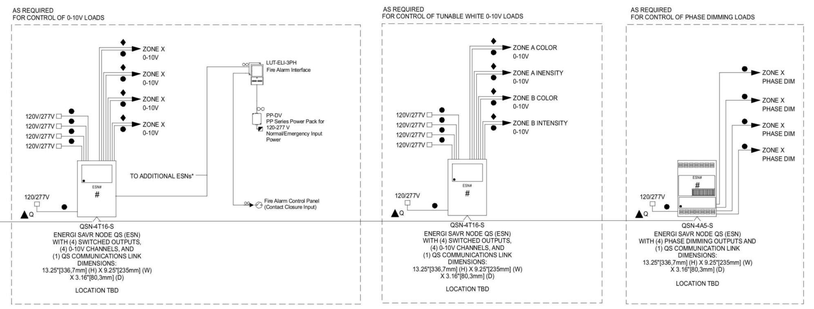
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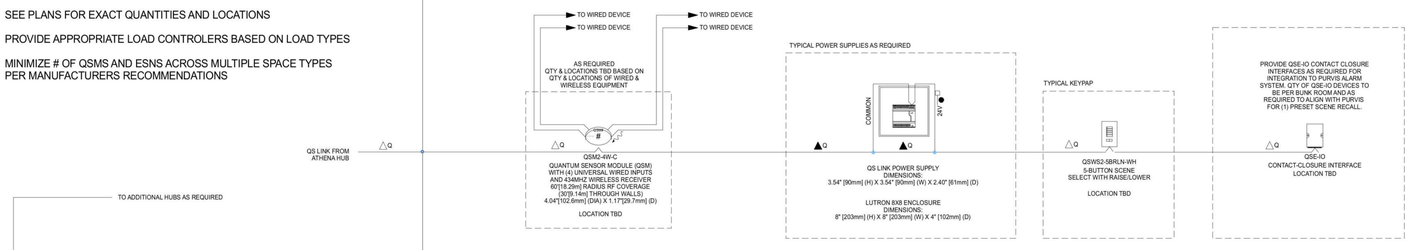
CONCEPT DRAWING NOTES:
CONTROL SYSTEM DRAWING IS PROVIDED FOR CONCEPTUAL PURPOSES ONLY AND IS NOT INTENDED FOR CONSTRUCTION. EXACT EQUIPMENT REQUIREMENTS, INCLUDING LOCATIONS AND QUANTITIES, SHOULD BE VERIFIED IN ACCORDANCE WITH THE MOST UP-TO-DATE LIGHTING/ELECTRICAL REFLECTED CEILING PLANS, LIGHTING FIXTURE SCHEDULES, PANEL SCHEDULES, CONTROL INTENT AND SPECIFICATIONS. SHADE EQUIPMENT SHOULD BE VERIFIED IN ACCORDANCE WITH ARCHITECTURAL PLANS, SPECIFICATIONS AND WINDOW SCHEDULES/DETAILS.

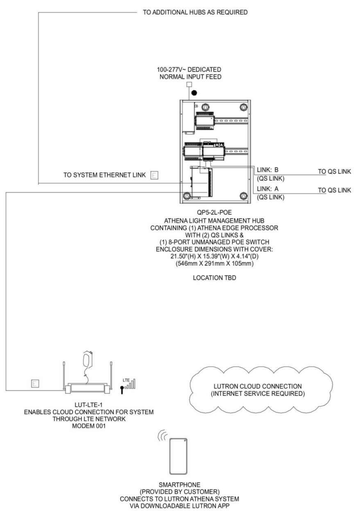
SEE PLANS FOR EXACT QUANTITIES AND LOCATIONS

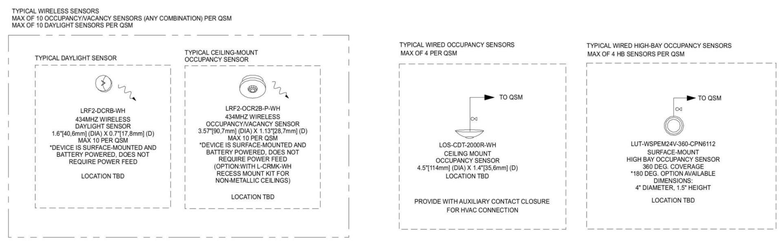
PROVIDE APPROPRIATE LOAD CONTROLERS BASED ON LOAD TYPES

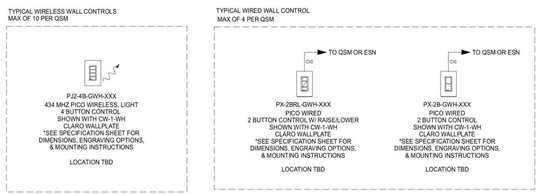
MINIMIZE # OF QSMS AND ESNS ACROSS MULTIPLE SPACE TYPES PER MANUFACTURERS RECOMMENDATIONS













TYPICAL LOAD SIDE TRANSFER RELAYS

PROVIDED BY LVS CONTROLS

WIRING LEGEND:

△Q QS CONTROL LINK. (SEE WIRE DESCRIPTION BELOW)
▲Q QS CONTROL LINK. (SEE WIRE DESCRIPTION BELOW)
(CONNECT WIRES 1, 3 AND 4. DO NOT CONNECT WIRE # 2)

QS WIRING AS REQUIRED BY CONTROL LINK LENGTH
(REFER TO QS SMART PANEL POWER SUPPLY WIRING GUIDE FOR SHADE WIRING NOTES):

TOTAL CONTROL LINK LENGTH	WIRE GAUGE	AVAILABLE FROM LUTRON IN ONE CABLE:
LESS THAN 500ft (152.4 m)	POWER (TERMINALS 1&2): 1 PAIR 18 AWG (1.0 mm²)	GRX-CBL-346S (NON-PLENUM) OR GRX-PCBL-346S (PLENUM)
	DATA (TERMINALS 3&4): 1 PAIR 22 AWG (0.5 mm²), TWISTED AND SHIELDED*	
500ft (152.4 m) TO 2,000ft (610 m)**	POWER (TERMINALS 1&2): 1 PAIR 12 AWG (4.0 mm²)	GRX-CBL-46L (NON-PLENUM) OR GRX-PCBL-46L (PLENUM)
	DATA (TERMINALS 3&4): 1 PAIR 22 AWG (0.5 mm²), TWISTED AND SHIELDED*	

*ALTERNATE DATA-ONLY CABLE: USE APPROVED DATA LINK CABLE (22 AWG [0.5 mm²] TWISTED/SHIELDED) FROM BELDEN (MODEL # 9451).
**TOTAL LENGTH OF THE QS LINK MUST NOT EXCEED 2,000 ft (600 m).

- INPUT POWER (NORMAL-EMERGENCY)
- INPUT POWER (NORMAL)
- 2 #12AWG (4 mm2)
- 3 #12AWG (4 mm2)
- 0-10V SIGNAL: 2 #18AWG (1.0 mm2)
- CONTACT CLOSURE SIGNAL: 2 #18AWG (1.0 mm2)
- CONTACT CLOSURE SIGNAL: 3 #18AWG (1.0 mm2)
- CLEAR CONNECT - TYPE A WIRELESS SIGNAL
- CLEAR CONNECT - TYPE X WIRELESS SIGNAL
- LUTRON SENSOR CABLE C-CBL-522S OTHERWISE USE 3 #22 AWG (1.0 mm2)
- LUTRON SENSOR CABLE C-CBL-522S OTHERWISE USE 4 #22 AWG (1.0 mm2)
- D DMX CONTROL
- E CAT5E OR BETTER CABLE FOR LUTRON NETWORK TERMINATED WITH RJ45 CONNECTORS. 328 ft (100 m) MAXIMUM RUN
- E POWER OVER ETHERNET (POE) ETHERNET LINK, CAT5E OR BETTER CABLE FOR LUTRON NETWORK TERMINATED WITH RJ45 CONNECTORS. 328 ft (100 m) MAXIMUM RUN

QS EQUIPMENT

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PROJECT

CONSTRUCTION DOCUMENTS 12/19/25

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
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CITY OF WORCESTER
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WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

ELECTRICAL LIGHTING CONTROL DIAGRAM

SHEET NUMBER

E03.10

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GENERAL NOTES

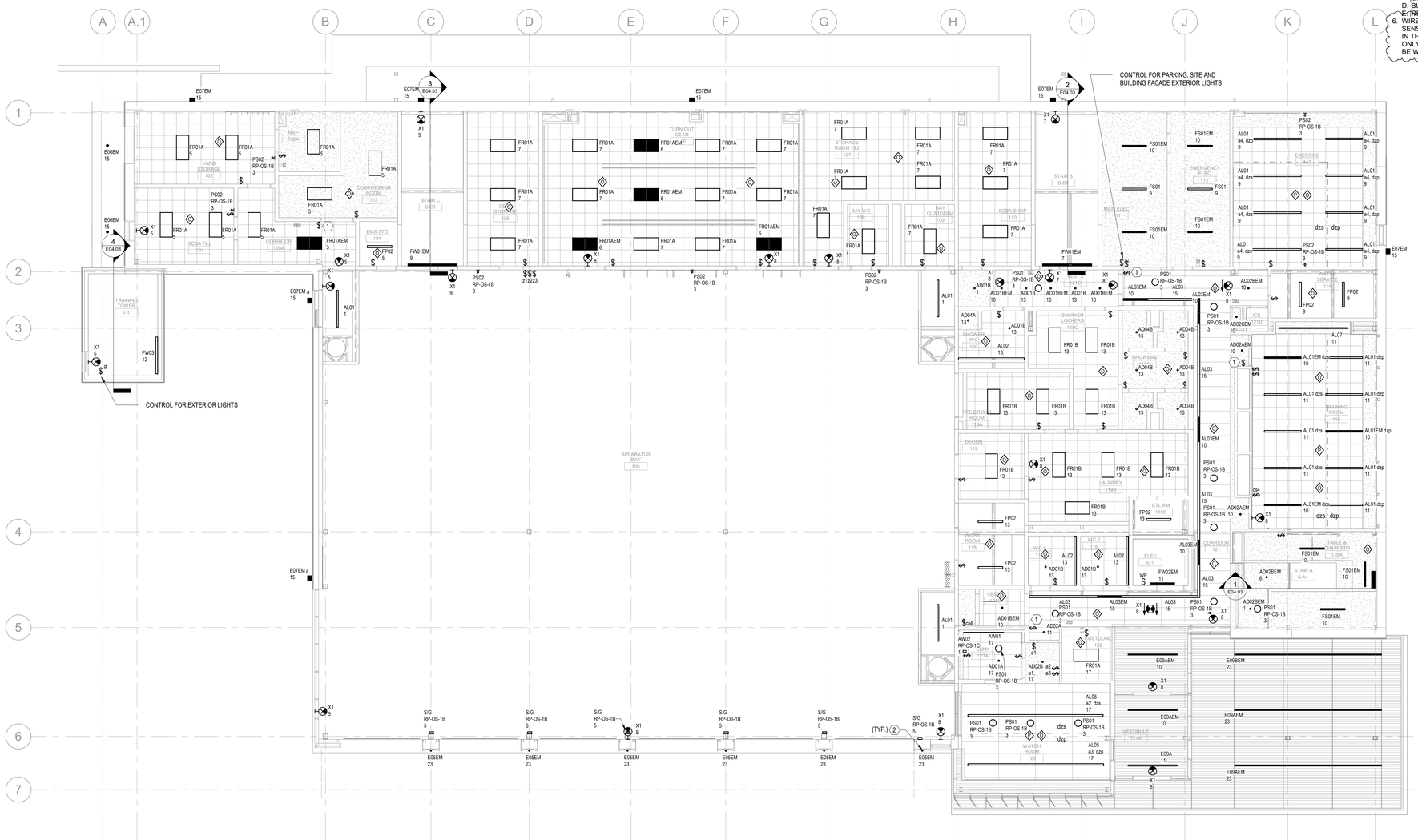
1. SEE DRAWING E00.00 FOR LEGENDS, NOTES, AND ABBREVIATIONS.
2. COORDINATE LOCATION OF ALL COMMON AREA LIGHTING CONTROL SWITCHES WITH ARCHITECT PRIOR TO INSTALLATION.
3. LIGHT FIXTURES DESIGNATED AS EMERGENCY SHALL BE PROVIDED WITH UL 924 BYPASS RELAY, AND FOLLOW SAME CONTROL SEQUENCE AS INDICATED IN CONTROL NARRATIVE. UPON LOSS OF NORMAL POWER, EMERGENCY FIXTURES SHALL TURN ON TO FULL BRIGHTNESS.
4. U.O.N. LIGHT FIXTURES TO BE FED FROM THE FOLLOWING PANELS.
   A. ALL NORMAL LIGHTING SHALL BE FED FROM LP-1A
   B. ALL EMERGENCY LIGHTING AND EXIT SIGNS SHALL BE FED FROM PP-EM-1.
5. TYPICAL CONTROL BY ROOM TYPE:
   A. OFFICES /STUDY: MANUAL ON/AUTOMATIC OFF
   B. CORRIDORS: FIXTURES DESIGNATED EMERGENCY ,SHALL REMAIN ON 24/7.
   C. STORAGE, IT, OTHER ROOMS: MANUAL ,ON/AUTOMATIC OFF
   D. BUNK ROOM: MANUAL ON/AUTOMATIC OFF
   ~~E. TRESTROOM: MANUAL ON/ AUTOMATIC OFF~~
6. WIRELESS OCCUPANCY SENSORS, DAYLIGHT SENSORS AND WALL SWITCHES SHALL BE INSTALLED IN THE DAY ROOM AND KITCHEN/DINING ROOMS ONLY. ALL OTHER SENSORS AND SWITCHES SHALL BE WIRED, UON.

1

KEY NOTES

1 MANUAL OVERRIDE SWITCH FOR CORRIDOR.

2 DRIVERS, BRANCH WIRING AND CONDUIT BETWEEN FIXTURES, AND REQUIRED JUNCTION BOXES FOR TYPE E05EM LUMINAIRES SHALL BE LOCATED INTERIOR TO THE APPARATUS BAY. CONTRACTOR TO LIMIT EXTERIOR EXPOSED BRANCH WIRING AND CONDUIT TO FIXTURE.



1 ELECTRICAL FIRST FLOOR LIGHTING RCP
1/8" = 1'-0"

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CITY OF WORCESTER

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CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

ELECTRICAL FIRST FLOOR LIGHTING RCP

SHEET NUMBER

E04.01

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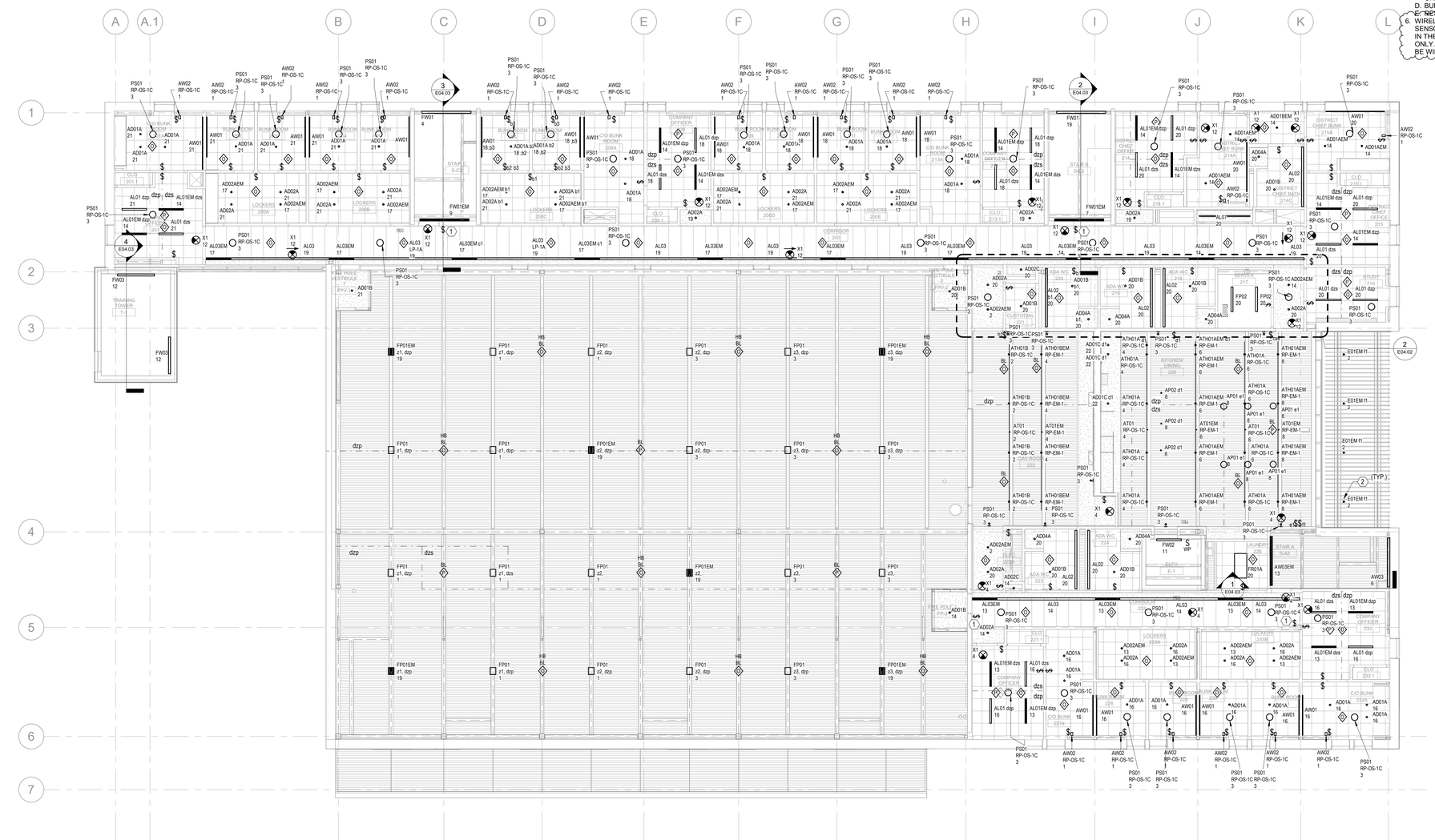
GENERAL NOTES

1. SEE DRAWING E00.00 FOR LEGENDS, NOTES, AND ABBREVIATIONS.
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   D. BUNK ROOM: MANUAL ON/AUTOMATIC OFF
   E. RESTROOM: MANUAL ON/AUTOMATIC OFF
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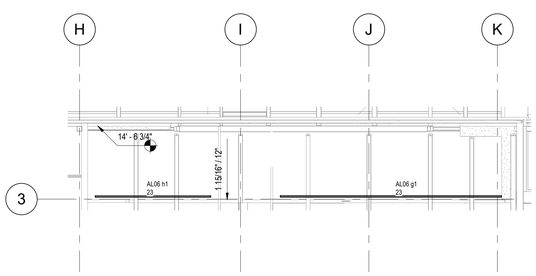
KEY NOTES

1 MANUAL OVERRIDE SWITCH FOR CORRIDOR.

2 BRANCH WIRING AND CONDUIT TO TERRACE LUMINAIRES SHALL BE ROUTED ALONG STRUCTURAL FRAME.



1 ELECTRICAL SECOND FLOOR LIGHTING RCP
1/8" = 1'-0"



2 ELECTRICAL SECOND FLOOR ENLARGED RCP
1/8" = 1'-0"

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PROJECT

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CITY OF WORCESTER

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WORCESTER, MA 01605

KEY PLAN

ISSUE CHART

CONSTRUCTION DOCUMENTS 12/19/25

MARK	ISSUE	DATE
1	Addendum #7	1/23/26

Job Number 157132.000

TITLE

ELECTRICAL SECOND FLOOR LIGHTING RCP

SHEET NUMBER

E04.02

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PANEL: PP-OS-1A

LOCATION: EMERGENCY ELEC 111
SUPPLY FROM: ATS-OS-1A
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 480/277 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 65 KAIC
BUS RATING: 600 A
MAIN CB: 600 A

CKT	CIRCUIT DESCRIPTION	LC	CT	TRIP	POLES	A	B	C	POLES	TRIP	CT	LC	CIRCUIT DESCRIPTION	CKT
1	ASHP-1 - EXTERIOR	HVAC	1	110 A	3	11584... 12714...			3	60 A	1	HVAC	DOAS-1 - ROOF	2
3	--	--	--	--	--		11584... 12714...		--	--	--	--	--	4
5	--	--	--	--	--			11584... 12714...	--	--	--	--	--	6
7	ASHP-1 - EXTERIOR	HVAC	1	110 A	3	11584... 18000...			3	100 A	1	HVAC	WH-2 - RM 114	8
9	--	--	--	--	--		11584... 18000...		--	--	--	--	--	10
11	--	--	--	--	--			11584... 18000...	--	--	--	--	--	12
13	VRF-1 - EXTERIOR	HVAC	1	30 A	3	3520... 53999...			3	300 A	1	HVAC...	TF-OS-1A	14
15	--	--	--	--	--		3520... 54818...		--	--	--	--	--	16
17	--	--	--	--	--			3520... 54892...	--	--	--	--	--	18
19	VRF-2 - EXTERIOR	HVAC	1	50 A	3	4960... 4062...			3	100 A	1	LIGH...	LP-1A	20
21	--	--	--	--	--		4960... 2679...		--	--	--	--	--	22
23	--	--	--	--	--			4960... 2917...	--	--	--	--	--	24
25	EUH-4 - APPARATUS BAY	HVAC	1	20 A	3	3324... 0 VA			3	110 A	--	--	SPARE	26
27	--	--	--	--	--		3324... 0 VA		--	--	--	--	--	28
29	--	--	--	--	--			3324... 0 VA	--	--	--	--	--	30
31	EUH-5 - APPARATUS BAY	HVAC	1	20 A	3	3324... 0 VA			3	20 A	--	--	SPARE	32
33	--	--	--	--	--		3324... 0 VA		--	--	--	--	--	34
35	--	--	--	--	--			3324... 0 VA	--	--	--	--	--	36
37	SPARE	--	--	20 A	3	0 VA 0 VA			3	20 A	--	--	SPARE	38
39	--	--	--	--	--		0 VA 0 VA		--	--	--	--	--	40
41	--	--	--	--	--			0 VA 0 VA	--	--	--	--	--	42
				TOTAL LOAD:		127050 VA	126482 VA	126783 VA						
				TOTAL AMPS:		459 A	457 A	458 A						

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	218757 VA	100.00%	218757 VA	
LIGHTING (LTG)	10587 VA	125.00%	13233 VA	**TOTAL CONN. LOAD:** 380314 VA
Motor	3000 VA	100.00%	3000 VA	**TOTAL EST. DEMAND:** 350736 VA
POWER	73195 VA	100.00%	73195 VA	**TOTAL CONN..:** 457 A
RECEPTACLE (R)	74460 VA	56.72%	42230 VA	**TOTAL EST. DEMAND:** 422 A
Spare	360 VA	100.00%	360 VA	

NOTES:

PANEL: PP-OS-2A

LOCATION:
SUPPLY FROM: PP-OS-1B-2
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 120/208 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 10 KAIC
BUS RATING: 100 A
MAIN CB: 100 A

CKT	CIRCUIT DESCRIPTION	Load Classification	TRIP	POLES	A	B	C	POLES	TRIP	Load Classification	CIRCUIT DESCRIPTION	CKT
1	VAV - 232	HVAC	20 A	1	0 VA 420 VA			1	20 A	HVAC	DSF 1,2,4,5 - APPARATUS BAY	2
3	TRAP PRIMER - LEVEL 2	POW...	20 A	1		480 VA 62 VA		2	20 A	POW...	SHUT OFF VALVE - VEST 2	4
5	DHU - PPE DRYING ROOM 119A	HVAC	20 A	1			750 VA 62 VA	--	--	--	--	6
7	C-1, C-2 - PPE DRYING ROOM 119A	HVAC	20 A	1	1770 VA 456 VA			2	20 A	HVAC	FCU 1-21, BS-8	8
9	EF-D1 - ROOF	HVAC	20 A	2		117 VA 456 VA		--	--	--	--	10
11	--	--	--	--			117 VA 117 VA	2	20 A	HVAC	EF-D2 - ROOF	12
13	FCU - LAV 120	HVAC	20 A	2	850 VA 117 VA			--	--	--	--	14
15	--	--	--	--		850 VA 1247 VA		2	20 A	HVAC	R-2 - RM 226	16
17	FCU - 230, 231, 232	HVAC	20 A	2			912 VA 1247 VA	--	--	--	--	18
19	--	--	--	--	912 VA 1247 VA			2	20 A	HVAC	R-1 - RM 226	20
21	FCU - WATCH ROOM 123	HVAC	20 A	2		788 VA 1247 VA		--	--	--	--	22
23	--	--	--	--			788 VA 788 VA	2	20 A	HVAC	FCU 118, 123	24
25	FCU - 229, 232A	HVAC	20 A	2	788 VA 788 VA			--	--	--	--	26
27	--	--	--	--		788 VA 1181 VA		2	20 A	HVAC	FCU 119B, 119A, 119	28
29	FCU- 227, 227a, 228	HVAC	20 A	2			1181 VA 1181 VA	--	--	--	--	30
31	--	--	--	--	1181 VA 1181 VA			2	20 A	HVAC	FCU - 232A, 232	32
33	SPARE	--	20 A	2		0 VA 1181 VA		--	--	--	--	34
35	--	--	--	--			0 VA 0 VA	1	20 A	--	SPARE	36
37	SPARE	--	20 A	2	0 VA 0 VA			1	20 A	--	SPARE	38
39	--	--	--	--		0 VA 0 VA		1	20 A	--	SPARE	40
41	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	42
			TOTAL LOAD:		9709 VA	8293 VA	7129 VA					
			TOTAL AMPS:		82 A	71 A	59 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	24641 VA	100.00%	24641 VA	
POWER	605 VA	100.00%	605 VA	**TOTAL CONN. LOAD:** 25128 VA
				TOTAL EST. DEMAND: 25128 VA
				TOTAL CONN..: 70 A
				TOTAL EST. DEMAND: 70 A

NOTES:

PANEL: PP-OS-1D

LOCATION: COMPRESSOR ROOM 103
SUPPLY FROM: DP-OS-1A
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 120/208 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 10 KAIC
BUS RATING: 100 A
MAIN CB: 100 A

CKT	CIRCUIT DESCRIPTION	LC	TRIP	POLES	A	B	C	POLES	TRIP	LC	CIRCUIT DESCRIPTION	CKT
1	FSD - RM 102A	POW...	20 A	1	500 VA 543 VA			1	20 A	HVAC	HHWP-2 - RM 102A	2
3	GF-1 - RM 102A	HVAC	20 A	1		864 VA 1181 VA		2	20 A	HVAC	FCU 202, 203, 204	4
5	MD-1 APPARATUS BAY 100	HVAC	20 A	1			500 VA 1181 VA	--	--	--	--	6
7	HHWP 1 - RM 102A	HVAC	20 A	2	272 VA 456 VA			2	20 A	HVAC	FCU 208A, 208, 200	8
9	--	--	--	--		272 VA 456 VA		--	--	--	--	10
11	FCU 101, 100A	HVAC	20 A	2			788 VA 1244 VA	2	20 A	HVAC	FCU 201A, 201, 200A, BS-2	12
13	--	--	--	--	788 VA 1244 VA			--	--	--	--	14
15	FCU 205, 207, 206	HVAC	20 A	2		1181 VA 500 VA		1	20 A	POW...	RTU - FUTURE POWER 1	16
17	--	--	--	--			1181 VA 0 VA	2	20 A	--	SPARE	18
19	FCU - RM 102, 103	HVAC	20 A	2	850 VA 0 VA			--	--	--	--	20
21	-- 1	--	--	--		850 VA 0 VA		2	20 A	--	SPARE	22
23	RTU TELECOMM - FUTURE POWER	POW...	20 A	1			500 VA 0 VA	--	--	--	--	24
25	SPARE	--	20 A	2	0 VA 0 VA			2	20 A	--	SPARE	26
27	--	--	--	--		0 VA 0 VA		--	--	--	--	28
29	SPARE	--	20 A	2			0 VA 0 VA	2	20 A	--	SPARE	30
31	--	--	--	--	0 VA 0 VA			--	--	--	--	32
33	SPARE	--	20 A	2		0 VA 0 VA		2	20 A	--	SPARE	34
35	--	--	--	--			0 VA 0 VA	--	--	--	--	36
37	SPARE	--	20 A	1	0 VA 0 VA			2	20 A	--	SPARE	38
39	SPARE	--	20 A	1		0 VA 0 VA		1	20 A	--	SPARE	40
41	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	42
			TOTAL LOAD:		4459 VA	5073 VA	5228 VA					
			TOTAL AMPS:		37 A	43 A	44 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	13440 VA	100.00%	13440 VA	
POWER	1500 VA	100.00%	1500 VA	**TOTAL CONN. LOAD:** 14751 VA
				TOTAL EST. DEMAND: 14751 VA
				TOTAL CONN..: 41 A
				TOTAL EST. DEMAND: 41 A

NOTES:

PANEL: PP-OS-1B

LOCATION: EMERGENCY ELEC 111
SUPPLY FROM: ATS-OS-1B
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 480/277 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 65 KAIC
BUS RATING: 600 A
MAIN CB: 600 A

CKT	CIRCUIT DESCRIPTION	LC	TRIP	POLES	A	B	C	POLES	TRIP	LC	CIRCUIT DESCRIPTION	CKT
1	EUH-1 - RM 114	HVAC	20 A	1	2493 VA 33156...			3	300 A	HVAC...	TF-OS-1B	2
3	EUH-2 - STAIR S-A1	HVAC	20 A	1		2493 VA 34308 VA		--	--	--	--	4
5	EUH-3 - STAIR S-C1	HVAC	20 A	1			2493 VA 35289 VA	--	--	--	--	6
7	EUH-8 - STAIR S-B1	HVAC	20 A	1	2493 VA 3520 VA			3	30 A	HVAC	VRF-3 - EXTERIOR	8
9	EUH-6 - APPARATUS BAY	HVAC	20 A	3		3324 VA 3520 VA		--	--	--	--	10
11	--	--	--	--			3324 VA 3520 VA	--	--	--	--	12
13	--	--	--	--	3324 VA 4320 VA			3	40 A	HVAC	VRF-4 - EXTERIOR	14
15	EF-3 - ROOF	HVAC	20 A	3		746 VA 4320 VA		--	--	--	--	16
17	--	--	--	--			746 VA 4320 VA	--	--	--	--	18
19	--	--	--	--	746 VA 6250 VA			3	40 A	POWER	COMPRESSOR - RM 103	20
21	EF-2 - ROOF	HVAC	30 A	3		3867 VA 6250 VA		--	--	--	--	22
23	--	--	--	--			3867 VA 6250 VA	--	--	--	--	24
25	--	--	--	--	3867 VA 3324 VA			3	20 A	HVAC	EUH-7 - APPARATUS BAY	26
27	WH-1 - RM 114	HVAC	100 A	3		18000 VA 3324 VA		--	--	--	--	28
29	--	--	--	--			18000... 3324 VA	--	--	--	--	30
31	--	--	--	--	18000 VA 0 VA			3	90 A	--	SPARE	32
33	DOAS-2 - ROOF	HVAC	125 A	3		27667 VA 0 VA		--	--	--	--	34
35	--	--	--	--			27667... 0 VA	--	--	--	--	36
37	--	--	--	--	27667 VA 0 VA			3	40 A	--	SPARE	38
39	HVAC MEP 102A	HVAC	20 A	1		2597 VA 0 VA		--	--	--	--	40
41	SPARE	--	125 A	3			0 VA 0 VA	--	--	--	--	42
43	--	--	--	--	0 VA 0 VA			3	30 A	--	SPARE	44
45	--	--	--	--		0 VA 0 VA		--	--	--	--	46
47	SPARE	--	20 A	3			0 VA 0 VA	--	--	--	--	48
49	--	--	--	--	0 VA 0 VA			3	20 A	--	SPARE	50
51	--	--	--	--		0 VA 0 VA		--	--	--	--	52
53	SPARE	--	20 A	1			0 VA 0 VA	--	--	--	--	54
55	SPARE	--	20 A	1	0 VA --			1	--	--	PREPARED SPACE	56
57	SPARE	--	20 A	1		0 VA --		1	--	--	PREPARED SPACE	58
59	SPARE	--	20 A	1			0 VA --	1	--	--	PREPARED SPACE	60
			TOTAL LOAD:		108109 VA	109152 VA	107897 VA					
			TOTAL AMPS:		390 A	394 A	390 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	268918 VA	100.00%	268918 VA	
KITCHEN (K)	9200 VA	80.00%	7360 VA	**TOTAL CONN. LOAD:** 325155 VA
POWER	29215 VA	100.00%	29215 VA	**TOTAL EST. DEMAND:** 319759 VA
RECEPTACLE (R)	17160 VA	79.14%	13580 VA	**TOTAL CONN..:** 391 A
APPLIANCE (APPL)	960 VA	100.00%	960 VA	**TOTAL EST. DEMAND:** 385 A

NOTES:

PANEL: PP-OS-1B-2

LOCATION: EMERGENCY ELEC 111
SUPPLY FROM: TF-OS-1B
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 120/208 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 10 KAIC
BUS RATING: 600 A
MAIN CB: 600 A

CKT	CIRCUIT DESCRIPTION	LC	TRIP	POLES	A	B	C	POLES	TRIP	LC	CIRCUIT DESCRIPTION	CKT
1	DSF-3 - RM 113	HVAC	20 A	1	0 VA 373 VA			1	20 A	HVAC	HWP 1&2 - RM 114	2
3	HRV-1 - ROOF	HVAC	20 A	1		1812 VA 93 VA		2	20 A	HVAC	EF-1 - ROOF	4
5	DRYING RACK - 119A	POWER	20 A	1			1980 VA 93 VA	--	--	--	--	6
7	FCU - 214, 214A	HVAC	20 A	2	788 VA 1244 VA			2	20 A	HVAC	FCU 107, 106, 105, BS-1	8
9	--	--	--	--		788 VA 1244 VA		--	--	--	--	10
11	FCU 209, 210, 200D	HVAC	20 A	2			1637 VA 0 VA	1	20 A	HVAC	VAV - 200	12
13	--	--	--	--	1637 VA 1637 VA			2	20 A	HVAC	FCU 112, 111, 110	14
15	FCU 121.13, 113, 121	HVAC	20 A	2		1244 VA 1637 VA		--	--	--	--	16
17	--	--	--	--			1244 VA 1306 VA	2	20 A	HVAC	BS-3,4 - RM 200	18
19	NG-1 - RM 114	HVAC	20 A	1	1200 VA 1306 VA			--	--	--	--	20
21	FCU - 216, 217	HVAC	20 A	2		914 VA 0 VA		1	20 A	HVAC	VAV - 200	22
23	--	--	--	--			914 VA 11040 VA	3	100 A	POWE...	RP-OS-2A	24
25	FCU - 215A, 215	HVAC	20 A	2	788 VA 9560 VA			--	--	--	--	26
27	--	--	--	--		788 VA 13380 VA		--	--	--	--	28
29	ACCU-1 - EXTERIOR	HVAC	90 A	3			5280 VA 788 VA	2	20 A	HVAC	HVAC BUNK ROOM 211	30
31	--	--	--	--	5280 VA 788 VA			--	--	--	--	32
33	--	--	--	--		5280 VA 777 VA		3	20 A	HVAC	ACCU-2 - EXTERIOR	34
35	ACCU-3 - EXTERIOR	HVAC	20 A	3			777 VA 777 VA	--	--	--	--	36
37	--	--	--	--	777 VA 777 VA			--	--	--	--	38
39	--	--	--	--		777 VA 250 VA		1	20 A	HVAC	VAV TURN OUT GEAR - 106	40
41	RP-OS-2A	HVAC...	100 A	3			9709 VA 1220 VA	1	20 A	POWER	TRAP PRIMER - ZONE 1A	42
43	--	--	--	--	8293 VA							44
45	--	--	--	--		7129 VA						46
47	HVAC SERVER 217	HVAC	20 A	2			394 VA 0 VA	2	20 A	--	SPARE	48
49	--	--	--	--	394 VA 0 VA			--	--	--	--	50
51	SPARE	--	20 A	2		0 VA 0 VA		2	20 A	--	SPARE	52
53	--	--	--	--			0 VA 0 VA	--	--	--	--	54
55	SPARE	--	20 A	1	0 VA 0 VA			2	20 A	--	SPARE	56
57	SPARE	--	20 A	1		0 VA 0 VA		--	--	--	--	58
59	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	60
			TOTAL LOAD:		33156 VA	34308 VA	35289 VA					
			TOTAL AMPS:		276 A	287 A	296 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
HVAC	67306 VA	100.00%	67306 VA	
KITCHEN (K)	9200 VA	80.00%	7360 VA	**TOTAL CONN. LOAD:** 102744 VA
POWER	10465 VA	100.00%	10465 VA	**TOTAL EST. DEMAND:** 97552 VA
RECEPTACLE (R)	17160 VA	79.14%	13580 VA	**TOTAL CONN..:** 285 A
APPLIANCE (APPL)	960 VA	100.00%	960 VA	**TOTAL EST. DEMAND:** 271 A

NOTES:

PANEL: LP-1A

LOCATION: EMERGENCY ELEC 111
SUPPLY FROM: PP-OS-1A
MOUNTING: SURFACE
ENCLOSURE: Type 1

VOLTS: 480/277 Wye
PHASE: 3
WIRE: 4

A.I.C. RATING: 22 KAIC
BUS RATING: 100 A
MAIN CB: 100 A

CKT	CIRCUIT DESCRIPTION	LC	TRIP	POLES	A	B	C	POLES	TRIP	LC	CIRCUIT DESCRIPTION	CKT
1	LTG - APPARATUS BAY 100	LTG	20 A	1	1211 VA 48 VA			1	20 A	LTG	LTG - STAIR C	2
3	LTG - APPARATUS BAY 100	LTG	20 A	1		1126 VA 46 VA		1	20 A	LTG	LTG - STAIR C	4
5	LTG - 100A, 103, 101, 102, 102A, 104	LTG	20 A	1			216 VA 83 VA	1	20 A	LTG	LTG- STAIR A	6
7	LTG - 106, 107, 110, 108, 109	LTG	20 A	1	525 VA 243 VA			1	20 A	LTG	LTG- KITCHEN	8
9	LTG - 113, 114	LTG	20 A	1		299 VA 93 VA		1	20 A	LTG	LTG - SITE (NOTE 1)	10
11	LTG - 121.13, 121, 115A, 121A	LTG	20 A	1			258 VA 1092 VA	1	20 A	LTG	LTG - TRAINING TOWER T-1	12
13	LTG - 119, 20D, 118, 117, 116, 120, 121C	LTG	20 A	1	520 VA 171 VA			1	20 A	LTG	LTG - CORRIDOR 232	14
15	LTG - CORRIDOR 121	LTG	20 A	1		239 VA 387 VA		1	20 A	LTG	LTG - 232A, 232B	16
17	LTG - 123, 122	LTG	20 A	1			491 VA 394 VA	1	20 A	LTG	LTG - 206, 207, 209, 211, 210, 212, 208A,...	18
19	LTG - CORRIDOR 200, STAIR B	LTG	20 A	1	572 VA 652 VA			1	20 A	LTG	LTG - 223, 224, 225, 220, 219, 218, 222,...	20
21	LTG - 200C, 200B, 204, 200A, 202, 203,...	LTG	20 A	1		341 VA 27 VA		1	20 A	LTG	LTG - 226	22
23	LTG - SECOND FLOOR AL6	LTG	20 A	1			263 VA 0 VA	1	20 A	--	SPARE	24
25	SPARE	--	20 A	1	0 VA 0 VA			1	20 A	--	SPARE	26
27	SPARE	--	20 A	1		0 VA 0 VA		1	20 A	--	SPARE	28
29	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	30
31	SPARE	--	20 A	1	0 VA 0 VA			1	20 A	--	SPARE	32
33	SPARE	--	20 A	1		0 VA 0 VA		1	20 A	--	SPARE	34
35	SPARE	--	20 A	1			0 VA 0 VA	1	20 A	--	SPARE	36
37	SPARE	--	20 A	1	0 VA 120 VA			3	20 A	-	LUTRON LUT-ELI EMERGENCY...	38
39	SPARE	--	20 A	1		0 VA 120 VA		--	--	--	--	40
41	SPARE	--	20 A	1			0 VA 120 VA	--	--	--	--	42
			TOTAL LOAD:		4062 VA	2679 VA	2917 VA					
			TOTAL AMPS:		15 A	10 A	11 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS
LIGHTING (LTG)	9298 VA	125.00%	11622 VA	
Spare	360 VA	100.00%	360 VA	**TOTAL CONN. LOAD:** 9658 VA
				TOTAL EST. DEMAND: 11982 VA
				TOTAL CONN..: 12 A
				TOTAL EST. DEMAND: 14 A

NOTES:
NOTE 1: PROVIDE METERING FOR SITE LIGHTING CIRCUIT AND CONNECT TO THE POWER MONITORING SYSTEM.

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ANDELMANLELEK
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PROJECT

WORCESTER SOUTH DIVISION FIRE STATION PROJECT
25 MADISON ST
WORCESTER, MA 01608

CITY OF WORCESTER

455 MAIN STREET
WORCESTER, MA 01605

CONSTRUCTION DOCUMENTS 12/19/25

KEY PLAN

ISSUE CHART

MARK	ISSUE	DATE
2	Addendum #7	1/23/26
1	Addendum #5	1/16/26

Job Number 157132.000

TITLE

ELECTRICAL PANEL SCHEDULES SHEET 1

SHEET NUMBER

E09.01

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