

Request for Bid Proposal		Marshall University Office of Purchasing One John Marshall Drive Huntington, WV 25755-4100	Bid# 00173492
		Direct all inquiries regarding this order to: (304) 696-3498	Addendum No. 01

Vendor:	For information call: Purchasing Contact: Missy Workman Phone: (304) 696-3498 Email: workman57@marshall.edu & bidquestions@marshall.edu
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Sealed requests to bid for furnishing the supplies, equipment or services described below will be received by the Institution. TO RECEIVE CONSIDERATION FOR AWARD, UNLESS OTHERWISE NOTED, THE BID WILL BE SUBMITTED ON THIS FORM AND UPLOADED INTO THE MU BONFIRE PORTAL ON OR BEFORE THE DATE AND TIME SHOWN FOR THE BID OPENING. When applicable, prices will be based on units specified; and Bidders will enter the delivery date or time for items contained herein. The Institution reserves the right to accept or reject bids on each item separately or as a whole, to reject any or all bids, to waive informalities or irregularities and to contract as the best interests of the Institution may require. BIDS ARE SUBJECT TO THE GENERAL TERMS AND CONDITIONS AS SET FORTH HEREIN.

DATE 7.23.2026	MANDATORY PRE-BID MEETING: July 9, 2026 at 10:00 AM Charleston Airport - Bill Noe Flight School Room 102 (See address below) ALL BIDDERS MUST ATTEND	DEPARTMENT REQUISITION NO. 00173492	BIDS OPEN: July 30, 2026 at 3:00 PM est. Broadcast via Teams link: https://tinyurl.com/MU-Noe-Flight-School-bid-open	BIDDER MUST ENTER DELIVERY DATE FOR EACH ITEM BID
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Item #	Quantity	Description	Unit Price	Extended Price
		<u>ADDENDUM NO. 01</u> Project Name: 00173492 Marshall University Bill Noe Flight School New Hangar and Classrooms in Charleston, West Virginia Purpose: Add Required Maintenance Bond within the Terms & Conditions Requirements, attached the Maintenance Bond Forms, Updated the Bid Form of Proposal, added the "Bid Time" on the Instructions to Vendors pg. 3, Attached Pre-Bid Sign-in Sheet, Attached Pre-Bid Meeting Notes, and added Architectural and Engineering Documents to answer questions and align with Marshall University's RFB Solicitation. Bidding Documents may be obtained from: C&B Blueprint, Inc 824 Sixth Street, Huntington, WV 25701 Phone: 304-525-2175		
Total				

To the Office of Purchasing,
In compliance with the above, the undersigned offers and agrees, if this offer is accepted within _____ calendar days (30 calendar days unless a different period is inserted by the purchaser) from the bid open date, specified above, to furnish any or all items upon which prices are offered, at the price set opposite each item, delivered at the designated point(s), within the time specified.

Bidder guarantees shipment from _____	Bidder's name Vendor _____
_____ within _____ days	Signed By _____
FOB _____ After receipt of order at address shown	Typed Name _____
Terms _____	Title _____
	Email _____
	Street Address _____
	City/State/Zip _____
	Date _____ Phone _____
	Fein _____

SOLICITATION NUMBER: 00173492

Addendum Number: 01

The purpose of this addendum is to modify the solicitation identified as ("Solicitation") to reflect the change(s) identified and described below.

Applicable Addendum Category:

- ☐ Modify Bid Opening Date and Time
- ☐ Modify Specifications of Product or Service being sought
- ☒ Attachment of Vendor Questions and Responses
- ☒ Attachment of Pre-Bid Sign-in Sheet
- ☒ Attachment of Pre-Bid Meeting Minute Notes
- ☐ Correction of error
- ☒ Other

Description of Modification to Solicitation:

Addendum issued to publish and distribute the attached documentation to the vendor community.
Updated Maintenance Bond Requirements in Terms & Conditions & Added the Maintenance Bond Forms

Updated the Bid Form of Proposal

Added the "Bid Time" within the Instructions to Vendors pg. 3

Attached the Pre-Bid Meeting Notes

Attached Pre-Bid Sign-in Sheet

Update Architectural and Engineering Documents to align with Marshall University's RFB Solicitation

Bidding Documents: C&B Blueprint, Inc 824 Sixth St Huntington, WV 25701 Phone: 304-525-2175

NO OTHER CHANGES

Additional Documentation: Documentation related to this Addendum (if any) has been included herewith and is specifically incorporated herein by reference.

Terms and Conditions:

1. All provisions of the Solicitation and other addenda not modified herein shall remain in full force and effect.
2. Vendor should acknowledge receipt of all addenda issued for this Solicitation by completing an Addendum Acknowledgment, a copy of which is included herewith. Failure to acknowledge addenda may result in bid disqualification. The addendum acknowledgement should be submitted with the bid to expedite document processing.



Addendum No. 01
Questions and Answers Request for Bid (RFB)
00173492 Marshall University Bill Noe Flight School
New Hangar & Classrooms

Questions Due: July 14, 2026, | Addendum Issue: July 23, 2026, | Bid Open: July 30, 2026

A. GENERAL

The following procurement items have been revised:

- A. Maintenance Bond with the Terms and Conditions Requirements has been checked as required.
- B. Maintenance Bond Forms are attached.
- C. Bid Form of Proposal – Added the Bid Time on the Instructions to Vendors pg. 3
- D. Pre-Bid Sign-in Sheet attached.
- E. Pre-Bid Meeting Notes attached.

B. SPECIFICATIONS

ADD - Section 083323: Overhead Coiling Doors as attached to this Addendum.
ADD – Section 235523: Low Intensity, Gas-fired Radiant Heaters
ADD – Section 270526: Grounding and Bonding for Communications Systems
ADD – Section 270528: Pathways for Communications Systems
ADD – Section 270529: Hangers and Supports for Communications Systems
ADD – Section 270553: Identification for Communications Systems
ADD – Section 271100: Communications Equipment Room Fittings
ADD – Section 271116: Communications Racks, Frames and Enclosures
ADD – Section 281300: Access Control Software and Database Management
ADD – Section 281300: Access Control
ADD – Section 281500: Access Control Hardware Devices
ADD – Section 281643: Perimeter Security Systems
ADD – Section 282000: Video Surveillance
REMOVE – Section 263212: Mobile Engine Generators

C. DRAWINGS

REVISED – Sheet AH6.01R: Schedules and Diagrams as attached to this Addendum.
REVISED – Sheet E2.01R: Hangar Power
REVISED – Sheet E5.01R: Hangar Systems
REVISED – Sheet E6.01R: Panel Schedules
REVISED – Sheet E6.02R: Electrical Riser
REVISED - Sheet E6.03R: Electrical Details
ADD - Sheet E6.05: Telecommunications Details

D. QUESTIONS AND RESPONSES

Q1. Is there a way to obtain digital copies of the plans and specs for this project via a link or any other manner?

A1. A. C&B Blueprint, Inc., 824 Sixth Street, Huntington, WV 25701; Phone # 304-525-2175

A1. B. RFB Bidding Documents may be obtained from (This is also on the Cover page of the RFB):

- ✓ <https://marshall.bonfirehub.com/opportunities/240827>
- ✓ <https://www.marshall.edu/procurement-services/resources/bids-and-proposals/>

Q2. Please provide what you are asking for on the Contractor and Subcontractor Requirements on the bid



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opening checklist?

A2. Please read Terms and Conditions Section 8. Subcontractor List Submission and See the Subcontractor List Submission (Form) within the Terms & Conditions

Q3. Please provide the Request for Release - B&O tax form in the bid opening checklist

A3. The project is not in the Charleston city limits; there is no B&O tax.
You are free to create your own checklist to ensure all documents and forms are submitted correctly.

Q4. Is the Criteria for Selection of Lowest Bidder in the bid opening checklist supposed to be submitted with the bid or within 24 hours?

A4. Due with Submission

Q5. Please provide a geotechnical report. Where can this be found?

A5. The Geotechnical Report is attached to this Addendum and is for information only, it is not a contract document.

Q6. Good morning, I am on the following link and I do not see plans and specifications. Could you please let me know if I need to be on a different website:

<https://marshall.bonfirehub.com/opportunities/240827> ; When I called C&B Blueprint they did not have any plans either

A6. Our Construction and Planning Team has confirmed they are at C&B Blueprint, please try back with them. If they do not have them, please reach back out to me at bidquestions@marshall.edu

Q7. Any sort of a budget number that I could take a look at just so I can make sure that we are in the ballpark I do have some indications of interest on this.

A7. Budget numbers are not available

Q8. I was wanting to look at the bid documents for the Flight School Project but am having trouble locating them

A8. The plans are available are available at C&B Blueprint and the RFB documents can be found on the websites listed on the Cover Page of the RFB

Q9. Will the timing be pushed to later to have more time to prepare our bids

A9. No, at this time, we will not be pushing any of the established dates; The project is being funded with grant money that must be used within a specific timeframe

Q10. While confirming the address for today's pre-bid meeting, it stated to email for directions

A10. 600 Eagle Mountain Road—Charleston International Yeager Airport Charleston WV 25311 (past the WV State Hangar on the left side Large M on the building) - go in the first set of double doors and ring the doorbell on the right side to be let in.



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Q11. On drawing S0.00 Metal building systems paragraph C indicates that we are to bid the project per the drawings but in metal building systems paragraph C-a indicates that the contractor is not allegeable for a change order if the foundations change is this correct?

A11. The bids will be adjusted by the unit prices for either net-add or net-deduct depending on the final foundation sizes. Strike Note 2Ca. Note 2Cb is revised as, "Upon submittal of the building reactions, the EOR will adjust the foundation design for the submitted reactions. All bids will be adjusted with a change order based on the unit prices listed on SH1.00A submitted during bidding."

Q12. Drawing SH1.00A, the footing schedule says not for construction. Please provide what we are supposed to price?

A12. The foundation plan has been labeled 'not for construction' since we have not received final or preliminary pre-engineered metal building drawings or reactions. The current foundation design is based on assumed pre-engineered metal building reactions and shall serve as the basis of design for all bids. 'For construction' foundation design will be provided after final pre-engineered metal building drawings are reviewed and approved. Bids will be adjusted via change order based on the unit price per cubic yard of concrete and unit price per ton of rebar.

Q13. S0.10 Special inspections says: Special Inspections and Tests, Statements of Special Inspections, Responsibilities of Contractors, Submittal to the Building Official, and Structural Observations must Satisfy the Requirements to the 2018 International Building Code and any Local or State Provisions. If There are any Discrepancies with this Document, the more Strict Code shall Govern. The Owner or The Owner's Authorized Agent of the Project is Responsible for Hiring One or more approved Agencies to Provide Special Inspections and Tests. The Approved Agency shall meet the Requirements of IBC 1703.1.1, 1703.1.2, 1703.1.3, and 1703.1.4"

Who is responsible for the payment of the special inspector?

A13. Where required, responsibility for engaging a qualified testing agency for Special Inspections and Testing is upon the Owner.

Q14. Are you requiring the contractor to provide PEMB foundation engineering prior to us bidding the project on drawing S0.00 Metal Building System?

A14. No, the Contractor is not required to provide PEMB foundation engineering prior to bidding the project.

Q15. When can geotechnical report be available?

A15. Please see response to Q & A5.

Q16. What is the duration of this project?

A16. Substantial Completion by August 1, 2027



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Q17. Will there need to be connections for job trailers?

A17. Connections for job trailers are as required to make them functional on site as described in Section 015000 Temporary Facilities and Controls.

Q18. There is a spec section for a generator, but there is no generator called out on the electrical one line or power drawings. Is there a generator required for this project?

A18. Specification for generator will be removed. New portable generator cabinet shall be Berthold W12 – 3C – S to match existing building equipment. Details will be shown on E2.01 and E6.01. Manual transfer switch will be removed in favor of kirk-key system on MDP to match existing site.

Q19. On sheet E201, note 3, a new telecom rack is called out to be installed, but there is no detail for said rack or required equipment. Neither is there a div 27 spec section. What is required for the new rack and equipment to connect to the existing network? If a fiber optic cable is required for network connection, where does the fiber connect from? Are there any specs for the telecom system at all?

A19. New drawing E6.05 added with telecom details. Division 27 Specification has been added. Coordinate with Owner and Owner's IT for existing equipment specifications.

Q20. Is there div 28 spec?

A20. Division 28 specification has been added in this Addendum.

Q21. On sheet E6.02, the electrical one line, it shows panel "C" but I cannot find panel "C" on any of the electrical drawings. Where is panel "C" located?

A21. Panel C is shown for future work. It will be installed as part of the next phase of the project, dealing with the connectors and pool area. Note added to E6.02 to reflect this.

Q22. Is there a panel schedule for panels "P" and "C"?

A22. Panel schedules for panels "P" and "C" will be part of the future connector and pool phase of the project. Note on E6.02 has been added to reflect this.

Q23. On sheet E7.01 it shows a proposed pool building and connector buildings. Are there any electrical plans for these buildings? Are these sections going to be included in this project?

A23. Pool and connectors are part of the future phase of this project and are on the site plan for reference only.

Q24. On sheet E5.01, note 2 states that camera drops shown are for future installation, but it also states that the security contractor is to install the cameras and cables. Which is it? Are these icons for



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conduit installation only and future installation of cameras/cables, or is this a full install by the security contractor?

A24. Cameras, cables and conduits shall be installed for this phase. Coordinate with Owner for exact cameras and cables needed for installation.

Q25.A. On sheet E6.03, the security door detail it states in multiple places that the EC is to provide device cabling, but it does not state what that cabling should be nor does it mention the device manufacturer. What are the cabling requirements for the security door?

A25.A. Coordinate with Owner and Owner's IT department for existing security door devices specifications. Follow manufacturers cabling requirements.

Q25.B. What are the specs for devices?

A25.B. Coordinate with Owner and Owner's IT department for existing security door devices specifications.

Q25.C. Are there specifications for the security doors?

A25.C. Security door spec is 087100

Q25.D. Where is location of the security door headend?

A25.D. Coordinate with Owner and Owner's IT department for location of security door headend.

Q26. Where is the new fire pump control panel located?

A26. Fire pump control panel is located in Fire Suppression room 103. This has been added to E2.01 and reflects the location shown on FP2.01.

Q27. Whom are the acceptable temperature controls contractor for this project?

A27. Only local controls are required to allow system to operate. Connection to a DDC control system is not required. Infrared heaters, high volume low speed fans, and make up air unit to be provided with factory controls. Exhaust fan line voltage thermostats and relays to be manufacturers preference.

Q28. Our intent is to provide a compliant, cost-effective alternate for consideration while maintaining the project requirements, including the applicable BABA requirements?

A28. Marshall University will only accept bids that meet the sealing and submission requirements set forth in the solicitation documents

Q29. Can we push the question deadline back 1 week to allow for more time to examine the documents?

A29. Please see Q & A9.

Q30. Will Phase 2 be bid separately or negotiated with the low bid contractor?

A30. Phase 2 is expected to be negotiated with the Phase 1 low bidder rather than separately bid.



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- Q31.** Is there any concern about rock and excavation since a significant amount of underground work is required?
- A31.** Rock conditions are known and addressed in the geotechnical report, but contractors should anticipate foundation over-excavation. The geotechnical report is included in this addendum.
- Q32.** Has foundation engineering already been completed, and who is responsible for final foundation verification? Will Thrasher be responsible for coordinating foundation requirements with the metal building manufacturer?
- A32.** Preliminary foundation engineering based on assumed PEMB reaction and shall serve as the basis of design for all bids. Delegated design engineering for the PEMB is the responsibility of the contractor. The contractor will submit reactions for review by the EOR. Final foundation design will be provided after the PEMB drawings are reviewed and approved.
- Q33.** Are the foundations substantially designed at this point? How complete are the foundation designs?
- A33.** The current foundation design is based on assumed pre-engineered metal building reactions and shall serve as the basis of design for all bids. 'For construction' foundation design will be provided after final pre-engineered metal building drawings are reviewed and approved. Bids will be adjusted via change order based on the unit price per cubic yard of concrete and unit price per ton of rebar.
- Q34.** How will foundation-related adjustments be handled?
- A34.** If design changes occur, bids related to the foundation will be adjusted via change order based on the unit price per cubic yard of concrete and unit price per ton of rebar.
- Q35.** Do you all have an engineer value or budget for the project, phase 1 or 2?
- A35.** Please see Q & A7.
- Q36.** The drawings indicate that the project is based on NFPA 409 2026 edition. The current WV State Fire Code was adopted in 2024 but on July 1 2026, a new State Fire Code went into effect. The new 2026 code does not reference the 2026 NFPA 409. Please confirm that this project will be based around the 2026 edition of NFPA 409.
- A36.** We received a variance from the Fire Marshal to use NFPA – 2026.
- Q37.** If we cannot base the fire protection design around the 2026 edition of NFPA 409, then the hangar would be classified as a Group I hangar. The drawings show the door opening to be 30’.
- A37.** See response to Q & A36.
- Q38.** The fire protection drawings show that the sprinkler system is to be calculated at .17/5000, but I do not see any reference to foam. I assume that you are using option 5 from Chapter 7.4.2 which spells out the fire protection requirements when using a UL Listed ignitable liquid drainage floor assembly/system.



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A38. Per Fire Marshal variance and review, foam is not required. Sprinkler heads directly to sprinkle structural frame and trench drain and drainage holding tank.

Q39. We also need to address the holding tank note on FP2.01. The note says that the Fire Protection contractor is to size and select a holding tank for sprinkler discharge. The sprinkler system flow will be approximately 900gpm plus fuel flow of 200 gpm or 400 gpm depending on aircraft size. What duration?

A39. NFPA 409 – 2026, paragraph 6.8.2.1.11.2 states “Retention locations for fire protection water and ignitable liquids shall have 110 percent capacity of the required fire protection system discharge and the estimated spill volume.”

Q40. Underground fire line is shown as 6” which will not be large enough to support the fire pump and needs to be sized per NFPA 20. Anything greater than 750gpm flow requires the suction piping to be 8” or larger.

A40. There is a main 12” line that ends behind the existing hangar; we will either take an 8” from there, or extend the 12” (American Water) to the new hangar and enter the building as an 8” line.

Q41. Drawing FP5.01 shows some fire pump details but we cannot find specifics such as size (gpm), pressure and electrical (208v, 230v, 460v)? This information needs to be coordinated so we can size the motor which goes on to size emergency generator.

A41. Pump gpm and size is based on final sprinkler calculations and shall be sized from the final calculations. Voltage shall be 208/3phase.

Q42. I do not see any mention of an automatic transfer switch on the fire pump controller which is a WV and NFPA 20 requirement.

A42. There is no Manual Transfer switch now on the building. A new portable generator cabinet will be installed along with a Kirk key system on the MDP.

Q43. It appears that the specifications (211313 3.11D-F) require all sprinkler piping to be black, schedule 40. Would there be any consideration to use black schedule 10 for piping that is roll grooved with welded openings?

A43. Schedule 10 minimum lightwall welded or seamless steel pipe with corrosion resistant coating, CRR Value of 1 minimum, ASTM A53 and A135.

- a. Grooved mechanical couplings and fittings with EPDM gasket, malleable iron or ductile iron, 800 psi minimum rating ASTM A47 and A536, UL Listed, FM Approved
- b. Lightwall, 150 psi, butt weld fittings, ANSI B16.9

Q44. Can Assa Abloy Sargent be an approved substitution for door hardware.



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A44. No, Assa Abloy Sargent is not an approved substitution, new hardware is to match hardware in the existing facility.

E. SUPPLIER REMINDERS

Important:

Suppliers are responsible for carefully reviewing all solicitation requirements and ensuring their submission is complete and fully compliant. Failure to comply with solicitation requirements, attend mandatory meetings or site visits, or provide required information may result in disqualification from the solicitation.

From Marshall University:

- ✓ Attendance at the Mandatory Pre-Bid Meeting is required. Suppliers that did not attend are not eligible to submit a bid
- ✓ Read the solicitation, Instructions to Suppliers, Terms and Conditions, A/E Documents, Specifications, Scope of Work, Exhibits, and all attachments in their entirety prior to preparing and submitting your Bid
- ✓ Review the bid submission checklist before submitting your response and ensure all required documents are included
- ✓ Monitor the procurement website for addenda and solicitation updates throughout the bidding period
- ✓ Ensure your Bid is properly completed, signed, **Labeled**, **SEALED**, and submitted in accordance with all solicitation requirements and instructions
- ✓ Allow sufficient time for delivery to ensure receipt before the bid opening date and time
- ✓ Written Questions Requirement: Suppliers must submit all questions in writing to bidquestions@marshall.edu

From Thrasher:

- ✓ **Background Checks and Airport Security Requirements**
 - Individuals requiring airport badges must pass extensive background checks
 - Criminal history and FBI fingerprint checks are part of the process
 - If personnel are unlikely to qualify, contractors should avoid submitting applications unnecessarily
- ✓ Working in a commercial service airport environment involves additional security requirements



American Geotech, Inc.
601 Ohio Avenue
Charleston, WV 25302
(304) 340-4277
Fax 340-4278

AMERICAN GEOTECH, INC.

Geotechnical, Environmental and Testing Engineers

REPORT OF

**GEOTECHNICAL EXPLORATION AND ENGINEERING ANALYSIS
PROPOSED NEW HANGER, POOL BUILDING & CONNECTORS
MARSHALL UNIVERSITY AVIATION-BILL NOE FLIGHT SCHOOL
600 EAGLE MOUNTAIN ROAD - YEAGER AIRPORT
CHARLESTON, WEST VIRGINIA**

Prepared For

**THE THRASHER GROUP, INC.
BRIDGEPORT, WEST VIRGINIA**

MARCH - 2026

(This report contains 15 pages, plus appendices)

AMERICAN GEOTECH, INC.

GEOTECHNICAL, ENVIRONMENTAL AND TESTING ENGINEERS

601 OHIO AVENUE
CHARLESTON, WV 25302
(304) 340-4277
Fax (304) 340-4278

March 10, 2026

Mr. Phillip M. Freeman, AIA
The Thrasher Group, Inc.
600 White Oak Boulevard
Bridgeport, WV 26330

**Re: Report of Geotechnical Exploration and Engineering Analysis
Proposed New Hanger, Pool Building and Connectors
Marshall University Aviation - Bill Noe Flight School
600 Eagle Mountain Road - Yeager Airport
Charleston, West Virginia**

Dear Mr. Freeman:

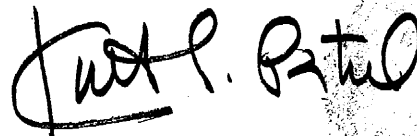
In accordance with your request and authorization, American Geotech, Inc. (AGI) has completed the subsurface exploration and geotechnical engineering analysis for the above referenced project. The detailed geotechnical report is attached herewith.

It is recommended that the contract documents must follow International Building Code (IBC) requirements, including a Schedule of Special Inspection Services for soils and foundations in the plans. At a minimum, the Geotechnical Engineer of Record (GER) shall provide on-site observation, testing, and special inspection services during site grading, soil compaction, foundation and floor slab construction.

We appreciate having the opportunity to provide our services to you. If you have any questions concerning the information contained in this report, please do not hesitate to contact us.

Respectfully Submitted,

AMERICAN GEOTECH, INC.



Kanti S. Patel, M.S.C.E., P.E.
Principal Engineer

GEOTECHNICAL EXPLORATION AND ENGINEERING ANALYSIS

PROPOSED HANGER, POOL BUILDING AND CONNECTORS MARSHALL UNIVERSITY AVIATION - YEAGER AIRPORT CHARLESTON, WEST VIRGINIA

EXECUTIVE SUMMARY

A brief summary of our recommendations for this project is presented below. This summary should be read in context with the entire report for proper interpretation.

Special Conditions

- The controlling geotechnical concern for this project will be the foundation construction, which will include rock excavation and limited over-excavation of fill or overblasted rock.
- Rock excavation will be required for the foundation excavation over most of the building areas. It should be possible to excavate these weathered rock materials to the design bearing depth using conventional excavating equipment fitted with rock teeth, given that the materials have been overblasted.
- All existing fill and overblast encountered during the foundation excavations of the hanger column footings and pool building footings must be removed to the level of intact weathered bedrock. The presence of such fill and overblast will require over-excavation to depths of up to approximately 7 feet below the design bearing elevation, to extend the footings to intact weathered bedrock.
- The hanger minimum concrete floor slab thickness should be 6 inches with minimum reinforcements independent of the exterior column footings. We do not have the column reactions at this time.
- It is recommended that the contract documents must follow International Building Code (IBC) requirements, including a Schedule of Special Inspection Services for soils and foundations in the plans. At a minimum, the Geotechnical Engineer of Record (GER) shall provide on-site observation, testing, and special inspection services during site grading, soil compaction, foundation and floor slab construction.

Site Development

- The subgrade should be proof-rolled using a fully-loaded, tandem axle dump truck, under the supervision of the geotechnical engineer or his authorized representative, to identify any areas in need of undercutting and replacement with controlled, compacted, engineered fill. Four passes should be made by the proof-rolling equipment in each of two perpendicular directions.
- We recommend that all soft or yielding subgrade materials within the building footprint be removed 2 feet to the level of the underlying firm materials and replaced with controlled, compacted, engineered fill. An allowance for 400 cubic-yards of undercut and backfilling with engineered structural fill shall be provided in the contract documents.

Foundations

- It is our opinion that the proposed pool building and new connector structures can be supported on rigid spread footing foundation systems installed to bear on intact weathered bedrock.
- The new hanger can be supported by isolated exterior column footings connected by a perimeter stem wall rigid footing.
- We recommend that the foundation be designed for a maximum allowable bearing pressure of 3,000 pounds-per-square-foot (PSF) for continuous and/or isolated spread footings, provided that all bearing materials are approved by the GRE before pouring concrete.
- All existing fill materials and overblasted rock encountered during hanger column footing and pool building foundation excavations must be undercut and the excavations extended to bear upon intact weathered rock. The over-excavation performed to remove overblast material should be backfilled to the final bearing elevation using lean concrete, having a minimum compressive strength of 1,500 pound per square inch (psi).
- Total excavation depths for the hanger column footings and pool building foundation can range from 5 to 6 feet below the bottom of the footer to encounter intact bedrock.
- The rigid footings for the connector structures and stem wall of the hanger can be supported by the existing overblasted rock materials at the minimum frost depth of 36 inches below the final exterior grade.
- An allowance of 40 cubic-yards of over-excavation below bearing elevation and backfilling with lean concrete should be provided in the contract documents.

Floor Slabs

- The existing fill materials or new engineered fill are considered suitable for floor slab support, following the recommended proof-rolling and subgrade preparation activities. We recommend that any soft or yielding materials within the building footprint be removed to the level of the underlying firm materials and replaced with controlled, compacted, engineered fill.
- A floor slab-on-grade underlain with a subgrade prepared as outlined above can be designed utilizing a modulus of subgrade reaction of 120 pounds-per-cubic-inch (pci).

INTRODUCTION

In accordance with your request and authorization, American Geotech, Inc. has completed the subsurface exploration and geotechnical engineering analysis for the proposed hanger, pool building and connector structures in Charleston, West Virginia. We performed our evaluation utilizing the results obtained from the drilling of ten (10) Standard Penetration Test soil borings (B-1 to B-10), the observations made during a reconnaissance visit to the subject site, and our experience with similar scenarios. The subsequent sections discuss our field exploration, exploration results, and provide geotechnical engineering recommendations for the site preparation, foundation design, floor slab support, pavement section design, and retaining wall parameters. The exploration was performed in accordance with our proposal/agreement dated February 26, 2026.

PROJECT INFORMATION

The site of the proposed hanger and pool building is located on the northeastern end of Yeager Airport old runway 33 and taxiway C, on the western side of the new Eagle Mountain Road extension. The two connector structures will connect the existing office building and hanger of the existing Marshall University Bill Noe Flight School, and the existing hanger to the new hanger. The overall site area has been subject to earthwork operations, which have provided for the presently existing ground surface contours. Previously, the site area was a crowned ridge and hillslope environment of the kind typically observed in central West Virginia. The site has been cut during the earthwork operations for construction of the airport. Much of the site excavation had been accomplished through rock ripping and blasting. The proposed buildings are situated within the cut portion of the ridge. Embankment slopes are present along portions of the exterior limits of the level site area. These slopes are on the order of 1.5 horizontal:1 vertical, based on the provided site drawing. A new asphalt paved parking lot is planned along the northern side of the existing hanger, to expand the existing paved vehicular parking lot.

The new construction proposed for the site includes a 30,000 sq-ft pre-engineered metal hanger style building. The rectangular building will be single-story with a high 23 feet bay height, having dimensions of roughly 250 feet by 120 feet. The building will be supported by exterior columns and exterior strip footings, with clear-span roof trusses. The floor slab will consist of an industry standard concrete slab-on-grade. The 5,000 sq-ft pool building will consist of a masonry structure supported by load-bearing exterior walls and interior columns. The two (2) connector structures between the existing buildings and new hanger will consist of lightly-loaded metal frame structures, with metal or masonry exteriors. The finished floor elevation is expected to be a few feet above the existing surface grades, to match with the existing hanger. A layer of topsoil or asphalt runway/taxiway pavement is currently present over the most of the site. The existing hanger consists of a clear-span steel frame and sided building, with a concrete slab-on-grade. The Maier Aviation building consists of a frame and masonry building, with a concrete slab-on-grade.

SUBSURFACE EXPLORATION

During our March 2 and 3, 2026 exploration, seven Standard Penetration Test (SPT) soil borings (B-1 to B-10) were drilled to depths ranging from 3.0 to 12.0 feet below the existing site grades. The borings were drilled in general accordance with ASTM D-1586 procedures utilizing track-mounted drilling equipment, at the locations shown on the Test Boring Location Plan included as an attachment to this report. The test boring locations were staked in the field by Thrasher, at the provided GPS coordinates. Split spoon samplers were used to recover the material samples, which were utilized in the visual classification procedures performed for the development of the test boring logs, which are also included as attachments to this report. The split spoon sampler, having a 2.0-inch outside diameter and a 1¾-inch inside diameter, was driven with a 140-pound automatic hammer falling a distance of 30 inches. The material samples were recovered at 2.5 foot intervals within the top 10 feet. The bore holes were maintained and the test borings were advanced between samples using 2.25-inch inside diameter continuous hollow stem augers.

Observations of the groundwater level were made by the drill crew during the drilling process, as well as immediately following the completion of the drilling, in each of the soil test borings. Upon completion of the drilling operations, the holes were backfilled with the auger cuttings and the recovered samples were returned to our geotechnical engineering laboratory, where they were visually classified and grouped by the project engineer. The laboratory testing program included moisture content determinations and pocket penetrometer readings on selected representative samples. The attached test boring logs were prepared by the project engineer utilizing the recovered material samples, the results of the laboratory testing, and the notes taken in the field by the drill foreman during the drilling operations. The logs reference the depth, thickness, and visual description of the encountered material strata, as well as the sample identification data.

SUBSURFACE CONDITIONS

Approximately 2 to 6 inches of topsoil was present at the ground surface at test borings B-1, B-5, B-7, and B-10. Thick layers of asphaltic pavement and stone materials were observed to be present at B-3, B-6, and B-8, to depths of 1.3 to 1.5 feet. Fill materials were encountered in boring locations B-1 to B-4, B-7, B-9 and B-10, to depths ranging from 2.0 to 5.0 feet. Overblasted shale and sandstone was present in all borings to depths of roughly 2.0 to 9.5 feet below the existing surface. In general, the site is characterized by a shallow and uneven weathered bedrock surface at all boring locations.

The existing fill materials in the referenced borings consisted of brown, grayish-brown, maroon and tan silty and sandy clay with varying percentages of rock fragments, sand and coal. In B-2, the unengineered fill layer consisted of tan and gray clayey sand with sandstone fragments. These fill layers were noted to be moist, having moisture contents varying from 8.7% to 19.3%. The SPT results obtained within this fill ranged from 14 to 35 blows-per-foot (bpf), which are considered stiff to very stiff in consistency or dense in relative density. Pocket penetrometer testing of selected fill samples resulted in readings of 1.75 to 3.5 tons-per-square-foot (tsf).

Natural soil material was encountered below the fill layer in B-9 at a depth of 2.0 feet. The natural colluvial soil consisted of brown and tan clayey sand with sandstone pieces, which was additionally described as decomposed in-place sandstone. The SPT result obtained within the natural soil/decomposed rock stratum was on the order of 16 bpf, which is considered medium dense in relative density. The natural soil was noted to be moist, with a moisture content of 11.3%. The natural soil deposit extended to depth of 2.0 feet below the existing surface grade, where weathered bedrock materials were encountered.

Overblasted bedrock materials were encountered in all test borings and, generally, consisted of alternating layers of sandstone and shale. In B-1 and B-6, maroon claystone was encountered below the existing pavement or fill layers. In B-2 and B-3, maroon, reddish-brown, brown, grayish-brown and gray clayey shale was present below the existing fill layer at 2.5 feet below the existing surface. SPT values within the overblast layers varied from 12 to 64 bpf, with numerous locations experiencing split spoon refusal conditions.

Intact weathered bedrock materials were encountered below the existing overblast in all of the test borings. The intact bedrock encountered at depths of 2.5 to 9.5 feet consisted of gray, brown and tan fine-grained sandstone. The referenced bedrock materials were classified as soft to hard. Auger refusal occurred at depths of 3.0 feet to 12.0 feet in all test borings.

Groundwater was not encountered, during or at completion of the drilling, in any of the test boring locations. We should state, however, that fluctuations in the location of the groundwater table, as well as in perched or trapped water conditions, can occur as a result of seasonal variations in precipitation, evaporation, overland runoff, and other factors not immediately apparent at the time of our exploration.

TEST BORING	FILL DEPTH	OVERBLAST DEPTH
B-1	2.0 FT	7.0 FT
B-2	2.5 FT	6.5 FT
B-3	2.5 FT	9.5 FT
B-4	2.0 FT	5.0 FT
B-5	N/A	2.5 FT
B-6	1.5 FT	5.5 FT
B-7	5.0 FT	8.5 FT
B-8	N/A	5.5 FT
B-9	2.0 FT	4.5 FT
B-10	2.0 FT	4.0 FT

ANALYSIS AND RECOMMENDATIONS

The controlling geotechnical concern for this project will be the foundation construction. Given that the various building sites are underlain by up to 5.0 feet of unengineered fill or 7.0 feet of overblast, over-excavation to depths of up to 7.0 feet below the design bearing elevations will be required for the exterior column footings of the hanger building and all footings for the pool building, to extend the footings to intact bedrock. Considering the shallow bedrock in all other foundation areas, rock excavation will be required for the foundation excavation over most of the building areas. It should be possible to excavate these weathered rock materials to the required bearing depths using conventional excavating equipment fitted with rock teeth, given that these materials have been overblasted. Removal of the existing bedrock materials to significant depths beyond our auger refusal depths may require a rock ram. It should also be expected that some undercutting will be required at the subgrade level, due to the presence of damp surface soils across the site and existing underground utility backfill, which may encounter seepage water.

Site Preparation

Prior to the commencement of any earthwork operations, all structural areas (as defined by the limits of the new building footprint area, new exterior pavement areas, and any other site areas planned for modification through earthwork) should be stripped of any existing structures, pavements, vegetative growth (including the topsoil and rootmat), relict foundations/slabs, soft/wet soils and any otherwise deleterious materials. Any existing surficial materials which have been softened by exposure to precipitation and environmental conditions should also be stripped. Following the site stripping operations, the materials at the subgrade elevation should be proof-rolled using a vehicle having a minimum single-axle weight of 20 tons, under the supervision of the geotechnical engineer. A fully-loaded tandem axle dump truck is recommended for this observational test. The proof-rolling equipment should make at least 4 passes over the entire subgrade in each of two perpendicular directions. Localized soft or yielding areas should be undercut 2 feet to firm materials and replaced with compacted, engineered fill. An allowance for 400 cubic-yards of undercut and backfilling with engineered structural fill shall be provided in the contract documents.

Any new engineered fill or backfill required to reach proposed subgrade or finished grade elevations should be placed in maximum 8 inch lifts if compaction is to be accomplished with heavy equipment, and in maximum 4 inch lifts if compaction is to be accomplished with hand operated tampers. The material should be compacted to at least 98% of the Standard Proctor maximum density within $\pm 3\%$ of the optimum moisture content, as determined by ASTM D-698 and substantiated by on-site testing. Soil materials utilized as structural fill or backfill should have a liquid limit less than 40, a plasticity index less than 15, and have no individual aggregate particle sizes greater than 4 inches in any dimension. On-site existing fill and natural soils are suitable for use as engineered fill, provided that all deleterious materials are removed.

Utility Installation and Backfilling

New utility lines should be bedded using #8 limestone chips to at least 6 inches above the top of the pipe. A minimum 4 inch thickness of gravel bedding should be provided below the pipe and

be compacted using a vibraplate. The grade and slope should be checked at the top of the gravel bedding before placement of the pipe to prevent points of sag along the pipe's length. All utility trenches, including drop inlets and manholes, can be backfilled from the top of the gravel bedding to the final subgrade elevation using 150 to 200 PCI CLSM or flowable fill for best long-term performance.

Foundation Design

Foundation selection must satisfy two basically independent criteria. First, the bearing pressure transmitted to the foundation materials should not exceed the safe allowable bearing capacity at the bearing elevation. This allowable bearing capacity includes an adequate factor of safety applied to the material's shear strength. Second, settlements due to the consolidation of the underlying materials during the operating life of the structure must be within tolerable limits.

Hanger - Based on our field exploration results, our understanding of the proposed hanger construction, and our experience with similar scenarios, it is our opinion that the hanger can be supported on a rigid spread footing foundation system installed to bear on intact weathered bedrock. As the exterior column footings will primarily carry the structural loads of the hanger, the columns footings must be extended through any fill or overblasted rock to intact bedrock strata. The required over-excavation will result in total excavations of 5 to 6 feet below the bottom of the footer to reach intact bedrock for the column footings. Over-excavations, to follow the intact bedrock surface, should be backfilled to the higher design bearing elevation using lean concrete. The stem wall footings can be constructed at the conventional bearing depth of 36 inches below the final exterior grade.

Pool Building - It is our opinion that the pool building can be supported on a rigid spread footing foundation system installed to bear on weathered bedrock. As the pool building will consist of load-bearing masonry walls, the perimeter footings must be extended through any fill or overblasted rock to intact bedrock strata. The required over-excavation will result in total excavations of 5 to 6 feet below the bottom of the footer to reach intact bedrock. Over-excavations, to follow the intact bedrock surface, should be backfilled to the design bearing elevation of 36 inches below the final exterior grade using lean concrete.

Connector Buildings - The connector buildings are expected to consist of lightly-loaded wood or steel frame structures and should be supported on rigid spread footing foundation systems bearing on existing soft or weathered rock. These structures can bear within the overblasted rock stratum at a conventional frost depth of 36 inches below final exterior grade.

For buildings supported on rigid spread footing foundation systems bearing on weathered bedrock, it is recommended that the foundations be designed for a maximum allowable bearing pressure of 3,000 pounds-per-square-foot (PSF) for continuous and/or isolated spread footings, provided that the bearing materials are approved by the GRE before pouring concrete. We recommend that any continuous footings be a minimum of 24 inches wide and 18 inches thick, and that any isolated column footings be a minimum of 3 feet by 3 feet and 18 inches thick. The footings should be sized for a total live and dead load at the base of the column or wall. Reinforcement in the rigid footings should consist of two mats of three (3) steel reinforcement

bars evenly spaced within 3 inches from the top and bottom of the footer (dual mat). Reinforcing steel in continuous foundations should extend through the length of the footing, passing through any corners or column footings in the continuous foundation system. The base of all footings should be extended at least 36 inches below the final exterior grade for frost protection.

All existing fill materials and overblasted rock encountered during hanger column footing and pool building foundation excavations must be undercut and the excavations extended to bear upon intact weathered rock. The presence of such materials should be expected and will require over-excavation to depths of up to 6.0 feet below the design bearing elevation to remove all encountered existing soil or overblast materials. An allowance of 40 cubic-yards of undercut and backfilling with 1,500 PSI lean concrete should be provided in the contract documents.

Excavated rock at the foundation bearing level may become weakened or softened if left exposed to the environment for too long a time. We therefore recommend that foundation concrete be placed on the same day as the excavation occurs. Should the degradation of the bearing materials take place, we recommend that these materials be removed from the foundation excavations prior to concrete placement. We additionally recommend that any loose materials be removed from the foundation excavations prior to reinforcing steel placement. The materials at the base of the foundation excavations should be observed and tested by the geotechnical engineer or his authorized representative prior to concrete placement, to verify competency.

For a foundation system designed and constructed as recommended above, the estimated total and differential settlements should be approximately 0.25 and 0.125 inches respectively. The differential settlement will result in an angular distortion of approximately 0.0005 inches-per-inch across a distance of 20 feet. If masonry walls are used, the potential effects of the settlement on the structures can be minimized by providing control/construction joints at critical locations and every 20 feet along the masonry walls. Control/construction joints should be provided where changes in the wall height or loading conditions occur, or where a transition in bearing materials occurs. We do not recommend rigid connections between the existing structures and new additions.

Seismic Soils Classification and Evaluation

Site Class B is recommended for the seismic design considerations, based upon our test borings, our knowledge and understanding of the area geology, and the 2018 International Building Code (IBC). The overburden soils at this site are identified as Site Class D. The depth of bedrock within the building area varies from 2.0 to 5.0 feet below the present surface and the bedrock belongs to Soil Site Class B. The actual seismic design should be performed by a structural engineer. The following potential hazards resulting from earthquake motions have been evaluated:

1. A slope stability analysis is beyond our scope of work for this project, and we are of the understanding that no such analysis has been performed at this site. Any new fill slopes should be no steeper than 3H:1V for long-term stability or a retaining structure should be provided.

2. We are recommending that the bedrock materials below the existing fill soils act as the bearing strata. The bedrock will not undergo liquefaction due to earthquake motions.
3. As the building support will be derived from the underlying bedrock, potential lateral flow/spreading is unlikely.
4. As no faults are present within the site area, surface rupture within these areas is unlikely.

The following seismic design recommendations are offered based on seismic design maps prepared and provided by IBC 2018.

- Mapped Acceleration Parameters
 $S_S = 0.154$
 $S_1 = 0.064$
- Site Coefficients
 $F_a = 0.9$
 $F_v = 0.8$
 $T_L = 12$
- Seismic Design Parameters
 $S_{MS} = 0.139$
 $S_{M1} = 0.051$
 $S_{DS} = 0.092$
 $S_{D1} = 0.034$

Floor Slab Support

The existing fill materials or new engineered fill will be considered suitable for floor slab support, following the recommended proof-rolling and subgrade preparation activities. We recommend that existing soft or yielding materials within the building footprints be removed to the level of the underlying firm materials and replaced with controlled, compacted, engineered fill. The minimum concrete slab thickness for the hanger should be 6 inches, while 4 inch thick concrete slabs are adequate for the pool building and connector structures.

The floor slabs supported on fill materials or newly placed controlled, compacted, engineered structural fill should have the subgrade prepared as outlined in the previous Site Preparation section. The subgrade should be proof-rolled using a fully-loaded tandem axle dump truck under the supervision of the geotechnical engineer or his authorized representative, to identify any areas in need of undercutting and replacement with controlled, compacted, engineered fill. A floor slab-on-grade underlain with a subgrade prepared as outlined above can be designed utilizing a modulus of subgrade reaction of 120 pounds-per-cubic-inch (pci).

Additionally, we recommend that a 6 inch thick freely draining granular base course (#8 limestone chips) be placed beneath any floor slab. This granular layer will aid in the final grading of the slab subgrade, and help to inhibit any water from rising to the floor slab. Prior to the placement of concrete, we also recommend that a vapor barrier, conforming to ASTM E 1745, be placed on top of the granular material to provide additional moisture protection. The

surface curing of the slab should also be given attention, so as to minimize uneven drying and the associated potential cracking. A conventional concrete floor slab-on-grade should be isolated from the associated building foundation system. This can be accomplished with the use of proper construction joints. Also, to help minimize the widths and propagation of any shrinkage cracks which may develop near the surface of the slab, wire mesh reinforcement placed within the top half of the slab section should be included in the floor slab design. Those slab sections bearing on soil materials can experience differential settlement on the order of 0.25 inch. The differential settlement will cause cracking of the floor slabs, especially within transitional areas of the slab sections supported on soils and fill.

Pavement Design Parameters

Any pavement section subgrade prepared as outlined in the Site Preparation section should be suitable for pavement support. If consideration is given to utilizing the existing materials for the direct support of the pavement sections, the materials should be moisture conditioned to within 2% wet of their optimum moisture content and compacted in place to at least 98% of the maximum dry density per ASTM D-698 within the top foot. The subgrade should then be proof-rolled utilizing a 20 ton vibratory smooth drum roller, making a minimum of two passes up and back in each of two perpendicular directions, under the supervision of the geotechnical engineer or his authorized representative to identify any areas in need of additional compaction or undercutting and replacement with controlled, compacted, engineered fill. In the portions of the site where significant cut has taken place and bedrock materials are present at very shallow depths, minimal subgrade preparation will most likely be required.

The following are our estimates of the thicknesses for standard and heavy duty pavement sections. The proper placement of the subgrade drainage layer is the most critical aspect necessary for the long-term performance of the pavement sections. Due to variable subgrade soils, a CBR value of 6 is recommended, based on the soil properties. We also recommend Terminal Serviceability of $pt=2.0$, regional factor $R=1.4$, reliability of 85%, and 10 year service life be used in the analysis.

Standard Duty Pavement - Automobile Parking

<u>Recommended Course</u>	<u>Thickness</u>
Hot-Mix Asphaltic Concrete Wearing Surface WVDOH 401	2.0 inches
Hot-Mix Asphaltic Concrete Base WVDOH 401	3.0 inches
Compacted Crushed Aggregate Subbase WVDOH Class I	6.0 inches

Heavy Duty Pavement - Taxiways and Aircraft Parking

<u>Recommended Course</u>	<u>Thickness</u>
Hot-Mix Asphaltic Concrete Wearing Surface WVDOH 401	2.0 inches
Hot-Mix Asphaltic Concrete Base WVDOH 401	4.0 inches
Compacted Crushed Aggregate Subbase WVDOH Class I	8.0 inches

Apron and Taxiway Rigid Pavement

<u>Recommended Course</u>	<u>Thickness</u>
Portland Cement Concrete w/Reinforcement WVDOH 501	6.0 inches
Compacted Crushed Aggregate Subbase WVDOH Class I	6.0 inches

The above pavement thicknesses are based on a strict quality control program. Not only is the compaction and the stability of the subgrade important, but the compaction of all asphaltic layers and aggregate bases are of equal importance. Drainage should be maintained in both the granular base course and the finished pavement surface. The subgrade should be properly graded to facilitate positive drainage during construction, and any water above the subgrade should be allowed to drain prior to further material placement. We would also recommend that in any pavement areas such as dumpster pads and loading docks, a cementitious concrete pavement be utilized, to accommodate the atypical loading conditions with respect to the asphaltic pavement design. It is important to remember that pavement sections designed for automobile parking may be damaged by the transit and parking of larger delivery or service type vehicles.

Retaining Wall Construction

All walls retaining 4 or more feet of unbalanced earth should be designed as retaining walls. Such a retaining wall must be capable of resisting the lateral earth pressures that will be imposed on the wall. Lateral earth pressures to be resisted by the wall will be partially dependent upon the method of construction. Assuming that the wall is relatively rigid and structurally braced against rotation, it should be designed for a condition approaching "at rest" lateral pressures. However, in the event that the wall is free to deflect during backfilling, as for any exterior wall that is not restrained or rigidly braced, the "active" pressure conditions will be applicable for the design. The following lateral earth pressure parameters are recommended for the retaining wall design, assuming a level backfill and assuming that hydrostatic water pressure does not develop behind the wall.

<u>Lateral Earth Pressure Coefficient</u>	<u>Value</u>
At-Rest Coefficient (K_0)	0.50
Active Coefficient (K_A)	0.45
Passive Coefficient (K_P)	3.0
Unit Weight of Soil (Moist)	120 pcf
Friction Factor for Foundations and Bearing Materials	0.32

Again, the above design parameters assume that a minimum 3 ft wide blanket of clean, well graded granular backfill (less than 7% fines) is placed behind the wall in order to provide positive drainage. We recommend the use of clean #57 limestone as granular backfill behind the wall. The backfill placed behind the retaining wall should be compacted to 95% of the maximum dry density. We caution that operating compaction equipment directly behind the wall can create lateral earth pressures far in excess of those recommended for design. Therefore, bracing of the wall may be needed during backfilling operations.

Maintaining positive drainage behind the wall at all times will be critical to the long-term stability of the wall. Therefore, perforated PVC pipes and a gravel drainage blanket encased in filter fabric should be inserted behind the wall to intercept and drain the subsurface water.

The free-standing retaining wall foundation should be keyed at least 1 foot into the underlying shale or sandstone bedrock formations. Stepping down the retaining wall foundation excavations may be required in some areas due to the sloping ground surface. Foundation steps should be made at 90° angles, so that only horizontal or vertical surfaces are produced. The mass gravity wall should be supported on a compacted gravel leveling pad keyed into bedrock and prepared in accordance with the manufacturer's recommendations.

Rock excavation will be required at this site to complete the site preparation and wall foundation installation as planned. In general, excavation through the soft shale bedrock at this site should be possible using conventional excavating equipment fitted with rock teeth. However, a rock ram should be used to facilitate removing the rock to the required depths and any encountered sandstone near the wall bearing elevation.

Construction Considerations

The surface materials consist of sandy/silty clays and weathered rock, which are susceptible to significant shear strength loss when wet and disturbed. Excessive rutting and muddy conditions may be common during construction occurring in wet seasons. If possible, the construction activities should be conducted during the dry months of the year. If conducted in wet weather, foot traffic should be minimized in and around the excavations. Where necessary, a 3 to 4 inch thick lean concrete "mud mat" can be poured to protect the bearing soils. Drainage should be maintained away from the foundation, both during and after construction. Concrete should be placed in the footing excavations within a half day of their initial excavation, or a "mud mat" should be provided to protect the bearing soils. Each footing excavation should be inspected by geotechnical personnel to verify that the bearing conditions are consistent with the design assumptions.

Construction Monitoring

Testing and inspection by geotechnical personnel will be a critical aspect of this project. At a minimum, these services should be provided during site preparation, undercutting, and structural fill placement, as well as during the foundation installation activities (for bearing soil observation and testing, reinforcing steel observation, and concrete testing) and retaining wall construction.

Environmental Concerns

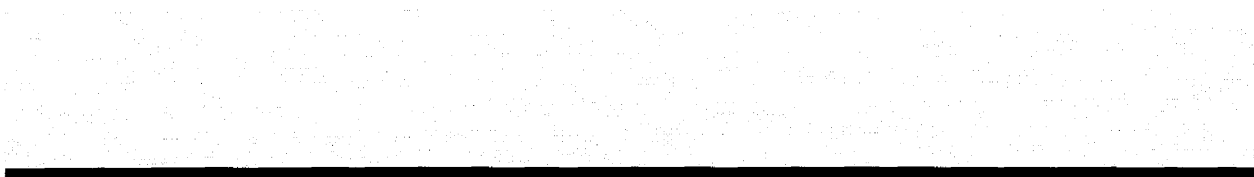
As stated in this report, the purpose of this exploration has been to address the geotechnical related issues only. An environmental assessment can be provided at your request.

LIMITATIONS

This report was prepared for use by Thrasher Group, and their authorized consultants, to aid in the design of this project. The report has been prepared in accordance with accepted geotechnical engineering practices and no other warranties, either expressed or implied, are made. The recommendations stated herein are contingent on American Geotech observing and evaluating all geotechnical aspects of the required work. We cannot be held responsible for any misinterpretations or improper implementation of our recommendations by other firms providing quality control services.

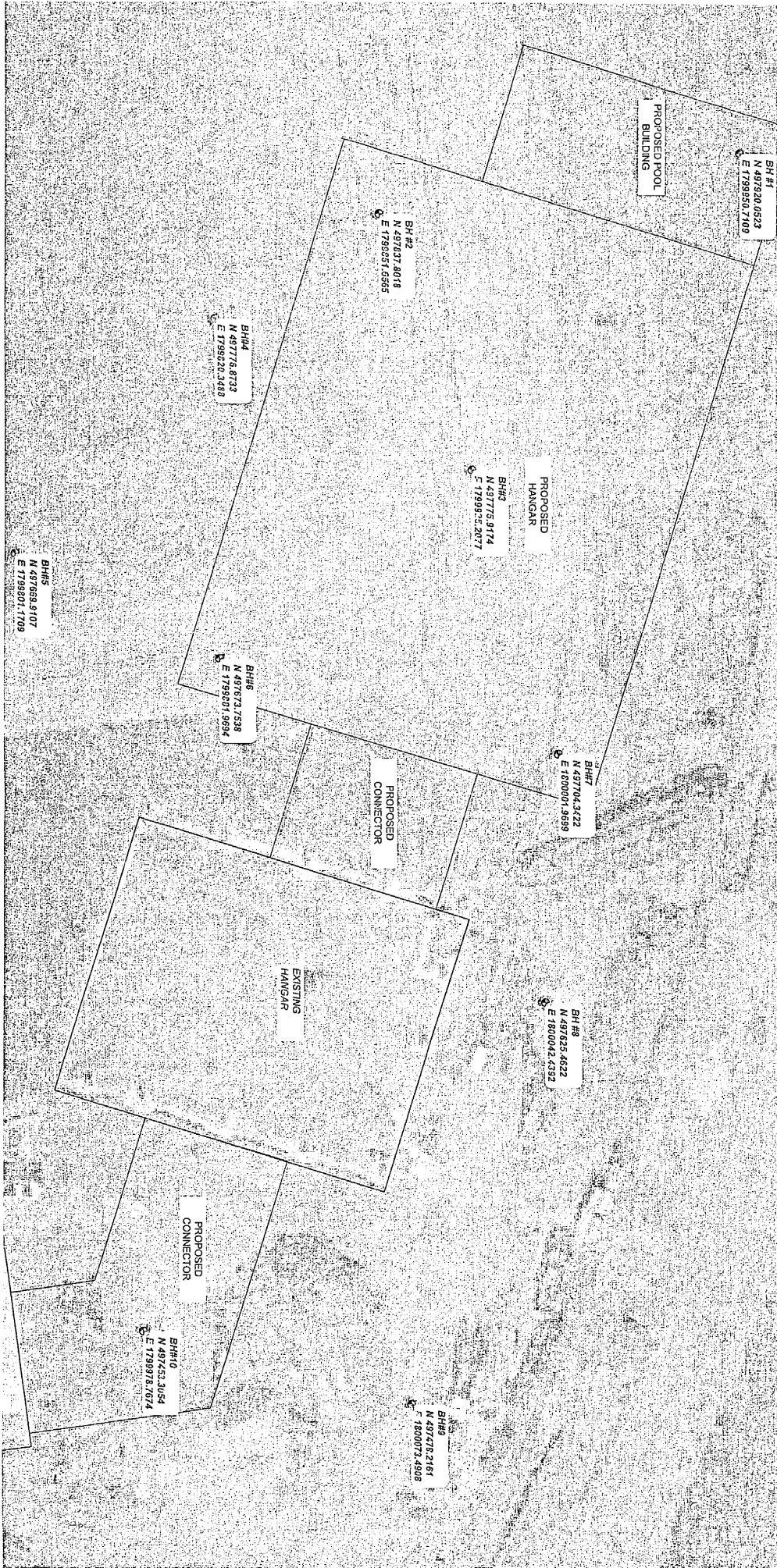
The recommendations presented in this report are based on data obtained from test borings made at the approximate locations shown on the Test Boring Location Plan. Variations which may exist between the test borings may not become evident until during construction. If significant variations are noted, we should be contacted so that the field conditions can be examined and the applicable recommendations revised, if necessary. Similarly, in the event of changes in the nature, design or location of the structure, or if other developments are planned, we should be notified so that we may review such changes to verify or make appropriate modifications to our previous conclusions and recommendations, which may be invalidated by any such changes.

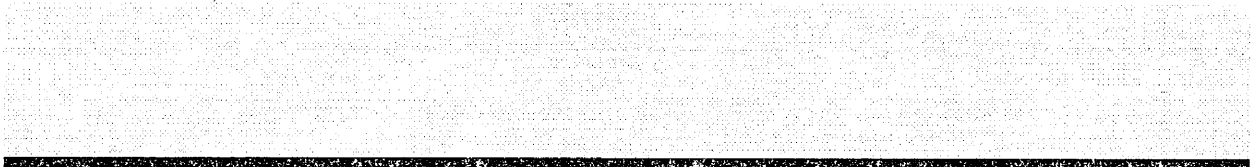
We recommend that this complete report be provided to the various design team members, the contractors and the project owner. Potential contractors should be informed of this report in the "Instructions to Bidders" section of the bid documents. The report should not be included or referenced in the actual contract documents.



TEST BORING LOCATION

*American Geotech, Inc.
601 Ohio Avenue
Charleston, West Virginia 25302*





Soil Test Boring Logs and Laboratory Data

*American Geotech, Inc.
601 Ohio Avenue
Charleston, West Virginia 25302*

Test Boring Log: Terminology and Symbols

Terminology

Grain Size

Soil Fraction		Particle Size	U.S. STD. Sieve Size
Boulders		Larger than 12"	Larger than 12"
Cobbles		3" to 12"	3" to 12"
Gravel	Coarse	¾" to 3"	¾" to 3"
	Fine	4.75 mm to ¾"	#4 to ¾"
Sand	Coarse	2.00 to 4.75 mm	#10 to #4
	Medium	0.425 to 2.00 mm	#40 to #10
	Fine	0.075 to 0.475 mm	#200 to #40
Fines	Clays & Silts	smaller than 0.075 mm	smaller than #200

Plasticity characteristics differentiate between silts and clays

Relative Density

Term	"N" Value
very loose	0 - 4
loose	5 - 10
medium dense	11 - 30
dense	31 - 50
very dense	over 50

Consistency

Term	ID Procedures	"N" Value
Soft	Easily penetrated by thumb	0 - 4
Medium Stiff	Penetrated by thumb with moderate effort	5 - 8
Stiff	Penetrated by thumb with great effort	9 - 15
Very Stiff	Readily indented by thumbnail	16 - 30
Hard	Indented by thumbnail with difficulty	31 - 50
Very Hard		over 50

Relative Moisture Description

Dry	Soil noticeably below optimum moisture
Moist	near optimum, but less than liquid limit
Damp	near or exceeding liquid limit
Wet	soil below water table

Symbols

Drilling and Sampling

RC - Rock Coring: Sizes AW, BW, NW, NQ
RQD - Rock Quality Designator
DC - Drive Casing
HSA - Hollow Stem Auger
FA - Flight Auger
AG - Auger
HA - Hand Auger
SS - 2" diameter Split Barrel Sampler
ST - 3" diameter Thin-Walled Tube Sampler
AS - Auger Sample
WS - Wash Sample
NR - No Recovery
S- Sounding
ATV - All Terrain Vehicle

Laboratory Tests

PP - Pocket Penetrometer Reading, Tons/ft²
QU - Unconfined Strength, Tons/ft²
W - Moisture Content, %
LL - Liquid Limit, %
PL - Plastic Limit, %
D - Dry Unit Weight, lbs/ft³

Standard Penetration Test

The penetration resistance, or N-value as it is commonly referred to, is the summation of the number of blows required to drive the last two successive 6" penetrations of the 2" diameter -18" long split barrel sampler. The sampler is driven with a 140 lb. weight falling 30". The standard penetration test is performed in compliance with procedures as set forth in ASTM D-1586

Water Level Measurement

NW - No water encountered
WD - While drilling
BCR - Before casing removal
ACR - After casing removal
CW - Caved and wet
CM - Caved and moist
BP - Backfilled upon completion

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. **BORING NO.** B - 1
PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV **DATE START** 3/2/26
BORING LOCATION As staked - N 497920.0523, E 1799950.7109 **DATE COMP.** 3/2/26
ELEV. REF. None available **ORDER NO.** _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE			
			NO.	TP	DEPTH	BLOWS/6" REC.
	0.0	0.2' Topsoil.				
	0.2	Grayish-brown and maroon silty 1.8' clay with rock fragments (FILL), moist, very stiff.	1	ss	0.0' - 1.5'	6-11-12 16"
	2.0	2.5' Maroon claystone, very soft.	2	ss	2.5' - 4.0'	7-6-8 17"
	4.5	2.5' Brown sandstone, broken and clayey, fine-grained, very soft.	3	ss	5.0' - 6.5'	4-8-13 14"
	7.0	Gray and tan sandstone, fine- 5.0' grained, weathered, soft to medium hard.	4	ss	7.5' - 9.0'	27-16-9 15"
			5	ss	10.0' - 10.2'	⁵⁰ / ₂ " 2"
	12.0	Auger refusal @ 12.0 feet. Boring completed.				

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

AMERICAN GEOTECH, INC.
 Geotechnical, Environmental & Testing Engineers
 601 Ohio Avenue
 Charleston, WV 25302
 304-340-4277

WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER _____ BP _____ HRS. _____ NW _____ FT.
 WATER USED IN DRILLING _____ No _____ FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. **BORING NO.** B - 2
PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV **DATE START** 3/2/26
BORING LOCATION As staked - N 497837.8018, E 1799851.6565 **DATE COMP.** 3/2/26
ELEV. REF. None available **ORDER NO.**

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	Tan and gray clayey sand with 2.5' sandstone fragments (FILL), moist, dense.	1	ss	0.0' - 1.5'	28-25-10	18"
	2.5	2.0' Brown, reddish-brown and gray clayey shale, very soft.	2	ss	2.5' - 4.0'	6-6-6	18"
	4.5	2.0' Tan sandstone, fine-grained, broken and clayey, medium hard.	3	ss	5.0' - 5.4'	50/5"	4"
	6.5	Auger refusal @ 6.5 feet. Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

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 304-340-4277

WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) NW FT.
 AT COMPLETION(▼) NW FT.
 AFTER BP HRS. NW FT.
 WATER USED IN DRILLING No FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. **BORING NO.** B - 3
PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV **DATE START** 3/2/26
BORING LOCATION As staked - N 497775.9174, E 1799925.2077 **DATE COMP.** 3/2/26
ELEV. REF. None available **ORDER NO.** _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	1.5' Asphalt(12") and stone(6").					
	1.5	Brown and grayish-brown sandy					
		1.0' clay with rock fragments (FILL),	1	ss	1.0' - 2.5'	10-13-12	8"
		moist, very stiff.					
	2.5	2.5' Maroon and grayish-brown clayey	2	ss	2.5' - 4.0'	27-9-8	15"
		shale, very soft.					
	5.0	Orangish-brown and brown	3	ss	5.0' - 6.5'	7-10-9	15"
		4.5' sandstone, broken and clayey,	4	ss	7.5' - 9.0'	33-17-22	18"
		fine-grained, soft.					
	9.5	2.0' Tan sandstone, fine-grained,	5	ss	10.0' - 10.3'	50/4"	3"
		medium hard.					
	11.5	Auger refusal @ 11.5 feet.					
		Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

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WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER BP HRS. _____ NW _____ FT.
 WATER USED IN DRILLING No FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. BORING NO. B-4

PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV DATE START 3/3/26

BORING LOCATION As staked - N 497776.8733, E 1799820.3488 DATE COMP. 3/3/26

ELEV. REF. None available ORDER NO. _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	2.0' Brown sandy clay with sandstone pieces (FILL), moist, very stiff.	1	ss	0.0' - 1.5'	9-7-20	18"
	2.0						
		3.2' Gray sandstone, fine-grained, weathered, soft to medium hard.	2	ss	2.5' - 3.6'	8-28- ⁵⁰ / _{1"} ⁵⁰ / _{2"}	13"
			3	ss	5.0' - 5.2'		2"
	5.2	Auger refusal @ 5.2 feet. Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

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WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER BP HRS. _____ NW _____ FT.
 WATER USED IN DRILLING No FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. **BORING NO.** B-5
PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV **DATE START** 3/3/26
BORING LOCATION As staked - N 497669.9107, E 1799801.1709 **DATE COMP.** 3/3/26
ELEV. REF. None available **ORDER NO.** _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	0.5' Topsoil.					
	0.5						
		2.0' Tan sandstone, fine-grained, fractured, soft to medium hard.	1	ss	0.0' - 0.8'	26- ⁵⁰ / ₃ "	9"
	2.5	0.5' Gray sandstone, fine-grained, medium hard.	2	ss	2.5' - 3.0'	⁵⁰ / ₆ "	5"
	3.0	Auger refusal @ 3.0 feet. Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

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 304-340-4277

WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER BP HRS. _____ NW _____ FT.
 WATER USED IN DRILLING No FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. **BORING NO.** B - 6
PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV **DATE START** 3/2/26
BORING LOCATION As staked - N 497673.7538, E 1799881.9694 **DATE COMP.** 3/2/26
ELEV. REF. None available **ORDER NO.** _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	1.5' Asphalt(12") and stone(6").					
	1.5	1.0' Maroon claystone, slickensided, soft.	1	ss	1.0' - 2.5'	15-10-10	16"
	2.5	Gray sandstone, fine-grained,	2	ss	2.5' - 3.6'	7-26- ⁵⁰ / _{1"}	13"
		3.0' weathered, fractured, medium hard to hard.	3	ss	5.0' - 5.6'	33- ⁵⁰ / _{1"}	6"
	5.5	Auger refusal @ 5.5 feet. Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

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WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER BP HRS. _____ NW _____ FT.
 WATER USED IN DRILLING No FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. **BORING NO.** B-7
PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV **DATE START** 3/2/26
BORING LOCATION As staked - N 497704.3422, E 1800001.9699 **DATE COMP.** 3/2/26
ELEV. REF. None available **ORDER NO.** _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	0.3' Topsoil.					
	0.3						
		Brown silty clay, trace sand and 4.7' rock fragments, coal layer (FILL), moist, stiff to very stiff.	1	ss	0.0' - 1.5'	3-3-11	16"
			2	ss	2.5' - 4.0'	10-12-11	5"
	5.0	Reddish-brown to tan sandstone, 3.5' fine-grained, weathered, medium hard.	3	ss	5.0' - 5.5'	⁵⁰ / ₆ "	4"
			4	ss	7.5' - 8.2'	35- ⁵⁰ / ₂ "	8"
	8.5	Auger refusal @ 8.5 feet. Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

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 304-340-4277

WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER BP HRS. _____ NW _____ FT.
 WATER USED IN DRILLING No FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. **BORING NO.** B - 8
PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV **DATE START** 3/3/26
BORING LOCATION As staked - N 497625.4622, E 1800042.4392 **DATE COMP.** 3/3/26
ELEV. REF. None available **ORDER NO.** _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	1.3' Asphalt(10") and stone(6").					
	1.3						
		3.2' Orangish-brown sandstone, fine-grained, weathered, soft to tough.	1	ss	0.8' - 2.3'	10-38-26	15"
			2	ss	2.5' - 3.3'	13- ⁵⁰ / ₃ "	9"
	4.5	Brown to tan sandstone, fine-grained, highly weathered, medium hard.					
			3	ss	5.0' - 5.3'	⁵⁰ / ₄ "	4"
	5.5	Auger refusal @ 5.5 feet. Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

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WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER BP HRS. _____ NW _____ FT.
 WATER USED IN DRILLING No FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. **BORING NO.** B-9
PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV **DATE START** 3/3/26
BORING LOCATION As staked - N 497478.2161, E 1800073.4908 **DATE COMP.** 3/3/26
ELEV. REF. None available **ORDER NO.** _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	Maroon and tan sandy clay with					
		2.0' rock fragments (FILL), moist, very	1	ss	0.0' - 1.5'	3-5-12	16"
		stiff.					
	2.0	Brown and tan clayey sand with					
		2.5' sandstone pieces (decomposed	2	ss	2.5' - 4.0'	3-4-12	18"
		sandstone), moist, medium dense.					
	4.5	3.5' Tan sandstone, fine-grained,	3	ss	5.0' - 5.3'	50/3"	3"
		weathered, soft to medium hard.	4	ss	7.5' - 7.9'	50/5"	4"
	8.0	Auger refusal @ 8.0 feet.					
		Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

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 Geotechnical, Environmental & Testing Engineers
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 Charleston, WV 25302
 304-340-4277

WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER _____ BP _____ HRS. _____ NW _____ FT.
 WATER USED IN DRILLING _____ No _____ FT.

LOG OF TEST BORING

CLIENT The Thrasher Group, Inc. BORING NO. B - 10

PROJECT Proposed Hanger, Pool Building and Connectors - Charleston, WV DATE START 3/3/26

BORING LOCATION As staked - N 497453.3054, E 1799978.7674 DATE COMP. 3/3/26

ELEV. REF. None available ORDER NO. _____

ELEV. FT.	DEPTH FT.	DESCRIPTION OF MATERIALS	SAMPLE				
			NO.	TP	DEPTH	BLOWS/6"	REC.
	0.0	0.3' Topsoil.					
	0.3	Brown and tan sandy clay with					
		1.7' sandstone pieces (FILL), moist,	1	ss	0.0' - 1.5'	2-5-10	18"
		stiff.					
	2.0	2.0' Tan sandstone, fine-grained,	2	ss	2.5' - 2.8'	50/4"	4"
		fractured, medium hard.					
	4.0	Auger refusal @ 4.0 feet.					
		Boring completed.					

GENERAL NOTES
 DRILLER J. Davison
 RIG NO. CME-45B
 RIG TYPE Track
 METHOD HSA/SS

AMERICAN GEOTECH, INC.
 Geotechnical, Environmental & Testing Engineers
 601 Ohio Avenue
 Charleston, WV 25302
 304-340-4277

WATER LEVEL OBSERVATIONS
 IMMEDIATE(▼) _____ NW _____ FT.
 AT COMPLETION(▼) _____ NW _____ FT.
 AFTER BP HRS. _____ NW _____ FT.
 WATER USED IN DRILLING No FT.

AMERICAN GEOTECH, INC.
601 Ohio Avenue
Charleston, West Virginia 25302

The Thrasher Group, Inc.
Prop. Hanger and Pool Building
Charleston, West Virginia

TABULATION OF TEST DATA

Hole No.	Sample No.	Depth (ft.)	Unconfined Compressive Strength (tsf)	Failure Strain (%)	Dry Density (pcf)	Water Content (%)	Pocket Penetrometer (tsf)
B-1	S-1	0.0 - 1.5				16.0	1.75
	S-2	2.5 - 4.0				9.1	3.25
	S-3	5.0 - 6.5				7.2	
	S-4	7.5 - 9.0				3.4	
B-2	S-1	0.0 - 1.5				10.2	
	S-2	2.5 - 4.0				8.4	1.0
	S-3	5.0 - 5.4				7.6	
B-3	S-2	2.5 - 4.0				6.7	
	S-3	5.0 - 6.0				11.0	
B-4	S-1	0.0 - 1.5				8.7	

AMERICAN GEOTECH, INC.
601 Ohio Avenue
Charleston, West Virginia 25302

The Thrasher Group, Inc.
Prop. Hanger and Pool Building
Charleston, West Virginia

TABULATION OF TEST DATA

Hole No.	Sample No.	Depth (ft.)	Unconfined Compressive Strength (tsf)	Failure Strain (%)	Dry Density (pcf)	Water Content (%)	Pocket Penetrometer (tsf)
	S-2	2.5 - 3.6				5.1	
B-5	S-1	0.0 - 0.8				7.4	
	S-2	2.5 - 3.0				4.6	
B-6	S-1	1.0 - 2.5				10.1	
	S-2	2.5 - 3.6				5.2	
B-7	S-1	0.0 - 1.5				14.1	
	S-2	2.5 - 4.0				19.3	
	S-3	5.0 - 5.5				10.6	
	S-4	7.5 - 8.2				3.9	
B-8	S-1	0.8 - 2.3				5.9	

AMERICAN GEOTECH, INC.
601 Ohio Avenue
Charleston, West Virginia 25302

The Thrasher Group, Inc.
Prop. Hanger and Pool Building
Charleston, West Virginia

TABULATION OF TEST DATA

Hole No.	Sample No.	Depth (ft.)	Unconfined Compressive Strength (tsf)	Failure Strain (%)	Dry Density (pcf)	Water Content (%)	Pocket Penetrometer (tsf)
	S-2	2.5 - 3.3				4.5	
	S-3	5.0 - 5.3				3.8	
B-9	S-1	0.0 - 1.5				10.7	
	S-2	2.5 - 4.0				11.3	
	S-3	5.0 - 5.3				5.0	
B-10	S-1	0.0 - 1.5				9.1	3.5
	S-2	2.5 - 2.8				3.5	

SECTION 083323 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulated service doors.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
2. Show locations of controls, locking devices detectors or replaceable fusible links, and other accessories.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.
- B. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:
 - 1. Design Wind Load: As indicated on Drawings.
 - 2. Testing: According to ASTM E330/E330M or DASMA 108 for garage doors and complying with acceptance criteria of DASMA 108.
- C. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 DOOR ASSEMBLY

- A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C.H.I. Overhead Doors, Inc.
 - b. Clopay Building Products.
 - c. Cornell; a Cornell Cookson company.
 - d. Overhead Door Corporation.
 - e. Wayne Dalton; a division of Overhead Door Corporation.
- B. Operation Cycles: Door components and operators capable of operating for not less than 50,000.
- C. Insulated Door Curtain R-Value: 7.2 deg F x h x sq. ft./Btu.

- D. Door Curtain Material: Galvanized steel.
- E. Door Curtain Slats: Flat profile slats of 2-5/8-inch center-to-center height.
 - 1. Insulated-Slat Interior Facing: Plastic.
- F. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from hot-dip galvanized steel and finished to match door.
- G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
- H. Hood: Match curtain material and finish.
 - 1. Mounting: As indicated on Drawings.
- I. Locking Devices: Equip door with locking device assembly.
 - 1. Locking Device Assembly: Cremone-type, both jamb sides locking bars, operable from inside and outside with cylinders.
- J. Electric Door Operator:
 - 1. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.
 - 2. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
 - 3. Motor Exposure: Interior.
 - 4. Motor Electrical Characteristics:
 - a. Horsepower: 1/2 hp.
 - b. Voltage: 208 V ac, single phase, 60 Hz.
 - 5. Emergency Manual Operation: Crank type.
 - 6. Obstruction-Detection Device: Automatic photoelectric sensor; self-monitoring type.
 - 7. Control Station(s): Interior mounted where indicated on Drawings.
- K. Curtain Accessories: Equip door with weatherseals.
- L. Door Finish:
 - 1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
 - 2. Interior Curtain-Slat Facing: Finish as selected by Architect from manufacturer's full range.

2.3 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
 - 1. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
 - 2. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.5 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

2.6 LOCKING DEVICES

- A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
 - 1. Lock Cylinders: As standard with manufacturer and keyed to building keying system.
 - 2. Keys: Two for each cylinder.
- B. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.7 CURTAIN ACCESSORIES

- A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

2.8 COUNTERBALANCE MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.9 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than 25-lbf force to turn crank. Fabricate gearbox to be oiltight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

2.10 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated for each door assembly.
 - 1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 - 2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
- D. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.
- E. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
- F. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.
- G. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- H. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Power-Operated Doors: Install automatic garage doors openers according to UL 325.

3.2 FIELD QUALITY CONTROL

- A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

END OF SECTION 083323

SECTION 235523 - LOW-INTENSITY, GAS-FIRED, RADIANT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section includes gas-fired, negative pressure, two stage, low intensity tubular radiant heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Data: For each type of gas-fired radiant heater indicated, include rated capacities, operating characteristics, and optional accessories.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
3. Equipment Detail: Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connection.

1.3 DRAWINGS

A. Coordination Drawings: Include plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Illustrations showing how and where equipment shall be applied.
2. Wall or roof penetrations for purposes of depicting the location of either (both) supply air intake or exhaust venting.
3. Gas piping size and appliance connections.
4. Thermostat (controls) placement with applicable wiring diagram detail.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

- A. Manufacturer shall provide a Limited Appliance Warranty no less than: one (1) year on vacuum pump, three (3) years on all internal control components, five (5) years on radiant pipe exchangers, and ten (10) years on stainless steel burner from date of substantial completion.

PART 2 - PRODUCTS

2.1 APPLIANCE CONSTRUCTION STANDARDS

- A. Equipment shall be certified to the ANSI Z83.20 standard and bear the CSA mark for United States.
- B. 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.

2.2 APPLICANCE APPLICATION STANDARDS

- A. Installation of this heater must comply with all applicable local, state, and national specifications, regulations, and building codes. In the absence of local codes, the installation must conform to the latest edition of:
- B. United States: National Fuel Gas Code, ANSI Z223.1 (NFPA 54).
- C. When applicable, follow building specific codes and regulations as dictated in the heaters Installation, Operation and Maintenance Manual (IOPM).

2.3 LOW-INTENSITY, INFRARED, GAS-FIRED, RADIANT HEATERS

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - 1. Detroit Radiant (Basis of Design).
 - 2. Roberts Gordon.
 - 3. Reznor.
- B. Fuel Type: Burner shall be designed for natural gas having characteristics the same as those of gas available at project site.
- C. Gas Control: Operation shall include a defined input differential. Heater must be CSA Design Certified to operate at an input differential of at least 20% between the low and nominal rated input modes.
 - 1. The heater's control system shall be designed to shut off the gas flow to the main burner in the event either a gas supply or power supply interruption occurs.

2. The heater's air flow control system shall provide a 7 second pre-purge prior to initiating burner operation.
- D. Combustion Chamber: Shall be 4-inch O.D., 16 ga. titanium-stabilized aluminized steel finished with a corrosion-resistant, black coating with an emissivity level documented at 0.92 or higher.
- E. Burner Type: Units shall operate under a negative pressure with exhaust gases pulled through the exchanger pipe to a common exhaust pump. Each burner shall receive its combustion air independently. Burners that have exhaust gases from upstream burners passing over them shall not be permitted. Burners shall operate at a minimum of 3.5" W.C. manifold pressure to achieve proper air-gas mixing. Burners that require air filters shall not be permitted.
- F. Burner: Stainless-steel venturi burner. The flame anchoring screen shall have a minimum temperature rating equivalent to 304 grade stainless steel. Non-stainless-steel burners shall not be permitted.
- G. Exhauster Pumps: Systems designed for condensing or non-condensing shall have a cast aluminum housing for corrosion resistance. Cast iron housings shall not be permitted.
 1. Motors ½ hp and higher shall be TEFC type standard efficiency. Motors shall be equipped with thermal protection and capacitor starters.
 2. Provide 120V/230V; 1 Phase motors.
- H. Premium Combustion Burner: Shall be constructed from 304-grade stainless steel and die formed in a venturi-style design. Flame arrestor shall be a minimum of ¼" thick constructed from sintered steel or perforated stainless steel. Burner design shall also include secondary air vanes to maximize flame rotation and heat distribution. Non-venturi or ceramic style flame arrestor designs shall not be permitted.
- I. Radiant Emitter Tube: Shall be 4-inch O.D., 16 ga. aluminized steel finished with a corrosion-resistant, black coating with an emissivity level documented at 0.92 or higher. Calorized or hot rolled steel tubes shall not be permitted. A 304-grade stainless steel emitter tube shall be used when specified for harsher environments.
- J. Condensate Tail Pipe: Shall be 4-inch O.D., 16 ga. 304 stainless steel. Pipe shall be able to be cut to any length without having raw carbon steel exposed at the edges. Glass lined, porcelain lined, or other material prone to chipping and cracking shall not be permitted.
- K. Tube Connections: The heater's combustion chamber and radiant emitter tube shall connect via a 4-inch slip-fit, interlocking connection in which the upstream tube slides into the next tube and is held by a 4-inch aluminized bolted clamp. 4-inch 304-grade stainless steel clamps shall be used to join combustion tubes to radiant tubes. A non-swaged or butted tube connection system shall not be permitted.
- L. Reflector Material: Shall be 0.024-inch, highly polished aluminum. Reflector shall have a polished bright finish with clear visual reflection ability. Mill finish material shall not be permitted. A 304-grade stainless steel reflector shall be used when specified for harsher environments.
- M. Reflector Design: Shall be a multi-faceted design with a dual-pass radiant emittance pattern designed to increase tube temperature and maximize radiant output. The reflectors shall be

rotatable from 0° to 45° when required and include fitted reflector end cap and clips. The heater's reflector hanging system shall be designed to permit expansion while minimizing noise and/or rattles. Single-pass design reflectors or those that claim a 100% emittance pattern thus bypassing the radiant tube shall not be permitted.

- N. Burner Control Box: Totally enclosed, corrosion-resistant, aluminized-steel exterior with enameled finish. Heater shall be supplied with a 24" stainless steel flexible gas connector.
- O. Sight Glass: Heater shall be equipped with a sight glass allowing a visual inspection of igniter and burner operation from floor level. Sight glass visible only at appliance level shall not be permitted.
- P. Air Intake: An air intake collar shall be supplied as part of the burner control assembly fitted to accept a 4-inch O.D. PVW or DWV air supply duct.
- Q. Baffle: Heater shall utilize downstream turbulator baffle(s) for maximum heat transfer.

2.4 BURBER CONTROLS, OPERATION & MARKINGS

- A. Each burner assembly shall include a safety differential pressure switch to monitor combustion air flow, as to provide complete burner shutdown due to insufficient combustion air or flue blockage. A single differential pressure switch at the exhaust assembly shall not be permitted.
- B. Staged operation shall be mechanical in nature and controlled via a direct 24 V connection directly to the valve assembly. Heaters that control staging via air pressure or air ducting shall not be permitted.
- C. The heater shall incorporate a self-diagnostic ignition module and feature an ignition system with three (3) tries prior to entering soft lockout followed by hard lockout.
- D. Burner assembly shall not require or incorporate the use of air filters.
- E. Heater control assembly shall include three (3) operational indicator lights indicating status of low fire operation, high fire operation, and pressure switch operation.
- F. The heater's ignitor warm-up control system shall provide a 7-second pre-purge prior to initiating burner operation and a 90-second post-purge upon completion, effectively removing all combustion by-products from the heat exchangers.
- G. Ignition System: Hot surface silicon carbide composition. Igniter shall be readily accessible and serviceable without having to remove the burner. Spark ignition systems shall not be permitted.
- H. Heater will depict the published clearances to combustibles for adherence during both installation and operation. Clearance safety tags restating this hazard shall also be provided and located near the heater's control device.
- I. Thermostat control shall be two stage operating on 24 volts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and connect gas-fired radiant heaters, associated fuel and vent features, and system according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.
- B. Suspend heater from substrate as per the manufacturer's instructions using fittings (chain, cable, rod, etc.) rated for the working load limit and area conditions.
- C. Maintain manufacturer's published clearances to combustibles. In locations used for the storage of combustible materials, signs must be posted to specify the maximum permissible stacking height.

3.2 CONNECTIONS

- A. Piping and installation requirements are specified in other Division 23 Sections.
- B. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to gas-fired radiant heaters to allow service and maintenance. Refer to manufacturer's instructions for proper gas connection details.
- C. Gas Piping: Comply with NFPA 54 and manufacturer's installation instructions.
- D. Vent Connections: Adhere to manufacturer's installation instructions.
- E. Electrical Connections: Comply with applicable requirements in Division 26 Sections. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Verify bearing lubrication.
 - 3. Verify proper motor rotation.
 - 4. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- B. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.

- C. Prepare test and inspection reports.

END OF SECTION 235523

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:

1.3 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 1. Ground rods.
 2. Ground and roof rings.
 3. BCT, TMGB, TGBs, and routing of their bonding conductors.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with TIA-607-B.

2.2 CONDUCTORS

- A. Comply with UL 486A-486B.
- B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 8 AWG.
- C. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.
- C. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

- D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.
 - 1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 - 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 - 3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-B.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, 4 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 1. Use crimping tool and the die specific to the connector.
 2. Pretwist the conductor.
 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors: Bond all metal parts of access floors to the TGB.

3.7 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
 - 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.
- C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 270526

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SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Hooks.
9. Boxes, enclosures, and cabinets.
10. Polymer-concrete handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS

- A. Product data for each type of product.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.
- D. Samples: For wireways surface pathways and tele-power poles and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale and coordinated with each other, using input from installers of items involved.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Data: Seismic rating for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

- B. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated GRC.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: Setscrew or compression.
 - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Rigid HDPE: Comply with UL 651A.

- E. Continuous HDPE: Comply with UL 651A.
- F. RTRC: Comply with UL 2515A and NEMA TC 14.
 - 1. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum riser or general-use installation unless otherwise indicated.
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. General Requirements for Metal Wireways and Auxiliary Gutters:
 - 1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- B. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.6 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.

2.7 SURFACE NONMETALLIC PATHWAYS:

- A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.
- B. Finish: Texture and color selected by Architect from manufacturer's standard colors.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.8 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. stainless steel.
- E. J or U shape.

2.9 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 - 4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.
 - 5. Gangable boxes are allowed.

- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
 - 1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures:
 - a. Material: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- K. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- L. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.
- M. General Requirements for Polymer Concrete Handholes:

1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 3. Comply with TIA-569-D and SCTE 77.
- N. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
- O. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 2. Cover Legend: Molded lettering, "COMMUNICATIONS".

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.
- B. Pathway Fittings: Compatible with pathways and suitable for use and location.
- C. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- D. Install surface pathways only where indicated on Drawings.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- I. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- J. Support conduit within 12 inches of enclosures to which attached.
- K. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from nonmetallic conduit and fittings to RNC, Type EPC-40-PVC, and fittings before rising above floor.
- L. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- N. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

- Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- R. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes where indicated on Drawings or indicated by owner.
 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- T. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- U. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- W. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

- a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

Y. Mount boxes at heights indicated on Drawings. Install boxes with height measured to center of box unless otherwise indicated.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Set metal floor boxes level and flush with finished floor surface.

DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Install backfill.
2. After installing conduit, backfill and compact.
3. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
4. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

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SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Nonmetallic slotted-channel systems.
5. Equipment supports.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, shown and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, 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. Dimensioned Outline Drawings of Equipment Unit: 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.
- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 2. Component Importance Factor: 1.0.
- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles, with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Material for Channel, Fittings, and Accessories: Galvanized steel.
 3. Channel Width: 1-5/8 inches.

4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
 6. Toggle Bolts: Stainless-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-C.
 - 4. NECA 101.
 - 5. NECA 102.
 - 6. NECA 105.
 - 7. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Use expansion anchor fasteners.
 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69, Spring-tension clamps.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 270529

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SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Underground-line warning tape.
2. Bands and tubes.
3. Cable ties.
4. Miscellaneous identification products.
5. Labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Identification Schedule:

1. Outlets: Scaled drawings indicating location and proposed designation.
2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
3. Racks: Scaled drawings indicating location and proposed designation.
4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, polyester flexible labels with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels:
 - a. Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 SIGNS

- A. Baked-Enamel Signs:
 - 1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal Size: 7 by 10 inches.
- B. Laminated-Acrylic or Melamine-Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.

- c. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
- d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch .
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Verify identity of each item before installing identification products.

- C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- D. Apply identification devices to surfaces that require finish after completing finish work.
- E. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- F. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- G. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label 6 inches from cable end.
- H. Snap-Around Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- I. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- J. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
- K. Cable Ties: General purpose, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.2 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
 - 1. System legends shall be as follows:
 - a. Telecommunications.
- D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
 - 1. Wiring closet designation.
 - 2. Colon.
 - 3. Faceplate number.
- E. Equipment Room Labeling:
 - 1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 - 2. Patch Panels: Label individual rows in each rack, starting at top and working down, with self-adhesive labels.
 - 3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Room number being served.
 - b. Colon.
 - c. Faceplate number.
- F. Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- G. Horizontal Cables: Label each cable with a vinyl-wraparound label indicating the following, in the order listed:
 - 1. Room number.
 - 2. Colon.
 - 3. Faceplate number.
- H. Instructional Signs: Self-adhesive labels.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
- J. Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive label.
 - 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.

3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.
 - c. Computer room air conditioners.
 - d. Fire-alarm and suppression equipment.
 - e. Egress points.
 - f. Power distribution components.

END OF SECTION 270553

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. Boxes, enclosures, and cabinets.
3. Power strips.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, from manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

- B. Backboard Paint: Pre-painted.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, ferrous alloy, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.4 POWER STRIPS

- A. Comply with requirements in Section 271116 "Communications Racks, Frames, and Enclosures."
- B. Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Rack mounting, with detachable flanges.
 - 3. Height: 1 RU..
 - 4. Housing: Metal.
 - 5. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
 - 6. Front-facing receptacles.
 - 7. LED indicator lights for power and protection status.
 - 8. LED indicator lights for reverse polarity and open outlet ground.

9. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
10. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
11. Close-coupled, direct plug-in line cord.
12. Rocker-type on-off switch, illuminated when in on position.
13. Surge Protection: UL 1449, Type 3.
 - a. Maximum Surge Current, Line to Neutral: 27 kA.
 - b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
 - c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V and 500 V. for neutral to ground.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G. Backboards:
 1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
 2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
 3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.2 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."

- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual", "Firestopping Practices" Ch.

END OF SECTION 271100

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. Freestanding and wall-mounted equipment cabinets.
3. Power strips.
4. Grounding.
5. Labeling.

1.2 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Seismic Qualification Data: Certificates, from manufacturer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 - 2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. UL listed.
- C. RoHS compliant.
- D. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.2 19-INCH EQUIPMENT RACKS

- A. Description: Two- and four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
- B. General Requirements:
 - 1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Material: Extruded steel.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 - 4. Color: Black.
- C. Floor-Mounted Racks:
 - 1. Overall Height: 72 inches.
 - 2. Overall Depth: 23 inches.
 - 3. Upright Depth: 3 inches.
 - 4. Two-Post Load Rating: 200 lb.

5. Four-Post Load Rating: 1000 lb.
 - a. Numbering: Every rack units, on interior of rack.
6. Threads: 10-32.
7. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
8. Base shall have a minimum of four mounting holes for permanent attachment to floor.
9. Top shall have provisions for attaching to cable tray or ceiling.
10. Self-leveling.

D. Wall-Mounted Racks:

1. Height: 22 inches.
2. Depth: 29 inches.
3. Load Rating: 150 lb.
4. Number of Rack Units per Rack: 8.
5. Threads: 10-32.
6. Wall Attachment: Four mounting holes.
7. Equipment Access: Integral swing.

E. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 19-INCH EQUIPMENT CABINETS

- A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.

B. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

C. Modular Freestanding Cabinets:

1. Overall Height: 72 inches.
2. Overall Depth: 23 inches.
3. Load Rating: 3000 lb.

4. Number of Rack Units: 38.
 - a. Numbering: Every rack units, on interior of rack.
5. Threads: 10-32.
6. Removable and lockable side and top panels.
7. Hinged and lockable front and rear doors.
8. Adjustable feet for leveling.
9. Screened ventilation openings in roof and rear door.
10. Cable access provisions in roof and base.
11. TGB.
12. Rack-mounted, 550-cfm fan with filter.
13. Power strip.
14. All cabinets keyed alike.

D. Modular Wall Cabinets:

1. Height: 18 inches.
2. Depth: 23 inches.
3. Load Rating: 150 lb.
4. Number of Rack Units: 8.
5. Threads: 10-32.
6. Lockable front and rear doors.
7. Louvered side panels.
8. Cable access provisions top and bottom.
9. Grounding lug.
10. Rack-mounted, 250-cfm fan.
11. Power strip.
12. All cabinets keyed alike.

E. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting, with detachable flanges.
3. Height: 1 RU.
4. Housing: Metal.
5. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
6. Front-facing receptacles.

7. LED indicator lights for power and protection status.
8. LED indicator lights for reverse polarity and open outlet ground.
9. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
10. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
11. Cord connected with 15-foot line cord.
12. Rocker-type on-off switch, illuminated when in on position.
13. Surge Protection: UL 1449, Type 3.
 - a. Maximum Surge Current, Line to Neutral: 27 kA.
 - b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
 - c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V and for neutral to ground.

2.5 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.
 1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
 2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.6 LABELING

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

- A. Comply with NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.
- C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.
 - 1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.
- D. Labels shall be machine printed. Type shall be 1/8 inch in height.

END OF SECTION 271116

SECTION 281300 - ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

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. Security access central-control station.
 - 2. One or more security access networked workstations.
 - 3. Security access operating system and application software.
 - 4. Security access controllers connected to high-speed electronic-data transmission network.
- B. Related Requirements:
 - 1. Section 281500 "Access Control System Hardware Devices" for access control system hardware, such as keypads, card readers, and biometric identity devices.
 - 2. Coordinate with owner for exact requirements based on existing system.

1.3 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- D. Location: A Location on the network having a workstation-to-controller communications link, with additional controllers at the Location connected to the workstation-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- E. Workstation: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.

- G. RF: Radio frequency.
- H. ROM: Read-only memory. ROM data are maintained through losses of power.
- I. TCP/IP: Transport control protocol/Internet protocol.
- J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.
- C. Product Schedules.
- D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Workstation operating system documentation.
 2. Workstation installation and operating documentation, manuals, and software for the workstation and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each workstation.
 3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on [USB] [cloud] media of the hard-copy submittal.
 4. System installation and setup guides with data forms to plan and record options and setup decisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Laser Printers: Three toner cassettes and one replacement drum unit.
 2. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
 3. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Central Station, Workstations, and Controllers:
1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
 2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
 3. Indoor, Uncontrolled Environment: NEMA 250, Type 3R enclosures. System components installed in non-air-conditioned non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
 4. Outdoor Environment: NEMA 250, NEMA 250, Type 3R Type 4X enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick.
 5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
 6. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SOFTWARE

- A. Coordinate with owner for exact requirements based on existing system.

2.2 DESCRIPTION

- A. Security Access System: Workstation-based central station and field-installed controllers, connected by a high-speed electronic-data transmission network.
- B. System Software: Coordinate with owner for exact requirements based on existing system.

- C. Network connecting the central station and workstations shall be a WAN using TCP/IP with a capacity of connecting up to 99 workstations. System shall be portable across multiple communication platforms without changing system software.
- D. Network(s) connecting workstations and controllers shall consist of one or more of the following:
 - 1. Local area, IEEE 802.3 Fast Ethernet Gigabit-Ethernet, star topology network based on TCP/IP.
 - 2. Local area, IEEE 802.11 compatible wireless mesh network, based on TCP/IP.

2.3 OPERATION

- A. Security access system shall use a single database for access-control and credential-creation functions.
- B. Distributed Processing: A fully distributed processing system.
 - 1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
 - 2. Intermediate controllers for access control are prohibited.
 - 3. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the central station.
- C. Number of Locations:
 - 1. Support at least 32,000 separate Locations using a single workstation with combinations of direct-connect, or TCP/IP LAN connections to each Location.
 - 2. Each Location shall have its own database and history in the central station.
 - 3. Locations may be combined to share a common database.
- D. Data Capacity:
 - 1. 130 different card-reader formats.
 - 2. 999 comments.
 - 3. 48 graphic file types for importing maps.
- E. Location Capacity:
 - 1. 1024 reader-controlled doors.
 - 2. 50,000 total-access credentials.
 - 3. 2048 supervised alarm inputs.
 - 4. 2048 programmable outputs.
 - 5. 32,000 custom action messages per Location to instruct operator on action required when alarm is received.
- F. System Network Requirements:

1. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
 2. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
 3. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.
 4. Communications controller may be used as an interface between the central-station display systems and the field device network. Communications controller shall provide functions required to attain the specified network communications performance.
- G. Central station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central station shall control system networks to interconnect all system components, including workstations and field-installed controllers.
- H. Field equipment shall include controllers, sensors, and controls.
1. Controllers shall serve as an interface between the central station and sensors and controls.
 2. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.
 3. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
 4. Controllers are classified as alarm-annunciation or entry-control type.
- I. False-Alarm Reduction: The design of the central station and controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.
- J. Error Detection:
1. Use a cyclic code method to detect single- and double-bit errors, burst errors of eight bits or fewer, and at least 99 percent of all other multibit and burst errors between controllers and the central station.
 2. Interactive or product error-detection codes alone will not be acceptable.
 3. A message shall be in error if one bit is received incorrectly.
 4. Retransmit messages with detected errors.
 5. Allow for an operator-assigned two-digit decimal number to each communications link representing the number of retransmission attempts.
 6. Central station shall print a communication failure alarm message when the number of consecutive retransmission attempts equals the assigned quantity.
 7. Monitor the frequency of data transmission failure for display and logging.
- K. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.
- L. Door Hardware Interface:
1. Comply with requirements in Section 087100 "Door Hardware" and Section 087111 "Door Hardware (Descriptive Specification)" for door hardware required to be monitored or controlled by the security access system.

2. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

2.4 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, "National Electrical Code."
- C. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

2.5 APPLICATION SOFTWARE

- A. System Software: Based on 32-bit, Microsoft Windows central-station and workstation operating system and application software.
 1. Multiuser multitasking shall allow independent activities and monitoring to occur simultaneously at different workstations.
 2. Graphical user interface shall show pull-down menus and a menu-tree format.
 3. Capability for future additions within the indicated system size limits.
 4. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
 5. Password-protected operator login and access.
- B. Peer Computer Control Software: Detect a failure of a central computer and cause the other central computer to assume control of all system functions without interruption of operation. Both central computers shall have drivers to support this mode of operation.
- C. Application Software: Interface between the alarm annunciation and entry-control controllers to monitor sensors and DTS links, operate displays, report alarms, generate reports, and help train system operators.
 1. Reside at the central station, workstations, and controllers as required to perform specified functions.
 2. Operate and manage peripheral devices.
 3. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
 4. Import custom icons into graphics to represent alarms and I/O devices.
 5. Globally link I/O so that any I/O can link to any other I/O within the same Location without requiring interaction with the host workstation. This operation shall be at the controller.
 6. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host workstation. This operation shall be at the controller.
 7. Messages from workstation to controllers and controllers to controllers shall be on a polled network that utilizes check summing and acknowledgment of each message.

Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.

8. Selectable poll frequency and message time-out settings shall handle bandwidth and latency issues for TCP/IP, RF, and other workstation-to-controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
9. Automatic and encrypted backups for database and history backups shall be automatically stored at the central-control workstation and encrypted with a nine-character alphanumeric password that must be used to restore or read data contained in backup.
10. Operator audit trail for recording and reporting all changes made to database and system software.
11. Support network protocol and topology, TCP/IP, Novel Netware, Digital Pathworks, Banyan Vines, LAN/WAN, and RAS.

D. Workstation Software:

1. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
2. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

E. Controller Software:

1. Controllers shall operate as autonomous, intelligent processing units.
 - a. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
 - b. Controllers shall be part of a fully distributed processing-control network.
 - c. The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.
2. The following functions shall be fully implemented and operational within each controller:
 - a. Monitoring inputs.
 - b. Controlling outputs.
 - c. Automatically reporting alarms to the central station.
 - d. Reporting of sensor and output status to the central station on request.
 - e. Maintaining real time, automatically updated by the central station at least once a day.
 - f. Communicating with the central station.
 - g. Executing controller resident programs.
 - h. Diagnosing.
 - i. Downloading and uploading data to and from the central station.

3. Controller Operations at a Location:

- a. Up to 64 controllers connected to TIA 485-A communications loop. Globally operating I/O linking and anti-passback functions between controllers within the same Location without central-station or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the central station or workstations are off-line.
- b. In the event of communication failure between the central station and a Location, there shall be no degradation in operations at the controllers at that Location. Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
- c. Buffered events shall be handled in a first-in-first-out mode of operation.

4. Individual Controller Operation:

- a. Controllers shall transmit alarms, status changes, and other data to the central station when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the central station, shall be stored for later transmission to the central station. Storage capacity for the latest 1024 events shall be provided at each controller.
- b. Card-reader ports of a controller shall be custom configurable for at least [120] <Insert number> different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different controllers or within the same controller.
- c. Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
- d. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
- e. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
- f. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
- g. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.
- h. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the central station.

5. Communications Monitoring:

- a. System shall monitor and report status of TIA 485-A communications loop of each Location.

- b. Communication status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which controller last missed a poll.
 - c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each controller.
6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

F. workstation-to-Controller Communications:

1. Central-station or workstation communications shall use the following:
 - a. Direct connection using serial ports of the workstation.
 - b. TCP/IP LAN interface cards.
 - c. Dial-up or cable modems for connections to Locations.
2. Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only," or as an ASCII output port. Serial ports shall have adjustable data transmission rates and shall be selectable under program control.
3. Use multiport communications board if more than two serial ports are needed.
 - a. Use a 4-, 8-, or 16-serial port configuration that is expandable to 32- or 64-serial ports.
 - b. Connect the first board to an internal PCI bus adapter card.
4. Direct serial, TCP/IP, and dial-up, cable, or satellite communications shall be alike in the monitoring or control of the system except for the connection that must first be made to a dial-up or voice-over IP Location.
5. TCP/IP network interface card (NIV) shall have an option to set the poll-frequency and message-response time-out settings.
6. Workstation-to-controller and controller-to-controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications in this subparagraph shall be verified and buffered, and retransmitted if not acknowledged.

G. Direct Serial or TCP/IP workstation-to-Controller Communications:

1. Communication software on the workstation shall supervise the workstation-to-controller communications link.
2. Loss of communications to any controller shall result in an alarm at all workstations running the communication software.
3. When communications are restored, all buffered events shall automatically upload to the workstation, and any database changes shall be automatically sent to the controller.

H. Broadband Workstation-to-Controller Communications:

1. Communication software on the workstation shall supervise the workstation-to-controller communications link during dial-up modem connect times.
 2. Communication software shall be programmable to routinely poll each of the remote dial-up or cable modem Locations, collecting event logs and verifying phone lines at operator-selectable time intervals for each Location.
 3. System shall be programmable for dialing and connecting to all dial-up or cable modem Locations and for retrieving the accrued history transactions on an automatic basis as often as once every 10 minutes and up to once every 9999 minutes.
 4. Failure to communicate to a dial-up Location three times in a row shall result in an alarm at the workstation.
 5. Time offset capabilities shall be present so that Locations in a different geographical time zone than the host workstation will be set to, and maintained at, the proper local time. This feature shall allow for geographical time zones that are ahead of or behind the host workstation.
 6. The controller connected to a dial-up or cable modem shall automatically buffer all normal transactions until its buffer reaches 80 percent of capacity. When the transaction buffer reaches 80 percent, the controller shall automatically initiate a call to the central station and upload all transactions.
 7. Alarms shall be reported immediately.
 8. Dial-up or cable modems shall be provided by manufacturer of the system. Modems used at the controller shall be powered by the controller. Power to the modem shall include battery backup if the controller is so equipped.
- I. Controller-to-Controller Communications:
1. TIA 485-A, four-wire, point-to-point, regenerative (repeater) communications network methodology.
 2. TIA 485-A communications signal shall be regenerated at each controller.
- J. Database Downloads:
1. All data transmissions from workstations to a Location, and between controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
 2. If a controller is reset for any reason, it shall automatically request and receive a database download from the workstation. The download shall restore data stored at the controller to their normal working state and shall take place with no operator intervention.
- K. Operator Interface:
1. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
 2. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
 3. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.

4. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
5. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.
6. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:
 - a. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
 - b. Maps to provide real-time display animation and allow for control of points assigned to them.
 - c. System to allow inputs, outputs, and override groups to be placed on different maps.
 - d. Software to allow changing the order or priority in which maps will be displayed.
7. Override Groups Containing I/Os:
 - a. System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
 - b. Icon shall change automatically to show the live summary status of points in that group.
 - c. Override group icon shall provide a method to manually control or set to time-zone points in the group.
 - d. Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.
8. Schedule Overrides of I/Os and Override Groups:
 - a. To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
 - b. Each schedule shall be composed of a minimum of two dates with separate times for each date.
 - c. The first time and date shall be assigned the override state that the point shall advance to when the time and date become current.
 - d. The second time and date shall be assigned the state that the point shall return to when the time and date become current.
9. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.

L. Operator Access Control:

1. Control operator access to system controls through three password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.
2. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.

3. A minimum of 1024 unique user accounts shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.
4. The password shall not be displayed or printed.
5. Each password shall be definable and assignable for the following:
 - a. Selected commands to be usable.
 - b. Access to system software.
 - c. Access to application software.
 - d. Individual zones that are to be accessed.
 - e. Access to database.

M. Operator Commands:

1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
2. Command inputs shall be acknowledged and processing shall start in not less than one second(s).
3. Tasks that are executed by operator's commands shall include the following:
 - a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
 - b. Place Zone in Access: Used to remotely disable intrusion-alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
 - c. Place Zone in Secure: Used to remotely activate intrusion-alarm circuits emanating from a specific zone.
 - d. System Test: Allows the operator to initiate a system-wide operational test.
 - e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
 - f. Print reports.
 - g. Change Operator: Used for changing operators.
 - h. Security Lighting Controls: Allows the operator to remotely turn on or turn off security lights.
 - i. Display Graphics: Used to show any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
 - j. Run system tests.
 - k. Generate and format reports.
 - l. Request help with the system operation.
 - 1) Include in main menus.
 - 2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
 - 3) Provide navigation to specific topic from within the first help window.
 - 4) Help shall be accessible outside the application program.
 - m. Entry-Control Commands:

- 1) Lock (secure) or unlock (open) each controlled entry and exit up to four times a day through time-zone programming.
 - 2) Arm or disarm each monitored input up to four times a day through time-zone programming.
 - 3) Enable or disable readers or keypads up to two times a day through time-zone programming.
 - 4) Enable or disable cards or codes up to four times a day per entry point through access-level programming.
4. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:
 - a. Command entered is incorrect or incomplete.
 - b. Operator is restricted from using that command.
 - c. Command addresses a point that is disabled or out of service.
 - d. Command addresses a point that does not exist.
 - e. Command is outside the system's capacity.

N. Alarms:

1. System Setup:
 - a. Assign manual and automatic responses to incoming-point status change or alarms.
 - b. Automatically respond to input with a link to other inputs, outputs, or operator-response plans; unique sound with use of WAV files; and maps or images that graphically represent the point location.
 - c. Sixty-character message field for each alarm.
 - d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages. Setup shall assign messages to access point, zone, or sensor based on Owner's requirements.
 - e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
 - f. Allow 25 secondary messages with a field of four lines of 60 characters each.
 - g. Store the most recent 1000 alarms for recall by the operator using the report generator.
2. Software Tamper:
 - a. Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
 - b. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond the authorization level.
 - c. Maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.

- d. Allow only acknowledgment of software tamper alarms.
 3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
 4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
 5. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
 6. Alarm Automation Interface: High-level interface to central-station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in the same manner as burglar alarms, using a TIA 232-F ASCII interface.
 7. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.
 8. Camera Control: Provides operator ability to select and control cameras from graphic maps.
- O. Alarm Monitoring: Monitor sensors, controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.
1. Displayed alarm data shall include type and location of alarm. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
 2. Maps shall automatically display the alarm condition for each input assigned to that map if that option is selected for that input location.
 3. Alarms initiate a status of "pending" and require the following two handling steps by operators:
 - a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
 - b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.
 4. Each workstation shall display the total pending alarms and total unresolved alarms.
 5. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
 6. Alarms shall transmit to the central station in real time except for allowing connection time for dial-up locations.
 7. Alarms shall be displayed and managed from a minimum of four different windows.
 - a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
 - b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
 - c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.

- d. **Graphic Map Display:** Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
 8. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
 9. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
 10. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
 11. Identical alarms from the same alarm point shall be acknowledged at the same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
 12. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and controllers.
 13. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.
- P. **Monitor Display:** Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.
1. **Color Code:**
 - a. **FLASHING RED:** Alerts operator that a zone has gone into an alarm or that primary power has failed.
 - b. **STEADY RED:** Alerts operator that a zone is in alarm and alarm has been acknowledged.
 - c. **YELLOW:** Advises operator that a zone is in access.
 - d. **GREEN:** Indicates that a zone is secure and that power is on.
 2. **Graphics:**
 - a. Support 32,000 graphic display maps and allow import of maps from a minimum of 16 standard formats from another drawing or graphics program.
 - b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
 - c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on the graphic map.
 - d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic maps associated with I/Os.
 - e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
 - f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
 - g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

- Q. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.
1. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.
- R. Report-Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest-priority activity. Report-generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.
1. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of the period; and the default printer.
 2. Printing on Request: An operator may request a printout of any report.
 3. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm (such as door alarm, intrusion alarm, tamper alarm, etc.), the type of sensor, the location, the time, and the action taken.
 4. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
 5. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
 6. Automatic History Reports: Named, saved, and scheduled for automatic generation.
 7. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
 8. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
 9. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
 10. Who Is "In" (Muster) Report:
 - a. Emergency Muster Report: One-click operation on toolbar launches report.
 - b. Cardholder Report. Contain a count of persons who are "In" at a selected Location and a detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.
 11. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that data are available on-site at all times.
 12. History Reports: Custom reports that allow the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.
 - a. Initially store history on the hard disk of the host workstation.
 - b. Permit viewing of the history on workstations or print history to any system printer.

- c. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
 - d. Each report shall depict the date, time, event type, event description, and device; or I/O name, cardholder group assignment, and cardholder name or code number.
 - e. Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.
 - f. Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.
- 13. Reports shall have the following four options:
 - a. View on screen.
 - b. Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to the system.
 - c. "Save to File" with full path statement.
 - d. System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.
- 14. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:
 - a. Active, inactive, or future activate or deactivate.
 - b. Code number, name, or imprinted card number.
 - c. Group, Location access levels.
 - d. Start and stop code range.
 - e. Codes that have not been used since a selectable number of days.
 - f. In, out, or either status.
 - g. Codes with trace designation.
- 15. The reports of system database shall allow options so that every data field may be printed.
- 16. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.

S. Anti-Passback:

- 1. System shall have global and local anti-passback features, selectable by Location. System shall support hard and soft anti-passback.
- 2. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes through a reader of opposite designation.
- 3. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.
- 4. Timed Anti-Passback: A controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.

5. Provide four separate zones per Location that can operate without requiring interaction with the host workstation (done at controller). Each reader shall be assignable to one or all four anti-passback zones. In addition, each anti-passback reader can be further designated as "Hard," "Soft," or "Timed" in each of the four anti-passback zones. The four anti-passback zones shall operate independently.
6. The anti-passback schemes shall be definable for each individual door.
7. The Master Access Level shall override anti-passback.
8. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential-holder population anti-passback status to a neutral status.

T. Visitor Assignment:

1. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only those access levels that have been designated as approved for visitors.
2. Provide an automated log of visitor name, time and doors accessed, and name of person contacted.
3. Allow a visitor designation to be assigned to a credential holder.
4. Security access system shall be able to restrict the access levels that may be assigned to credentials issued to visitors.
5. Allow operator to recall visitors' credential-holder file once a visitor is enrolled in the system.
6. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.
7. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.

U. Training Software: Enables operators to practice system operation, including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

V. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

1. The enrollment station shall not have alarm response or acknowledgment functions.
2. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
3. The program shall provide means to disable the enrollment station when it is unattended, to prevent unauthorized use.
4. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity-verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.

5. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:
 - a. MASK: Determines a specific format with which data must comply.
 - b. REQUIRED: Operator is required to enter data into field before saving.
 - c. UNIQUE: Data entered must be unique.
 - d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
 - e. NAME ID: Data entered will be considered a unique ID for the cardholder.
6. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
7. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
8. Batch card printing.
9. Default card data can be programmed to speed data entry for sites where most card data are similar.
10. Enhanced ASCII File Import Utility: Allows the importing of cardholder data and images.
11. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

2.6 SYSTEM DATABASE

- A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.
- B. Database Operations:
 1. System data management shall be in a hierarchical menu-tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
 2. Navigational Aids:
 - a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
 - b. Point and click feature to facilitate data manipulation.
 - c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
 - d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.
 3. Data entry shall be automatically checked for duplicate and illegal data and shall be verified for valid format.
 4. System shall generate a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo

field is used for noting the purpose for which the item was entered, reasons for changes that were made, and the like.

C. File Management:

1. File management shall include database backup and restoration system, allowing selection of storage media, including 3.5-inch floppy disk, Zip and Jaz drives, and designated network resources.
2. Operations shall be both manual and automatic modes. The number of automatic sequential backups before the oldest backup will be overwritten; FIFO mode shall be operator selectable.
3. Backup program shall provide manual operation from any workstation on the LAN and shall operate while system remains operational.

D. Operator Passwords:

1. Support up to 32,000 individual system operators, each with a unique password.
2. One to eight alphanumeric characters
3. Allow passwords to be case sensitive.
4. Passwords shall not be displayed when entered.
5. Passwords shall have unique and customizable password profile, and allow several operators to share a password profile. Include the following features in the password profile:
 - a. Predetermine the highest-level password profile for access to all functions and areas of program.
 - b. Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
 - c. Restrict doors to which an operator can assign access.
6. Operators shall use a user name and password to log on to system. This user name and password shall be used to access database areas and programs as determined by the associated profile.
7. Make provision to allow the operator to log off without fully exiting program. User may be logged off but program will remain running while displaying the login window for the next operator.

E. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).

1. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
2. Use data-entry windows to view, edit, and issue access levels. Access-authorization entry-management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
3. Allow assignment of multiple cards/codes to a cardholder.
4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
5. Each door may be assigned four time zones.

6. Access codes may be up to 11 digits in length.
7. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.
8. Visitor Access: Issue a visitor badge for data tracking or photo ID purposes without assigning that person a card or code.
9. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visible annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
10. Allow each cardholder to be given either an unlimited number of uses or a number from one to 9999 that regulates the number of times the card can be used before it is automatically deactivated.
11. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

F. Security Access Integration:

1. Photo ID badging and photo verification shall use the same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.
2. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
3. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.

G. Operator Comments:

1. With the press of one appropriate button on the toolbar, the user shall be permitted to enter operator comments into the history at any time.
2. Automatic prompting of operator comment shall occur before the resolution of each alarm.
3. Operator comments shall be recorded by time, date, and operator number.
4. Comments shall be sorted and viewed through reports and history.
5. The operator may enter comments in two ways; either or both may be used:
 - a. Manually entered through keyboard data entry (typed), up to 65,000 characters per each alarm.
 - b. Predefined and stored in database for retrieval on request.
6. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

H. Group:

1. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
2. System software shall have the capacity to assign one of 32,000 group names to an access authorization.

3. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
4. Allow sorting of history reports and code list printouts by group name.

I. Time Zones:

1. Each zone consists of a start and stop time for seven days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
2. Up to four time zones may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a time zone.
3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.
4. System shall have the capacity for 2048 time zones for each Location.

J. Holidays:

1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time-zone schedule for that 24-hour period.
2. System shall have the capacity for 32,000 holidays.
3. Three separate holiday schedules may be applied to a time zone.
4. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in the system and will not be purged.
5. Holidays not designated to occur each year shall be automatically purged from the database after the date expires.

K. Access Levels:

1. System shall allow for the creation of up to 32,000 access levels.
2. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
3. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
4. System shall be able to create multiple door and time-zone combinations under the same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same controller.

L. User-Defined Fields:

1. System shall provide a minimum of 99 user-defined fields, each with up to 50 characters, for specific information about each credential holder.
2. System shall accommodate a title for each field; field length shall be 20 characters.
3. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.

4. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
5. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
6. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.
7. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include a search for a character string.
8. System shall have the ability to print cardholders based on and organized by the user-defined fields.

2.7 SURGE AND TAMPER PROTECTION

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.8 CENTRAL-STATION HARDWARE

- A. Central-Station Computer: Standard workstation of modular design.
- B. Desktop Workstations
 1. Coordinate with owner for exact requirements based on existing system.
 2. Performance Requirements:
 - a. Performance requirements may dictate equipment exceeding minimum requirements indicated.
 - b. Capable of running Microsoft Windows.
 - c. Energy Star compliant.
 - d. Processor:
 - 1) Coordinate with owner for exact requirements based on existing system.

- e. RAM:
 - 1) Coordinate with owner for exact requirements based on existing system.
- f. Primary Hard Drive:
 - 1) Coordinate with owner for exact requirements based on existing system.
- g. Second Hard Drive:
 - 1) Coordinate with owner for exact requirements based on existing system.
- h. Optical Drive:
 - 1) Coordinate with owner for exact requirements based on existing system.
- i. Optical Read and Write Drive:
 - 1) Coordinate with owner for exact requirements based on existing system.

Expansion slots: Coordinate with owner for exact requirements based on existing system.
- j. Video Card:
 - 1) Coordinate with owner for exact requirements based on existing system.
- k. Sound Card:
 - 1) At least 128 voice wavetable synthesis.
 - 2) Capable of delivering three-dimensional sound effects.
 - 3) High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
- l. Network Interface Card: Include card with connection, as applicable.
 - 1) 10-100-1000 base TX Ethernet with RJ45 connector port.
 - 2) 100 base FX Ethernet with SC or ST port.
- m. Wireless Ethernet, 802.11 a/b/g/n.
- n. Optical Modem: Full duplex link for connection to optical fiber cable provided.
- o. I/O Ports:
 - 1) Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
 - 2) One serial port.
 - 3) One parallel port.
 - 4) Two PS/2 ports.
 - 5) One RJ-45.
 - 6) One stereo line-in and line-out on back panel.
 - 7) One microphone and headphone connector on front panel.

- 8) One IEEE 1394 on front and back panel with workstation I-e card.
 - 9) One ESATA port on back panel.
 - p. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.
 - 3. Keyboard:
 - a. 101 key enhanced keyboard.
 - b. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
 - c. Wireless operation within up to 72 inches (1800 mm) in front of workstation.
 - 4. Pointing Device:
 - a. Either a two- or three-button mouse.
 - b. Wireless operation within up to 72 inches (1800 mm) in front of workstation.
 - 5. Flat Panel Display Monitor:
 - a. Coordinate with owner for exact requirements based on existing system.
 - 6. Speakers:
 - a. Two, with individual controls for volume, bass and treble.
 - b. Signal to Noise Ratio: At least 65 dB.
 - c. Power: At least 4 W per speaker/channel.
 - d. Magnetic shielding to prevent distortion on the video monitor.
 - 7. I/O Cabling: Include applicable cabling to connect I/O devices.
 - 8. Software:
 - a. Factory installed operating system.
- C. Portable Workstations
- 1. Coordinate with owner for exact requirements based on existing system.
 - 2. Performance Requirements:
 - a. Performance requirements may dictate equipment exceeding minimum requirements indicated.
 - b. Energy Star compliant.
 - c. Hardware and software shall support local down-loading to DDC controllers.
 - d. Data transfer rate to DDC controller shall be at network speed.
 - 3. Processor:
 - a. Coordinate with owner for exact requirements based on existing system.
 - 4. RAM:

- a. Coordinate with owner for exact requirements based on existing system.
5. Hard Drive:
 - a. Coordinate with owner for exact requirements based on existing system.
6. Video Card: Coordinate with owner for exact requirements based on existing system.
7. Input and Output Ports:
 - a. Serial port.
 - b. Shared port for external keyboard or mouse.
 - c. Four USB 3.0 ports.
 - d. Ethernet port.
 - e. HDMI port.
 - f. IEEE 1394 port.
8. Battery:
 - a. Capable of supporting operation of portable workstation for a minimum of 8 hours.
 - b. Battery life of at least three years.
 - c. Battery charge time of less than three hours.
 - d. Spare Batteries: One.
9. Keyboard:
 - a. 85-key keyboard.
 - b. Full upper- and lowercase ASCII keyset.
10. Integral Pointing Device: Touchpad with two buttons. Gesture enabled.
11. Display:
 - a. Coordinate with owner for exact requirements based on existing system.
12. Network Interfaces
 - a. Network Interface Card: Include card with connection, as application.
 - 1) 10-100-1000 base TX Ethernet with RJ45 connector port.
 - 2) 100 base FX Ethernet with SC or ST port.
 - b. Wireless:
 - 1) Internal with integrated antenna, capable of supporting 802.11 a/b/g/n.
13. Digital Video Disc Rewrite Recorder (DVD+/-RW):
 - a. Coordinate with owner for exact requirements based on existing system.
14. Accessories:
 - a. Nylon carrying case.

- b. Docking station.
- c. Mobile broadband card.
- d. Wireless optical mouse.
- e. 1-2 TB portable hard drive.
- f. Light-sensitive Web cam and noise-cancelling digital array microphone.
- g. Category 6a patch cable. Minimum cable length shall be 6ft .
- h. HDMI cable. Minimum cable length shall be 6ft.

D. Servers

- 1. Description: x86 based computer used for client-server computing.
- 2. Coordinate with owner for exact requirements based on existing system.
- 3. Mounting: Coordinate with owner for exact requirements based on existing system.
- 4. Power: dual power supply, minimum 300 W.
- 5. Performance Requirements:
 - a. Performance requirements may dictate equipment exceeding minimum requirements indicated.
 - b. Energy Star compliant.
- 6. Processor:
 - a. Coordinate with owner for exact requirements based on existing system.
- 7. RAM:
 - a. Coordinate with owner for exact requirements based on existing system.
- 8. Redundant Array of Independent Disks: Coordinate with owner for exact requirements based on existing system.
- 9. Drive Bays: Eight at 2.5 inches or eight at 3.5 inches. Hot swappable.
- 10. Hard Drives: Coordinate with owner for exact requirements based on existing system.
- 11. Hard-Drive Storage: Coordinate with owner for exact requirements based on existing system.
- 12. Network Interface: Coordinate with owner for exact requirements based on existing system.
- 13. DVD +RW Drive.
- 14. Color, flat-screen display
- 15. Keyboard and mouse.
- 16. Next-day on-site warranty for three-year period following Substantial Completion.
- 17. Servers shall include the following:
 - a. Full-feature backup server (server and backup minimum requirement).
 - b. Software licenses.
 - c. Cable installation between server(s) and network.
- 18. Web Server:
 - a. If required to be separate, include Web server hardware and software to match, except backup server is not required.

- b. Firewalls between server Web and networks.
- c. Password protection for access to server from Web server.
- d. Cable installation between the server(s) and building Ethernet network.

19. Power each server through a UPS unit.

2.9 CONTROLLERS

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.
- B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.
- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
- D. Alarm Annunciation Controller:
 - 1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network, with dc line supervision on each of its alarm inputs.
 - a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
 - b. Alarm-Line Supervision:
 - 1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal, and for conditions as described in UL 1076 for line security equipment by monitoring for abnormal open, grounded, or shorted conditions using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 10 percent or more for longer than 500 ms.
 - 2) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.
 - c. Outputs: Managed by central-station software.
 - 2. Auxiliary Equipment Power: A GFI service outlet inside the controller enclosure.
- E. Entry-Control Controller:
 - 1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, door strikes, magnetic latches, gate and door operators, and exit push buttons.

- a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
 - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
 - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
 - 2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
 - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
2. Inputs:
 - a. Data from entry-control devices; use this input to change modes between access and secure.
 - b. Database downloads and updates from the central station that include enrollment and privilege information.
3. Outputs:
 - a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
 - b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
 - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
 - d. Door Prop Alarm: If a portal is held open for longer than 30 seconds, alarm sounds.
4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
 - a. Store up to 1000 transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.
6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.

- a. Backup Battery: Valve-regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata 9-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
- b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
- c. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.
- d. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
 - 1) Trouble Alarm: Normal power-off load assumed by battery.
 - 2) Trouble Alarm: Low battery.
 - 3) Alarm: Power off.

2.10 DOOR AND GATE HARDWARE INTERFACE

- A. Exit Device with Alarm: Operation of the exit device shall generate an alarm[and annunciate a local alarm]. Exit device and alarm contacts are specified in Section 087100 "Door Hardware."
- B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Section 087100 "Door Hardware."
- C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Section 087100 "Door Hardware."
- D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Section 087100 "Door Hardware."
- E. Vehicle Gate Operator: Interface electrical operation of gate with controls in this Section. Vehicle gate operators shall be connected, monitored, and controlled by the security access controllers. Vehicle gate and accessories are specified in Section 323113 "Chain Link Fences and Gates."

2.11 FIELD-PROCESSING SOFTWARE

- A. Operating System:

1. Local processors shall contain an operating system that controls and schedules that local processor's activities in real time.
2. Local processor shall maintain a point database in its memory that includes parameters, constraints, and the latest value or status of all points connected to that local processor.
3. Execution of local processor application programs shall utilize the data in memory resident files.
4. Operating system shall include a real-time clock function that maintains the seconds, minutes, hours, date, and month, including day of the week.
5. Local processor real-time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds (the time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown).

B. Startup Software:

1. Causes automatic commencement of operation without human intervention, including startup of all connected I/O functions.
2. Local processor restart program based on detection of power failure at the local processor shall be included in the local processor software.
3. Initiates operation of self-test diagnostic routines.
4. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made.
5. If the database and application programs are resident, the local processor shall immediately resume operation.

C. Operating Mode:

1. Local processors shall control and monitor inputs and outputs as specified, independent of communications with the central station or designated workstations.
2. Alarms, status changes, and other data shall be transmitted to the central station or designated workstations when communications circuits are operable.
3. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station or designated workstations, shall be stored for later transmission to the central station or designated workstations.
4. Storage for the latest 4000 events shall be provided at local processors, as a minimum.
5. Local processors shall accept software downloaded from the central station.
6. Panel shall support flash ROM technology to accomplish firmware downloads from a central location.

D. Failure Mode: Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure-mode) state, consistent with the failure modes shown and the associated control device.

E. Functions:

1. Monitoring of inputs.
2. Control of outputs.
3. Reporting of alarms automatically to the central station.

4. Reporting of sensor and output status to central station upon request.
5. Maintenance of real time, automatically updated by the central station at least once a day.
6. Communication with the central station.
7. Execution of local processor resident programs.
8. Diagnostics.
9. Download and upload data to and from the central station.

2.12 FIELD-PROCESSING HARDWARE

A. Alarm Annunciation Local Processor:

1. Respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
3. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
4. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
5. Local processor shall report line supervision alarms to the central station.
6. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 milliseconds.
7. Alarm condition shall be transmitted to the central computer during the next interrogation cycle.
8. Local processor outputs shall reflect the state of commands issued by the central station.
9. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
10. Local processor shall have at least four command outputs.
11. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.

B. Processor Power Supply:

1. Local processor and sensors shall be powered from an uninterruptible power source.
2. Uninterruptible power source shall provide eight hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored.
3. If the facility is without an emergency generator, the uninterruptible power source shall provide 24 hours of battery backup power.
4. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa.
5. Batteries shall be sealed, non-outgassing type.
6. Power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.
7. Loss of primary power shall be reported to the central station as an alarm.

- C. Auxiliary Equipment Power: A GFI service outlet shall be furnished inside the local processor's enclosure.
- D. Entry-Control Local Processor:
 - 1. Entry-control local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
 - 2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
 - 3. Entry-control local processor shall provide local entry-control functions including communicating with field devices such as card readers, keypads, door strikes, magnetic latches, gate and door operators, and exit push buttons.
 - 4. Processor shall also accept data from entry-control field devices as well as database downloads and updates from the central station that include enrollment and privilege information.
 - 5. Processor shall send indications of successful or failed attempts to use entry-control field devices and shall make comparisons of presented information with stored identification information.
 - 6. Processor shall grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
 - 7. Entry-control local processor shall use inputs from entry-control devices to change modes between access and secure.
 - 8. Local processor shall maintain a date-time- and location-stamped record of each transaction and transmit transaction records to the central station.
 - 9. Processor shall operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the local processor and the central station.
 - 10. Processor shall store a minimum of 4000 transactions during periods of communication loss between the local processor and the central station for subsequent upload to the central station upon restoration of communication.
 - 11. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
 - 12. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
 - 13. Local processor shall report line supervision alarms to the central station.
 - 14. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 ms.
 - 15. Alarm condition shall be transmitted to the central station during the next interrogation cycle.
 - 16. Entry-control local processor shall include the necessary software drivers to communicate with entry-control field devices. Information generated by the entry-control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal.
 - 17. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges.

18. Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time- and location-stamped record of each transaction.
19. Transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
20. Local processor outputs shall reflect the state of commands issued by the central station.
21. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
22. Local processor shall have at least four addressable outputs.
23. The entry-control local processor shall also provide control outputs to portal-control devices.
24. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.
25. The system manufacturer shall provide strategies for downloading database information for panel configurations and cardholder data to minimize the required download time when using IP connectivity.

2.13 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to workstations, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.

1. Record setup data for control station and workstations.
 2. For each Location, record setup of controller features and access requirements.
 3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
 4. Assign action message names and compose messages.
 5. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
 6. Prepare and install alarm graphic maps.
 7. Develop user-defined fields.
 8. Develop screen layout formats.
 9. Discuss badge layout options; design badges.
 10. Complete system diagnostics and operation verification.
 11. Prepare a specific plan for system testing, startup, and demonstration.
 12. Develop acceptance test concept and, on approval, develop specifics of the test.
 13. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.3 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, cable and asset management software shall reflect as-built conditions.

3.4 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
 - 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
 - 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.6 PROTECTION

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."
- B. Develop separate training modules for the following:
 - 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
 - 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
 - 3. Security personnel.
 - 4. Hardware maintenance personnel.
 - 5. Corporate management.

END OF SECTION 281300

SECTION 281500 - ACCESS CONTROL HARDWARE DEVICES

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. Card readers, credential cards, and keypads
 - 2. Cables
 - 3. Transformers

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.
- C. Product Schedules.
- D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
 - 2. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 - 1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 - 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
 - 3. Indoor, Uncontrolled Environment: NEMA 250, Type 1 enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
 - 4. Outdoor Environment: NEMA 250, NEMA 250, Type 4X enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph.

PART 2 - PRODUCTS

2.1 OPERATION

- A. Security access system hardware shall use a single database for access-control and credential-creation functions.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, "National Electrical Code."
- C. Comply with SIA DC-03.

2.3 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

- A. Manufacturer: Shall be compatible with existing SALTO System.
- B. Card Readers:
 - 1. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
 - 2. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
 - 3. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:
 - a. Indoors, controlled environment.
 - b. Indoors, uncontrolled environment.
 - c. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.
 - 4. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
 - 5. Stripe Swipe Readers: Bidirectional, reading cards swiped in both directions, powered by the controller. Reader shall be set up for ABA Track or magnetic-stripe encoding (match existing system).
 - a. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.
 - b. Readers for outdoors shall be in a polymeric plastic enclosure with all electronics potted in plastic. Rated for operation in ambient conditions of minus 40 to plus 160 deg F in a humidity range of 10 to 90 percent.

6. Wiegand Swipe Reader: Set up for **26**-bit data cards. Comply with SIA AC-01.
7. Wiegand Key-Insert Reader: Set up for 26-bit data cards.
8. Bar-Code Reader: Set up for Code 128.
9. Insert Readers: Requiring the card to be inserted from the bottom, powered by the controller.
10. Touch-Plate and Proximity Readers:
 - a. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
 - b. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
 - c. The card reader shall read proximity cards in a range from direct contact to at least 6 inches (150 mm) from the reader.

C. Keypads:

1. Entry-control keypads shall use a unique combination of alphanumeric and other symbols as an Identifier.
2. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII-code ordinal sequence.
3. Communication protocol shall be compatible with the local processor.
4. Keypad Display:
 - a. Keypads shall include a digital visual indicator and shall provide visible and audible status indications and user prompts.
 - 1) Display shall indicate power on or off and whether user passage requests have been accepted or rejected.
 - b. Design of the keypad display or keypad enclosure shall limit viewing angles of the keypad as follows:
 - 1) Maximum Horizontal Viewing Angle: Plus or minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display.
 - 2) Maximum Vertical Viewing Angle: Plus or minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.
5. Keypad Response Time:
 - a. The keypad shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 ms or less from the time the last alphanumeric symbol is entered until a response signal is generated.
6. Keypad Power:
 - a. The keypad shall be powered from the source as shown and shall not dissipate more than 150 W.

7. Keypad Mounting Method:
 - a. Keypads shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
8. Keypad Duress Codes:
 - a. Keypads shall provide a means for users to indicate a duress situation by entering a special code.
- D. Keypad and Wiegand-Swipe-Reader Combination: Designed to require an entry on the keypad before presenting the credential card.
 1. Keypad: Allow the entry of four alphanumeric characters that are associated with a specific credential. Keypads shall contain an integral alphanumeric/special symbol keyboard with symbols arranged in ascending ASCII-code ordinal sequence. Keypad display or enclosure shall limit viewing angles of the keypad as follows:
 - a. Maximum Horizontal Viewing Angle: Plus or minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display.
 - b. Maximum Vertical Viewing Angle: Plus or minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.
 2. Wiegand Swipe Reader: Set up for 26-bit data cards to generate a unique card identification code. Comply with SIA AC-01.
 3. The reader shall have "flash" download capability to accommodate card format changes. The card reader shall have capability of transmitting data to security control panel and shall comply with ISO/IEC 7816.
 4. Communication Protocol: Compatible with local processor.
- E. Credential Cards:
 1. Modification: Entry-control cards shall be able to be modified by lamination direct print process during the enrollment process without reduction of readability. The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the badge holder used at the site.
 2. Card Size and Dimensional Stability: Credential cards shall be 2-1/8 by 3-3/8 inches. The credential card material shall be dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.
 3. Card Material: Abrasion resistant, nonflammable, nontoxic, and impervious to solar radiation and effects of ultraviolet light.
 4. Card Construction:
 - a. Core and laminate or monolithic construction.
 - b. Lettering, logos, and other markings shall be hot stamped into the credential material or direct printed.
 - c. Incorporate holographic images as a security enhancement.
 - d. Furnish equipment for on-site assembly and lamination of credential cards.

2.4 CABLES

- A. General Cable Requirements: Comply with requirements in Section 26519 "Low-Voltage Electrical Power Conductors and Cables" and as recommended by system manufacturer for integration requirement.
- B. PVC-Jacketed, TIA 232-F.
 - 1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors
 - 2. Polypropylene insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with UL 1581.
- C. Plenum-Rated TIA 232-F Cables:
 - 1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PE insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with NFPA 262.
- D. PVC-Jacketed, TIA 485-A Cables:
 - 1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. NFPA 70 Type: Type CM or Type CMG.
 - 6. Flame Resistance: Comply with UL 1581.
- E. Plenum-Rated TIA 485-A Cables:
 - 1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Fluorinated ethylene propylene insulation.
 - 3. Unshielded.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. NFPA 70 Type: Type CMP
 - 6. Flame Resistance: NFPA 262, Flame Test.
- F. Multiconductor, PVC, Reader and Wiegand Keypad Cables:
 - 1. No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.

2. NFPA 70, Type CMG.
3. Flame Resistance: UL 1581 vertical tray.
4. For TIA 232-F applications.

G. Paired, PVC, Reader and Wiegand Keypad Cables:

1. Three pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
2. NFPA 70, Type CM.
3. Flame Resistance: UL 1581 vertical tray.

H. Paired, PVC, Reader and Wiegand Keypad Cables:

1. Three pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
2. NFPA 70, Type CM.
3. Flame Resistance: UL 1581 vertical tray.

I. Paired, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Three pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum-foil/polypropylene-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

J. Multiconductor, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Six conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

K. LAN Cabling:

1. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.5 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.2 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Install cables and wiring according to requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5e rating of components and optical fiber rating of components, and that ensure Category 6 and optical fiber performance of completed and linked signal paths, end to end.
- F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.3 CABLE APPLICATION

- A. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. between terminations.
- D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. between terminations.
- E. Card Readers and Keypads:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft.
 - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
 - 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. between terminations.
- G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. between terminations.

3.4 GROUNDING

- A. Comply with Section 270526 "Grounding and Bonding for Communications Systems."
- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
 - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
 - 2. Bus: Mount on wall of main equipment room with standoff insulators.
 - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.5 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.

3.6 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568-C.1.
 - 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
 - 3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
 - 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.

2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

END OF SECTION 281500

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SECTION 281643 - PERIMETER SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Perimeter detection and alarm system.
- B. Related Sections:
 - 1. Section 271313 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.
 - 2. Section 271323 "Communications Optical Fiber Backbone Cabling" for multi- and single-mode backbone (riser-rated) optical fiber.
 - 3. Section 271513 "Communications Copper Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.
 - 4. Section 271523 "Communications Optical Fiber Horizontal Cabling" for multi- and single-mode horizontal (general use, riser-, and plenum-rated) optical fiber.
 - 5. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cabling between master control units and field-mounted devices and control units.
 - 6. Section 281600 "Intrusion Detection" for indoor-type intrusion detection devices.
 - 7. Section 282300 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.
- C. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
- D. Monitoring Station: Facility that receives signals and always has personnel in attendance to respond to signals. A central station is a monitoring station that is listed.
- E. Standard Intruder: A person who weighs 100 lb or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.
- F. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

1.2 ACTION SUBMITTALS

- A. Product Data: Components for sensing, detecting, and control.
- B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

ADDED ADDENDUM #1 – JULY 23, 2026

1. Raceway Riser Diagrams: Detail raceway runs required for perimeter security. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
 2. UPS: Sizing calculations.
 3. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
 4. Master Control-Unit Console Layout: Show required artwork and device identification.
 5. Device Address List: Coordinate with final system programming.
 6. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
 7. Details of surge protection.
 8. Sensor detection patterns and adjustment ranges.
- C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Product Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. One spare control-unit board(s) for strain-sensitive cable system and [one] cable repair and splice kit(s).
 2. One of each spare sensor and PIR unit and [one] alignment telescope(s) for long-range PIR system.
 3. Fuses: Three of each kind and size.
 4. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
 5. Security Fasteners: Furnish no fewer than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

ADDED ADDENDUM #1 – JULY 23, 2026

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings by a Technician.
4. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
5. Testing Supervisor: Currently certified by BICSI as a Technician to supervise on-site testing.

B. Testing Agency Qualifications: Certified by BICSI.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to 4000 feet.
2. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick.
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of perimeter security devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Description: Perimeter protection system with fence-mounted systems, buried sensors, and/or volumetric detectors integrated into a single perimeter detection and alarm system.
- B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
 - 1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
 - 2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
 - 3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.
- C. System Control: Master control unit shall directly monitor gate detection devices, perimeter detection units, and connecting wiring.
- D. System Control: One or more remote, addressable control units operate under control of a master control-unit microcomputer in a multiplexed distributed control system or as part of a network. Control units shall receive programming by multiplexed signal transmission from the associated master control unit and hold data in nonvolatile memory. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
- E. Operator Commands:
 - 1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
 - 2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
 - 3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
 - 4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
 - 5. Protected Zone Test: Initiate operational test of a specific protected zone.
 - 6. System Test: Initiate system-wide operational test.
- F. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
- G. Automatic Control of Related Systems: Alarm or supervisory signals from certain perimeter security devices control the following functions in related systems:
 - 1. Switch selected lights.
 - 2. Open a signal path between certain intercommunication stations.
 - 3. Shift sound system to "listening mode" and open a signal path to certain system speakers.

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4. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
 5. <Insert description of automatic control required>.
- H. Response Time: [Two] <Insert number> seconds between actuation of any alarm and its indication at master control unit.
- I. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, control units, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
- J. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
- K. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.2 SYSTEM COMPONENT REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Control Units, Devices, and Communications to Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.
- C. FM Global Compliance: FM-Approved and -labeled perimeter security devices and equipment.
- D. Comply with NFPA 70.
- E. Perimeter Security Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
- F. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

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- G. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.
- H. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.
- I. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.
- J. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.
- K. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.
- L. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.3 ENCLOSURES

- A. Interior Electronics: NEMA 250, Type 12.
- B. Exterior Electronics: NEMA 250, Type 4X, stainless steel.
- C. Corrosion Resistant: NEMA 250, Type 4X, stainless steel.
- D. Terminal cabinets in handholes and manholes shall be NEMA 250, Type 6, Type 6P.
- E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.4 SECURE AND ACCESS DEVICES

- A. Coordinate with owner for exact requirements based on existing system.
- B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.
- C. Key-Operated Switch: Change protected zone between secure and access conditions.

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2.5 STRAIN-SENSITIVE CABLE

- A. Coordinate with owner for exact requirements based on existing system.
- B. Description: Fence-mounted strain-sensitive, coaxial transducer cable shall monitor chain-link-type and welded-mesh-type fence and generate an alarm when a standard intruder attempts to climb over, cut through, or lift fence fabric.
- C. Environment: Suitable for exterior installation and the following conditions:
 - 1. Ambient Temperatures: Ranging from minus 22 to plus 158 deg F
- D. Transducer Cable:
 - 1. UV-resistant cable furnished by system manufacturer.
 - 2. Suitable for up to 1000 feet of sensor cable per single-zone control unit and up to 2000 feet of sensor cable per dual-zone processor.
 - 3. Sensitivity shall be uniform throughout its entire length, requiring only one variable sensitivity adjustment throughout its entire length.
- E. Control Unit:
 - 1. Field mounted, with tamper switch at control-unit board.
 - 2. Electronic circuitry shall discriminate between acceptable fence movement and intrusion-related disturbances.
 - 3. Sensitivity, count control, and climb-over processors shall be adjustable with a minimum of five individual count-control and climb-over adjustments.
 - 4. Control-unit output shall have adjustable pulse width to adjust the time the alarm relay will activate per detected intrusion attempt.
- F. System Performance:
 - 1. Immune to RFI and EMI environments; interference shall have no effect on normal operational characteristics.
 - 2. Trouble and Tamper: Entire sensor system shall be fully supervised with individually monitored tamper and supervision alarms. Disconnecting, cutting, or shorting of strain-sensitive cable results in supervisory alarm.
 - 3. Intrusion Simulation: Each zone shall have a self-test feature that, when activated by a signal from master control unit will produce an intrusion alarm and verify operation of sensor.

2.6 LONG-RANGE PIR DETECTORS

- A. Coordinate with owner for exact requirements based on existing system.
- B. Description: Volumetric passive infrared detection system.
- C. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
- D. Environment: Suitable for exterior installation and the following conditions:

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1. Ambient Temperatures: Ranging from minus 30 to plus 150 deg F
- E. System Performance: Detect an interruption of dual-infrared light beams that link transmitters and receivers. Generate an alarm when signal is interrupted due to presence of an object that interrupts both beams.
 1. Sensitivity: Field adjustable to allow adjustment of range from 25 to 500 feet generating an alarm within 20 to 50 ms when both beams are interrupted.
 2. Detection system shall adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
 3. Motion Detection: Detect standard-intruder movement at rates from 0.1 to 50 fps.
 4. Supervision: Generate supervisory alarm if any portion of system is tampered with.
 5. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.7 GEOPHONE FENCE DETECTION

- A. Coordinate with owner for exact requirements based on existing system.
- B. Description: Fence-mounted system to detect attempts to cut or climb the protected fence, using geophone sensors that respond to specific shock or vibrations.
- C. Environment: Suitable for exterior installation and the following conditions:
 1. Ambient Temperatures: Ranging from minus 30 to plus 150 deg F
- D. System Performance:
 1. Control Unit: 10 zone capacity for processing geophone generated analog signals. Each zone shall consist of not more than 10 sensors.
 - a. Adjustments: For each zone, provide stepped gain control for sensitivity and switches for geophone signal filters to minimize nuisance alarms. System shall adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
 - b. Trouble Condition Signal: Generate when any zone fails.
 - c. Supervisory Condition Signal: Generate on interference with control-unit operation or when detecting a break-in into an enclosure housing electronics.
 2. Sensors: Fence mounted 20 feet o.c.
 3. Cable for Interconnection of System Components: Shielded, PVC jacketed and armored, as supplied by system manufacturer.
 4. Test each zone simulating an alarm condition. Test by command from master control.

2.8 VIDEO MOTION SENSOR

- A. Coordinate with owner for exact requirements based on existing system.

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- B. Description: Video-surveillance-based detection system.
- C. Device Performance: Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.
 - 1. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
 - 2. Modular design that allows for expansion or modification of number of inputs.
 - 3. Adjustable Controls:
 - a. Number of detection zones.
 - b. Size of detection zones.
 - c. Sensitivity of detection of each protected zone.
 - 4. Mounting: Standard 19-inch rack as described in EIA/ECA 310-E.
- D. Environment: Suitable for installation in interior air-conditioned spaces.

2.9 GATE UNITS

- A. Coordinate with owner for exact requirements based on existing system.
- B. Description: Fence-mounted gate-movement detectors, balanced-magnetic type, and UL listed for outdoor locations. Units shall be designed for mounting on single- or double-leaf swinging or rolling gates and have armored jumper cables between switch and stationary junction box for wiring to master control unit and tamper switches in junction box.
- C. Device Performance: Bias magnet and at least three encapsulated-reed switches that resist compromise from introduction of foreign magnetic fields, with integral overcurrent protective device to limit current to 80 percent of switch capacity.
- D. Remote Test: Simulate movement of actuating magnet from master control unit.

2.10 FIELD-MOUNTED CONTROL UNITS

- A. Field-mounted control units shall include the power supply and detector specific functions, and provide for communications with the master control unit. Control unit shall include read-only resident software needed for startup, a time clock, and all automatic operations. Software shall be downloaded from the master control unit.
- B. Battery Backup: UPS, providing six hours of run time during a power outage, with two-rate automatic battery charger to fully recharge batteries within 12 hours after normal power is restored.
 - 1. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy.
 - 2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.

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- C. Annunciation: Indicate a change in system condition and switching of system or component to backup power.

2.11 MASTER CONTROL UNIT

- A. Coordinate with owner for exact requirements based on existing system.
- B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
 - 1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - 2. Include a real-time clock for time annotation of events on the event recorder.
 - 3. Addressable initiation devices that communicate device identity and status.
 - 4. Control circuits for operation of mechanical equipment in response to an alarm.
- C. Construction: Freestanding equipment rack or Desk-mounted console, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.
- D. Comply with UL 609 UL 681 UL 1076.
- E. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: LCD type, one, two, or three line(s) of 40 or 80 characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands
 - 3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display.
 - 4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
 - 5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
 - a. Acknowledge alarm.
 - b. Silence alarm.
 - c. System reset.

- d. LED test.
 - 6. Timing Unit: Solid state, programmable, 365 days.
 - 7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
 - 8. Alarm Indication: An audible signal sounds and an LED lights at master control unit identifying the protected zone or addressable detector originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
 - 9. Alarm Indication: An audible signal sounds and a plain-language identification of the protected zone or addressable detector originating the alarm appears on LED or LCD display at master control unit. Annunciator panel displays a common alarm light and sounds an audible tone.
 - 10. Alarm Indication: An audible signal sounds and a plain-language identification of the protected zone or addressable detector originating the alarm appears on LED, LCD or cathode-ray-tube display at master control unit. Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.
 - 11. Alarm activation sounds a bell, siren, strobe bell, or siren and strobe. Coordinate with Owner for exact requirements.
 - F. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.
 - G. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.
 - H. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS shall be sized to provide a minimum of six hours of master control-unit operation.
 - I. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify, with permanent labels, individual components and modules within cabinets.
 - J. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
- 2.12 AUDIBLE AND VISUAL ALARM DEVICES
- A. Coordinate with owner for exact requirements based on existing system.
 - B. Bell: 10 inches in diameter, rated to produce a minimum sound output of 84 dB at 10 feet from master control unit.
 - 1. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

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- C. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet, plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on, five minutes off.
 - 1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.
- D. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet from master control unit.
 - 1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.
- E. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
 - 1. Light Output: 115 cd, minimum.
 - 2. Flash Rate: 60 per minute.

2.13 SECURITY FASTENERS

- A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
- B. Coordinate with owner for exact requirements based on existing system.
- C. Drive System Types: Pinned Torx-Plus, pinned Torx, or pinned hex (Allen).
- D. Socket Flat Countersunk Head Fasteners:
 - 1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
 - 2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
- E. Socket Button Head Fasteners:
 - 1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
 - 2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
- F. Socket Head Cap Fasteners:
 - 1. Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
 - 2. Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
- G. Protective Coatings for Heat-Treated Alloy Steel:
 - 1. Zinc chromate, ASTM F 1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
 - 2. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

3.1 SYSTEM INSTALLATION

- A. Comply with UL 681 and NFPA 731.
- B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."
- C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."
- D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.
 - 2. Connect new equipment to existing monitoring equipment at the Supervising Station.
 - 3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- E. Security Fasteners: Where accessible to public, install perimeter security components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.
- F. Wiring Method: Install power, signal, and data transmission wire and cable in metal raceways according to Section 270543 "Underground Pathways and Structures for Communications Systems" and Section 270528 "Pathways for Communications Systems." Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with perimeter security system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- H. Wires and Cables:

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1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
 2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
 3. Cable for Low-Voltage Control and Signal Circuits: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 280513 "Conductors and Cables for Electronic Safety and Security."
 4. Data and Television Signal Transmission Cables: Install according to Section 280513 "Conductors and Cables for Electronic Safety and Security."
-
- I. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
 - J. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
 - K. Stain-Sensitive Transducer Cable: Attached to fence at 12-inch intervals with tie wraps.

3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 270553 "Identification for Communications Systems."
- B. Install instructions frame in a location visible from master control unit.

3.3 GROUNDING

- A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
- B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
- D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 270526 "Grounding and Bonding for Communications Systems."

3.4 FIELD QUALITY CONTROL

- A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones

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and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Perimeter security systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
3. Geophone System Tests: Test each zone at a minimum of two different locations. Test each zone as follows:
 - a. Horizontal Movement: Adjust sensitivity to screen out alarms from wind.
 - b. Vertical Climb: 100 percent detection required. Set count at three occurrences within 90-second window.
 - c. Cut Test: 100 percent detection required. Set count at two occurrences within 120-second window.
 - d. Set sensitivity to value as low as possible, consistent with reliable detection.
 - e. If performance tests fail, make adjustments to sensors to comply with requirements. Retest failing and adjacent zones to comply with test.
4. Strain-Sensitive Cable System Tests: Adjust sensitivity and count control to value as low as possible, consistent with reliable detection.
5. Long-Range PIR System Tests: Adjust sensitivity and hold time between activity duration to value as low as possible, consistent with reliable detection.

D. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

E. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the perimeter security system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 281643

SECTION 282000 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.
- B. Related Requirements:
 - 1. Section 281300 "Access Control System Software and Database Management" to integrate access control system interface and control.
 - 2. Section 283100 "Intrusion Detection" to integrate video surveillance used for intrusion detection.
 - 3. Section 283121 "Area and Perimeter Intrusion Detection" to integrate video surveillance used for intrusion detection.
 - 4. Section 285121 "Detention Monitoring and Control Systems" to integrate video surveillance with detention monitoring interface and control.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
 - 3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
 - 4. UPS: Sizing calculations.
 - 5. Wiring Diagrams: For power, signal, and control wiring.
- C. Design Data: Include equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For video surveillance, cameras, camera-supporting equipment, 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. Dimensioned Outline Drawings of Equipment Unit: 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.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 2. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
 3. Interior, Uncontrolled Environment: System components installed in non-air-conditioned temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R, Type 4, Type 12, Type 12K enclosures.
 4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph [and snow cover up to 24 inches thick]. Use NEMA 250, Type 3, Type 3R, Type 3S, Type 4, Type 4X enclosures.
 5. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.
- B. Surge Protection: Protect components from voltage surges entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
 - 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
- C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. 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 and the unit will be fully operational after the seismic event."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NECA 1.
- D. Comply with NFPA 70.
- E. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.3 STANDARD CAMERAS

- A. Manufacturers:
 - 1. Coordinate with owner for exact camera specifications to match existing system.

B. Color Camera:

1. Comply with UL 639.
2. Pickup Device: CCD interline transfer, 380,000 771(H) by 492(V) pixels.
3. Horizontal Resolution: 480 lines.
4. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
5. With AGC, manually selectable on or off.
6. Sensitivity: Camera shall provide usable images in low-light conditions.
7. Sensitivity: Camera shall deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test shall be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.
8. Manually selectable modes for backlight compensation or normal lighting.
9. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
10. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
11. Motion Detector: Built-in digital.

C. Automatic Color Dome Camera: Assembled and tested as a manufactured unit, containing dome assembly, color camera, motorized pan and tilt, zoom lens, and receiver/driver.

1. Comply with UL 639.
2. Pickup Device: CCD interline transfer, 380,000 768(H) by 494(V) pixels.
3. Horizontal Resolution: 480 lines.
4. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
5. With AGC, manually selectable on or off.
6. Sensitivity: Camera shall provide usable images in low-light conditions.
7. Sensitivity: Camera shall deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test shall be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.
8. Manually selectable modes for backlight compensation or normal lighting.
9. Pan and Tilt: Direct-drive motor, 360-degree rotation angle, and 180-degree tilt angle. Pan-and-tilt speed shall be controlled by operator. Movement from preset positions shall be not less than 300 degrees per second.
10. Preset Positioning: Eight user-definable scenes, each allowing 16-character titles. Controls shall include the following:
 - a. In "sequence mode," camera shall continuously sequence through preset positions, with dwell time and sequencing under operator control.
 - b. Motion detection shall be available at each camera position.
 - c. Up to four preset positions may be selected to be activated by an alarm. Each of the alarm positions may be programmed to output a response signal.
11. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
12. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
13. Motion Detector: Built-in digital.
14. Dome shall support multiplexed control communications using coaxial cable recommended by manufacturer.

2.4 LENSES

- A. Coordinate with owner for exact lens requirements based on existing system.
- B. Description: Optical-quality coated lens, designed specifically for video-surveillance applications and matched to specified camera. Provide color-corrected lenses.
 - 1. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
 - 2. Fixed Lens: With calibrated focus ring.
 - 3. Zoom Lens: Motorized, remote-controlled unit, rated as "quiet operating." Features include the following:
 - a. Electrical Leads: Filtered to minimize video signal interference.
 - b. Motor Speed: Variable.
 - c. Lens shall be available with preset positioning capability to recall the position of specific scenes.

2.5 POWER SUPPLIES

- A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera and lens.
 - 1. Enclosure: NEMA 250, Type 1, Type 3, Type 4X.

2.6 CAMERA-SUPPORTING EQUIPMENT

- A. Coordinate with owner for exact requirements based on existing system.
- B. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
- C. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.
 - 1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
 - 2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
 - 3. Speed: 12 degrees per second in both horizontal and vertical planes.
 - 4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
 - 5. Built-in encoders or potentiometers for position feedback[, **and thermostat-controlled heater**].
 - 6. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.
- D. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

- E. Protective Housings for Fixed and Movable Cameras: Steel or 6061 T6 aluminum enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
 - 1. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit shall identify tamper alarms and indicate location in alarm display. Tamper switches and central-control unit are specified in Section 283100 "Intrusion Detection."
 - 2. Camera Viewing Window: Polycarbonate Lexan window, aligned with camera lens.
 - 3. Duplex Receptacle: Internally mounted.
 - 4. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
 - 5. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
 - 6. Sun shield shall not interfere with normal airflow around the housing.
 - 7. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
 - 8. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
 - 9. Enclosure Rating: NEMA 3R, NEMA 4X
- F. Coordinate with owner for exact requirements based on existing system.
- G. Screen Size (Diagonal Dimension: Match existing.
- H. Horizontal Resolution:
- I. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, contrast, color, and tint controls.
- J. Degaussing: Automatic.
- K. Mounting: Single, 14-inch Dual, 9-inch, vertical, EIA 19-inch electronic equipment rack or cabinet complying with CEA 310-E. Match existing.
- L. Electrical: 120-V ac, 60 Hz.

2.7 DIGITAL VIDEO RECORDERS

- A. Coordinate with owner for exact requirements based on existing system.
- B. Description: Digital, time-lapse type, full-frame and motion recorder, with removable hard drive.
 - 1. Recording Time: 400 hours minimum.
 - 2. Resolution: 720 by 480 lines, minimum.
 - 3. Programming shall be from trackball and push buttons on face of the recorder, settings shall be displayed on any video monitor connected to the recorder. Programming shall include the following:

- a. Motion analysis graph.
 - b. Password protection.
 - c. Alarm and timer controls.
 - d. Continuous recording option.
 - e. Time-lapse operating modes.
 - f. Search video by time, event, or motion.
4. Programming: SmartMedia card for software updating, image archiving, and image transfer to a PC.
5. Storage: 80-GB, removable hard drive. Software shall permit hot-swapping drives.
6. Compression: MPEG-2.
7. Time and Date Generator: Records time (hr:min:sec) and date legend of each frame.
8. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
9. Mounting: Standard 19-inch rack complying with CEA 310-E, or freestanding desktop.

2.8 NETWORK VIDEO RECORDERS

- A. Coordinate with owner for exact requirements based on existing system.
- B. External storage or internal 250-1, 500-GB hard disk drive.
 1. Video and audio recording over TCP/IP network.
 2. Video recording of MPEG-2 and MPEG-4 streams.
 3. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
 4. Duplex Operation: Simultaneous recording and playback.
 5. Continuous and alarm-based recording.
 6. Full-Featured Search Capabilities: Search based on camera, time, or date.
 7. Automatic data replenishment to ensure recording even if network is down.
 8. Digital certification by watermarking.
 9. Internal RAID storage or non-RAID storage of up to 1500 GB.
 10. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
 11. Full integration with LAN, Intranet, or Internet through standard Web browser or video management software.
 12. Integrated Web server FTP server functionality.
 13. Supports up to 16 devices.

2.9 DIGITAL SWITCHERS

- A. Coordinate with owner for exact requirements based on existing system.
- B. Quad Switch: For displaying images from four cameras on a single monitor. Provide color switcher.
 1. Controls: Unit-mounted front panel.
 2. Resolution: 720 by 480 lines.

3. Modes: Auto, manual, and alarm. In manual mode, each channel can also be viewed in single display mode. In the event of an alarm, alarming channel shall automatically switch to full screen. If several alarms are activated, channels in alarm shall be in auto-switching mode.
 4. Channel Loss Alarm: Audible buzzer; occurrence details shall be recorded.
 5. Time: Indicate date and time.
 6. Timing of Auto-Switcher: 1 to 30 seconds, selectable.
 7. Mounting: Standard 19-inch rack complying with CEA 310-E, or freestanding desktop.
- C. Manual Switch Bank: Low-loss, high-isolation, multiple-video switch to allow manual switching of multiple quad switches and cameras to a single output. Switches shall be illuminated.
- D. Sequential Switchers: Automatically sequence outputs of multiple cameras to single monitor.
1. Switching Time Interval: Continuously adjustable, 5 to 20 seconds minimum, with manual override.
 2. Skip-Sequential-Hold Switch: One for each camera, with LED to indicate active camera.
 3. Camera Identification Legend: Either on-screen message or label at skip-sequential switch.
 4. Alarm Switching: In the event of an alarm, alarming channel shall automatically switch the monitor to full screen.
 5. Mounting: Standard 19-inch rack complying with CEA 310-E.
- E. PTZ Controls: Arranged for multiple-camera control, with switches to select camera to be controlled.
1. Pan-and-Tilt Control: Joystick type.
 2. Zoom Control: Momentary-contact, "in-out" push button.
 3. Automatic-Scan Control: A push button for each camera with pan capability that places camera in automatic-scanning mode.

2.10 IP VIDEO SYSTEMS

- A. Coordinate with owner for exact requirements based on existing system.
- B. Description:
1. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
 2. System shall have seamless integration of all video surveillance and control functions.
 3. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
 4. System design shall include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit shall provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.

5. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
6. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
7. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
8. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.

2.11 VIDEO MOTION SENSORS (INTERIOR)

- A. Coordinate with owner for exact requirements based on existing system.
- B. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs shall be composite video as defined in SMPTE 170M. Provide an alarm output for each video input.
 1. Detect movement within protected zone of intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of two. Reject all other changes in video signal.
 2. Modular design that allows for expansion or modification of number of inputs.
 3. Controls:
 - a. Size of detection zones.
 - b. Sensitivity of detection of each protected zone.
 4. Mounting: Standard 19-inch rack complying with CEA 310-E.

2.12 CONTROL STATIONS

- A. Coordinate with owner for exact requirements based on existing system.
- B. Description: Heavy-duty, freestanding, modular, metal furniture units arranged to house electronic equipment. Coordinate component arrangement and wiring with components and wiring of other systems.
- C. Equipment Mounting: Standard 19-inch rack complying with CEA 310-E.
- D. Normal System Power Supply: 120 V, 60 Hz, through a locked disconnect device and an isolation transformer in central-station control unit. Central-station control unit shall supply power to all components connected to it unless otherwise indicated.
- E. Power Continuity for Control Station: Batteries in power supplies of central-station control units and individual system components shall maintain continuous system operation during outages of both normal and backup ac system supply.
 1. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portions of system served

- including audible trouble signal devices for up to four hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
- 2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.

- F. Annunciation: Indicate change in system condition and switching of system or component to backup power.

2.13 SIGNAL TRANSMISSION COMPONENTS

- A. Cable: Coaxial cable elements have 75-ohm nominal impedance. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Video Surveillance Coaxial Cable Connectors: BNC type, 75 ohms. Comply with requirements in Section 2260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 WIRING

- A. Comply with requirements in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Install cables in raceways unless otherwise indicated.
 - 1. Except raceways are not required in accessible indoor ceiling spaces and attics.
 - 2. Except raceways are not required in hollow gypsum board partitions.
 - 3. Conceal raceways and wiring except in unfinished spaces.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- E. For communication wiring, comply with the following:
 - 1. Section 271313 "Communications Copper Backbone Cabling."
 - 2. Section 271323 "Communications Optical Fiber Backbone Cabling."
 - 3. Section 271333 "Communications Coaxial Backbone Cabling."
 - 4. Section 271513 "Communications Copper Horizontal Cabling."
 - 5. Section 271523 "Communications Optical Fiber Horizontal Cabling."
 - 6. Section 271533 "Communications Coaxial Horizontal Cabling."

- F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.2 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras with 84-inch- minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- B. Set pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
- C. Avoid ground loops by making ground connections only at the control station.
 - 1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.
- D. Identify system components, wiring, cabling, and terminals according to Section 270553 "Identification for Communications Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
 - a. Verify operation of auto-iris lenses.
 - b. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
 - c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 - d. Set and name all preset positions; consult Owner's personnel.
 - e. Set sensitivity of motion detection.
 - f. Connect and verify responses to alarms.
 - g. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
 4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation.
- C. Video surveillance system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

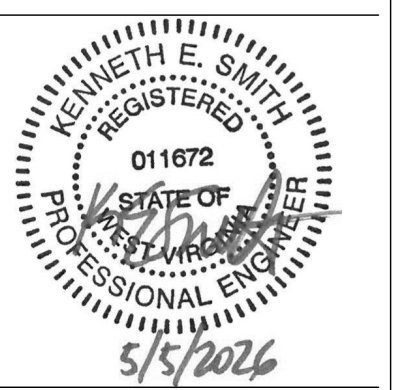
3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

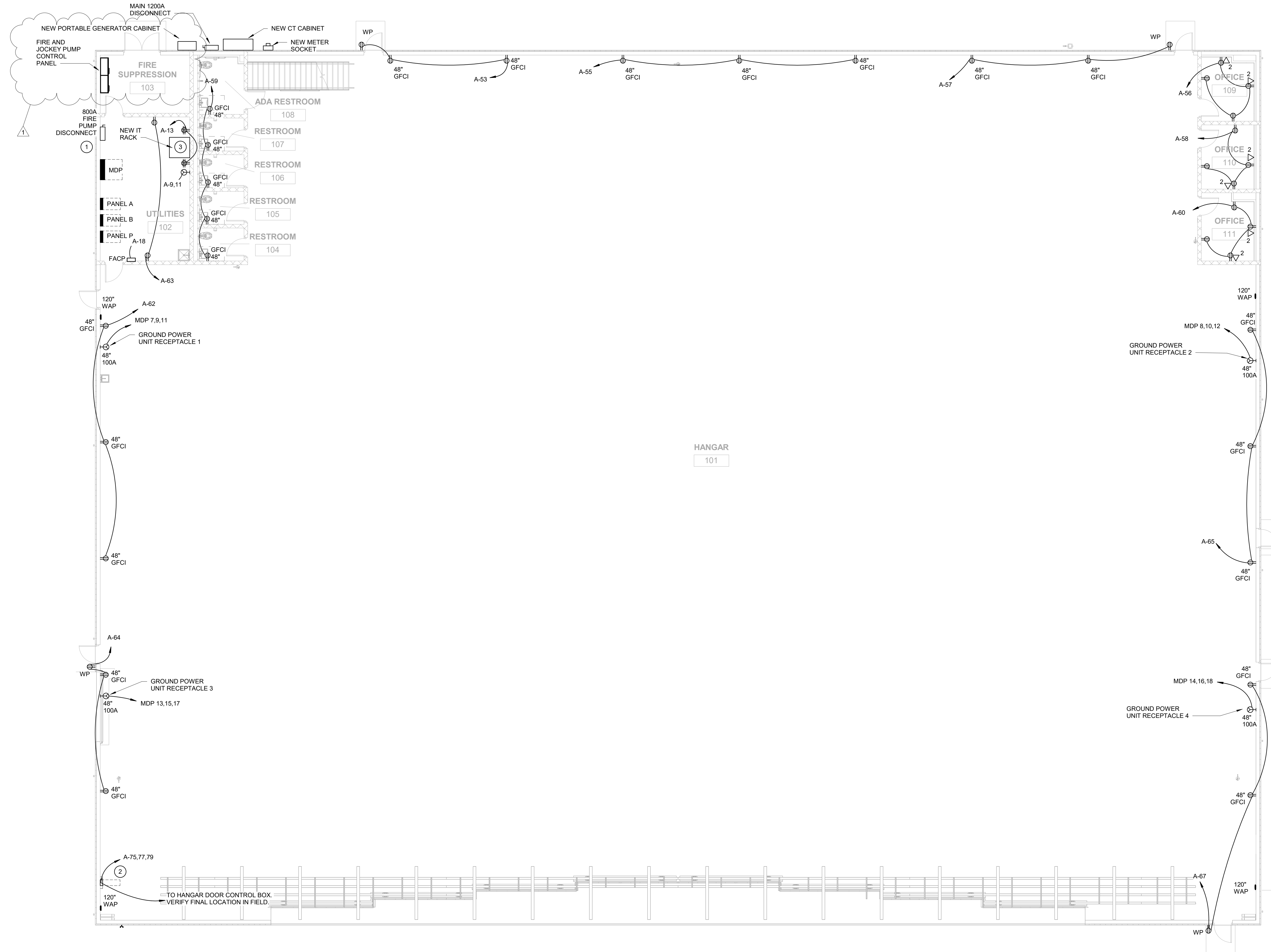
END OF SECTION 282000

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HANGAR - POWER KEYNOTES	
NUMBER	DESCRIPTION
1	SEE ELECTRICAL Riser ON E6.02 FOR MORE INFORMATION.
2	60A, 3 POLE, 208V FUSED @ 40A.
3	COORDINATE WITH OWNER'S IT TEAM FOR PROPERLY CONNECTING THE NEW HANGAR TO A SECURITY SYSTEMS TO OWNERS IT NETWORK. PROVIDE ALL EQUIPMENT AS REQUIRED FOR A COMPLETE FUNCTIONING SYSTEM.



HANGAR - POWER
1/8" = 1'-0"

[illegible]

MARSHALL UNIVERSITY
BILL NOE FLIGHT SCHOOL - NEW HANGAR AND CLASSROOMS
YEAGER AIRPORT
MAY 28, 2026
BIDDING DOCUMENTS

DRAWN: CLW DATE: 04/20/26
 APPROVED: TTG DATE: 04/20/26
 PROJECT No. _____

HANGAR - POWER

EET No.

E2.01R

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HANGAR - SYSTEMS KEYNOTES	
NUMBER	DESCRIPTION
1	WIRING DETAILS LOCATED ON E6.03.

HANGAR - SYSTEMS
1/8" = 1'-0"

[illegible]

MARSHALL UNIVERSITY
BILL NOE FLIGHT SCHOOL - NEW HANGAR AND CLASSROOMS
YEAGER AIRPORT
MAY 28, 2026
BIDDING DOCUMENTS

AWN: CLW DATE: 04/20/28
 APPROVED: Approver DATE: 04/20/28
 OBJECT No. _____

HANGAR - SYSTEMS

EET No.
E5.01R

USER: CLW

LAYOUT TAB: PANEL SCHEDULES
CAD FILE: _xref.dwg
PLOT DATE/TIME: 2026-05-28 09:29 AM
MARSHALL UNIVERSITY LIGHT SCHOOL HANGER 1E7-4

Panel: MDP																
X NEMA-1 NEMA-3R NEMA-4X Stainless Steel																
Location: UTILITIES 102																
120/208 Volts, 3 Phase, 4 Wire																
Main Lug Only										X Main Breaker						
Bus Rating: 1200 Amps										Main Breaker: 1200 Amps						
Minimum Interrupting Capacity:										22,000 Amps Sym.						
Flush Mount										X Surface Mount						
Provide if checked:										X PHASE MONITOR						
X Equipment Ground Bus										X SURGE PROTECTION DEVICE						
Sub-Feed Lugs										X SHUNT TRIP BREAKER						
Serving	Load (Watts)	Cond. Size 2	Wire Size 1	C/B Trip Amps	Cir. No.	Key Notes	A	B	C	Key Notes	Cir. No.	C/B Trip Amps	Wire Size 1	Cond. Size 2	Load (Watts)	Serving
HANGAR PANEL A	27528	4"	600 MCM	3P/400A	1	11	X			12	2	3P/225A	4/0	2 1/2"	20000	NEW SMALL CLASS
	27528				3			X			4				20000	
	27528				5				X		6				20000	
RECEPTACLE GROUND POWER UNIT 1	9600	2"	#1	3P/100A	7	10	X			10	8	3P/100A	#1	2"	9600	RECEPTACLE GROUND POWER UNIT 2
	9600				9			X			10				9600	
	9600				11				X		12				9600	
RECEPTACLE GROUND POWER UNIT 3	9600	2"	#1	3P/100A	13	10	X			10	14	3P/100A	#1	2"	9600	RECEPTACLE GROUND POWER UNIT 4
	9600				15			X			16				9600	
	9600				17				X		18				9600	
HANGAR PANEL B	20000	2 1/2"	4/0	3P/225A	19	13	X			12	20	3P/225A	4/0	2 1/2"	20000	POOL PANEL P
	20000				21			X			22				20000	
	20000				23				X		24				20000	
SPACE					25	5	X			SEE NOTE	26	3P/1200	600 MCM	4"		PORTABLE GENERATOR CABINET
					27			X			28					
					29				X		30					
Total Load-Odd Circuit (Watts)	200184	1. All wire size: #12 AWG minimum except as noted. 9. Breaker lock-on clip. 2. All conduit size: 3/4 inch minimum except as noted. 10. #8 Ground.										177600				Total Load-Even Circuit (Watts)
Total Load-Panel (Watts)	377784	3. Ground fault interrupting circuit breaker. 11.#3 Ground. 4. Spare circuit breaker. 12. New panel for future work.										1049.9				Total Connected Full Load Amps
		5. Space only. 13. #4 Ground.										1312.3				Total Derated Connected Full Load Amps
		6. Shunt-trip circuit breaker.														
		7. Arc-fault circuit breaker.														
		8. Solenoid operated circuit breaker.														
NOTE: PROVIDE KIRK-KEY INTERLOCK SYSTEM ON MAIN CIRCUIT BREAKER AND PORTABLE GENERATOR CABINET CIRCUIT BREAKER TO PREVENT PARALLEL OPERATION BETWEEN THE TWO SOURCES.																

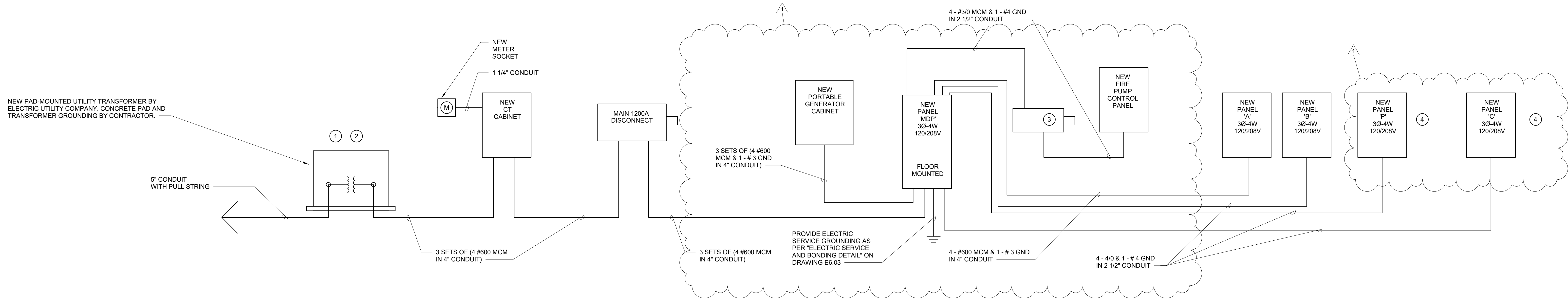
		Panel: B															
		X NEMA-1				NEMA-3R				NEMA-4X Stainless Steel							
		Location: UTILITIES 102															
		120/208				Volts,		3		Phase,				4		Wire	
		Main Lug Only						x		Main Breaker							
		Bus Rating:				Amps		Minimum Interrupting Capacity:				22,000		Amps Sym.			
		Flush Mount						X		Surface Mount							
		Provide if checked:								Isolated Ground Bus							
		X				Equipment Ground Bus				X				SURGE PROTECTION DEVICE			
						Sub-Feed Lugs								Through-Feed Lugs			
Serving	Load (Watts)	Cond. Size 2	Wire Size 1	C/B Trip Amps	Cir. No.	Key Notes	A	B	C	Key Notes	Cir. No.	C/B Trip Amps	Wire Size 1	Cond. Size 2	Load (Watts)	Serving	
			1P/20A	1	4	X				4	2	1P/20A					
			1P/20A	3	4			X		4	4	1P/20A					
			1P/20A	5	4				X	4	6	1P/20A					
			1P/20A	7	4	X				4	8	1P/20A					
			1P/20A	9	4			X		4	10	1P/20A					
			1P/20A	11	4				X	4	12	1P/20A					
			1P/20A	13	4	X				4	14	1P/20A					
			1P/20A	15	4			X		4	16	1P/20A					
			1P/20A	17	4				X	4	18	1P/20A					
			1P/20A	19	4	X				4	20	1P/20A					
			1P/20A	21	4			X		4	22	1P/20A					
			1P/20A	23	4				X	4	24	1P/20A					
			1P/20A	25	4	X				4	26	1P/20A					
			1P/20A	27	4			X		4	28	1P/20A					
			1P/20A	29	4				X	4	30	1P/20A					
			1P/20A	31	4	X				4	32	1P/20A					
			1P/20A	33	4			X		4	34	1P/20A					
			1P/20A	35	4				X	4	36	1P/20A					
			1P/20A	37	4	X				4	38	1P/20A					
			1P/20A	39	4			X		4	40	1P/20A					
			1P/20A	41	4				X	4	42	1P/20A					
Total Load-Odd Circuit (Watts)	0	1. All wire size: #12 AWG minimum except as noted. 2. All conduit size: 3/4 inch minimum except as noted. 9. Breaker lock-on clip.														0	Total Load-Even Circuit (Watts)
Total Load-Panel (Watts)	0	3. Ground fault interrupting circuit breaker. 4. Spare circuit breaker. 5. Space only. 6. Shunt-trip circuit breaker. 7. Arc-fault circuit breaker. 8. Solenoid operated circuit breaker.														0.0	Total Connected Full Load Amps
																0.0	Total Derated Connected Full Load Amps

		Panel: A															
		X NEMA-1 NEMA-3R NEMA-4X Stainless Steel															
		Location: UTILITIES 102															
		120/208 Volts, 3 Phase, 4 Wire															
		Main Lug Only X Main Breaker															
		Bus Rating: 400 Amps Main Breaker: 400 Amps															
		Minimum Interrupting Capacity: 22,000 Amps Sym.															
		Flush Mount X Surface Mount															
		Provide if checked: Isolated Ground Bus															
		X Equipment Ground Bus X SURGE PROTECTION DEVICE															
		Sub-Feed Lugs Through-Feed Lugs															
Serving	Load (Watts)	Cond. Size 2	Wire Size 1	C/B Trip Amps	Cir. No.	Key Notes	A	B	C	Key Notes	Cir. No.	C/B Trip Amps	Wire Size 1	Cond. Size 2	Load (Watts)	Serving	
CF-1	728	3/4"	#10	2P/15A	1			X			2	2P/15A	#12	3/4"	728	CF-2	
	728				3		X	4	728								
CF-3	728	3/4"	#10	2P/15A	5				X		6	2P/15A	#12	3/4"	728	CF-4	
	728				7		X	8	728								
UPS	1400	3/4"	#10	2P/30A	9			X			10	2P/30A	#10	3/4"	2250	EWH-1	
	1400				11			X	12	2250							
RECEPT - 102	1140	3/4"	#12	1P/20A	13		X				14	1P/20A	#12	3/4"	1392	VACUUM PUMP VP1	
VACUUM PUMP VP2	1152	3/4"	#12	1P/20A	15			X			16	1P/20A	#12	3/4"	1392	VACUUM PUMP VP3	
VACUUM PUMP VP4	1152	3/4"	#12	1P/20A	17				X	9	18	1P/20A	#12	3/4"	1000	FACP	
EH-1	750	3/4"	#12	2P/20A	19		X				20	2P/20A	#12	3/4"	750	EH-2	
	750				21		X	22	750								
EH-3	375	3/4"	#12	2P/20A	23			X			24	2P/20A	#12	3/4"	375	EH-4	
	375				25		X	26	375								
EH5	375	3/4"	#12	2P/20A	27				X		28	2P/20A	#12	3/4"	375	EH-6	
	375				29			X	30	375							
EH-7	375	3/4"	#12	2P/20A	31		X				32	2P/20A	#12	3/4"	250	EF-1	
	375				33		X	34	250								
EF-3	57	3/4"	#12	1P/20A	35		X				36	2P/20A	#12	3/4"	13	EF-2	
EF-4	1622	3/4"	#10	2P/25A	37			X			38	2P/20A	#12	3/4"	13		EF-5
	1622				39		X	40	1622								
EF-6	1622	3/4"	#10	2P/25A	41				X		42	2P/25A	#10	3/4"	1622	EF-7	
	1622				43		X	44	1622								
				1P/20A	45	4		X			46	2P/25A	#10	3/4"	1622	HP-2	
				1P/20A	47	4		X	48	1622							
HP-1	1560	3/4"	#12	2P/20A	49		X				50	2P/20A	#12	3/4"	1560	HP-3	
	1560				51		X	52	1560								
RECEPT - HANGAR 101 END	540	3/4"	#12	1P/20A	53				X		54	1P/20A	#12	3/4"	720	RECEPT - OFFICE 109	
RECEPT - HANGAR 101 END	540	3/4"	#12	1P/20A	55		X				56	1P/20A	#12	3/4"	720	RECEPT - OFFICE 110	
RECEPT - HANGAR 101 END	540	3/4"	#12	1P/20A	57			X			58	1P/20A	#12	3/4"	720	RECEPT - OFFICE 111	
RECEPT - RESTROOMS	900	3/4"	#12	1P/20A	59		X				60	1P/20A	#12	3/4"	720	RECEPT - HANGAR 101	
RECEPT - 102	360	3/4"	#12	1P/20A	61		X				62	1P/20A	#12	3/4"	540	RECEPT - HANGAR 101	
RECEPT - HANGAR 101	540	3/4"	#12	1P/20A	63			X			64	1P/20A	#12	3/4"	540	RECEPT - HANGAR 101	
RECEPT - HANGAR 101	540	3/4"	#12	1P/20A	65				X	10	66	1P/20A	#12	3/4"	100	BYPASS VALVE OILWATER SEP	
MARSHALL LIGHT SIGN 1	1560	3/4"	#10	2P/20A	67		X				68	1P/20A	#12	3/4"	500	CONTROLLER FOR CF-1,CF-3	
CONTROLLER - IH-3.4.5	500	3/4"	#12	1P/20A	71			X			70	1P/20A	#12	3/4"	500	CONTROLLER FOR CF-2,CF-4	
CONTROLLER - IH-1.2,11,12	500	3/4"	#12	1P/20A	73		X				74	1P/20A	#12	3/4"	500	CONTROLLER - IH-8.9,10	
HANGAR DOOR	4800	1 1/4"	#6	3P/40A	75			X			76	1P/20A	#12	3/4"	107	EXIT SIGNS AND EM LIGHTS	
	4800				77			X	78	2P/20A	#10	3/4"	1560	MARSHALL LIGHT SIGN 2			
	4800				79		X	80									
LCP	11748	2"	#1/0	2P/150A	81			X			82	2P/15A	#12	3/4"	858	MAU-1	
	11748				83			X	84	858							
Total Load-Odd Circuit (Watts)	69547	1. All wire size: #12 AVG minimum except as noted. 9. Breaker lock-on clip.														37733	Total Load-Even Circuit (Watts)
Total Load-Panel (Watts)	106280	2. All conduit size: 3/4 inch minimum except as noted. 10. Coordinate location with Plumbing Drawings.														295.4	Total Connected Full Load Amps
		3. Ground fault interrupting circuit breaker.															Total Derated Connected Full Load Amps
		4. Spare circuit breaker.															
		5. Space only.															
		6. Shunt-trip circuit breaker.															
		7. Arc-fault circuit breaker.															
		8. Solenoid operated circuit breaker.															

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ELECTRICAL RISER KEYNOTES	
NUMBER	DESCRIPTION
1	COORDINATE ALL NEW ELECTRIC SERVICE WORK WITH THE ELECTRICAL UTILITY COMPANY PRIOR TO THE INSTALLATION OF ANY EQUIPMENT.
2	PROVIDE A COMPLETE GROUNDING SYSTEM IN ACCORDANCE WITH ARTICLE 250 OF THE NEC.
3	NON FUSED FIRE PUMP CONTROL PANEL DISCONNECT MUST BE SIZED FOR THE FIRE PUMP LOCKED ROTOR AMPS, TYPICALLY 800A, 208V 3 PHASE. POWER SHALL BE FED FROM THE LINE SIDE OF THE MDP.
4	PANEL TO BE PART OF FUTURE PHASE OF PROJECT. SHOWN HERE FOR REFERENCE ONLY.



ELECTRICAL RISER
NOT TO SCALE

[illegible]

MARSHALL UNIVERSITY
LIGHT SCHOOL - NEW HANGAR AND CLASSROOMS

YEAGER AIRPORT
MAY 28, 2026
BIDDING DOCUMENTS

DRAWN: CLW DATE: 04/20/26
 APPROVED: TTG DATE: 04/20/26
 PROJECT No. _____

ELECTRICAL RISER

EET No.

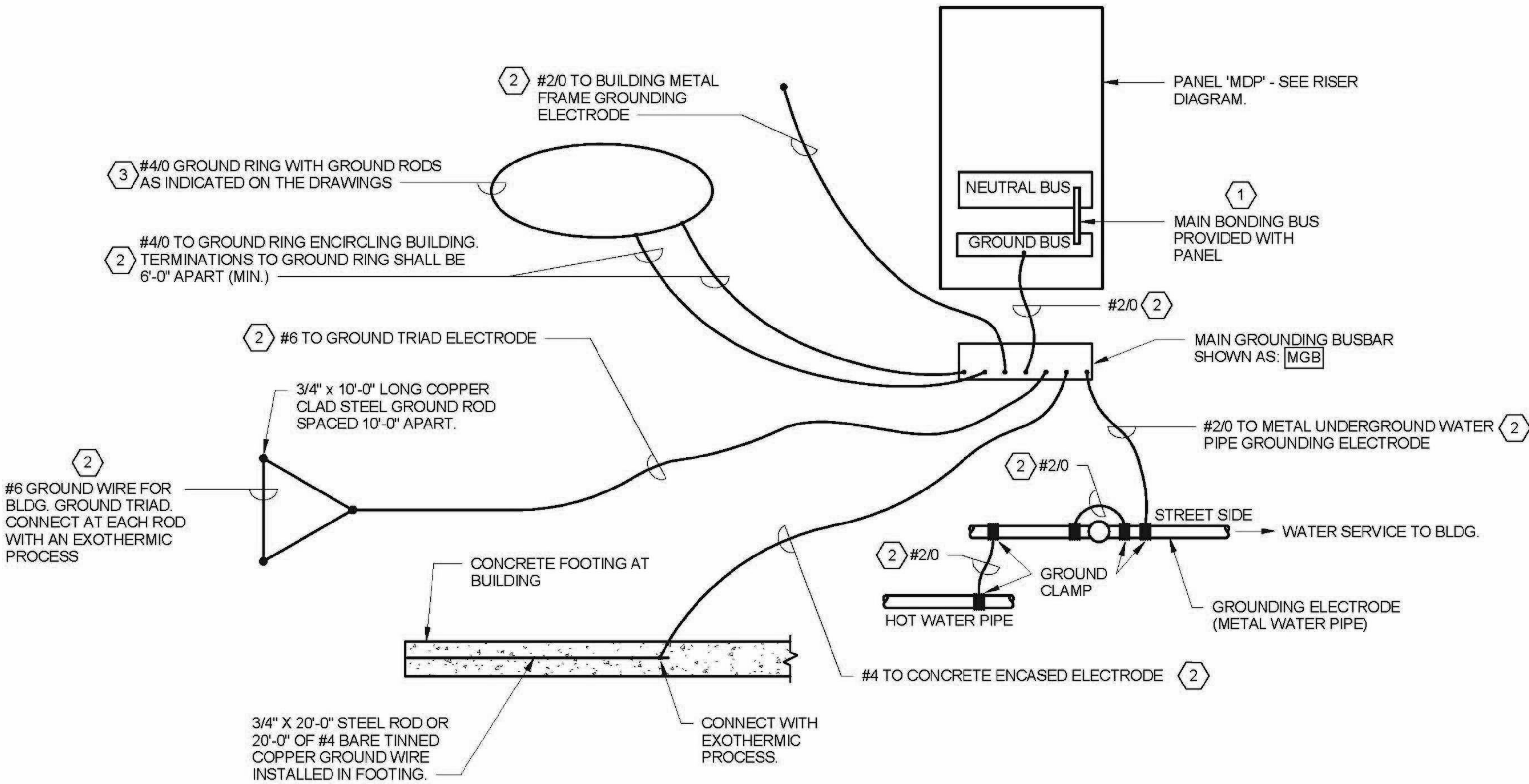
E6.02R

GROUNDING KEYED NOTES:

1. VERIFY EXACT GROUNDING TERMINATION LOCATIONS IN FIELD PRIOR TO INSTALLATION.
2. PROVIDE A COMPLETE GROUNDING SYSTEM IN ACCORDANCE WITH ARTICLE 250 OF THE NEC.

GROUNDING KEYED NOTES:

- 1 THE NEUTRAL / GROUND BOND BUS SHALL BE PROVIDED WITH PANEL. THE ELECTRICAL CONTRACTOR SHALL VERIFY THAT BOND BUS IS INSTALLED PRIOR TO ACCEPTING PANEL.
- 2 ALL GROUND WIRES SHALL BE STRANDED, BARE TINNED, COPPER, CONNECTED AT MAIN GROUNDING BUSBAR WITH TWO HOLE, LONG BARREL, COMPRESSION LUGS WITH VIEWPORT. CONNECT AT GROUND TRIAD, ETC. AS CALLED FOR ON DETAIL (THIS DRAWING).
- 3 LIGHTNING PROTECTION SYSTEM DOWN CONDUCTORS SHALL BE BONDED TO BUILDING'S GROUNDING ELECTRODE SYSTEM

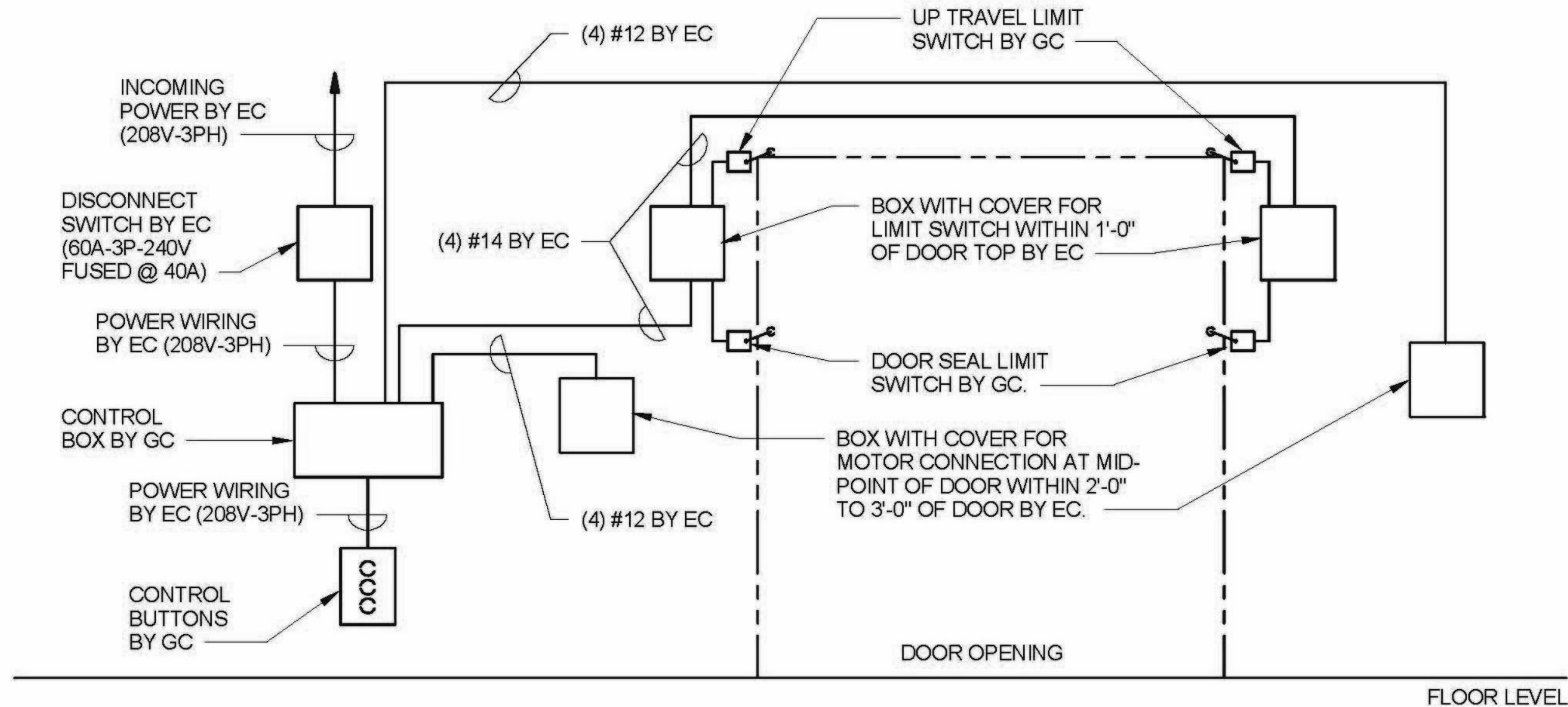


ELECTRIC SERVICE GROUNDING AND BONDING DETAIL

NTS

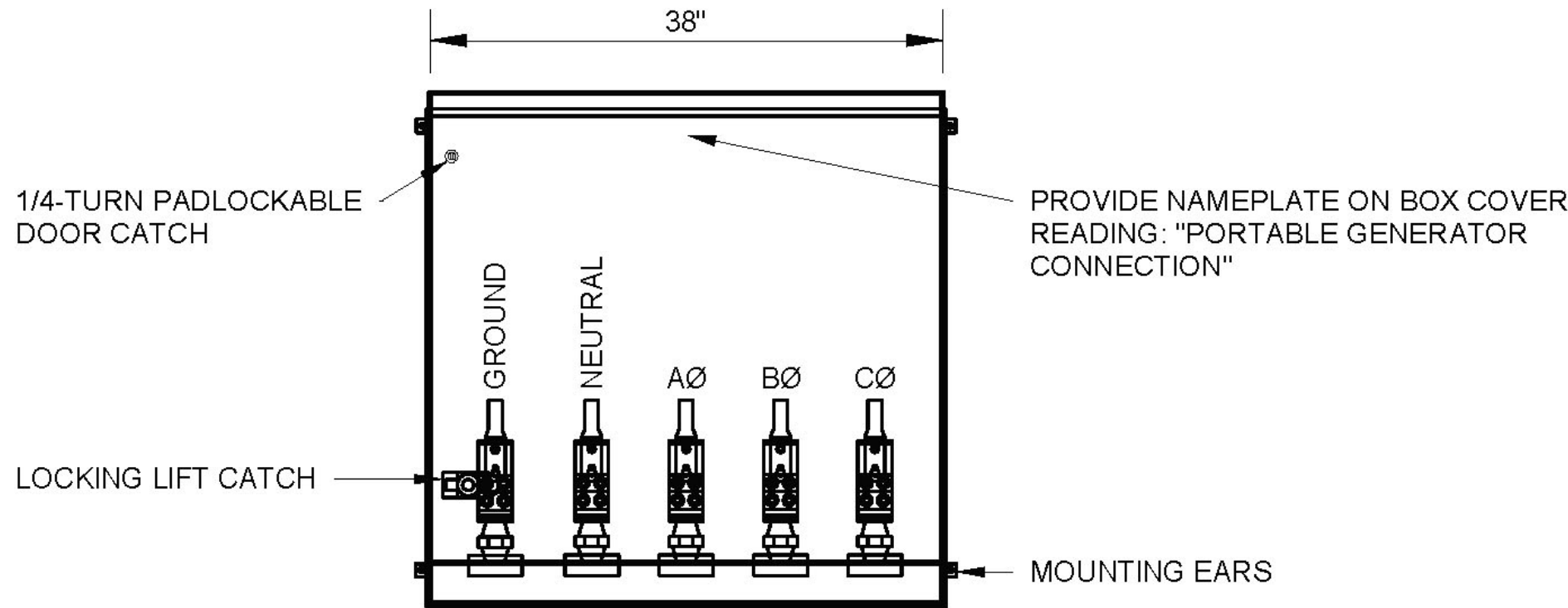
NOTES THIS DETAIL:

1. THIS DETAIL IS FOR ILLUSTRATIONAL PURPOSES ONLY. COORDINATE EXACT WIRING REQUIREMENTS AND FINAL LOCATION OF DEVICES WITH GENERAL CONTRACTOR AND DOOR SUPPLIER PRIOR TO INSTALLATION.
2. ALL WIRING SHALL BE INSTALLED IN CONDUIT.



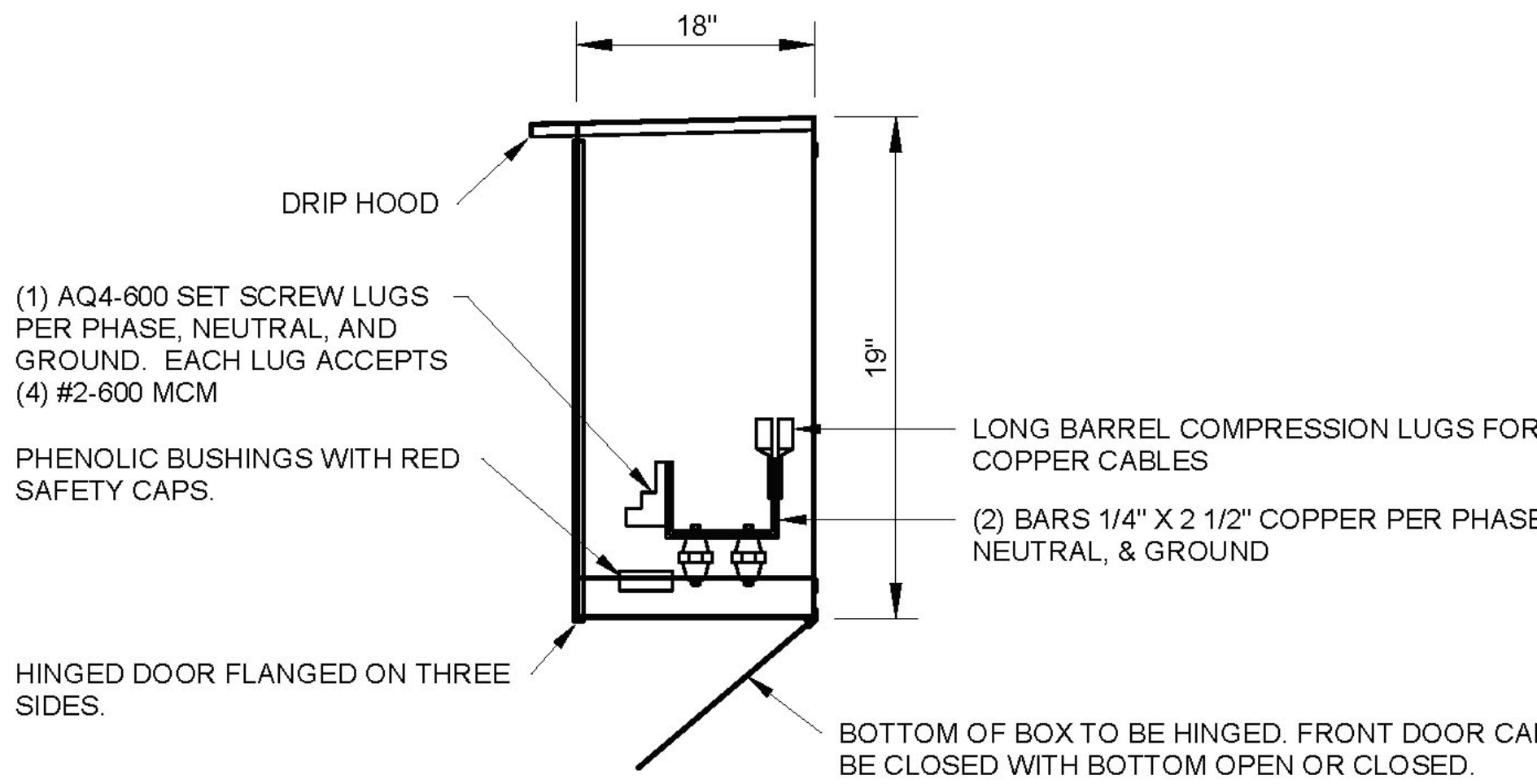
HANGAR DOOR WIRING DETAIL

NTS



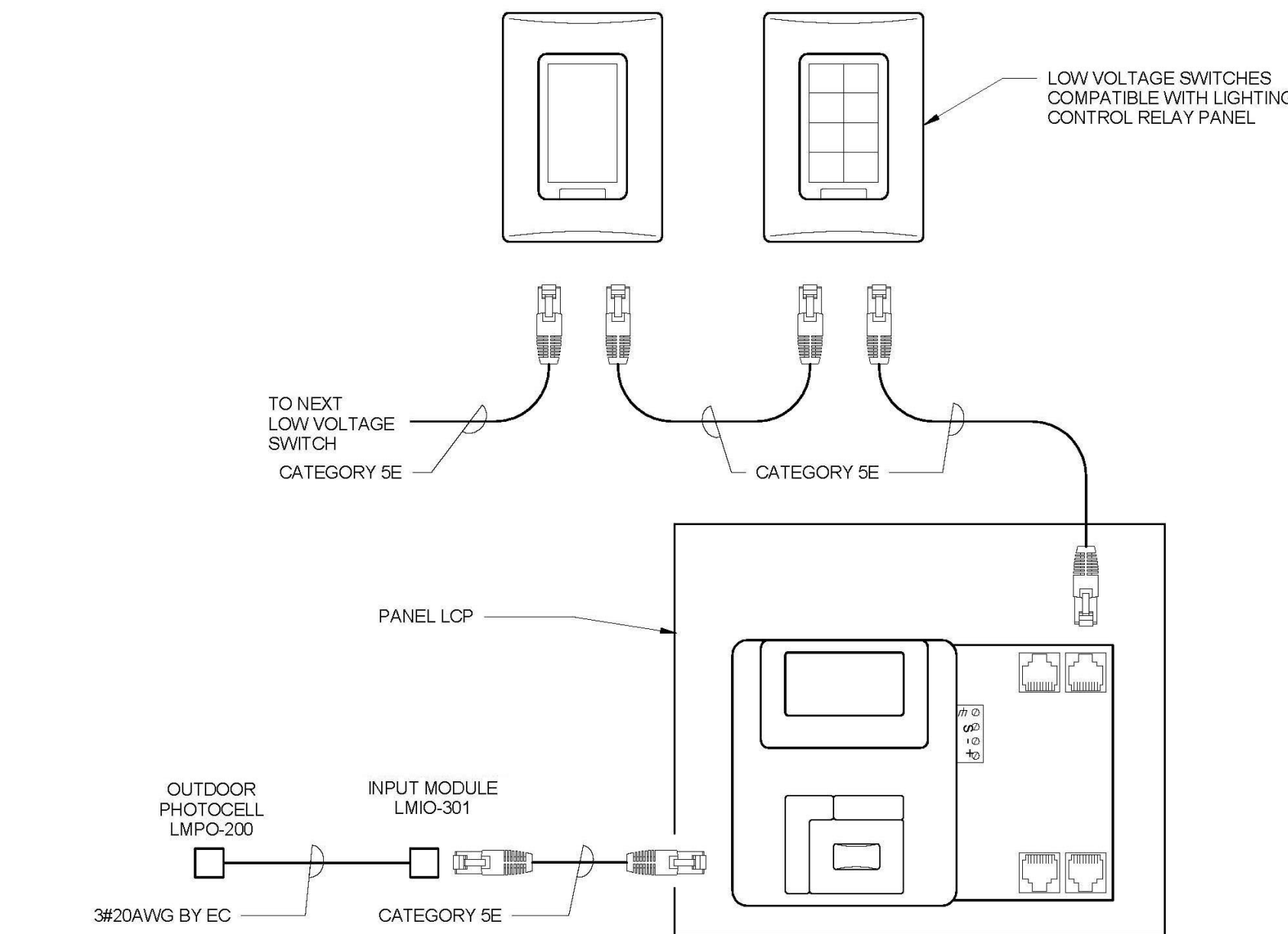
CONSTRUCTION NOTES:
MAT'L: 1/8" ALUMINUM
FINISH: BARE ALUMINUM
NEMA 3R BOLTED CONSTRUCTION

GENERATOR CONNECTION CABINET
CATALOG#: BERTHOLD W12-3C-S (OR APPROVED EQUAL)
1200A, 208/120V, 3PH, 4W
WALL MOUNTED UNIT
UNDERWRITERS LABORATORIES, INC. LISTED UNDER UL 1773



PORTABLE GENERATOR CABINET DETAIL

NTS



LIGHTING CONTROL PANEL DETAIL

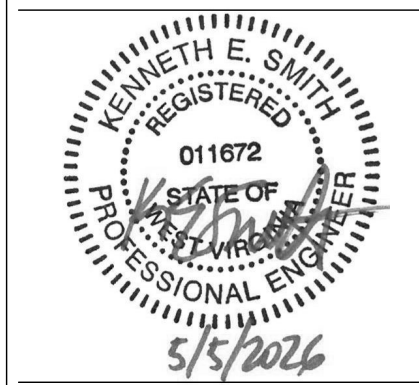
NTS

THRASHER

600 WHITE OAKS BLVD.
P.O. BOX 940
BRIDGEPORT, WV 26330
P (304) 624-4108
F (304) 624-7831

www.thrashergroup.com

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NO.	BY	DATE	DESCRIPTION
1			
07/14/26	ADDENDUM 1		

MARSHALL UNIVERSITY
BILL NOE FLIGHT SCHOOL - NEW HANGAR AND CLASSROOMS

YEAGER AIRPORT
MAY 28, 2026
BIDDING DOCUMENTS

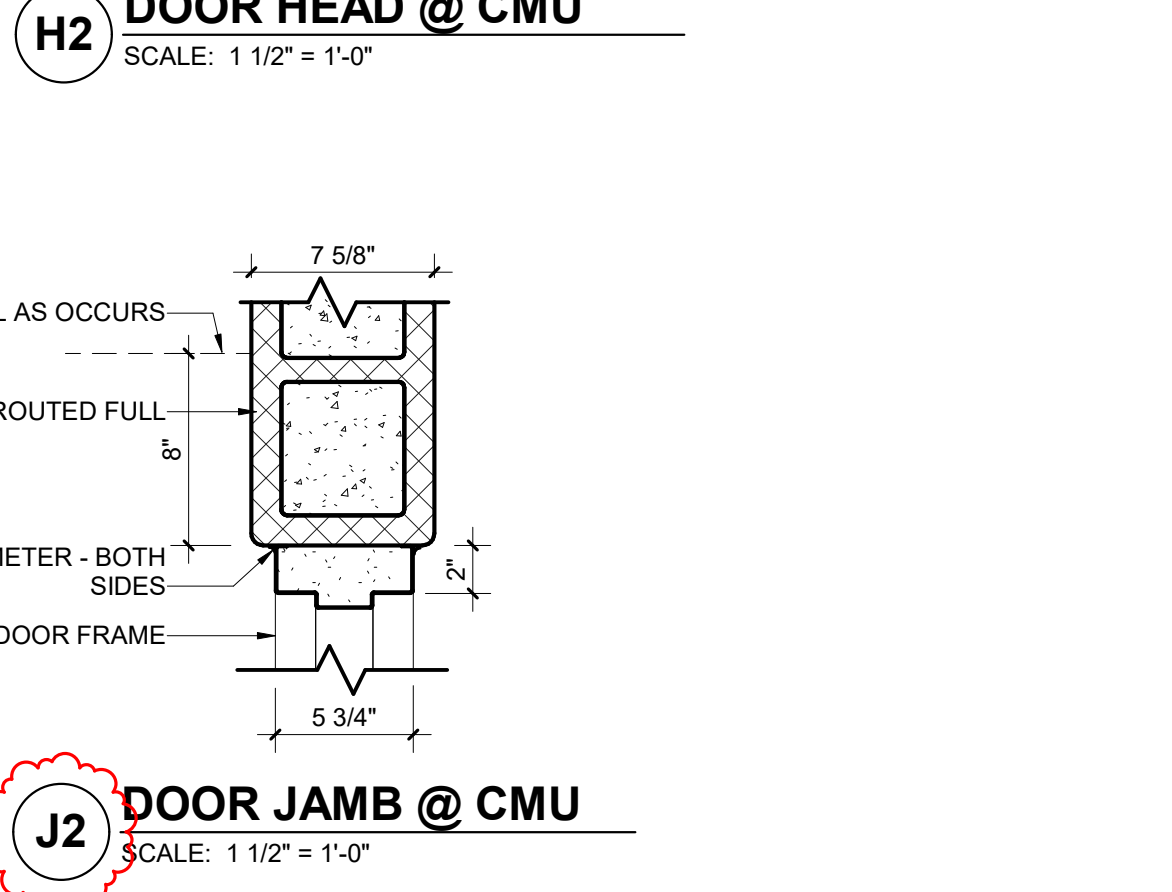
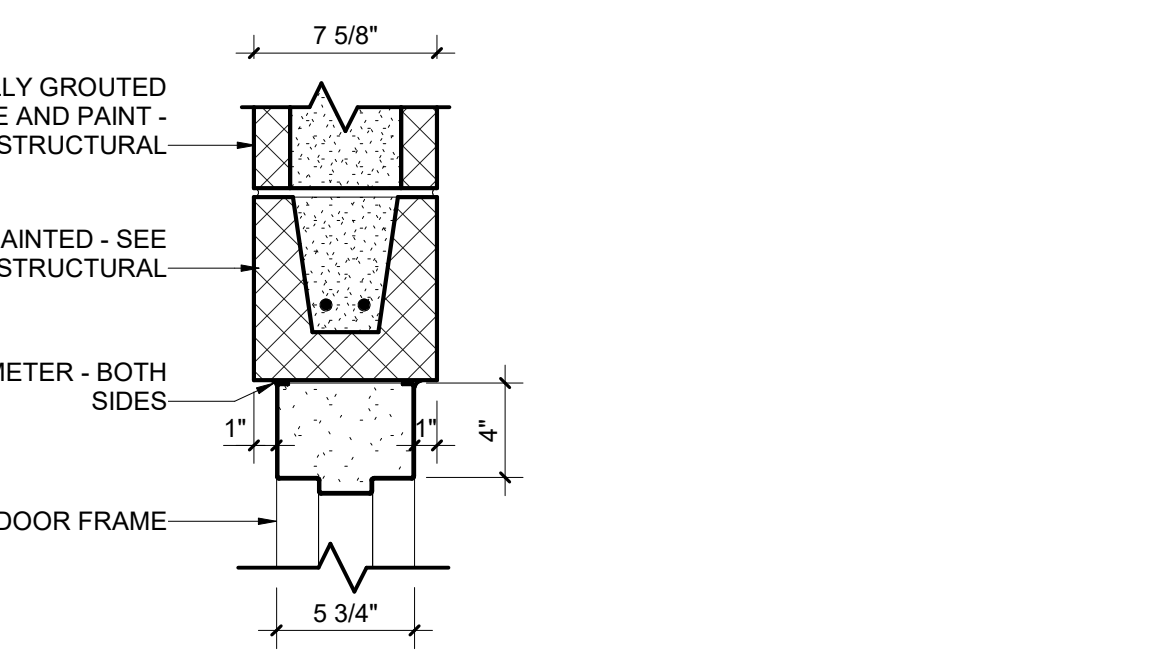
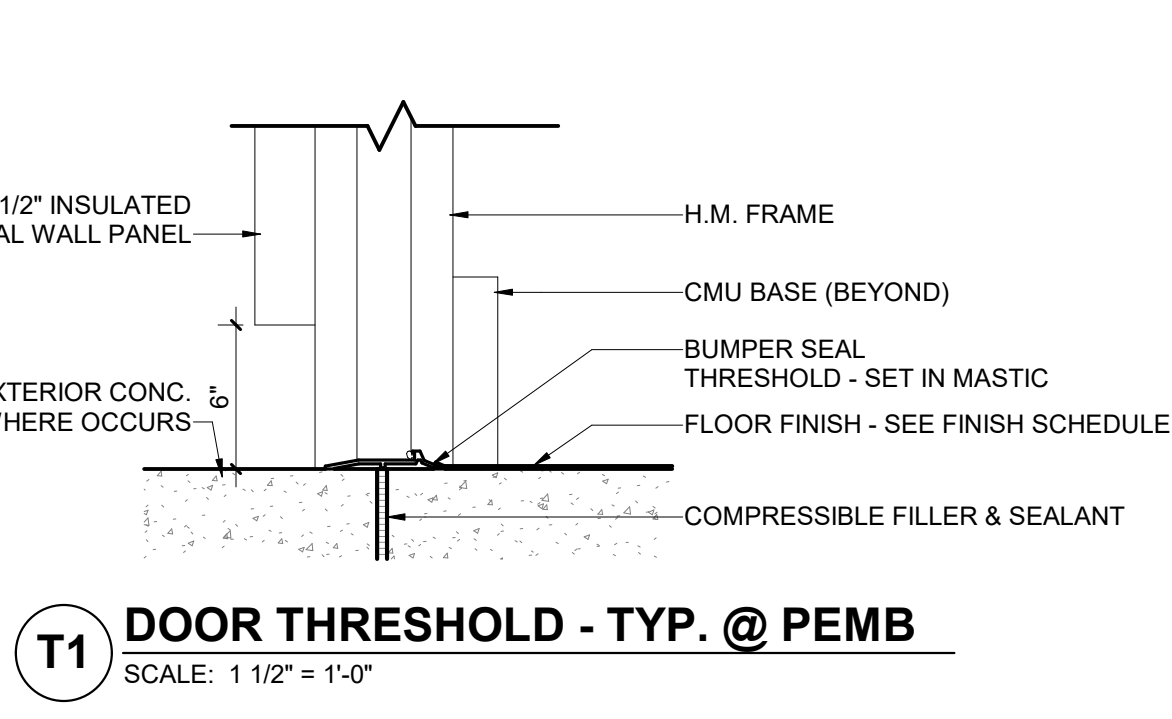
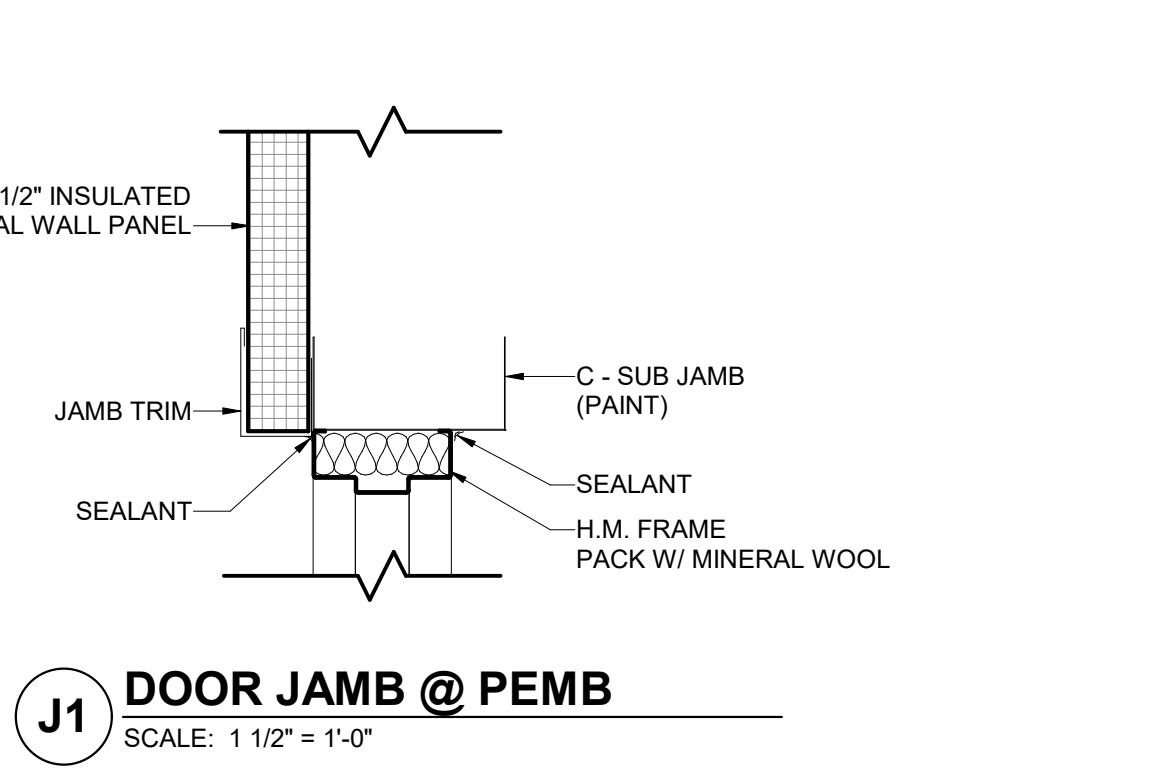
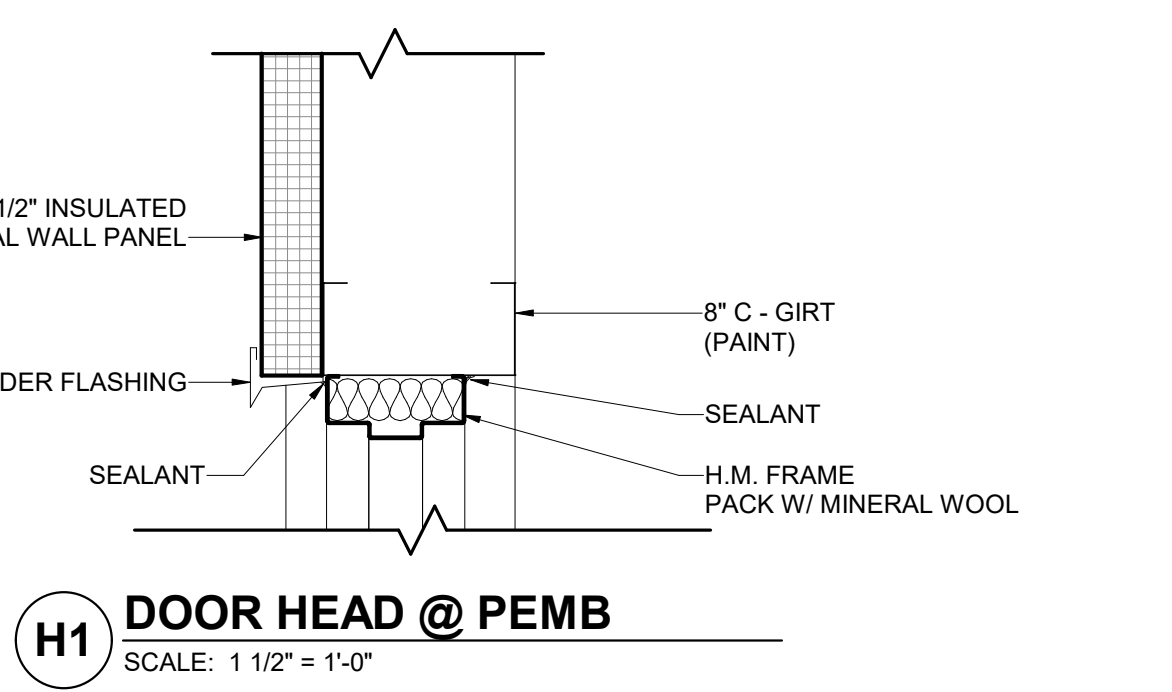
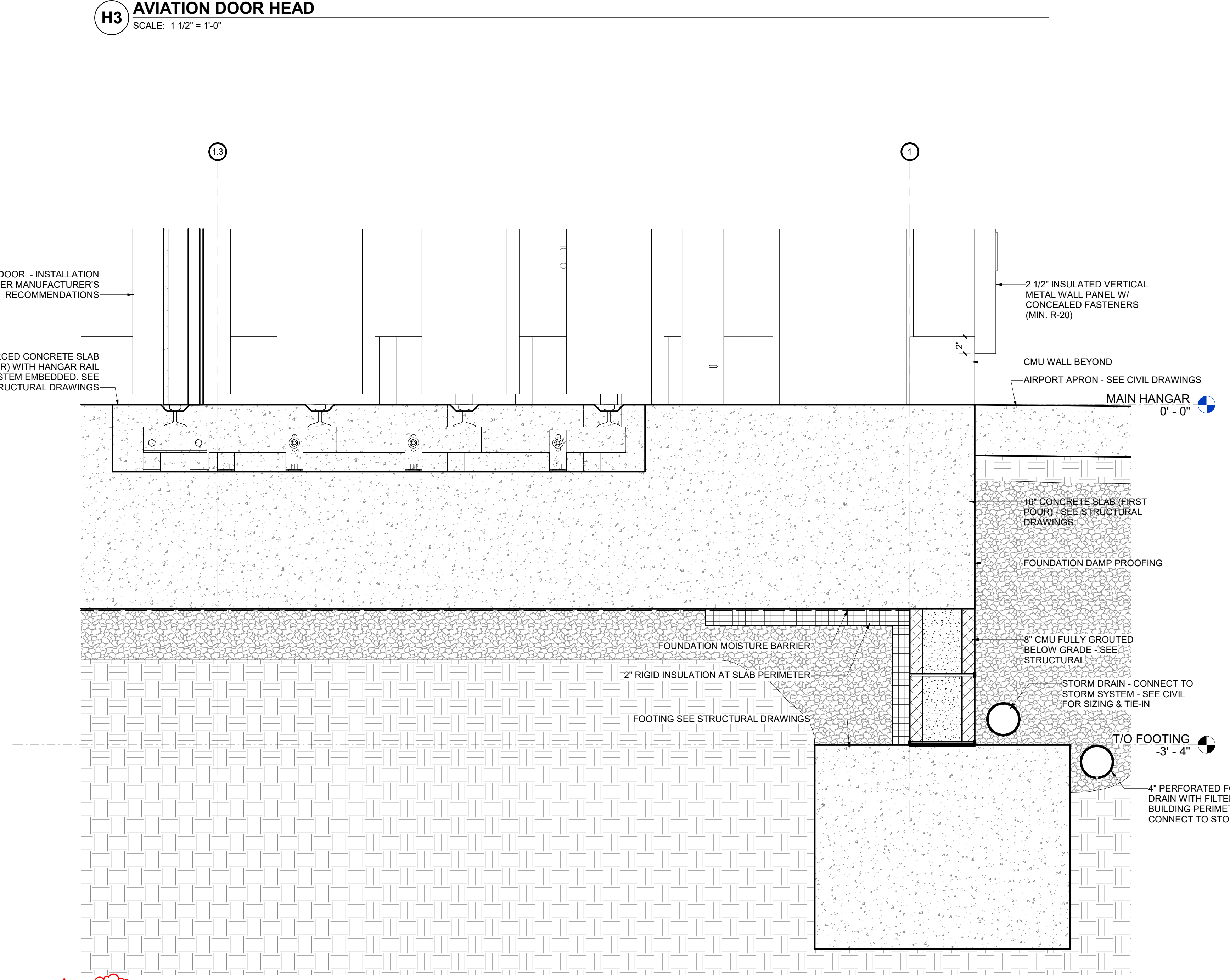
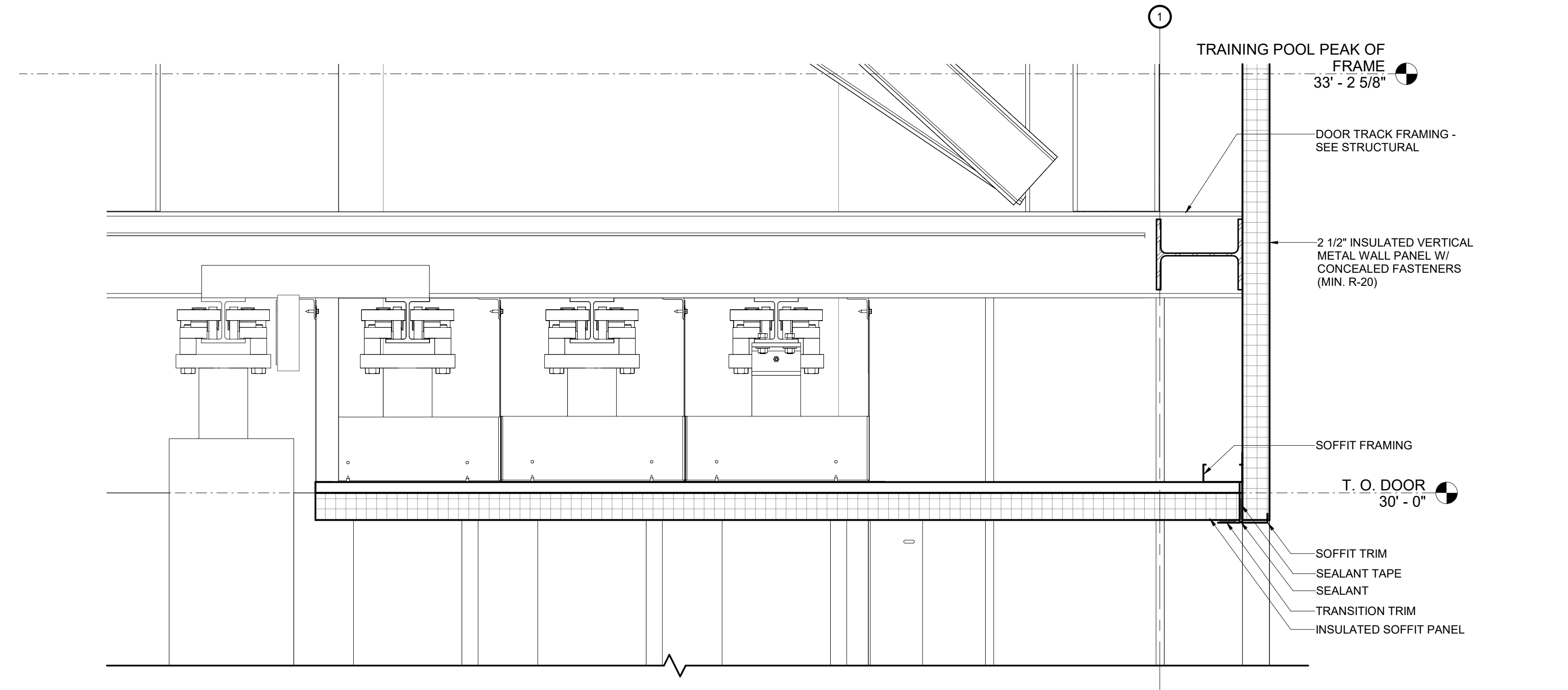
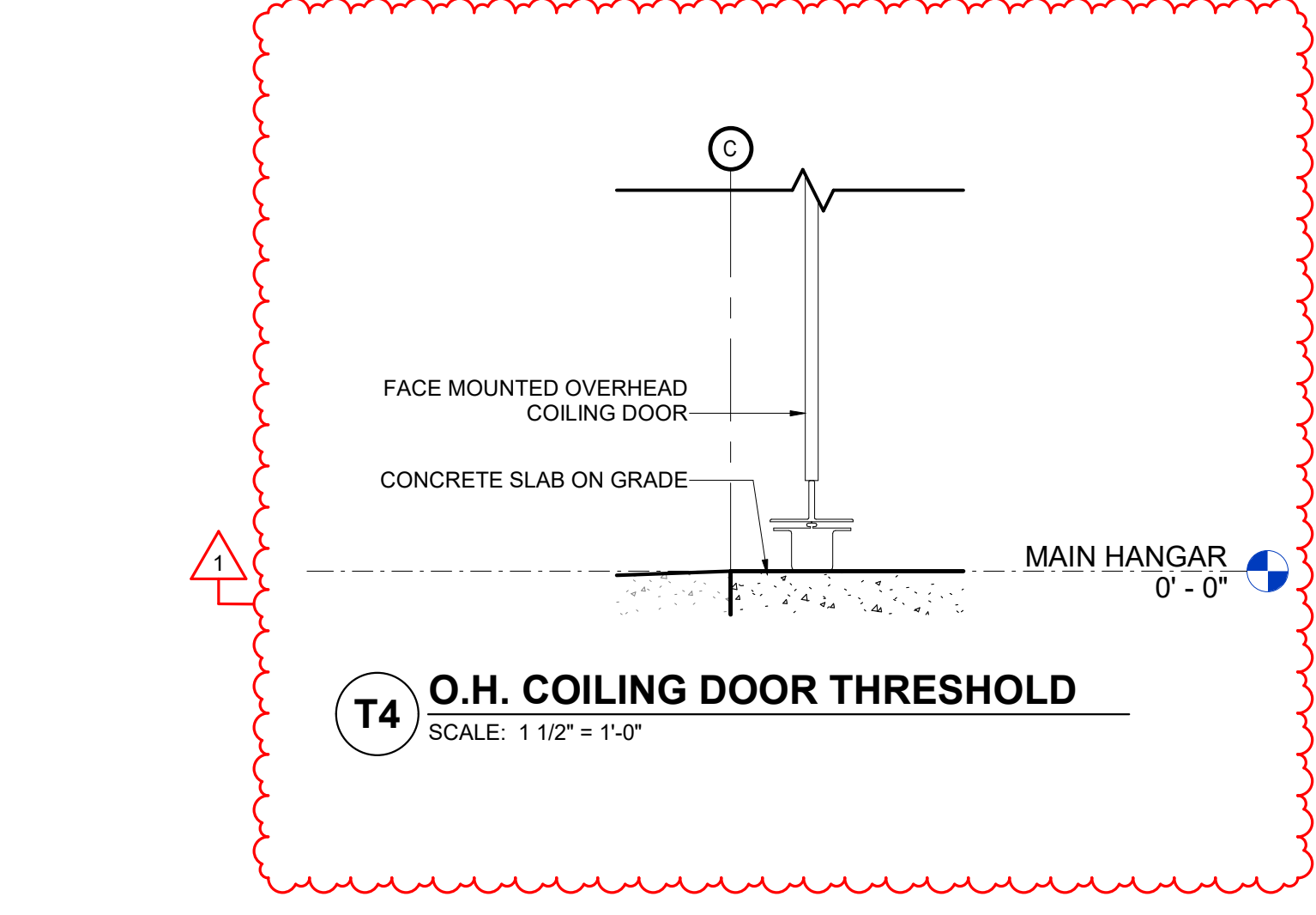
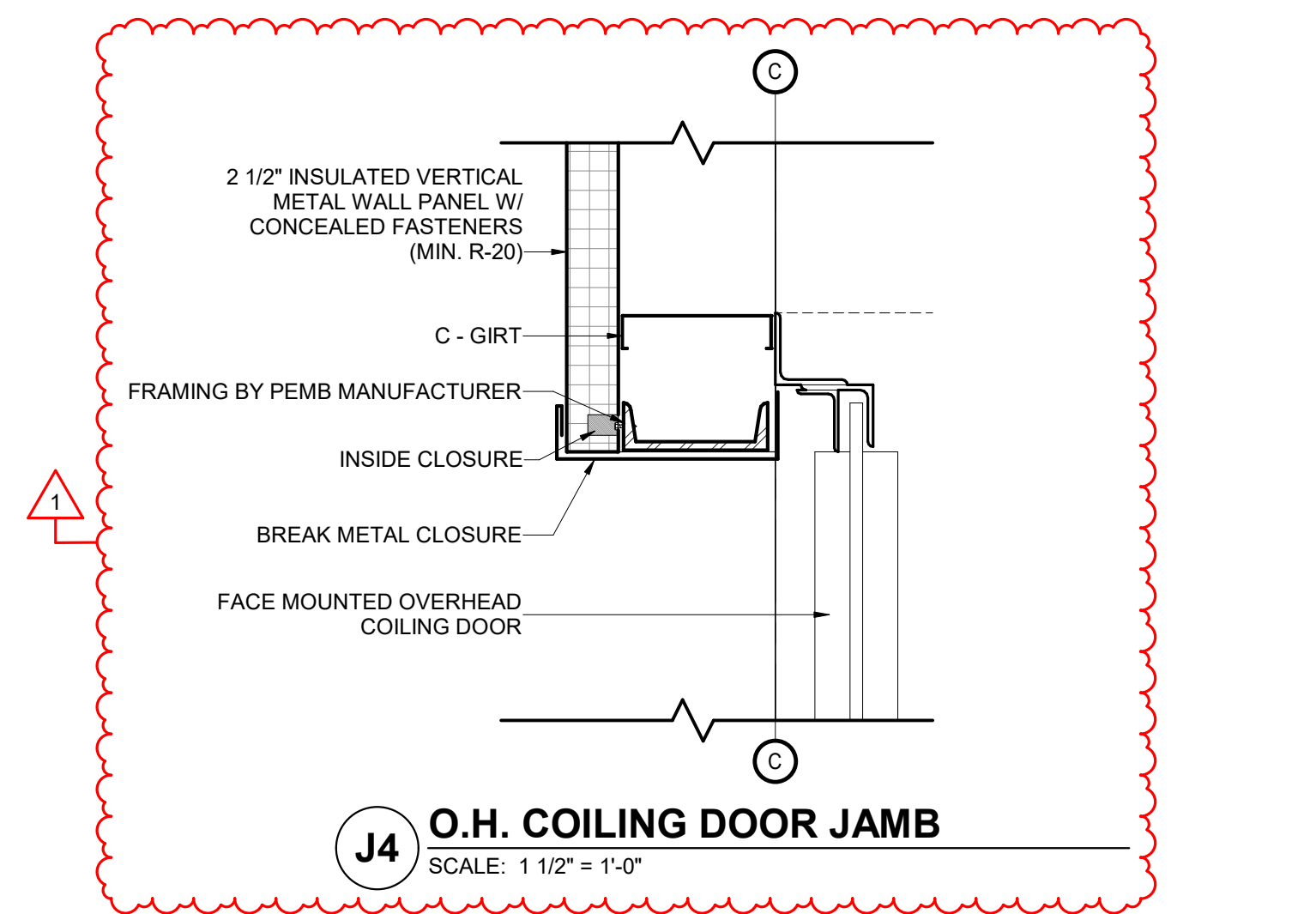
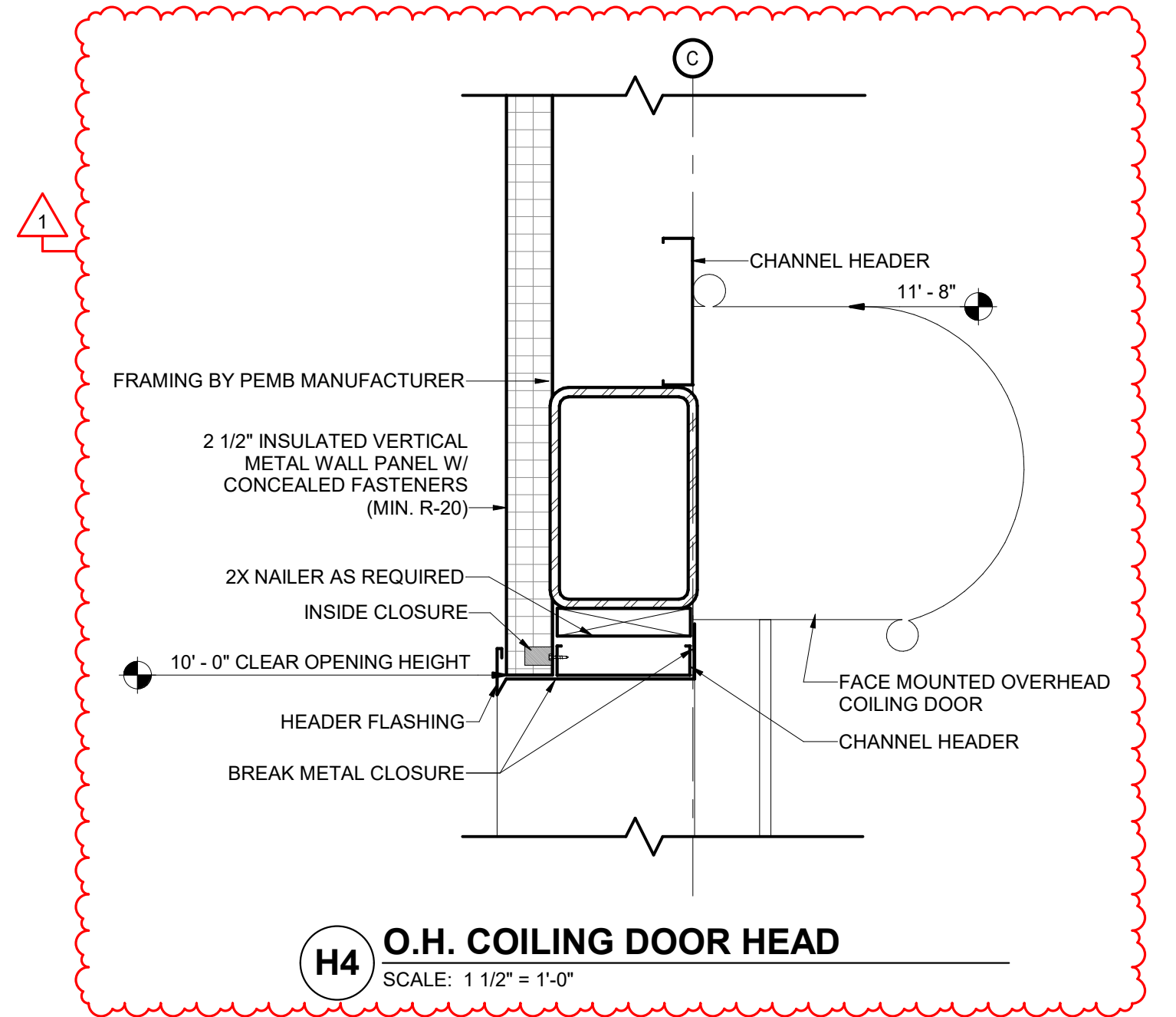
DRAWN: CLW DATE: 04/20/26
APPROVED: TTG DATE: 04/20/26
PROJECT No.: 760-11884

ELECTRICAL DETAILS

SHEET No.

E6.03R

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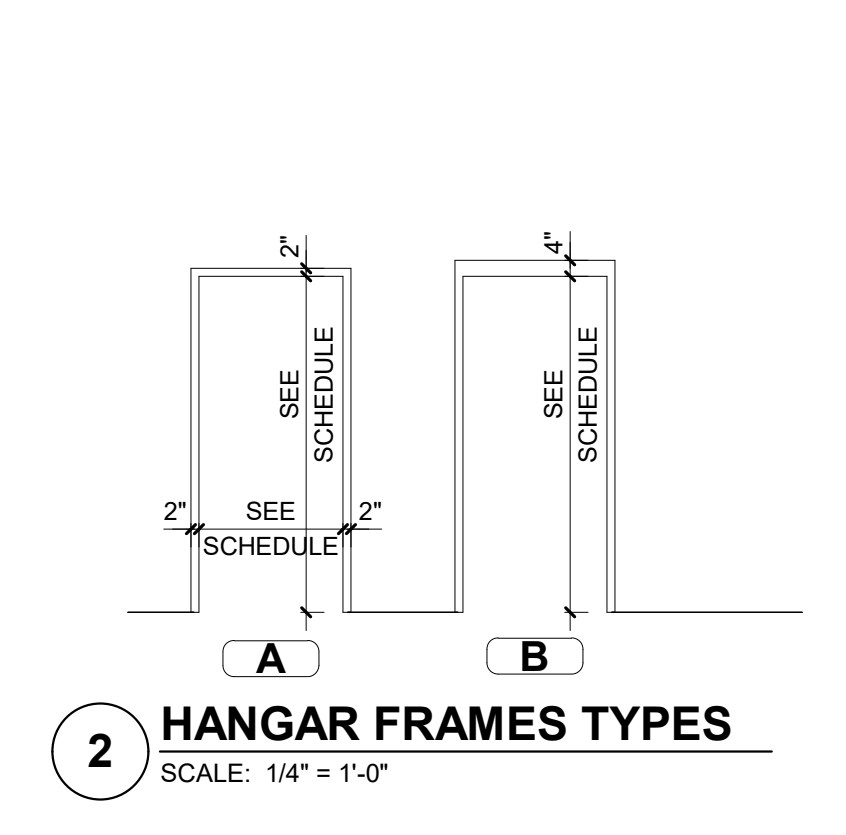
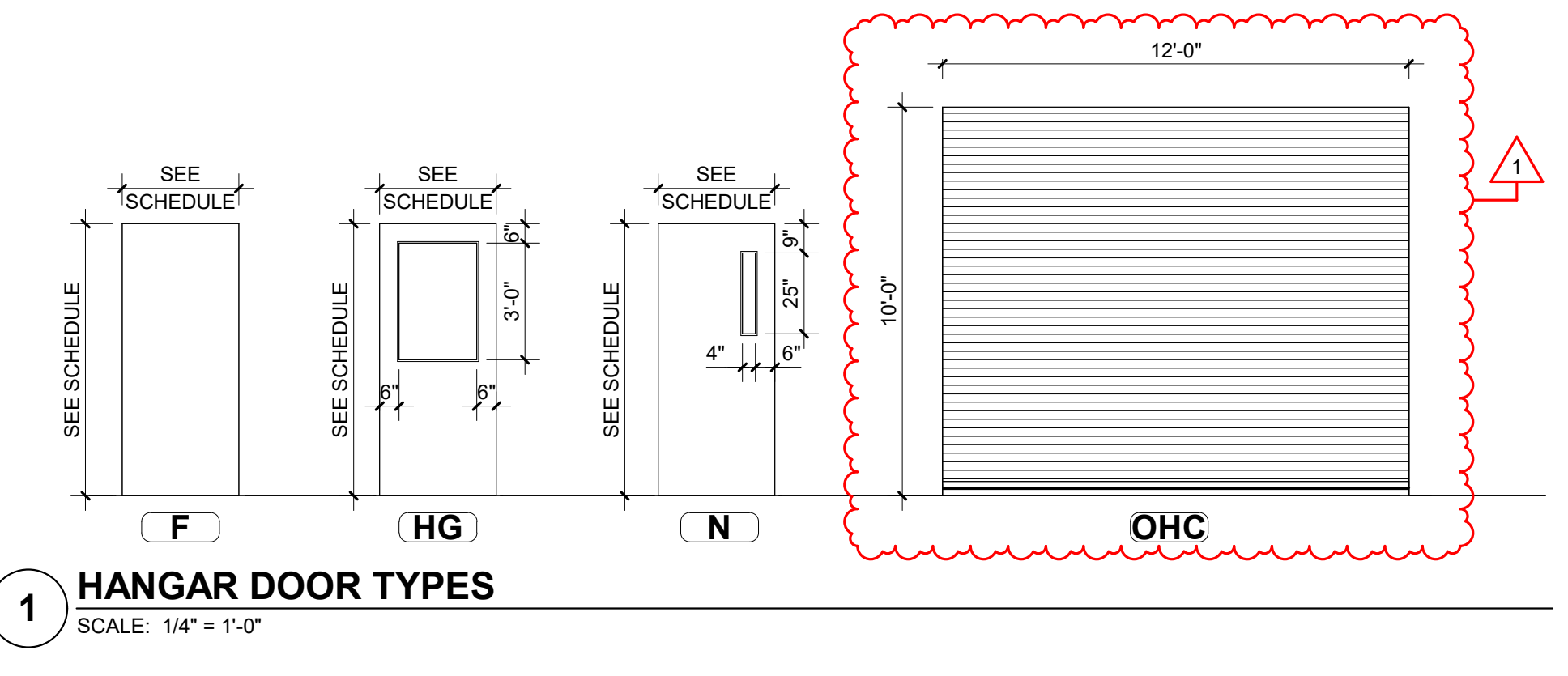
DOOR, FRAME, & WINDOW NOTES

- Field verify dimensions of all openings prior to fabrication.
- Provide shims and sealant at all openings.
- Heads, jambs, and thresholds (if present) of hollow metal frames installed within masonry walls are to be grouted full.
- Frame, door, glass (where present), and all other door components within a fire rated door are to be fabricated and installed as a complete assembly for the intended use.
- See structural drawings for information on masonry and steel details.
- Glazing to be of clear tempered glass in all non-rated hollow metal doors and frames.
- Width and height of overhead sectional doors shown on these plans represent the clear opening size. The exact size of the door and amount of shim space to be coordinated by the Contractor with the door manufacturer.

DOOR & FRAME ABBREVIATIONS

DOOR SCHEDULES MAY USE THE FOLLOWING ABBREVIATIONS:

- DOOR OR FRAME MATERIALS:**
GHM GALVANIZED HOLLOW METAL
HM HOLLOW METAL
IM INSULATED METAL
- DOOR OR FRAME FINISHES:**
P PAINT
FF FACTORY FINISH
- TYPES:**
AD AVIATION DOOR
F FLUSH
HG HALF GLASS
N NARROW LITE
OC OVERHEAD COILING INSULATED DOOR
- GLAZING:**
GL GLAZING TYPE 1
GL-FR1 45 MIN. FIRE RATED GLAZING
GL-FR2 90 MIN. FIRE RATED GLAZING



DOOR, FRAME, & HARDWARE SCHEDULE - PHASE 1

#	Type Mark	DOORS				FRAMES			CONSTRUCTION				ASSEMBLY			
		WIDTH	HEIGHT	DOOR MATERIAL	DOOR FINISH	FRAME TYPE	FRAME MATERIAL	FRAME FINISH	HEAD	JAMB	THRESHOLD	GLAZING TYPE	RATING	ACCESS CONTROLS	HARDWARE	REMARKS
101	AD	14'-0"	30'-0"	FF	FF	A	HM	P	H3	J3	T3	GL1				02
101A	HG	3'-0"	7'-0"	GHM	P	A	HM	P	H1	J1	T1	GL1		Yes		06
101B	OHC	12'-0"	11'-8 3/8"	IM	FF	-	-	FF	H4	J4	T4	GL1				02
101C	HG	3'-0"	7'-0"	GHM	P	A	GHM	P	H1	J1	T1	GL1		Yes		06
101D	N	3'-0"	7'-0"	HM	P	A	HM	P	H1	J1	T1	GL-FR2	90 MIN	Yes		07
101E	HG	3'-0"	7'-0"	GHM	P	A	GHM	P	H1	J1	T1	GL1		Yes		06
101F	HG	3'-0"	7'-0"	GHM	P	A	GHM	P	H1	J1	T1	GL1		Yes		06
101G	N	3'-0"	7'-0"	GHM	P	A	GHM	P	H1	J1	T1	GL-FR2	90 MIN	Yes		07
101H	HG	3'-0"	7'-0"	GHM	P	A	GHM	P	H1	J1	T1	GL1		Yes		06
101I	HG	3'-0"	7'-0"	GHM	P	A	GHM	P	H1	J1	T1	GL1		Yes		06
102	F	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	-	45 MIN.			04
103	F	7'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	-	90 MIN			04
103A	F	6'-0"	7'-0"	GHM	P	A	GHM	P	H1	J1	T1	-				08
104	F	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	-	45 MIN.			01
105	F	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	-	45 MIN.			01
106	F	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	-	45 MIN.			01
107	F	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	-	45 MIN.			01
108	F	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	-	45 MIN.			05
109	HG	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	GL-FR1	45 MIN.			03
110	HG	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	GL-FR1	45 MIN.			03
111	HG	3'-0"	7'-0"	HM	P	B	HM	P	H2	J2	-	GL-FR1	45 MIN.			03

General Notes:

1. Design Code: International Building Code (IBC) - 2018.
2. No provisions have been made for future horizontal or vertical expansion.
3. General Contractor shall verify all dimensions and conditions related to existing construction, existing services, and the site.
4. Construction loads shall not exceed design live loads. Shoring and re-shoring is the responsibility of the General Contractor.
5. The project is only stable in its completed form. The requirement for any and all bracing, shoring, or temporary supports and the planning sequences requiring them is the responsibility of the contractor.

Arrow Engineering's Scope of Services:
Arrow Engineering has been engaged as the structural engineer of record for this project. All modifications to the structure outside of what is explicitly shown herein, including interpretations of things not detailed on these drawings, must be reviewed by Arrow.

Design Data:

Live Loads:	
Hanger Slab	30 kip wheel load
Mezzanines	125 psf
First Floor Slabs (elsewhere)	100 psf

Collateral Loads:	
Typical Roof	10 psf

Roof Live Loads:	
Ordinary Flat Roof	20 psf

Snow Load Data:	
Ground Snow Load: P _g	30 psf
Flat Roof Snow Load: P _f	24 psf
Snow Exposure Factor: C _e	1.0
Thermal Factor: C _t	1.0
Snow Load Importance Factor: I _s	1.1
Slope Factor(s): C _s	1.0

Wind Load Data:	
Basic Design Wind Speed: V	107 mph
Risk Category:	Risk Category II
Wind Exposure Classification:	B
Internal Pressure Coefficient:	+ 0.55
C&B Base Wind Pressure (qh):	25 psf
Topographic Factor (Kzt):	1.1

Seismic Load Data:	
Risk Category:	Risk Category II
Seismic Importance Factor: I _e	1.00
Mapped Spectral Response Accel. Parameters:	S _s = 0.154; S ₁ = 0.064
Design Spectral Response Accel. Parameters:	S _u 0.092; S _w 0.034
Seismic Site Class:	B
Seismic Design Category:	A
Seismic Design Category:	By PEMB
Structure Weight:	By PEMB
Response Modification Coefficient: R	By PEMB
Seismic Response Coefficient: C _s	By PEMB
Seismic Procedure Used:	By PEMB

Geotechnical Design Data:	
Allowable Soil Bearing Pressure:	3,000 psf (assumed)
Active Pressure Lateral Soil Load:	100 psf / ft depth
At Rest Pressure Lateral Soil Load:	100 psf / ft depth
Passive Pressure Lateral Soil Load:	300 psf / ft depth
Coefficient of Friction:	0.25
Modulus of Subgrade Reaction:	120 pci

Flood Design Data:	
Flood Design Class:	X (unshaded)
Bottom Elevation of lowest horiz. member (noncoastal):	Approx. 980 ft

Other Loads:	
Guardrail/Handrail Live Load	50 plf / 200 lbs
HVAC Rooftop Units:	Refer to plans

Rain Load Data:	
15-Minute Rainfall Intensity:	5.40 in./hr
60-Minute Rainfall Intensity:	2.61 in./hr

Construction Means & Methods:

1. Contractor assumes responsibility for job site conditions, including safety of all persons, property, and condition of materials, during the course of work and for the duration of the project. The contractor shall indemnify and hold Owner and Structural Engineer harmless from any and all liability, real or alleged, in connection with the performance of the work on this project, excepting for liability arising from the sole negligence of Owner or Structural Engineer.
2. The structural engineers work as presented in these documents represents the finished structure. Where deemed necessary to convey the intent of the structural engineer's design, information regarding the existing structure may be provided on these documents; however, it is the responsibility of the contractor to verify all existing conditions and dimensions. The contractor shall provide all measures necessary to protect the new and existing structure during construction. Such measures shall include, but not be limited to: protection of sub-grade from freezing conditions, bracing of elements, shoring for loads due to construction equipment, temporary structures, and partially completed work. The contractor shall also assume responsibility for all temporary shoring, falsework, or required bracing to accomplish this work.
3. Observation visits to the site by structural engineer shall not include inspection of any item and a third party inspector shall complete all required inspections of the site.
4. The means and methods of construction rest solely in the responsibility of the contractor and the structural engineer has no control over or charge of these items nor shall not be responsible in any way for construction means, methods, techniques, sequences, or procedures, or safety or safety precautions and programs in connection with any construction activities, since these are solely contractor's responsibility.
5. The structural engineer will not be held responsible for the contractor's schedule or ability to carry out any construction activities in accordance with the contract documents or their own agreed upon timeline with the owner. Nor shall the structural engineer have control over or charge of actions of Contractor, Subcontractor, or any of their Agents, or employees, or any other persons performing portions of any construction activities. All inquiries to the engineer that arise during construction and all submittal reviews shall be allotted 14 days for responses.

Steel Roof and Composite Deck:

1. All steel deck to be manufactured, designed, and fabricated in accordance with the provisions of the latest edition of the Steel Deck Institute "Manual of Construction with Steel Deck" and requirements of the American Iron and Steel Institute (AISI) latest edition.
2. Steel deck to be supplied and detailed as indicated on the drawings.
3. Unspecified steel deck to be designed by the contractor to support the dead and live loads specified in this project for the span length and number of spans.
4. Composite deck may need to be shored for the spans indicated on the drawings. Contractor and supplier to confirm with the actual deck type chosen whether shoring is required. Shoring design is the responsibility of the contractor.
5. Deck specification is based on materials supplied by New Millennium building systems. Substitutions are acceptable if accompanied by evidence of matching this specification.
6. Concrete over steel deck applications are to be finished level. The weight of wet concrete will cause deflections in the steel framing. Any extra concrete required to achieve levelness is to be accounted for in the contractor's estimate. If the thickness of concrete required to achieve levelness exceeds 1/4 the depth of the concrete specified, cease pouring and notify Arrow Engineering immediately.
7. Contractor and deck supplier to coordinate location of all embedded items, cutouts, or features from other disciplines such as mechanical, electrical, or architectural items.

Shop Drawing and Submittal Requirements:

1. The project manual shall govern all submittal requirements.
2. The general contractor shall review, check, and stamp "Approved" all shop drawings prior to submitting them to the Architect. Shop drawings which have not been stamped "Approved" by the General Contractor do not conform to the requirements of the Contract Documents and will be rejected.
3. The General Contractor shall provide a shop drawing submittal schedule for anticipated submittals at least two weeks prior to submittal of the first set of shop drawings.
4. Submittals including shop drawings must be approved prior to the start of fabrication. All parties proceed at their own risk without approval on submittals. The maximum turn-around time for shop drawings must be two weeks (ten working days) from the date of receipt to Arrow Engineering to the date of return delivery. The general contractor is encouraged to communicate with Arrow on the need for faster approval times or when larger amounts of submittals are anticipated. All efforts will be made to expedite approval when requested.
5. Reproducing Arrow's drawings in whole or in part for use in shop drawings is cause for rejection of the entire submittal. All shop drawings and details shall be original and complete.
6. Electronic copies of Arrow's drawings may be available on a case-by-case basis for an additional charge. Requests for files must be submitted with as much lead time as other submittals.

Collateral Loads:	
Typical Roof	10 psf

Roof Live Loads:	
Ordinary Flat Roof	20 psf

Snow Load Data:	
Ground Snow Load: P _g	30 psf
Flat Roof Snow Load: P _f	24 psf
Snow Exposure Factor: C _e	1.0
Thermal Factor: C _t	1.0
Snow Load Importance Factor: I _s	1.1
Slope Factor(s): C _s	1.0

Wind Load Data:	
Basic Design Wind Speed: V	107 mph
Risk Category:	Risk Category II
Wind Exposure Classification:	B
Internal Pressure Coefficient:	+ 0.55
C&B Base Wind Pressure (qh):	25 psf
Topographic Factor (Kzt):	1.1

Seismic Load Data:	
Risk Category:	Risk Category II
Seismic Importance Factor: I _e	1.00
Mapped Spectral Response Accel. Parameters:	S _s = 0.154; S ₁ = 0.064
Design Spectral Response Accel. Parameters:	S _u 0.092; S _w 0.034
Seismic Site Class:	B
Seismic Design Category:	A
Seismic Design Category:	By PEMB
Structure Weight:	By PEMB
Response Modification Coefficient: R	By PEMB
Seismic Response Coefficient: C _s	By PEMB
Seismic Procedure Used:	By PEMB

Geotechnical Design Data:	
Allowable Soil Bearing Pressure:	3,000 psf (assumed)
Active Pressure Lateral Soil Load:	100 psf / ft depth
At Rest Pressure Lateral Soil Load:	100 psf / ft depth
Passive Pressure Lateral Soil Load:	300 psf / ft depth
Coefficient of Friction:	0.25
Modulus of Subgrade Reaction:	120 pci

Flood Design Data:	
Flood Design Class:	X (unshaded)
Bottom Elevation of lowest horiz. member (noncoastal):	Approx. 980 ft

Other Loads:	
Guardrail/Handrail Live Load	50 plf / 200 lbs
HVAC Rooftop Units:	Refer to plans

Rain Load Data:	
15-Minute Rainfall Intensity:	5.40 in./hr
60-Minute Rainfall Intensity:	2.61 in./hr

Seismic Load Data:	
Risk Category:	Risk Category II
Seismic Importance Factor: I _e	1.00
Mapped Spectral Response Accel. Parameters:	S _s = 0.154; S ₁ = 0.064
Design Spectral Response Accel. Parameters:	S _u 0.092; S _w 0.034
Seismic Site Class:	B
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Geotechnical Design Data:	
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Coefficient of Friction:	0.25
Modulus of Subgrade Reaction:	120 pci

Flood Design Data:	
Flood Design Class:	X (unshaded)
Bottom Elevation of lowest horiz. member (noncoastal):	Approx. 980 ft

Other Loads:	
Guardrail/Handrail Live Load	50 plf / 200 lbs
HVAC Rooftop Units:	Refer to plans

Rain Load Data:	
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Risk Category:	Risk Category II
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Seismic Procedure Used:	By PEMB

Geotechnical Design Data:	
Allowable Soil Bearing Pressure:	3,000 psf (assumed)
Active Pressure Lateral Soil Load:	100 psf / ft depth
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Passive Pressure Lateral Soil Load:	300 psf / ft depth
Coefficient of Friction:	0.25
Modulus of Subgrade Reaction:	120 pci

Flood Design Data:	
Flood Design Class:	X (unshaded)
Bottom Elevation of lowest horiz. member (noncoastal):	Approx. 980 ft

Structural Concrete:

1. Cast-in-place concrete work shall conform to the American Concrete Institute 318-14. The minimum compressive strength of all concrete used in this project shall be **4,000 psi**.
2. The air content of all concrete exposed to freezing and thawing or where required to be watertight shall be 4.5%-7.5%. All other applications shall be 3%-4%.
3. The water to cement ratio for all concrete subjected to freezing and thawing in moist conditions or required to be watertight shall have a maximum water-cement ratio of 0.45. All reinforced concrete exposed to deicing salts, brackish water, seawater, or spray from these sources shall have a maximum water-cement ratio of 0.40. All water used in concrete mixes (including that which is added at the site) must be potable and accounted for in the mix design published by the supplier.
4. Maximum aggregate size shall be 1 1/2", well graded, well-shaped (not elongated, flat, or slippery), and free of clay, dirt, and excess fines, U.N.O. Aggregate composition shall consist of quartz, limestone, dolomite, granite, or feldspar.
5. All cement shall be type 1 unless noted.
6. The maximum slump of any concrete shall be less than 3" unless noted.
7. All reinforcing to be ASTM A615, Grade 60.
8. The welded wire fabric used in floor slabs shall be ASTM A185. All wire mesh must be supported adequately during pouring to prevent sag under the weight of concrete or construction personnel. Provide 6w6-w2.9w2.9 welded wire fabric in all non-structural slabs on grade, unless otherwise noted.
9. All reinforcing shall be located a minimum amount of 'cover' from the surface according to the following:
- | | |
|--|------------------|
| All bars cast against or exposed to earth |3 inches |
| No. 6 bars or larger exposed to weather |2 inches |
| No. 5 or smaller bars exposed to weather |1.5 inches |
| No. 14 or larger bars in other applications |1.5 inches |
| No. 11 or smaller bars in other applications |0.75 inches |
10. Provide joints in all slabs-on-grade at a maximum spacing of 30 times the thickness of the slab. Control joints to be formed or cut to a depth of 1/5 the slab thickness. Control joints not required in footings or in elevated slabs unless otherwise noted.
11. Reinforcing bar lap splices and anchorage lengths shall conform with ACI 318-14. All splices shall be Type B.
12. Top layer of reinforcing steel in slabs and footings shall be considered top bars regardless of thickness of concrete below the bars.
13. Provide standard lap splice at all horizontal bars in corners and intersections.
14. Where not explicitly defined, all slabs and walls shall have minimum reinforcement per ACI 318-14 allowed for in their construction.
15. See architectural drawings for finish requirements including edge conditions. Curing practices may need to accommodate certain floor finishes which should be coordinated prior to pouring. Chamfer / tool any exposed edge of concrete with 1/2" chamfer unless otherwise noted.
16. Contractor shall coordinate the location of all embeds, conduits, anchor bolts, etc., with other disciplines prior to pouring any concrete in which these items are located.
17. The Contractor shall prepare shop drawings showing detail layouts of reinforcing, including dimensions, spacing, bending details, bar schedules, and similar items required for the proper construction of the work. Provisions for the connection of work by other trades shall be indicated on the shop drawings. The location of all embedded items shall be indicated by the contractor on the shop drawings. All shop drawings shall be submitted for approval in accordance with the requirements of the Contract Documents.

Collateral Loads:	
Typical Roof	10 psf

Roof Live Loads:	
Ordinary Flat Roof	20 psf

Snow Load Data:	
Ground Snow Load: P _g	30 psf
Flat Roof Snow Load: P _f	24 psf
Snow Exposure Factor: C _e	1.0
Thermal Factor: C _t	1.0
Snow Load Importance Factor: I _s	1.1
Slope Factor(s): C _s	1.0

Wind Load Data:	
Basic Design Wind Speed: V	107 mph
Risk Category:	Risk Category II
Wind Exposure Classification:	B
Internal Pressure Coefficient:	+ 0.55
C&B Base Wind Pressure (qh):	25 psf
Topographic Factor (Kzt):	1.1

Seismic Load Data:	
Risk Category:	Risk Category II
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Mapped Spectral Response Accel. Parameters:	S _s = 0.154; S ₁ = 0.064
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Seismic Site Class:	B
Seismic Design Category:	A
Seismic Design Category:	By PEMB
Structure Weight:	By PEMB
Response Modification Coefficient: R	By PEMB
Seismic Response Coefficient: C _s	By PEMB
Seismic Procedure Used:	By PEMB

Geotechnical Design Data:	
Allowable Soil Bearing Pressure:	3,000 psf (assumed)
Active Pressure Lateral Soil Load:	100 psf / ft depth
At Rest Pressure Lateral Soil Load:	100 psf / ft depth
Passive Pressure Lateral Soil Load:	300 psf / ft depth
Coefficient of Friction:	0.25
Modulus of Subgrade Reaction:	120 pci

Flood Design Data:	
Flood Design Class:	X (unshaded)
Bottom Elevation of lowest horiz. member (noncoastal):	Approx. 980 ft

Other Loads:	
Guardrail/Handrail Live Load	50 plf / 200 lbs
HVAC Rooftop Units:	Refer to plans

Rain Load Data:	
15-Minute Rainfall Intensity:	5.40 in./hr
60-Minute Rainfall Intensity:	2.61 in./hr

Seismic Load Data:	
Risk Category:	Risk Category II
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Flood Design Data:	
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Other Loads:	
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HVAC Rooftop Units:	Refer to plans

Rain Load Data:	
15-Minute Rainfall Intensity:	5.40 in./hr
60-Minute Rainfall Intensity:	2.61 in./hr

Structural Steel:

1. Detailing, fabrication, and erection of all structural steel work shall conform to the following codes and standards:
- The 16th edition of the American Institute of Steel Construction (AISC) Steel Construction Manual.
 - ANSI/AISC 360-22 – Specification for Structural Steel Buildings.
 - ANSI/AISC 360-22 – Code of Standard Practice for Structural Steel Buildings and Bridges.
2. Structural Steel materials shall conform to the following ASTM Specifications unless noted otherwise in the drawings or details:
- Wide-flange shapes, and channels (W, WT, C, MC), A992, Fy = 50 ksi
 - Hollow Structural Sections (HSS): A500, Gr. C, Fy = 50 ksi
 - Pipe: A53 Gr. B, Fy = 35 ksi
 - All other steel shapes (L, M, S, HP, Plates, Bars): A572 Gr. 50, Fy = 50 ksi
3. All steel shall receive a shop coat of primer at a minimum dry thickness of 1 mil. Prior to application of primer, steel surface shall be prepared in accordance with SSPC-SP1/SSPC-SP2 at minimum. Do not apply primer at the following locations: steel to be galvanized, steel to be embedded in concrete, steel surfaces to receive field welds, steel surfaces at slip critical connections, steel to receive spray-on fire proofing (locations as indicated by Architect). For areas indicated to be painted by the Architect, the primer must be compatible with the paint to be applied.
4. All exterior steel, including that which is installed outside of the controlled building envelope, and interior steel in humid environments shall be hot-dip galvanized per ASTM A123. Prior to galvanizing, steel surface shall be prepared by pickling in accordance with SSPC-SP8. Repair damaged or uncoated hot-dip galvanized coatings in accordance with ASTM A780.
5. Areas indicated as Architecturally Exposed Structural Steel (AESS) shall conform to Category AESS 2 per AISC 303-22, Table 10.1, at minimum, unless indicated otherwise in the drawings or details.
6. Splicing or penetrating structural steel members is prohibited unless indicated in the drawings or with the written approval of Arrow Engineering.
7. Where no camber is indicated, fabricate beams so that any natural camber is upward after erection.
8. Provide drain/weep holes in all steel as required to prevent the accumulation of water. All penetrations through main members shall not exceed "1" in diameter, shall be ground smooth, and kept clean and open.
9. Exposed ends of HSS members shall be capped with "X" plate unless noted otherwise.
10. Field modification of structural steel is prohibited without prior approval of the Architect and Arrow Engineering.
11. All copes, holes, openings, and modifications required in structural steel members for erection or the work of other trades shall be shown on the shop drawings for approval of the Architect and Arrow Engineering.
12. Column schedules provided in this drawing set are for general information only and may not include all columns located on the project. Note top and bottom of steel elevations are nominal. Cap plates, base plates, groud, etc. will affect the fabricated length and should be taken into account by the steel detailer.
13. The steel fabricator shall be certified under the AISC Quality Certification Program unless directed by the owner with consideration from Arrow Engineering.

Collateral Loads:	
Typical Roof	10 psf

Roof Live Loads:	
Ordinary Flat Roof	20 psf

Snow Load Data:	
Ground Snow Load: P _g	30 psf
Flat Roof Snow Load: P _f	24 psf
Snow Exposure Factor: C _e	1.0
Thermal Factor: C _t	1.0
Snow Load Importance Factor: I _s	1.1
Slope Factor(s): C _s	1.0

Wind Load Data:	
Basic Design Wind Speed: V	107 mph

BID FORM OF PROPOSAL

Marshall University Procurement Services

Old Main 125

One John Marshall Drive

Huntington, WV 25755

Requisition Number: **00173492**

Project Description: **Marshall University Bill Noe
Flight School New Hangar and Classrooms**

Issue Date: **June 25, 2026**

Name: _____

Address: _____

Address: _____

City: _____ State: _____ Zip Code: _____

W Va. Code §5-22-1: The apparent low bidder on a contract valued at more than \$250,000 for the construction, alteration, decoration, painting or improvement of a new or existing building or structure shall submit a list of all subcontractors who will perform more than \$25,000 of work on the project including labor and materials. This information shall be provided to the within one business day of the opening of bids for review prior to the awarding of a construction contract. Failure to submit the subcontractor list within one business day after the deadline for submitting bids may result in disqualification of the bid. The list shall include the names of the bidders and the license numbers.

Special Instructions: The bid/proposal process is highly controlled. To protect the integrity of the process, any questions or clarifications regarding this Request for Bid/Proposal must be handled through the Marshall University Procurement Services.

BASE BID INFORMATION:

The undersigned, hereinafter call the Bidder, being familiar with and understanding the Bidding documents and having examined the project site and being familiar with all local conditions affecting the Project, hereby proposes to furnish all labor, material, equipment, supplies, and transportation, and to perform all Work in accordance with the Bidding Documents within the time set forth therein, for the sum of:

BASE BID (/WRITTEN AMOUNT):

BASE BID (NUMERICAL):

Amount to be shown in both words and numbers, in the event of a difference between the written amount and the number amount, the written amount shall prevail.

BID FORM OF PROPOSAL

ALTERNATES: Bidder shall fill in the applicable blank with an increased or decreased bid amount and indicate which by **checking the word “ADD” or the word “DEDUCT” as applicable.** Marshall University reserves the right to accept or reject any or all bid amounts for Alternates, in whole or in part, and in any order. Such acceptance may affect lowest responsible and responsive bid chosen by Marshall University

If no change in the bid amount is required, indicate "No Change" or "\$0."

Failure to make an entry or an entry of "No Bid," "NI A," or similar entry on any Alternate shall cause the Bid to be rejected as non-responsive if that Alternate is selected by Marshall University.

Any statement of an amount for an alternate which has not been identified by checking the word ADD or DEDUCT, as applicable, shall reconsidered an ADD.

Marshall University may request additional alternates to be priced by the Bidder, if applicable, Marshall University shall include an additional Attachment to this Bid Form of Proposal indicating the additional requested alternates.

Marshall University has initially requested 1 alternates relating to this project.

Description:

High Performance Coating Applied to the Marshall University roof logo. Furnish materials, equipment, labor, and supervision necessary to prepare, paint, and protect Marshall University logo on the Hangar roof.

Alternate No: ONE

CHECK ONE: ADD ☐ DEDUCT ☐

Written Amount:

Numerical Amount:

Amount to be shown in both words and numbers, in the event of a difference between the written amount and the number amount, the written amount shall prevail.

BID FORM OF PROPOSAL

ALLOWANCES BID INFORMATION: 00173492

The amount of each Allowance shall be included in the Base Bid amount. Allowances shall be used solely for the purpose of determining the adjustment to the Contract Sum for the difference between the amount of the Allowance and the actual cost of the related Work provided.

Marshall University may notify Bidder of additional Allowance to be included in the Base Bid amount, if applicable, Marshall University shall include an additional Attachment to this Bid Form of Proposal indicating the additional allowances to notify Bidder.

Marshall University has initially included **2** Allowances to be included by Bidder in the Base Bid Amount relating to this project.

Allowance Number	Description	Amount
1	Quantity Allowance: Site development - Include allowance for 400 cubic yards of undercut and backfilling with engineered structural fill as noted in the geotechnical report	
2	Quantity Allowance: Foundations - Include allowance for 40 cubic yards of over-excavation below bearing elevation and backfilling with lean concrete as noted in the geotechnical report	

BID FORM OF PROPOSAL

UNIT PRICES BID INFORMATION:

The amount of each Allowance shall be included in the Base Bid amount. Allowances shall be used solely for the purpose of determining the adjustment to the Contract Sum for the difference between the amount of the Allowance and the actual cost of the related Work provided.

Marshall University may notify Bidder of additional Allowance to be included in the Base Bid amount, if applicable, Marshall University shall include an additional attachment to this Bid Form of Proposal indicating the additional allowances to notify Bid.

Unit Price	Description	Amount
1	Site development - Include allowance for 400 cubic yards of undercut and backfilling with engineered structural fill as noted in the geotechnical report	
2	Rebar for building's foundations: Description: Material & labor for add/deduct pending final foundation design for concrete foundations. Unit of Measurement: Per (l) one ton of Rebar	

BID FORM OF PROPOSAL

**COMPANY/VENDOR (“BIDDER”) WEST VIRGINIA CONTRACTOR’S
NUMBER:** _____

COMPANY/VENDOR (“BIDDER”) SIGNATURE:

Authorized Signature

Printed Name and Title of Authorized Representative

Date

Phone Number

Fax Number

MAINTENANCE BOND

KNOW ALL MEN BY THESE PRESENTS:

That _____
(Contractor name, complete address including ZIP Code and legal title)

as Principal, hereinafter called Contractor, and _____
(Surety name and complete address including ZIP Code)

_____ a corporation organized and existing under
the laws of the State of _____, with its principal office in the City of _____

as Surety, hereinafter called Surety, are held firmly bound unto _____
(Owner name, complete address including ZIP Code and legal title)

as Obligee, hereinafter called Owner, in the amount of _____
Dollars (_____), for the payment whereof Contractor and Surety bind themselves, their heirs, executors,
administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, Contractor has by written agreement dated _____
_____ entered into a contract with Owner for _____

in accordance with drawings and specifications prepared by _____

which contract is by reference made a part hereof, and is hereinafter referred to as the CONTRACT.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if Contractor shall, for a period of two (2) years from and after the date
of completion and acceptance of same by Owner, replace any and all defects arising in the Work, whether resulting from defective materials or
defective workmanship, after such period this obligation shall be null and void; otherwise it will remain in full force and effect.

The Surety hereby waives notice of any alteration or extension of time made by the Owner.

Whenever Contractor shall be, and declared by Owner to be in default under the CONTRACT, the Owner having performed Owner's obligations
thereunder, the Surety may promptly remedy the default, or shall promptly:

1. Complete the CONTRACT in accordance with its terms and conditions, and
2. Shall save the Owner harmless from any claims, judgments, or liens arising from the Surety's failure to either remedy the default or to
complete the CONTRACT in accordance with its terms and conditions in a timely manner.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the Owner named herein or the successors of
Owner.

Signed and sealed this * _____ day of _____ 20_____.

Principal Corporate Seal

(Contractor Name)

BY: _____ (Seal)
(Must be President, Vice President, Owner, Partner, Manager, Member,
or other duly Authorized Agent)

(Title)

Surety Corporate Seal

(Surety)

BY: _____ (Seal)

NOTE: Please attach Power of Attorney.

NOTE: Applicable sections of attached acknowledgments
must be completed and returned as part of the bond.

APPROVED AG 07-15-2024

ACKNOWLEDGMENTS

Acknowledgment by Principal if individual or Partnership

1. STATE OF _____
2. County of _____ to-wit: _____
3. I, _____, a Notary Public in and for the
4. county and state aforesaid, do hereby certify that _____
whose name is signed to the foregoing writing, has this day acknowledged the same before me in my said county.
5. Given under my hand this _____ day of _____ 20 _____
6. Notary Seal
7. _____
(Notary Public)
8. My commission expires on the _____ day of _____ 20 _____

Acknowledgment by Principal if Corporation

9. STATE OF _____
10. County of _____ to-wit: _____
11. I, _____, a Notary Public in and for the
12. county and state aforesaid, do hereby certify that _____
13. who as, _____ signed the foregoing writing for
14. a corporation, has this day, in my said county, before me, acknowledged the said writing to be the act and deed of the said corporation.
15. Given under my hand this _____ day of _____ 20 _____
16. Notary Seal
17. _____
(Notary Public)
18. My commission expires on the _____ day of _____ 20 _____

Acknowledgment by Surety

19. STATE OF _____
20. County of _____ to-wit: _____
21. I, _____, a Notary Public in and for the
22. county and state aforesaid, do hereby certify that _____
23. who as, _____ signed the foregoing writing for
24. _____ a corporation,
has this day, in my said county, before me, acknowledged the said writing to be the act and deed of the said corporation.
25. Given under my hand this _____ day of _____ 20 _____
26. Notary Seal
27. _____
(Notary Public)
28. My commission expires on the _____ day of _____ 20 _____

Sufficiency in Form and Manner of Execution Approved

Attorney General

This _____ day of _____ 20 _____.

By: _____
(Deputy Attorney General)

ACKNOWLEDGMENT PREPARATION INSTRUCTIONS

1. **IF PRINCIPAL IS AN INDIVIDUAL OR PARTNERSHIP, HAVE NOTARY COMPLETE LINES (1) THROUGH (8)**
2. **IF PRINCIPAL IS A CORPORATION, HAVE NOTARY COMPLETE LINES (9) through (18)**
3. **SURETY MUST HAVE NOTARY COMPLETE LINES (19) through (28)**
4. **ALL DATES MUST BE THE SAME**
 - a. **CONTRACT DATE** ("WHEREAS, 1. "Contractor has by written agreement dated" **AND** 2. "Signed and Seald this" **BONDS** 1st pg.)
 - b. **ACKNOWLEDGEMENTS BY NOTARY** ("Given under my hand this" - Line 5. Individual or Line 15. Corporation, and Line 25. Surety - **ACKNOWLEDGEMENTS** 2nd pg.)
 - c. **POWER OF ATTORNEY** ("Given under my hand and seal of said Companies at" **POA** Form 3rd pg.)
5. **NOTARIES MUST:**

ACKNOWLEDGMENT BY PRINCIPAL, IF INDIVIDUAL OR PARTNERSHIP

1. Enter name of State.
2. Enter name of County.
3. Enter name of Notary Public witnessing transactions.
4. Enter name of principal covered by bond if individual or partnership. (Must be Owner or General Partner of Sole Proprietorship or Partnership)
5. Notary enters date bond was witnessed. All Signature DATES need to match
6. Affix Notary Seal.
7. Notary affixes his/her signature.
8. Notary enters commission expiration date.

ACKNOWLEDGMENT BY PRINCIPAL IF CORPORATION

9. Enter name of State.
10. Enter name of County.
11. Enter name of Notary Public witnessing transactions.
12. Enter name of Corporate Officer signing bond.
13. Enter Title of Corporate Officer signing bond. (Must be President or Vice President of Corporation; Manager or Managing Member of Limited Liability Company)
14. Enter name of Company or Corporation.
15. Notary enters date bond was witnessed. All Signature DATES need to match.
16. Affix notary Seal.
17. Notary affixes his/her signature.
18. Notary enters commission expiration date.

ACKNOWLEDGMENT BY SURETY

19. Enter name of State.
20. Enter name of County.
21. Enter name of Notary Public witnessing transactions.
22. Enter name of person having power of attorney to bind Surety Company.
23. Enter Title of person binding Surety Company.
24. Enter name of Insurance Company (Surety).
25. Notary enters date bond was witnessed. All Signature DATES need to match.
26. Affix Notary Seal.
27. Notary affixes his/her signature.
28. Notary enters commission expiration date.

POWER OF ATTORNEY INSTRUCTIONS

Power of attorney for surety must be attached showing that it was in full force and effect on signature date indicated on the face of the bond. A corporate seal must also be affixed to the Power of Attorney form.

- a. Name of attorney in fact must be listed.
- b. Power of Attorney may not exceed imposed limitations.
- c. Certificate date, the signature date of bond must be entered. **All Signature DATES Must Match.**
- d. Signature of authorizing official must be affixed. (Signature may be facsimile).
- e. **Seal must be affixed.**

**MARSHALL UNIVERSITY
KANAWHA COUNTY, WEST VIRGINIA
MU BILL NOE FLIGHT SCHOOL**

**MANDATORY PRE-BID CONFERENCE
Thursday, July 9, 2026, at 10:00am**

Thrasher Project #T60-11664

Name	Representing	Phone #	Email Address
Jason Mcels	Wiseman Construction	304-344-1200	Awiseman@wiseman.corp.com jlink@wisemancorp.com
Casey Jarrett	M+L Electric	304-545-8567	casey.jarrett@munlelectric.com
John Rysta	Neighborgall Construction	304-525-5181	estimating@neighborgall.com
Dan Hill	Danhill Construction	304-663-5761	dan.hill@danhill construction.com
Jody Moore	Maynard C. Smith Construction	304-925-3190	estimating@mc5constructionwv.com
AUSTEN KING	AGSTEN CONSTRUCTION CO INC	304.343.5400	AKING@AGSTENCONSTRUCTION.COM
Jack Linville	Swope Construction Co.	304-325-8146	bid@swopeco.com
Tate Ashby	WB Fosson & Sons	(606) 371-3832	tashby@wbfosson.com
Tom Heck	WB Fosson & Son	606-923-0239	theck@wbfosson.com
Doug Denney	Collier Const.	740-352-9930	dougdenney@gmail.com

Name	Representing	Phone #	Email Address
Thomas Wheeler	March - Westin	304-690-4196	twheeler@marchwestin.com tanner@marchwestin.com
Davin Rhoads	Paramount Builders	681-557-7887	drhoads@ParamountWV.com dFoster@ParamountWV.com
Christina Wells	BPI, Inc.	(304) 760-8909	cwells@bpi-gc.com
Olivia Rees	WV Paving	740-438-9642	olivia.rees@wvpaving.com
Travis Bailey	Pray Construction	304-755-4944	TBailey@PrayConstruction.com
Scott Cunningham	SQA Construction	304-532-3659	estimating@sqagc.com
Chelsea Rhodes	New River Contracting	304-640-6818	Project@newRiverContracting.com info@newRiverContracting.com
Vadym KAZAKOV	Persinger & Associates	304-531-2717	WILL@Persingerandassociates.com
Tom Simms	BBL Carlton, LLC	304-345-1300	tsimms@bbcarton.com
Nicole Price	Thrasher	304-423-5991	nprice@thetrashergroup.com
Philip Freeman	THRASHER	304-423-5689	Pfreeman@thetrashergroup.com

Name	Representing	Phone #	Email Address
<i>Ryan Pleach</i>	<i>R.P. Pleach & Sons</i>	<i>304-523-7560</i>	<i>office@rpleach.com</i>
<i>Jarrett Smith</i>	<i>Marshall</i>	<i>304-881-2659</i>	<i>Smith1866@marshall.edu</i>
<i>JOE BELCHER</i>	<i>CRW</i>	<i>304-952-3986</i>	<i>JBELCHER@FLYCRW.COM</i>
<i>Missy Workman</i>	<i>Marshall University Procurement</i>	<i>304.696.3498</i>	<i>workman57@marshall.edu</i>

ADDENDUM ACKNOWLEDGEMENT

FORM SOLICITATION NO.: Addendum No.01

00173492 Marshall University Bill Noe Flight School New Hangar and Classrooms

Instructions: Please acknowledge receipt of all addenda issued with this solicitation by completing this addendum acknowledgment form. Check the box next to each addendum received and sign below. Failure to acknowledge addenda may result in bid disqualification.

Acknowledgment: I hereby acknowledge receipt of the following addenda and have made the necessary revisions to my proposal, plans and/or specifications, etc.

Addendum Numbers Received:

(Check the box next to each addendum received)

- | | |
|--|--|
| ☒ Addendum No. 1 | ☐ Addendum No. 6 |
| ☐ Addendum No. 2 | ☐ Addendum No. 7 |
| ☐ Addendum No. 3 | ☐ Addendum No. 8 |
| ☐ Addendum No. 4 | ☐ Addendum No. 9 |
| ☐ Addendum No. 5 | ☐ Addendum No. 10 |

I understand that failure to confirm the receipt of addenda may be cause for rejection of this bid. I further understand that any verbal representation made or assumed to be made during any oral discussion held between Vendor's representatives and any University personnel is not binding. Only the information issued in writing and added to the specifications by an official addendum is binding.

Company

Authorized Signature

Date

NOTE: This addendum acknowledgment should be submitted with the bid to expedite document processing.