SZOSTAK

ADDENDUM NUMBER TWO

29 October 2025

NC Department of Natural and Cultural Resources
Fort Fisher Aquarium – Renovation & Expansion
Phase 1
SCO ID #17-18042-02A

The following items supersede the bid documents dated 8 September 2025 and shall become a part of those bid documents with full force and effect, as though set forth therein. Bidders shall acknowledge receipt of this Addendum #2 in the appropriate place on the "Form of Proposal".

Where any article, division or subparagraph of the original contract documents or other addenda is supplemented herein, the provisions of the original documents shall remain in effect. All the supplemental provisions shall be considered as added thereto. Where any such article, division or subparagraphs are amended, voided or superseded thereby, the provisions of such article, division or subparagraph not so specifically amended, voided or superseded shall remain in effect.

It will be the responsibility of each Contractor to call such clarifications, additions to and changes in the plans and specifications to the attention of subcontractors concerned. The Designer in no way assumes any responsibility for notifying any subcontractor, material dealers or others not having received the original contract documents.

CHANGES TO THE DOCUMENTS:

GENERAL

1. Items discussed at the Pre-Bid Meeting and subsequent RFIs will be incorporated into a future Addendum, if required.

CHANGES TO THE SPECIFICATIONS:

1. Section 012300 ALTERNATES
    a. Added Alternate #11 Rooftop Units and Preferred Alternates PA-3 and PA-4.
2. Section 230923 DIRECT DIGITAL CONTROL SYSTEM FOR HVAC
3. Section 260573 POWER SYSTEM STUDIES
4. Section 262413 SWITCHBOARDS
5. Section 26416 PANELBOARDS
6. Section 262419 MOTOR-CONTROL CENTERS
7. Section 262816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS
8. Section 263213.13 DIESEL-ENGINE-DRIVEN GENERATOR SETS
9. Section 263600 TRANSFER SWITCHES
10. Section 264313 SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS
11. Section 271323 COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING
12. Section 271513 COMMUNICATIONS COPPER HORIZONTAL CABLING

CHANGES TO THE DRAWINGS:

Replace the following drawing sheets with those noted below:

1. A-7.8: WALL SECTIONS
    a. Updated Expansion Joint Locations
2. A-8.25: PLAN DETAILS
    a. Updated Expansion Joint Locations
3. F-0.1: FIRE PROTECTION GENERAL NOTES AND DETAILS
4. F-2.21A: FIRST FLOOR FIRE PROTECTION PLAN – CAPE FEAR SHOALS
5. F-2.21B: FIRST FLOOR FIRE PROTECTION PLAN – TOUCH & SHARK TANK
6. F-2.22A: SECOND FLOOR FIRE PROTECTION PLAN – CAPE FEAR SHOALS
7. F-2.22B: SECOND FLOOR FIRE PROTECTION PLAN – TOUCH & SHARK TANK
8. F-2.23B: THIRD FLOOR FIRE PROTECTION PLAN – SHARK TANK
9. S-001: GENERAL NOTES
10. S-111 B: FOUNDATION PLAN – TOUCH & SHARK TANK
11. S-121 B: FIRST FLOOR FRAMING PLAN – TOUCH & SHARK TANK
12. S-122 B: FIRST FLOOR SLAB REINFORCEMENT PLAN – TOUCH & SHARK TANK
13. S-125 C: FIRST FLOOR FRAMING PLAN – SOUTHEAST WING
14. S-130 B: SECOND FLOOR FRAMING PLAN – TOUCH & SHARK TANK
15. S-140 B: FRAMING PLAN UNDER SHALLOW TANKS AT SHARK TANK
16. S-150 B: THIRD FLOOR FRAMING PLAN – TOUCH & SHARK TANK
17. S-160 B: ROOF FRAMING PLAN – TOUCH & SHARK TANK
18. S-170 B: FRAMING PLAN – CONNECTOR AREA
19. S-300: TYPICAL FOUNDATION DETAILS
20. S-501: FIRST FLOOR SECTIONS
21. S-502: FIRST FLOOR SECTIONS
22. S-503: SOUTHEAST WING – FIRST FLOOR SECTIONS

Changes from 9/8/25 Bid Set documents noted with revision clouds.

ATTACHMENTS:

REVISED SPECIFICATION SECTIONS AS NOTED ABOVE

REVISED DRAWING SHEETS AS NOTED ABOVE

End of Addendum Number Two

SECTION 012300 – ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.2 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES FOR **PHASE ONE SCOPE**

A. Alternate No. **1** – **Not Used**

B. Alternate No. **2** – **Entry Lobby & Restroom Renovations**: Renovate main Entry Lobby area with expanded restroom space.

1. Base Bid: No changes to Entry Lobby or adjacent restrooms.
2. Alternate: Demolish interior areas in Entry Lobby #R123 and adjacent rooms per 1/AD-1.21B, and renovate per 1/A-2.21D, 1/A-3.21D and associated MEP+FP sheets.

C. Alternate No. **3** – **Exotic Aquatics Modifications & Additions**: Provide changes and additional exhibits in the Exotic Aquatics #R130 area in the existing aquarium space.

1. Base Bid: No changes to Exotic Aquatics #R130.
2. Alternate: Reconfigure circulation through Exotic Aquatics exhibits per A-2.21A and install exhibits per sheets X-209, X-210, X-211, X-212 along with associated life support systems and lighting.

D. Alternate No. **4** – **Level 2 Staff Bathroom Renovation**: Renovate existing staff bathrooms/showers in back of house area on level 2.

1. Base Bid: No changes to staff bathroom & shower rooms in this area.
2. Alternate: Demolish existing interior spaces per AD-1.22A and renovate per A-2.22A, A-3.22-A and associated MEP+FP sheets.

E. Alternate No. **5A** – **Renovate Level 1 Restroom #s R113 & R114**: Renovate existing men's and women's gang toilets R113 & R114.

1. Base Bid: No changes to these restrooms.
2. Alternate: Remove existing fixtures and partitions in R113 & R114 per 2/AD-1.21B and renovate per 5/A-4.11 and associated plumbing sheets.

F. Alternate No. **5B** – **Renovate Level 2 Restroom #s R215 & R216**: Renovate existing men's and women's gang toilets R215 & R216.

1. Base Bid: No changes to these restrooms.
2. Alternate: Remove existing fixtures and partitions in R215 & R216 per 2/AD-1.22B and renovate per 6/A-4.11 and associated plumbing sheets

G. Alternate No. **6** – **Main Parking Lot & Bus Lot**: Reconfigure main parking lot and satellite lot.

1. Base Bid: No work in either area.
2. Alternate: Reconfigure main and satellite parking areas per Civil sheets C-0, C-1, C-2.0, C-2.1, C-3, C-4 & C-5 and Landscape Sheets L-1.20 & L-1.30, including associated stormwater structures.

H. Alternate No. **7** – **Lighting & Controls in Existing Exhibits/Areas**: Provide new light fixtures and control system in existing exhibit spaces.

1. Base Bid: No change to lighting or controls in current exhibit areas.
2. Alternate: Provide new lighting fixtures and control systems per LT series drawings.

I. Alternate No. **8** – **Outdoor Classroom Roof**: Provide roof structure above outdoor classroom.

1. Base Bid: No roof covering in outdoor classroom area.
2. Alternate: Provide roof structure, roof covering, finish materials, lighting, sprinklers, and associated items in outdoor classroom area.

J. Alternate No. **9** – **Emergency Power Supply System (EPSS)**: Provide emergency generators and new fuel tank.

1. Base Bid: Engine-Generator sets, exhaust system and silencers, generators remote annunciators, day tanks DT01 and DT02, ATS-LS, ATS-LSS, ATS-OP, 20,000 gallon above ground fuel tank and concrete base, fuel piping, fuel tank control panel, fuel as specified, gen sets paralleling controls, feeders from gen sets to Switchboard EPS, grounding, engine -generators controls as shown in Detail 5/E-5.6, emergency power off switches, will be procured, installed, tested and commissioned **under a separate contract by the owner** per the Divisions 23 and 26 drawings and specifications submitted. Contractor must provide supporting branch power circuits to each gen set and intake and exhaust louvers and power circuits.

2. Alternate: Provide and install EPSS as described above and per the Divisions 23 and 26 drawings and specifications.

K. Alternate No. **10**– **Epoxy coated Concrete**: Provide epoxy coating on concrete floors in select areas.

1. Base Bid: Provide sealed concrete floors per the Finish Schedule on A-9.1.

2. Alternate: Provide epoxy coating to floor areas as called out on Finish Schedule A-9.1 in the “Comments” column.

L. Alternate No. **11**– **Rooftop Units**: Provide corrosion resistant cabinet construction for rooftop units per schedule on drawing M-6.2.

1. Base Bid: Provide **composite** cabinet construction.

2. Alternate: Provide **aluminum** cabinet construction.

Preferred Alternates

M. Preferred Alternate No**. PA-1**– Provide **Kessil W500 Aquascape Series** light fixtures for exhibits as specified in section 265100.

N. Preferred Alternate No**. PA-2**– Provide either **Kessil W2K Aquascape Series** or **Maxspect commercial LED Floodlight Series** light fixtures as specified in section 265100 for the Live Coral exhibit.

O. Preferred Alternate No**. PA-3**– Provide extension of the **existing Alerton Compass v2 building automation system** by **Hoffman Building Technologies**.

P. Preferred Alternate No**. PA-4**– Provide **Trane Chillers**, **Trane Indoor Air Handling Units**, and **Trane Rooftop Units** as scheduled.

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END OF SECTION 012300

SECTION 230923 DIRECT - DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish a totally native BACnet-based system. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2008, BACnet. In other words, all workstations and controllers, including unitary controllers, shall be native BACnet devices. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to systems installed under other sections.

B. This system shall be directly interfaced with the existing Alexandria Real Estate Equities BACnet BMS Server and shall be incorporated seamlessly into the existing graphics package and shall match all graphics standards. The existing server has all necessary software and licenses for this interface. All building automation functions for the installed system shall be integrated into the existing Alerton Server. This includes the ability to view, schedule, trend, and alarm all control points through the existing server software.

C. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

C. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

D. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

E. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

F. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

G. Provide and install all interconnecting cables between all operator's terminals and peripheral devices supplied under this section.

H. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

J. Provide a comprehensive operator and technician training program as described herein.

K. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

1.2 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2008. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc., and all air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. Operator's workstation software shall use Microsoft Windows 10 or greater as the computer operating system. The Energy Management and Control System (EMCS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited. All software required to program application specific controllers and all field level devices and controllers will be left with the owner. All software passwords required to program and make future changes to the system will also become the property of the owner. All software required to make any program changes anywhere in the system, along with scheduling and trending applications, will be left with the owner. All software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of the owner. All software required for all field engineering tools including graphical programming and applications will be left with the owner. All software passwords required to program and make future changes to field engineering tools, including graphical programming and applications will be left with the owner.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. Room sensors shall be provided with digital readout that allow the user to view room temperature, view outside air temperature, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

E. All application controllers for every terminal unit (VAV, HP, UV, etc.) air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet LAN.

1.3 APPROVED MANUFACTURERS

A. The basis of design shall be a new building automation system for the expansion and renovation areas by one of the approved listed manufacturers. As an alternate bid, extend the existing Alerton Compass v2 building automation system by Hoffman Building Technologies.

Approved Control Manufacturers:

1. Hoffman Building Technologies

2. Climatec
3. Brady Trane

1.4 QUALITY ASSURANCE

A. The Building Automation System (BAS) system shall be designed, installed, commissioned, and serviced by manufacturer authorized and trained personnel. System provider shall have an in-place support facility within 2 hours response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.

The contractor shall provide full-time, on-site, experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.

The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the design, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

B. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.

C. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

E. Control system shall be engineered, programmed and supported completely by representative's local office that must be within **50 miles** of project site.

1.5 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
2. ANSI/ASHRAE Standard 135-2008, BACnet.
3. Uniform Building Code (UBC), including local amendments.
4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
5. National Electrical Code (NEC).
6. FCC Part 15, Subpart J, Class A.
7. EMC Directive 89/336/EEC (European CE Mark).
8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

1.6 SUBMITTALS

A. Drawings

1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.

2. Drawings shall be submitted in the following standard sizes: 8” x 11 1/2” (ANSI B).

3. Drawings shall be available on USB or other digital media.

4. Print copies shall be provided upon request (in an effort to reduce the environmental impact, digital format will be the primary delivery method for submittals)

B. System Documentation

Include the following in submittal package:

1. System configuration diagrams in simplified block format.

2. All input/output object listings and an alarm point summary listing.

3. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.

4. Complete bill of materials, valve schedule and damper schedule.

5. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.

6. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.

7. For all system elements—operator’s workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.

8. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.

9. A list of all functions available and a sample of function block programming that shall be part of delivered system.

C. Project Management

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

1.7 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or

off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours, Monday through Friday and 48 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

1.8 RELATED WORK IN OTHER SECTIONS

A. Refer to Division 0 and Division 1 for related contractual requirements.

B. Refer to Section 230000 for General Mechanical Provisions.

C. Refer to Section 260000 for General Electrical Provisions.

PART 2 - PRODUCTS

2.1 Advanced Workstation (AWS) - Existing

A. General structure of workstation interaction shall be a standard client/server relationship with web server embedded in the server for browser only access. Server shall be used to archive data and store system database. The AWS shall support operation in a virtualized server environment. Thick and web clients shall access server for all archived data.

1. A single server license shall:

a. Allow a minimum of 50 thick client seats/installations.

b. Allow a minimum of 200 web client users.

c. Not restrict system size based on point count (BACnet or Integration).

B. Data Displays

1. Data displays shall render all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings, and wiring diagrams from as-built drawings.

2. Data displays shall render data using iconic graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, trendlog, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user.

3. Data display frame shall allow user to change all field-resident AWS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc., from any screen, no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic.

5. All displays and programming shall be generated and customized by the local use energy management and control system (EMCS) supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.

6. AWS shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. AWS shall include a library of equipment graphic components to assemble custom graphics. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.

7. A navigation tree for building, equipment and system diagnostic centric display organization shall be available from data display view. The tree navigation contents shall be customizable on a per-user and per-group basis.

8. Each display may be protected from viewing unless operator credentials have the appropriate access level. An access level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.

9. Data displays shall have the ability to link to content outside of the EMCS system. Such content shall include, but is not limited to launching external files in their native applications (for example, a Microsoft Word document).

10. A single system software license can support a minimum of 200 user accounts and web access.

11. Data displays shall support:

    a. Graphic items with custom geometry that offer both color gradient shading and variable opacity in scale to system variables, both analog and digital, and color range settings. For example, rooms on a floor plan graphic can be made to indicate the space temperature by varying the color of that room.

    b. Clear and custom geometry navigation buttons to provide intuitive navigation to system display or external URLs.

    c. Graphic files in JPG, PNG, and GIF file types.

    d. Viewing of up to 1,024 system data points (Analog, Binary, and/or Multi-state) in a single screen.

    e. Customizable mouse-over tooltip information of graphic items or data points can be displayed. The tooltips can be turned on and off. The default setting is off.

    f. Right click capability to directly access system functionality, such as Schedule, Trendlogs, and Alarms associated with a display object selected.

    g. Automatic zooming to the screen size detected to maximize the size of the display to match screen display area available. The zoom capability can be enabled or disabled, default is enabled. The background color, if solid, will be used to flood fill the remaining screen background.

    h. Supports user configurable embedded Data Viewer for a persistent trend log data view to accompany system data and graphic information on a single display.

C. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.

2. AWS shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID, User Name, and Password shall be shall support a minimum of 40 characters. All user information and passwords shall be stored in an encrypted form.

3. Each user shall be allowed individual assignment of only those control functions, menu items, navigation tree, and user-specific system start display, as well as restricted access to *discrete BACnet devices* to which that user requires access.

4. All passwords, user names, and access assignments shall be adjustable via Server and Thick client. Password shall be adjustable via the web client.

5. Users shall also have a set access level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct access levels for assignment to users.

6. The AWS and Thick Client shall include an Auto Logout feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

7. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

D. Operator Activity Log

1. An Operator Activity Log that tracks all operator changes and activities shall be included with AWS. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity Log display.

2. Log shall be gathered and archived to a hard drive on AWS as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

3. System shall have the option to require user comment recording in the Operator Activity Log upon any system point change.

4. Operator Activity log shall be accessible via the Web Client for viewing, sorting, filtering, and Printing.

E. Scheduling

1. AWS, Thick Client and Web Client shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.

2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.

3. Operator shall be able to change all information for a given weekly or exception schedule

if logged on with the appropriate access privileges.

4. AWS and Thick Client shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting Schedule.

5. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

6. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

7. Display of all three schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.

8. Any displayed data that is changeable by the operator may be selected using the right mouse button and the schedule shall then be selectable on the screen. Selection of the schedule using this method shall allow the viewing of the assigned schedule allow the point to be scheduled.

9. Schedule editor shall support drag-n-drop events and holidays onto the schedule calendar.

10. Schedule editor shall support drag-n-drop events default to a two-hour period, which can then be adjusted by the user.

11. Schedule editor shall support drag-n-drop holidays default for OFF all day and can be edited for multiple-day holidays.

12. Schedule editor shall support the view of affected zones when adding or editing timed events of a schedule.

13. The web client shall have the ability to search a list of all scheduled points and zones to access the schedule calendar.

14. Schedule time blocks shall present schedule detail via mouse-over information.

F. Alarm Indication and Handling

1. AWS shall provide visual, printed, and email means of alarm indication. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID’s authorization level.

2. Web client shall display a persistent alarm state for the system regardless of the data view including points in alarm but not acknowledged, and points that have gone into alarm and returned to normal without being acknowledged.

3. Alarm History shall provide log of alarm messages. Alarm log shall be archived to the hard

disk of the AWS. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.

4. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).

5. AWS, Thick Client, and Web Client shall allow for set up of alarms. UI shall walk user through all steps necessary for alarm generation. Alarm creation may be started by right-clicking on value displayed on graphic and then selecting Alarm setup.

6. Web client shall support color-coded indication of current alarms as follows:

    i. Red indicator shows number of active alarms that have not been acknowledged.

    j. Yellow indicator shows number of alarms that are still active but have been acknowledged.

    k. Blue indicator shows number of alarms that have returned to normal but have not been acknowledged.

    l. Color-coded indicators, when selected by the user, navigate to a pre-filtered view of alarm history.

    m. Alarm history can be filtered by color-coded indicator states.

7. Alarm annunciation includes navigation link to a user-selected display or URL.

8. Any displayed data that is changeable by the operator may be selected using the right mouse button and the alarm shall then be selectable on the screen. Selection of the alarm using this method shall allow the viewing of the alarm history or allow the creation of a new alarm.

G. Trendlog Information

1. AWS shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 50 million records before needing to archive data. Samples may be viewed at the web client. All trendlog records shall be displayed in standard engineering units.

2. AWS shall be capable of trending on an interval determined by a polling rate, or change-of-value.

3. AWS, Thick client, or Web Client shall be able to add and edit trendlogs and the setup information. This includes the information to be logged as well as the interval at which it is to be logged. All operations shall be password protected. Viewing may be accessed directly from any and all graphics on which a trended object is displayed.

4. AWS and Thick Client shall include a Trendlog Wizard for setup of multiple trend logs simultaneously. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right-clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.

5. AWS shall be capable of using Microsoft SQL as the system database.

6. Any displayed data that is changeable by the operator may be selected using the right mouse button and the trendlog shall then be selectable from a menu on the screen. Selection of the trendlog using this method shall allow the viewing of the trendlog data in the DataViewer.

7. DataViewer shall provide:

    a. Software that is capable of graphing the trend-logged object data shall be included.

    b. Access and ability to create, edit and view are restricted to users by user account credentials

    c. Specific and repeatable URL defines the trendlog(s) views for browser bookmarking and email compatibility.

    d. Call out of trendlog value at intersection of trend line and mouse-over vertical axis.

    e. Trendlog or Energy log and companion logs can be configured to display on one of two independent vertical scales embedded in the display.

    f. Click zoom for control of data set viewed along either graph axis.

    g. User-specifiable start and end dates as well as a fast scroll features that supports click zoom of macro scale view of the data for quickly finding data set based on visual signature.

    h. User export of the viewed data set to MS Excel.

    i. Web browser-based help.

    j. Optional min/max ranges (Upper Control Limits, Lower Control Limits) for each value.

H. Energy Log Information

1. AWS shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.

2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.

3. AWS operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.

4. AWS shall display data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

5. Web client shall display data in tabular format and graphical format. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

I. Demand Limiting

1. AWS shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator-selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or a single piece of equipment connected to system.

2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.

3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.

4. AWS shall be able to display the status of each and every load shed program. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

J. Reports

1. AWS shall be capable of periodically producing reports of trendlogs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.

2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

K. Field Engineering Tools

1. AWS shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.

2. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.

3. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.

4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.

5. Field engineering tool shall include Device Manager for detection of devices connected

anywhere on the BACnet network by scanning the entire network. This function shall display device instance, network identification, model number, and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller using the mouse.

6. AWS shall automatically notify the user when a device that is not in the database is added to the network.

7. AWS shall include backup/restore function that will back up entire system to selected medium and then restore system from that medium. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.

8. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

L. Software

1. At the conclusion of the project, contractor shall leave with owner a electronic copy that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.2 BUILDING CONTROLLER

A. General Requirements

1. BACnet Conformance

a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.

b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2. Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.

3. The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.

4. The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.

5. The controller shall be capable of running up to six (6) independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.

6. The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a wide area network (WAN) or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.

7. Programming shall be object-oriented using control function blocks and support DDC functions. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.

8. The programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.

9. Controller shall have 6,000 Analog Values and 6,000 Binary Values.

10. Controller IP configuration can be done via a direct USB connect with an operator's workstation or field computer.

11. Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.

12. Global control algorithms and automated control functions shall execute using a 64-bit processor.

13. Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.

14. Controller shall support two (2) on-board EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.

    a. Ports are capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.

15. Controller shall support two (2) ports—each of gigabit speed—Ethernet (10/100/1000) ports.

    a. Ports are capable of supporting various Ethernet protocols including, but not limited to BACnet IP, FOX, and Modbus.

16. All ports shall be capable of having protocol(s) assigned to utilize the port's physical connection.

18. Schedules

    a. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.

    b. Each building controller shall support a minimum of 380 BACnet Schedule Objects and 380 BACnet Calendar Objects.

19. Logging Capabilities

    a. Each building controller shall log as minimum 2,000 objects at 15-minute intervals. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

    b. Logs may be viewed both on-site or off-site using WAN or remote communication.

    c. Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.

    d. Archived data stored in database format shall be available for use in third-party

spreadsheet or database programs.

20. Alarm Generation

    a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

    b. Each alarm may be dialed out as noted elsewhere.

    c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.

    d. Controller must be able to handle up to 2,000 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

21. Demand Limiting

    a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 1,200 loads using a minimum of two types of shed programs.

    b. Load shedding programs in building controller modules shall operate as defined in section 2.1.I of this specification.

B. BACnet MS/TP

1. BACnet MS/TP LAN must be software-configurable from 9.6 to 115.4Kbps

    a. Each BACnet MS/TP LAN shall support 64 BACnet devices at a minimum.

    b. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. BACnet IP

1. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the local area network (LAN).

2. Must support interoperability on WANs and campus area networks (CANs), and function as a BACnet Broadcast Management Device (BBMD).

3. Each controller shall support at a minimum 128 BBMD entries.

4. BBMD management architecture shall support 3,000 subnets at a minimum.

5. Shall support BACnet Network Address Translation.

6. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

D. Expansion Ports

1. Controller shall support two (2) expansion ports.

a. Combining the two on-board EIA-458 ports with fully loaded expansion ports, the controller shall support six (6) EIA-485 trunks simultaneously.

F. Power Supply

1. Input for power shall accept between 17 and 30VAC, 47 and 63Hz.

2. Optional rechargeable battery for shutdown of controller including storage of all data in flash memory.

3. On-board capacitor will ensure continuous operation of real-time clocks for minimum of 14 days.

G. Controller shall be in compliance with the following:

1. UL 916 for open energy management

2. FCC Class B

3. ROHS

4. IEC 60703

5. C-Tick Listed

H. Controller shall operate in the following environmental conditions:

1. -4 to 149 °F without optional battery, or 32 to 122 °F with optional battery.

2. 0 to 95% relative humidity (RH), non-condensing.

2.3 CENTRAL PLANT AND AIR HANDLER APPLICATION CONTROLLERS

A. Provide one or more native BACnet application controllers for each air handler and provide native BACnet application controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller through either MS/TP LAN using BACnet protocol, or Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. BACnet Conformance

1. Application controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.

2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support either 0–10VDC or 0–20mA. Binary outputs shall have LED indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

1. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.

2. The position of each and every HOA switch shall be available system wide as a BACnet object property.

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal.

1. The following control blocks shall be supported:

    a. Natural Log

    b. Exponential

    c. Log base 10

    d. X to the power of Y

    e. Nth square root of X

    f. 5th Order Polynomial Equations

    g. Astronomical Clock (sunrise/sunset calculation)

    h. Time based schedules

E. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

F. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

G. Schedules

1. The controller shall support a minimum of 3 BACnet Schedule Objects and have a real time

clock on board with battery backup to maintain time through a power loss.

H. Logging Capabilities

1. Controller shall support a minimum of 50 trendlogs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

I. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.

2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.

3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

J. The controller processor shall be a 32-bit processor.

K. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.4 TERMINAL UNIT APPLICATION CONTROLLERS (Heat Pumps, AC Units, Fan-Coils)

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. BACnet Conformance

1. Application controllers shall, as a minimum, support MS/TP BACnet LAN types. They shall communicate directly using this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements and support all BACnet services necessary to provide the following BACnet functional groups:

a. Files Functional Group

b. Reinitialize Functional Group

c. Device Communications Functional Group

2. Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input,

Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.5 VAV BOX CONTROLLERS—SINGLE DUCT

A. Provide one native BACnet application controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. BACnet Conformance

1. Application controllers shall, at a minimum, support MS/TP BACnet LAN types. They shall communicate directly through this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements.

2. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall also include binary outputs on

board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller shall include microprocessor driven flow sensor for use in pressure independent control logic. All boxes shall be controlled using pressure-independent control algorithms and all flow readings shall be in CFM (LPS if metric).

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using the same programming tool as Building Controller and as described in operator's workstation section. All programming tools shall be provided as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operations for specific display requirements for intelligent room sensor.

F. On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator's workstation, portable computers, and special hand-held field tools shall not be needed for field calibration.

G. Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator's workstation.

2.6 AUXILIARY CONTROL DEVICES

A. Temperature Sensors

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. All temperature sensors shall use Thermistor or platinum RTD elements. All temperature sensors to be solid-state electronic, interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake, and in a location, that is in the shade most of the day. All Temperature Sensors shall be Alerton, ACI or Veris.

a. Room Temperature:

- Sensor Output: 10KΩ @ 77°F
- Sensor Accuracy: ±0.36°F from 32 to 158°F
- Operating Temperature Range: -40 to 212°F
- Operating Humidity Range: 0 to 90% RH non-condensing

b. Liquid Immersion Temperature:

- Sensor Output: 10KΩ @ 77°F
- Sensor Accuracy: ±0.36°F from 32 to 158°F
- Operating Temperature Range: -40 to 302°F
- Operating Humidity Range: 10 to 95% RH non-condensing

c. Duct (Single Point & Averaging) Temperature

- Sensor Output: 10KΩ @ 77°F
- Sensor Accuracy: ±0.36°F from 32 to 158°F
- Operating Temperature Range: -40 to 302°F
- Operating Humidity Range: 10 to 95% RH non-condensing

d. Outside Air Temperature

- Sensor Output: 10KΩ @ 77°F
- Sensor Accuracy: ±0.36°F from 32 to 158°F
- Operating Temperature Range: -40 to 302°F
- Operating Humidity Range: 10 to 95% RH non-condensing

B. Humidity Sensor

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. All humidity sensors shall be transmitters. Sensor output shall be 0-10V or 4-20mA signal. Sensor shall operate from 24 VDC or 24 VAC power source. The sensors shall be wall or duct mounted type as indicated on plans and in the sequence of operation. Wall sensors to be installed as indicated on drawings. Duct sensors to be installed such that the sensing element is in the main air stream. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake, and in a location, that is in the shade most of the day. All humidity sensors shall be Alerton or ACI.

a. Outdoor/Duct Humidity Sensor

- Sensor Output: 4-20mA or 0-10 VDC
- Sensor Accuracy: ±2% from 10 to 95% RH
- Operating Temperature Range: -40 to 140°F
- Operating Humidity Range: 0 to 100% RH
- Long Term Stability: 2% drift/5 years

b. Room Humidity Sensor

- Sensor Output: 4-20mA or 0-10 VDC

- Sensor Accuracy: ±2% from 10 to 95% RH
- Operating Temperature Range: -40 to 140°F
- Operating Humidity Range: 0 to 100% RH
- Long Term Stability: 2% drift/5 years

C. Indoor Air Quality (CO2) sensor

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. The sensor shall be compliant with ASHRAE 62.1 standard. The sensors shall be a non-dispersive infrared (NDIR) operation. Sensor shall have field selectable outputs of 0-10V or 4-20mA. Sensor shall operate from 24 VDC or 24 VAC power source. The sensors shall be wall or duct mounted type as indicated on plans and in the sequence of operation. Wall sensors to be installed as indicated on drawings. Mount 48 inches above finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. All CO2 sensors shall be Alerton, ACI or Veris.

    a. Wall Mounted

        - Sensor Range: 0-2000ppm
        - Sensor Accuracy: ±30ppm ±5% of measured value
        - Sensor Repeatability: ±20ppm ±1% of measured value
        - Operating Temperature Range: 32 to 122°F
        - Operating Humidity Range: 0 to 95% RH
        - 5-year calibration interval

    b. Duct Mounted

        - Sensor Range: 0-2000ppm or 0-5000ppm
        - Sensor Accuracy: ±30ppm ±5% of measured value
        - Sensor Repeatability: ±20ppm ±1% of measured value
        - Operating Temperature Range: 32 to 122°F
        - Operating Humidity Range: 0 to 95% RH
        - 5-year calibration interval

D. Differential Pressure Transmitters

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. Pressure range to suit application. Sensor shall have provision for zeroing by pushbutton or digital input. Sensor shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA. Sensor shall operate from 24 VDC or 24 VAC power source. Sensor shall be switch or jumper selectable for pressure ranges and for flow direction (uni-directional or bi-directional). All pressure sensors shall be Alerton, ACI or Veris.

a. Fluid Pressure Transmitter

- Sensor Pressure Range: 0-100 PSI, as needed
- Sensor Accuracy: ±2.0% FSO (includes linearity, hysteresis and repeatability.)
- Operating Temperature Range: -22 to 248°F
- Operating Humidity Range: 10 to 90% RH
- Enclosure rating: NEMA 4

b. Dry Media Pressure Transmitter

- Sensor Pressure Range: -5.0” W.C. to 5.0” W.C., as needed
- Sensor Accuracy: ±2.0% FSO (includes linearity, hysteresis and repeatability.)
- Operating Temperature Range: 32 to 140°F
- Operating Humidity Range: 0 to 95% RH

E. Control Relays

1. Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Acceptable Manufacturers are IDEC, Functional Devices or Veris.

F. Current Sensors

1. Current sensor shall be self-powered and solid state. The switches shall be selected to match the current of the application and output requirements of the DDC system. The current shall provide visual indication (LED) for output status and sensor. Current sensor shall be Alerton, ACI or Veris.

G. Intelligent Room Sensor with Touchscreen

1. Hardware
   a. Room sensor shall include:
      i. Backlit touchscreen LCD digital display
      ii. Temperature sensor
      iii. Humidity sensor
      iv. Programmable Status Light indicator
      v. CO2 sensor or BACnet MS/TP communication up to 115.2kbps
   b. Temperature sensor shall be a Uni-Curve Type II thermistor with an accuracy of +/- 0.36 °F (0.3 °C) at calibration point over the range of 32 to 158 °F or better.

c. Humidity sensor shall have an accuracy of +/-3% from 10 to 90% relative humidity (RH) or better, non-condensing.

d. The intelligent room sensor's Status Light indicator shall have a minimum of four (4) colors (blue, red, amber and green) that will cast a glow onto the wall below the sensor to be used as visual indicator to the occupants of the condition of the system. The color and on/off state of the Status Light indicator shall be fully programmable.

e. CO2 sensor shall have an accuracy of +/- 30 ppm over the range of 0–5000 ppm or better.

f. CO2 sensor shall utilize Automatic Baseline Correction to maintain sensor calibration without the need for manual calibration.

g. The user shall interact with the smart sensor using a touchscreen, with no buttons allowed.

h. The intelligent room sensor shall have provisions for a tamper proof installation requiring tools to be removed from the wall.

i. The touchscreen shall have a surface hardness of Mohs 7 or greater to prevent being easily scratched.

j. Controller shall function as room control unit, and allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator.

2. Display Content

a. The intelligent room sensor shall simultaneously display room setpoint, room temperature, and outside temperature at each controller.

b. The intelligent room sensor shall have the ability to add or remove from the display time-of-day, room humidity, and indoor air temperature to customize the view for the customer.

c. The intelligent room sensor must have the capability to show temperatures in degrees Fahrenheit or degrees Celsius.

d. A communication loss or improper communications wiring shall be displayed on the LCD screen to aid in trouble shooting.

e. Information about the version of firmware shall be displayable on the LCD screen.

f. A cleaning mode will be provided to allow for the touchscreen to be cleaned without inadvertently making changes to system parameters.

g. The intelligent room sensor shall have the ability to display the status of a lighting zone and control the on/off state of the zone from the touchscreen using a tenant-accessible display page.

h. The intelligent room sensor shall have the ability to display the status of a window zone (e.g., blinds) and control the on/off state of the zone from the touchscreen using a tenant-accessible display page.

i. After Hours Override shall:

vi. Override time may be set and viewed in 30-minute increments.

vii. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor.

viii. Time remaining shall be displayed.

ix. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.

3. Other Modes

a. The intelligent room sensor shall also allow service technician access to hidden functions for advanced system configuration. This functionality shall be accessed-protected with a configurable PIN number.

b. Field Service Mode shall allow access to common parameters as dictated by the application’s sequence of operations. The parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

c. If the intelligent room sensor is connected to VAV controller, Balance Mode shall allow a VAV box to be balanced and all air flow parameters viewed. The balancing parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

4. Intelligent Room Sensor shall be in compliance of the following:

a. UL Standard for Safety 916

b. FCC Part 15.107 & 109, Class B, CFR47-15

c. EMC Directive 89/336/EEC (European CE Mark)

2.7 ELECTRONIC ACTUATORS AND VALVES

A. Quality Assurance for Actuators and Valves

1. UL Listed Standard 873 and C.S.A. Class 4813 02 certified.

2. NEMA 2 rated enclosures for inside mounting, provide with weather shield for outside mounting.

3. Five-year manufacturer’s warranty. Two-year unconditional and three-year product defect from date of installation.

B. Execution Details for Actuators and Valves

1. Furnish a Freeze-stat and install “Hard Wire” interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.

2. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting. Or the actuator feedback signal may be wired to the DDC as an analog input for true actuator position status.

3. VAV box damper actuation shall be floating type or analog (2–10VDC, 4–20mA).

4. Booster-heat valve actuation shall be floating type or analog (2-10vdc, 4-20ma).

5. Primary valve control shall be analog (2–10VDC, 4–20mA).

C. Actuators for damper and control valves 0.5–6 inches shall be electric unless otherwise specified, provide actuators as follows:

1. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify actuators.

2. NEMA 2 rated actuator enclosures for inside mounting. Use additional weather shield to protect actuator when mounted outside.

3. Five-year manufacturer's warranty. Two-year unconditional and Three year product defect from date of installation.

4. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.

5. Position indicator device shall be installed and made visible to the exposed side of the actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the actuator.

6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for butterfly valve actuators.

7. A Pushbutton gearbox release shall be provided for all non-spring actuators.

8. Modulating actuators shall be 24VAC and consume 10VA power or less.

9. Conduit connectors are required when specified and when code requires it.

D. Damper Actuators:

1. Outside air and exhaust air damper actuators shall be mechanical spring return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.

2. Economizer actuators shall utilize analog control 2–10VDC, floating control is not acceptable.

3. Electric damper actuators (including VAV box actuators) shall be direct shaft-mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or set-screw type fasteners are not acceptable.

4. One electronic actuator shall be direct shaft-mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.

5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft-mounted per damper section. (See below execution section for more installation details.)

E. Valve Actuators 0.5–6 inches

1. Mechanical spring shall be provided on all actuators for pre-heat coil and actuators for AHU heating or cooling coil when units are mounted outside. See plans for fail-safe flow function: Normal Open or Normal Closed. Capacitors or other non-mechanical forms of fail-safe are not acceptable.

2. All zone service actuators shall be non-spring return unless otherwise specified.

3. The valve actuator shall be capable of providing the minimum torque required for proper valve close-off for the required application.

4. All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.

5. Override handle and gearbox release shall be provided for all non-spring return valve actuators.

F. Control Dampers.

1. The BAS contractor or sheet metal contractor shall furnish and size all automatic control dampers unless provided with packaged equipment. The sheet metal contractor shall install all dampers unless provided with packaged equipment.

2. All dampers used for modulating service shall be opposed blade type and arranged for normally open or normally closed operation as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop for effective throttling.

3. All dampers used for two-position or open-close control shall be parallel blade type arranged for normally open or closed operation as required.

4. Damper linkage hardware shall be constructed of aluminum or corrosion-resistant zinc and nickel-plated steel and furnished as follows:

5. Bearing support bracket and drive blade pin extension shall be provided for each damper section. Sheet metal contractor shall install bearing support bracket and drive blade pin extension. Sheet metal contractor shall provide permanent indication of blade position by scratching or marking the visible end of the drive blade pin extension.

6. Drive pin may be round only if V-bolt and toothed V-clamp is used to cause a cold weld effect for positive gripping. For single bolt or set-screw type actuator fasteners, round damper pin shafts must be milled with at least one side flat to avoid slippage.

7. Damper manufacturer shall supply alignment plates for all multi-section dampers.

G. Control Valves 0.5–6 inches

1. The BAS contractor shall furnish all specified motorized control valves and actuators. BAS contractor shall furnish all control wiring to actuators. The plumbing contractor shall install all valves. Equal percentage control characteristic shall be provided for all water coil control valves. Linear valve characteristic is acceptable for 3-way valves that are 2.5 inches and above.

2. Characterized control valves shall be used for hydronic heating or cooling applications and small to medium AHU water-coil applications to 100GPM. Actuators are non-spring return for terminal unit coil control unless otherwise noted. If the coil is exposed to the outside air stream, see plans for spring return requirement.

a. Leakage is zero percent, close-off is 200psi, maximum differential is 30psi; rangeability is 500:1.

b. Valves 0.5–2 inches shall be nickel-plated forged brass body, NPT screw type connections.

c. Valves 0.5–1.25 inches shall be rated for ANSI Class 600 working pressure. Valves 1.5 and 2 inches shall be rated for ANSI Class 400 working pressure.

d. The operating temperature range shall be 0–250 degrees F.

e. Stainless steel ball and stem shall be furnished on all modulating valves.

f. Seats shall be fiberglass reinforced Teflon.

g. Two-way and three-way valves shall have an equal percentage control port. Full stem rotation is required for maximum flow to insure stable BTU control of the coil.

h. Three-way valve shall be applicable for both mixing and diverting.

i. The characterizing disc is made of TEFZEL and shall be keyed and held secure by a retaining ring.

j. The valves shall have a blow-out proof stem design.

k. The stem packing shall consist of 2 lubricated O-rings designed for on-off or modulating service and require no maintenance.

l. The valves shall have an ISO type, 4-bolt flange for mounting actuator in any orientation parallel or perpendicular to the pipe.

m. A non-metallic thermal isolation adapter shall separate valve flange from actuator.

n. One fastening screw shall secure the direct coupling of the thermal isolation adapter between the actuator and the valve. This will prevent all lateral or rotational forces from affecting the stem and its packing O-rings.

3. Globe valves 0.5–2 inches shall be used for steam control or water flow applications.

a. Valves shall be bronze body, NPT screw type, and shall be rated for ANSI Class 250 working pressure.

b. Valves 0.5 inches (DN15) through 2 inches (DN50) with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (0.1%).

c. The operating temperature range shall be 20–280 degrees F.

d. Spring loaded TFE packing shall protect against leakage at the stem.

e. Two-way valves shall have an equal percentage control port.

f. Three-way valves shall have a linear control and bypass port.

g. Mixing and diverting valves must be installed specific to the valve design.

4. Globe Valve 2.5–6 inches

a. Valves 2.5 inches (DN65) through 6 inches (DN50) shall be iron body, 125 lb. flanged with Class III (0.1%) close-off leakage at 50 psi differential.

b. Valves with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (0.1%).

c. Flow type for two-way valves shall be equal percentage. Flow type for three-way valves shall be linear.

d. Mixing and diverting valves must be installed specific to the valve design.

H. Butterfly valves

1. Butterfly valves shall be sized for modulating service at 60–70 degree stem rotation. Isolation valves shall be line-size. Design velocity shall be less than 12 feet per second when used with standard EPDM seats.

a. Body is cast iron.

b. Disc is aluminum bronze standard.

c. Seat is EPDM standard.

d. Body Pressure is 200 psi, -30–275 degrees F.

e. Flange is ANSI 125/250.

f. Media Temperature Range is -22–240 degree F.

g. Maximum Differential Pressure is 200 psi for 2- to 6- inch size.

I. Butterfly Valve Industrial Actuators

1. Actuators shall be approved under Canadian Standards Association or other Nationally Recognized Testing Laboratory to UL standards. CSA Class 4813 02 or equal. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.

a. Actuator shall have a motor rated for continuous duty. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120VAC, 1pH, 60Hz supply. Two adjustable cam-actuated end travel limit switches shall be provided to control direction of travel. A self-resetting thermal switch shall be imbedded in the motor for overload protection.

b. Reduction gearing shall be designed to withstand the actual motor stall torque. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.

c. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.

d. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel will not rotate while the actuator is electrically driven.

e. The actuator shall be analog, floating, or two position as called out in the control sequence of operation. All Analog valves shall be positive positioning, and respond to

a 2–10VDC, 4-20mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any voltage input for control and any DC voltage feedback signal for position indication.

2. Performance Verification Test

   a. Control loops shall cause productive actuation with each movement of the actuator and actuators shall modulate at a rate that is stable and responsive. Actuator movement shall not occur before the effects of previous movement have affected the sensor.

   b. Actuator shall have capability of signaling a trouble alarm when the actuator Stop-Go Ratio exceeds 30%.

3. Actuator mounting for damper and valve arrangements shall comply to the following:

   a. Damper actuators: Shall not be installed in the air stream

   b. A weather shield shall be used if actuators are located outside. For damper actuators, use clear plastic enclosure.

   c. Damper or valve actuator ambient temperature shall not exceed 122 degrees F through any combination of medium temperature or surrounding air. Appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation shall be provided as necessary.

   d. Actuator cords or conduit shall incorporate a drip leg if condensation is possible. Water shall not be allowed to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point shall be avoided to prevent water from condensing in conduit and running into actuator.

   e. Damper mounting arrangements shall comply to the following:

      i. The ventilation subcontractor shall furnish and install damper channel supports and sheet metal collars.

      ii. No jack shafting of damper sections shall be allowed.

      iii. Multi-section dampers shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per section.

   f. Size damper sections based on actuator manufacturer’s specific recommendations for face velocity, differential pressure and damper type. In general:

      i. Damper section shall not exceed 24 ft-sq. with face velocity >1500 FPM.

      ii. Damper section shall not exceed 18 ft-sq. with face velocity > 2500 FPM.

      iii. Damper section shall not exceed 13 ft-sq. with face velocity > 3000 FPM.

   g. Multiple section dampers of two or more shall be arranged to allow actuators to be direct shaft mounted on the outside of the duct.

   h. Multiple section dampers of three or more sections wide shall be arranged with a 3-sided vertical channel (8 inches wide by 6 inches deep) within the duct or fan housing and between adjacent damper sections. Vertical channel shall be anchored at the top and bottom to the fan housing or building structure for support. The sides of each damper frame shall be connected to the channels. Holes in the channel shall allow damper drive blade shafts to pass through channel for direct shaft-mounting of

actuators. Open side of channel shall be faced downstream of the airflow, except for exhaust air dampers.

i. Multiple section dampers to be mounted flush within a wall or housing opening shall receive either vertical channel supports as described above or sheet metal standout collars. Sheet metal collars (12-inch minimum) shall bring each damper section out of the wall to allow direct shaft-mounting of the actuator on the side of the collar.

4. Valve Sizing for Water Coil

a. On/Off control valves shall be line size.

b. Modulating control valve body size may be reduced, at most, two pipe sizes from the line size or not less than half the pipe size. The BAS contractor shall size all water coil control valves for the application as follows:

i. Booster-heat valves shall be sized not to exceed 4–9psi differential pressure. Size valve for 50% valve authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.

ii. Primary valves shall be sized not to exceed 5–15psi differential pressure. Size valve for 50% valve authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.

iii. Butterfly valves shall be sized for modulating service at 60–70 degree rotation. Design velocity shall be 12 feet per second or less when used with standard EPDM seats.

c. Valve mounting arrangements shall comply to the following:

i. Unions shall be provided on all ports of two-way and three-way valves.

ii. Install three-way equal percentage characterized control valves in a mixing configuration with the “A” port piped to the coil.

iii. Install 2.5 inches and above, three-way globe valves, as manufactured for mixing or diverting service to the coil.

2.8 ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

C. Enclosures shall have hinged, locking doors.

D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

2.9 AIR FLOW MEASURING STATIONS (Thermal Dispersion Type)

A. Acceptable Manufacturers
1. EBTRON, Inc.
2. Ruskin

B. Types of Mounting Application
1. Fan-Inlet

2. Duct Mounted Probe

C. Specifications:
1. Transmitter Powered by 24VAC or VDC power supply
2. Airflow Range: 0 to 10,000 FPM (fan inlet)
0 to 4,000 FPM (duct mounted)
3. Transmitter Signal Range: 0-10 VDC or 4-20mA
4. Airflow Measuring Accuracy: ±3% of measured flow
5. Temperature Reading Range -20 to 140°F
6. Temperature Reading Accuracy: ±0.15°F
7. Operating Temperature Range: -20 to 120°F
8. Operating Humidity Range: 5-95% R.H., non-condensing

2.10 LIQUID FLOW METERS

A. Insertional Turbine Flow Meters
1. Approved Manufacturers
a. ONICON

2. Provide an ONICON Model F-1210 Dual Turbine Flow Meter complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. For bi-directional flow applications, provide ONICON Model FB-1210. The flow meter shall be hand-insertable up to 400 psi. The flow meter shall have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Wetted metal components shall be nickel-plated brass (unless optional 316L SS is otherwise specified). Optional 316L SS construction is required for HW applications operating over 250 degrees F, and for any application in non-metallic pipe. The maximum operating temperature shall be 280 degrees F, 300 F peak. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. The manufacturer's certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 0.5% of rate at the calibrated velocity, within ± 1% of rate over a 10:1 turndown (3.0 to 30 ft/s) and within ± 2% of rate over a 50:1 turndown (from 0.4 to 20 ft/s). The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V. Bi-directional meters shall include an isolated contact closure output for direction. The flow meter shall be covered by the manufacturer's two-year warranty.

B. Inline Magnetic Flow Meters
1. Approved Manufacturers
a. ONICON

2. Provide an ONICON F-3200 Series Electromagnetic Flow Meter complete with integral or remote electronics module. The electronics module shall include a backlit graphic display and keypad. Connections to the piping shall be ANSI class 150 flanges (ANSI class 300 available where required). The installing contractor is responsible for providing suitable mating flanges. The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316SS; the liner shall be polypropylene or ebonite for low temperature service, PFTE for hot water service. Each flow meter shall be individually wet-calibrated and accurate to within ±0.2% of reading from 1.6 to33 feet per second velocity. A certificate of calibration shall be provided with each flow meter. Output signals shall be 4-20 mA and programmable pulse. The flow meter shall be capable of measuring bi-directional flow. For installations in non-metallic pipe, install grounding rings between flanges. Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter (no special interface device or computer required). Each flow meter shall be covered by the manufacturer's two-year warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the owner's representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

3.2 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.3 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3 feet of clear access space in front of units. Obtain approval on locations from owner's representative prior to installation.

B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.

C. Identify all equipment and panels. Provide permanently mounted tags for all panels.

D. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections, and sized to suit pipe diameter without restricting flow.

3.4 INTERLOCKING AND CONTROL WIRING

A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings; coordinate with electrical contractor.

F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum-rated cable (without conduit).

3.5 DDC OBJECT TYPE SUMMARY

A. Provide all database generation.

B. Displays

1. System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on all system displays associated with economizer cycles.

C. Run Time Totalization

1. At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.

D. Trendlog

1. All binary and analog object types (including zones) shall have the capability to be automatically trended.

E. Alarm

1. All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.

F. Database Save

1. Provide backup database for all standalone application controllers on disk.

3.6 FIELD SERVICES

A. Prepare and start logic control system under provisions of this section.

B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.

D. Provide owner's representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.7 AS-BUILT DOCUMENTATION REQUIRED

A. Provide final as-built control drawings to match the installed system at the time of project completion.

3.8 TRAINING

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not be limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of three persons.

C. Provide on-site training above as required, up to 8 hours as part of this contract.

3.9 DEMONSTRATION

A. Demonstrate complete operating system to owner's representative.

END OF SECTION 230923

SECTION 260573 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Short-circuit study.
2. Overcurrent protective device coordination study.
3. Load-flow and voltage-drop study.
4. Arc-flash hazard study.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.

1.2 ACTION SUBMITTALS

A. Product Data: For power system analysis software to be used for studies.

1. Product Certificates: For power system study software applications, include certificate stating compliance with specified requirements, signed by software manufacturer.

B. Power System Study Reports:

1. Submit reports after approval of system protective devices submittals. Submittal may be in digital form.
2. Submit short-circuit study input data, including completed computer-program input data sheets.
3. Submit coordination study input data, including completed computer-program input data sheets.

    a. Submit load-flow, and voltage-drop data with coordination study.

4. Submit arc-flash study input data, including completed computer-program input data sheets.
5. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
6. Submit revised one-line diagram, reflecting field investigation results and results of short-circuit study.

C. Data files for studies in format compatible with Owner's power system analysis software.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination study and fault current study computer software programs, certifying compliance with IEEE 399.

1.4 QUALITY ASSURANCE

A. Submittals for power system studies must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

B. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.

C. Software algorithms must comply with requirements of standards and guides specified in this Section.

D. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

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

1. EDSA Micro Corporation.
2. EasyPower; brand of Bentley Systems, Inc.
3. Power Tools for Windows (PTW); brand of SKM Systems Analysis, Inc.

B. Standard Features:

1. Power System Analysis:

a. Power-systems-analysis software applications must have analytical capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 series standards.
b. Computer software application must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.
c. Computer software application must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

2. Analysis Standards:

a. Short-Circuit Current Analysis: In accordance with IEEE 3002.3.
b. Device Coordination Analysis: In accordance with IEEE 3004.3 and IEEE 3004.5.
c. Load-Flow Analysis: In accordance with IEEE 3002.2.

d. Harmonic Analysis: In accordance with IEEE 3002.8.
e. Transient Stability Analysis: In accordance with IEEE P3002.9.
f. Arc-Flash Hazard Analysis: In accordance with IEEE 1584.

3. Capable of printing arc-flash hazard warnings for equipment on vinyl, weather- and UV-resistant, pressure-sensitive adhesive labels complying with NFPA 70E.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard study:

1) Equipment designation.
2) Nominal voltage.
3) Protection boundaries.

a) Arc-flash boundary.
b) Restricted approach boundary.
c) Limited approach boundary.

4) Arc-flash PPE category.
5) Required minimum arc rating of PPE in Cal/cm squared.
6) Available incident energy.
7) Working distance.
8) Engineering report number, revision number, and issue date.

C. Other Available Features Required by the Project:

1. Simultaneous faults.
2. Explicit negative sequence.
3. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Collect and analyze data for power system studies.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.
3. For relocated equipment and equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.
4. Gather and tabulate required input data to support power system studies. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 3002 series standards as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

a. Product data for the Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
b. Electrical power utility impedance at service.
c. Power sources and ties.
d. Short-circuit current at each system bus (three phase and line to ground).
e. Full-load current of loads.
f. Voltage level at each bus.
g. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
h. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
i. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
j. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
k. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
l. Maximum demands from service meters.
m. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
n. Motor horsepower and NEMA MG 1 code letter designation.
o. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
p. Derating factors.

3.2 PREPARATION

A. Preparation of Data for Short-Circuit Study:

1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.
3. Prepare one-line diagram of modeled power system, showing the following:

a. Protective device designations and ampere ratings.
b. Conductor types, sizes, and lengths.
c. Transformer kVA and voltage ratings.
d. Motor and generator designations and kVA ratings.
e. Switchboard, motor-control center, and panelboard designations and ratings.
f. Derating factors and environmental conditions.
g. Revisions to electrical equipment required by study.

B. Preparation of Data for Overcurrent Protective Device Coordination Study:

1. Prepare data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, indicating the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.

b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.

2. Examine the Project's overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
3. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Preparation of Data for Arc-Flash Hazard Study:

1. Assemble data from short-circuit study and overcurrent protective device coordination study.
2. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.3 SHORT-CIRCUIT STUDY

A. Base study on device characteristics supplied by device manufacturer.

B. Extent of electrical power system to be studied is indicated on Drawings.

C. Study the electrical distribution system, beginning at the utility transformer, from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

D. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement to address asymmetrical requirements of interrupting equipment.

E. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

F. Include in report identification of protective device applied outside its capacity.

3.4 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

A. Base study on device characteristics supplied by device manufacturer.

B. Study the electrical distribution system, beginning at the utility transformer, from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. NEC Article 700 systems must be selectively coordinated to 0.10 seconds.

D. Transformer Primary Overcurrent Protective Devices:

1. Device must not operate in response to the following:

    a. Inrush current when first energized.
    b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    c. Permissible transformer overloads in accordance with IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings must protect transformers in accordance with IEEE C57.12.00, for fault currents.

E. Motor Protection:

1. Select protection for low-voltage motors in accordance with IEEE 3004.8 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V in accordance with IEEE 620.

F. Conductor Protection: Protect cables against damage from fault currents in accordance with ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 3004.7. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

G. Generator Protection: Select protection in accordance with manufacturer's published instructions and IEEE C37.102.

H. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement, to address asymmetrical requirements of interrupting equipment.

I. Include coordination of ground-fault protection devices.

J. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

K. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchboards, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Include in report identification of protective device applied outside its capacity.

3.5 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents.
2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.
3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.6 ARC-FLASH HAZARD STUDY

A. Comply with NFPA 70E, including Annex D, for arc-flash hazard study.

B. Preparatory Studies: Obtain short-circuit study and overcurrent protective device coordination study results prior to starting arc-flash hazard study.

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include low-voltage equipment locations.

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must account for changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:

1. Fault contribution from induction motors must not be considered beyond three to five cycles.

2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).

H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:

1. When circuit breaker is in separate enclosure.
2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.7 POWER SYSTEM STUDY REPORTS

A. Preparation of Power System Study Reports: Prepare and submit the following:

1. Short-Circuit Study Report Contents:

a. Executive summary of study findings.
b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.
2) Conductor types, sizes, and lengths.
3) Transformer kVA and voltage ratings.
4) Motor and generator designations and kVA ratings.
5) Switchboard, motor-control center, and panelboard designations and ratings.
6) Derating factors and environmental conditions.
7) Revisions to electrical equipment required by study.

d. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.
e. Short-Circuit Study Input Data:

1) One-line diagram of system being studied.
2) Power sources available.
3) Manufacturer, model, and interrupting rating of protective devices.
4) Conductors.
5) Transformer data.

f. Protective Device Evaluation:

1) Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2) Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3) For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4) For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5) Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

g. Short-Circuit Study Output Reports:

1) Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.
b) Calculated fault-current magnitude and angle.
c) Fault-point X/R ratio.
d) Equivalent impedance.

2) Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.
b) Calculated symmetrical fault-current magnitude and angle.
c) Fault-point X/R ratio.
d) Calculated asymmetrical fault currents based on fault-point X/R ratio; based on calculated symmetrical value multiplied by 1.6; and based on calculated symmetrical value multiplied by 2.7.

3) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.
b) Calculated symmetrical fault-current magnitude and angle.
c) Fault-point X/R ratio.
d) No AC Decrement (NACD) ratio.
e) Equivalent impedance.
f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

2. Overcurrent Protection Device Coordination Study Report Contents:

a. Executive summary of study findings.
b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.
2) Conductor types, sizes, and lengths.
3) Transformer kVA and voltage ratings.
4) Motor and generator designations and kVA ratings.
5) Switchboard, motor-control center, and panelboard designations.
6) Revisions to electrical equipment required by study.

d. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.

1) Phase and Ground Relays:

a) Device tag.
b) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
c) Recommendations on improved relaying systems, if applicable.

2) Circuit Breakers:

a) Adjustable pickups and time delays (long time, short time, and ground).
b) Adjustable time-current characteristic.
c) Adjustable instantaneous pickup.
d) Recommendations on improved trip systems, if applicable.

3) Fuses: Show current rating, voltage, and class.

e. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:

1) Device tag and title, one-line diagram with legend identifying portion of system covered.
2) Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
3) Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4) Plot the following listed characteristic curves, as applicable:

a) Power utility's overcurrent protective device.
b) Medium-voltage equipment overcurrent relays.
c) Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
d) Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
e) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
f) Cables and conductors damage curves.
g) Ground-fault protective devices.
h) Motor-starting characteristics and motor damage points.
i) Generator short-circuit decrement curve and generator damage point.
j) Largest feeder circuit breaker in each motor-control center and panelboard.

5) Maintain selectivity for tripping currents caused by overloads.
6) Provide adequate time margins between device characteristics such that selective operation is achieved.

7) Comments and recommendations for system improvements.

3. Arc-Flash Hazard Study Report Contents:

a. Executive summary of study findings.
b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
c. One-line diagram, showing the following:

1) Protective device designations and ampere ratings.
2) Conductor types, sizes, and lengths.
3) Transformer kVA and voltage ratings, including derating factors and environmental conditions.
4) Motor and generator designations and kVA ratings.
5) Switchboard, motor-control center, panelboard designations, and ratings.

d. Short-circuit study output data.
e. Overcurrent protective device coordination study report contents.
f. Arc-Flash Study Output Reports:

1) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:

a) Voltage.
b) Calculated symmetrical fault-current magnitude and angle.
c) Fault-point X/R ratio.
d) No AC Decrement (NACD) ratio.
e) Equivalent impedance.
f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

g. Incident Energy and Flash Protection Boundary Calculations:

1) Arcing fault magnitude.
2) Protective device clearing time.
3) Duration of arc.
4) Arc-flash boundary.
5) Restricted approach boundary.
6) Limited approach boundary.
7) Working distance.
8) Incident energy.
9) Hazard risk category.
10) Recommendations for arc-flash energy reduction.

h. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

3.8 FIELD ADJUSTMENT FOR DEVICE COORDINATION

A. Adjust relay and protective device settings in accordance with recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting must be by qualified low-voltage electrical testing and inspecting agency.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

3.9 WARNING LABELING OF ARC-FLASH HAZARDS

A. Apply arc-flash label on front cover of each section of equipment for each equipment included in study, including, but not limited to, each piece of equipment listed below:
1. Switchboards.
2. Panelboards.
3. Motor Control Centers.
4. Low voltage transformers.
5. Automatic Transfer Switches.
6. Safety switches.
7. Control panels.
8. Motor starters.

B. Base arc-flash label data on highest values calculated at each location.

C. Machine print warning labels with no handwritten or field-applied markings.

D. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

E. Indicate on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

END OF SECTION 260573

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.

B. Related Requirements:

1. Section 033000 “Cast-In-Place Concrete” specifies Equipment Bases and Foundations referenced by this Section.
2. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
3. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260573 "Power System Studies" for Short-circuit, Overcurrent protective device coordination, arc-flash hazard analysis and arc-flash label requirements.
8. Section 262813 “Fuses” specifies fuses referenced by this Section.
9. Section 264313 “Surge Protective Devices for Low-Voltage Electrical Power Circuits” specifies surge protection referenced by this Section.

C. References:

1. ANSI C12 - Code for Electricity Metering.
2. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments.
3. ANSI C57.13 - Requirements for Instrument Transformers.
4. ANSI/UL 1283 Standard for Safety, Electromagnetic Interference Filters, 5th Ed.
5. ANSI/UL 1449 Standard for Safety, Surge Protective Devices, 5th Ed.
6. NEMA AB 1 - Molded Case Circuit Breakers.
7. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
8. NEMA PB 2 - Dead Front Distribution Switchboards.
9. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
10. NFPA 70 - National Electrical Code.
11. UL891 – Standard for Switchboards.
12. UL489 – Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 ACTION SUBMITTALS

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge Protection devices Type (1 or 2).
    a. Modes of Protection (L-N, L-G, L-N, L-L).
    b. Voltage Protection Rating (VPR).
4. OCPD Requirements.
5. NEMA 250 Enclosure Type.
6. Ground-fault protection devices.
7. Accessories.
8. Other components.
9. Include dimensions, weight, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

C. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
9. Include diagram and details of proposed mimic bus.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 CLOSEOUT SUBMITTALS

A. Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of switchboard in project record documents.

C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

D. Test Reports: Indicate results of factory production tests.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Contract Closeout shall be as specified under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Furnish two of each key.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, store, and protect products under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

C. Deliver in 48-inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.

D. Store in a clean, dry space. Provide space heaters to maintain a condensation free environment. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.9 FIELD MEASUREMENTS

Verify that field measurements are as indicated on shop drawings.

1.10 SOURCE QUALITY CONTROL

A. Manufacturer quality control shall be as specified under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Shop inspect and test switchboard according to NEMA PB 2.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

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

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.

C. Ratings:

1. Voltage: 277/480 volts.
2. Configuration: Three phase, four wire wye, grounded.
3. Main Bus: Rating as shown on the drawings.
4. Integrated Equipment Rating: Rating as shown on the drawings.

D. Front connected, front accessible.

E. Main Devices: Drawout mounting.

F. Feeder Devices: Drawout mounting for circuit breakers over 1,200A; individually mounted for smaller circuit breakers.

G. Auxiliary Section Devices: Individually mounted.

H. Bus Material: Copper with silver plating, standard size.

I. Bus Connections: Bolted, accessible from front only for maintenance.

J. Copper Ground Bus: Extend length of switchboard.

K. Solid-state Trip Molded (up to 1,200A) and Insulated Case Main Circuit Breakers (larger than 1,200A): NEMA AB 1 with full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings

1. Adjustable instantaneous trip.
2. Adjustable long time pickup and delay.
3. Adjustable short time pickup and delay.
4. Ground fault pickup and delay. Provide ground fault alarm where trip is not required.
5. Arc flash reduction mode with external switch and indicator (1,200A and larger).
6. Include shunt trip, undervoltage release, and other accessories where indicated.
7. Display line currents and cause of trip.

L. Solid-state Trip Molded (up to 1,200A) and Insulated Case Feeder/Branch Circuit Breakers (larger than 1,200A): NEMA AB 1 with full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings

1. Adjustable instantaneous trip.
2. Adjustable long time pickup and delay.
3. Adjustable short time pickup and delay.
4. Ground fault pickup and delay. Provide ground fault alarm where trip is not required.
5. Arc flash reduction mode with external switch and indicator (1,200A and larger).
6. Include shunt trip, undervoltage release, and other accessories where indicated.
7. Display line currents and cause of trip.

M. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized.

N. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials and sizes indicated.

O. Key Interlock Kit: Where noted, externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

P. Drawout Circuit-Breaker Compartment:
1. Drawout Features: Circuit-breaker mounting assembly equipped with racking mechanism to position circuit breaker and hold it rigidly in connected, test, disconnected, and withdrawn positions. Include the following features:
2. Provide circuit-breaker racking system with positive stops at connected, test, disconnected, and withdrawn positions.
3. Interlocks: Prevent racking of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
4. Circuit-Breaker Positioning: Permit racking of open circuit breaker to or from connected, test, and disconnected positions only when compartment door is closed unless live parts are covered by full dead-front shield shutter. Permit manual withdrawal of open circuit breaker to position for removal from structure. When compartment door is open, status for connection devices for different positions includes the following:
   a. Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
   b. Disconnected Position: Primary and secondary devices and ground contact disengaged.
5. Primary Disconnect: Mount on stationary part of compartment. Disconnect must consist of set of contacts extending to rear through insulating support barrier, and of corresponding moving finger contacts on power circuit-breaker studs, which engage in only connected position. Assembly must provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on fingers. Load studs

must connect to bus extensions that terminate in solderless terminals in rear cable compartment.

6. Secondary Disconnect: Floating terminals mounted on stationary part of compartment that engage mating contacts at front of breaker.
7. Place 2,400A frame and larger circuit breakers at middle or top for bottom entry and at middle or bottom for top entry.

Q. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

R. Enclosures: Type 1 – General Purpose.

1. Align sections at front and rear.
2. Switchboard Maximum Height: 96 inches, excluding floor sills, lifting members and pull boxes.
3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
4. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard using blue color factory painting, or approved equivalent means.

2.2 CONTROL POWER

A. Control Circuits:

1. 120 VAC, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.3 METERING

A. Each new switchboard (except Switchboard EPS) and existing (X) Emergency Switchboard, shall be provided with a front mounted, digital power quality meter / analyzer package. The metering shall include a lighted LCD display of voltage, current, power, kVA, kVAR, power factor, frequency, total harmonic distortion, kW demand, amperes demand, kWH, kVARH, auxiliary voltage input and neutral current. Phase switching shall be provided and the display shall indicate the phase being displayed. The meter shall have BACnet IP communications for BMS interface. Provide all voltage and current transformers required to provide the above data.

B. Manufacturers: The metering/analyzer package shall be:
1. Eaton PXE Tier 1.
2. General Electric/ABB.
3. Siemens.
4. Square D/Schneider.
5. Substitutions: refer to provisions of the General and supplemental General Conditions and Division 1 specification sections.

C. Install at 60” AFF to bottom of the meter case or, if the meter is to be installed above 60” AFF but no more than 78”AFF, provide an angle adapter to lower the meter viewing angle. Angle adapter shall be acceptable to the Architect/Engineer.

2.4 METERING TRANSFORMERS

A. Current Transformers: ANSI C57.13, 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13, 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

B. Provide drawout circuit breaker trolly/lift for all switchboards with drawout mounting circuit breakers.

C. Racking handle to move circuit breaker manually between connected and disconnected positions.

D. Provide with integral surge protection device with overcurrent protection. See Specifications Section 264313.

E. Auxiliary Contacts: Four SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards in accordance with NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage in accordance with manufacturer's published instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.

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

3.2 PREPARATION

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Provide 4 inch concrete housekeeping pad under the provision of Division 3.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions, recommendations, applicable electrical codes and the contract drawings.

B. Reference Standards:

1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 2.1.
2. SPD, comply with NECA 1.
3. Consult Architect for resolution of conflicting requirements.

C. Switchboards shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260010, Paragraph 1.24 for additional requirements.

D. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."

    a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.
    b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.
    c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to switchboards.
    f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
5. Install filler plates in unused spaces of panel-mounted sections.
6. Install overcurrent protective devices, surge protection devices, and instrumentation.
    a. Set field-adjustable switches and circuit-breaker trip ranges.
7. Install spare-fuse cabinet.

E. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

F. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

G. Use crimped connectors and splices only. Wire nuts are unacceptable.

H. Upon completion of installation, and prior to final inspection, the Electrical Contractor shall reduce in size the “as-built” single line diagram (riser), frame same under plexiglass, and mount in a conspicuous place adjacent to the switchboard.

3.4 CONNECTIONS

A. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.

B. Support and secure conductors within switchboard in accordance with NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.5 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Mimic Bus:

1. Entire single-line switchboard bus work, as depicted on factory record drawing, on minimum 0.032 inch thick anodized aluminum photoengraved nameplate, located at eye level on front cover of switchboard incoming service section.
2. Entire single-line switchboard bus work, as depicted on factory record drawing, on engraved minimum 0.0625 inch thick laminated-plastic nameplate, located at eye level on front cover of switchboard incoming service section.
3. Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
4. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce concise visual presentation of principal switchboard components and connections.
5. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

E. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.6 FIELD QUALITY CONTROL

A. Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of UL, IEEE, and NEMA standards.

C. Perform the following field tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

D. Tests and Inspections:

1. Acceptance Testing:
   a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
   b. Test continuity of each circuit.
2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
3. Provide performance testing of arc energy reduction systems as required by NEC Art. 240.87(C).
4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
5. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Nonconforming Work:

1. Switchboard will be considered defective if it does not pass tests and inspections.
2. An SPD will be considered defective if it does not pass tests and inspections.
3. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.8 ADJUSTING

A. Testing, Adjusting, and Balancing: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

C. Tighten bolted bus connections in accordance with manufacturer’s instructions.

D. Adjust circuit breaker trip and time delay settings to values as required by the Coordination Study. Prior to final settings, adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

3.10 CLEANING

A. Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Cleaning: Vacuum dirt and debris from switchboard interior; do not use compressed air to assist in cleaning.

C. Touch up scratched or marred surfaces to match original finish.

3.11 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 262413

SECTION 262416 – PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Branch Circuit Panelboards.
2. Distribution Panelboards.
3. Disconnecting and overcurrent protective devices.

B. Related Requirements:
1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
5. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, and arc-flash hazard analysis studies.
6. Section 262813 "Fuses" specifies fuses and spare-fuse cabinets installed by this Section.
7. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies Type 1 and Type 2 surge protective devices installed by this Section.

C. References:

1. NECA Standard of Installation (published by the National Electrical Contractors Association).
2. NEMA AB1 - Molded Case Circuit Breakers.
3. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
4. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
5. NEMA PB 1 - Panelboards.
6. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
7. NFPA 70 - National Electrical Code.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
2. Include manufacturer's sample extended warranty language.

C. Shop Drawings: For each panelboard and related equipment:

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include circuit breaker and fusible switch arrangement and sizes.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.
12. Arrange panelboard branch circuit breakers as shown on the Drawings. Agreement of circuit breaker (pole) numbers with the Drawings panel schedules and floor plans is required in order to avoid confusion during construction, redrawing the circuitry for record drawing purposes and accurate documentation of the as-built conditions.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Panelboard Schedules: For installation in panelboards.

C. Submit manufacturer’s installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.

2. Field reports for voltage monitoring and adjusting.

1.5 CLOSEOUT SUBMITTALS

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of panelboards and record actual circuiting arrangements in project record documents.

C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

D. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Contract Closeout. As required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Furnish two of each panelboard key.

1.7 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with NEMA PB 1.

1.9 WARRANTY

A. Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within one year of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces specified in Section 018123 "Facility Seismic and Wind Criteria."

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Comply with NEMA PB 1.

E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
   1. Rated for environmental conditions at installed location. NEMA-4X surface mounted unless noted otherwise. NEMA-1 flush mounted in dry, conditioned, finished spaces.
   2. Height: 7 ft maximum.
   3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
   4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
   5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   7. Finishes:
      a. NEMA-1 Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Back Boxes: Galvanized steel.
      b. NEMA-4X Panels and Trim: Stainless Steel. Back Boxes: Stainless steel.

F. Phase, Neutral, and Ground Buses:

   1. Material: Hard-drawn copper, 98 percent conductivity.

      a. Plating must run entire length of bus.
      b. Bus must be fully rated for entire length.

   2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
   3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Terminations must allow use of 75 deg C rated conductors without derating.
   3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
   4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
   5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.

H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards

or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: As shown.

J. Panelboard Short-Circuit Current Rating:

1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.2 PANELBOARDS

A. UL QEUY - Distribution Panelboard:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ABB, Electrification Business.
b. Eaton.
c. Siemens Industry, Inc., Energy Management Division.
d. Square D; Schneider Electric USA.
e. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Distribution Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

4. Service Conditions:

a. Temperature: 104º F. (40º C.).
b. Altitude: N/A.
c. Terminal Rating: 75º C. minimum.

5. Standard Features:

a. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1) For doors more than 36 inch two latches, keyed alike.
b. Panelboard Bus: Copper, ratings as indicated. Provide 100% copper ground and neutrals buses in each panelboard. Provide insulated ground bus where

scheduled. Provide 200% copper neutral bus in each panelboard fed by a K rated transformer.

c. Minimum integrated short circuit rating: 10,000 amperes rms symmetrical for 208-volt panelboards; 30,000 amperes rms symmetrical for 480-volt panelboards, or as indicated.

d. Mains: Circuit breakers: NEMA AB 1, bolt-on or plug-on (Square D I-Line and similar only) type.

1) Circuit breakers in distribution panelboards shall be fully rated. Series rating is not acceptable.

2) Solid-state Trip Molded Case Main and Branch Circuit Breakers (where required by Coordination Study): Panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:

a) Adjustable instantaneous trip.

b) Adjustable long time pickup and delay.

c) Adjustable short time pickup and delay.

d) Ground fault pickup and delay. Provide ground fault alarm where trip is not required.

e) Arc flash reduction mode with external switch and indicator (1,200A and larger).

f) Include shunt trip, undervoltage release, and other accessories where indicated.

g) Display line currents and cause of trip.

3) Conventional Thermal Magnetic Molded Case Branch Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

4) Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

6. Enclosure: NEMA PB 1, Type 4X, cabinet box as specified.

7. Cabinet Front: Flush and Surface cabinet front door-in-door type with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Distribution panelboards larger than 400 amperes are not required to have door-in-door trims.

8. Other Available Features Required by Project (see panelboard schedules):

a. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.

b. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.

c. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.

d. Do not mount neutral bus in gutter.

e. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

B. UL QEUY – Branch Circuit Panelboard:

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

a. ABB, Electrification Business.

b. Eaton.
c. Siemens Industry, Inc., Energy Management Division.
d. Square D; Schneider Electric USA.
e. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

2. Source Limitations: Obtain products from single manufacturer.

3. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

4. Service Conditions:
   a. Temperature: 104º F. (40º C.).
   b. Altitude: N/A.
   c. Terminal Rating: 75º C. minimum.

5. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Lighting and Appliance Branch-Circuit Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

6. Standard Features:

   a. Mains: Circuit breakers: NEMA AB 1, bolt-on type.
      1) Circuit breakers in distribution panelboards shall be fully rated. Series rating is not acceptable.
      2) Solid-state Trip Molded Case Main and Branch Circuit Breakers (where required by Coordination Study): Panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
         a) Adjustable instantaneous trip.
         b) Adjustable long time pickup and delay.
         c) Adjustable short time pickup and delay.
         d) Ground fault pickup and delay. Provide ground fault alarm where trip is not required.
         e) Arc flash reduction mode with external switch and indicator (1,200A and larger).
         f) Include shunt trip, undervoltage release, and other accessories where indicated.
         g) Display line currents and cause of trip.
      3) Conventional Thermal Magnetic Molded Case Branch Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
      4) Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

7. Enclosure: NEMA PB 1, Type 4X cabinet box.
8. Cabinet Front: Flush and Surface cabinet front door-in-door type with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Distribution panelboards larger than 400 amperes are not required to have door-in-door trims.

9. Other Available Features Required by Project:
    a. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
    b. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
    c. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
    d. Do not mount neutral bus in gutter.
    e. Doors: Door-in-door construction with concealed hinges; secured with flush or multipoint latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

2.3 METERING

A. New panelboards larger than 400 amperes and Existing Panelboard (X)LSS shall be provided with a front mounted, digital power quality meter / analyzer package. The metering shall include a lighted LCD display of voltage, current, power, kVA, kVAR, power factor, frequency, total harmonic distortion, kW demand, amperes demand, kWH, kVARH, auxiliary voltage input and neutral current. Phase switching shall be provided and the display shall indicate the phase being displayed. The meter shall have BACnet IP communications for BMS interface. Provide all voltage and current transformers required to provide the above data. Existing (X) Panelboard LSS metering may be installed external to the panelboard in a NEMA-4X enclosure nippled to the panelboard.

B. Manufacturers:
    1. Eaton PXE Tier 1.
    2. General Electric/ABB.
    3. Siemens.
    4. Square D/Schneider.
    5. Substitutions: refer to provisions of the General and supplemental General Conditions and Division 1 specification sections.

C. Install at 60” AFF to bottom of the meter case or, if the meter is to be installed above 60” AFF but no more than 78”AFF, provide an angle adapter to lower the meter viewing angle. Angle adapter shall be acceptable to the Architect/Engineer.

2.4 METERING TRANSFORMERS

A. Current Transformers: ANSI C57.13, 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13, 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Keys: Two spares for each type of panelboard cabinet lock.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with NECA 407 and NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 407 and NEMA PB 1.1.
2. Consult Engineer for resolution of conflicting requirements.

C. Panelboards shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260010, Paragraph 1.24 for additional requirements.

D. Special Techniques:

1. Equipment Mounting:

a. Attach panelboard to vertical finished or structural surface behind panelboard.
b. Provide seismic control devices.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Provide mounting and anchoring devices.
4. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
5. Mount panelboard cabinet plumb and rigid without distortion of box.
6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.

a. Set field-adjustable, circuit-breaker trip ranges.
b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
9. Install filler plates in unused spaces.
10. Stub five 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub five 1 inch empty conduits into raised floor space or below slab not on grade. Identify each as SPARE.
11. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
12. Mount spare fuse cabinet in accessible location.

E. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Install warning signs.

C. Panelboard Nameplates: Label each panelboard with engraved plastic nameplate.

D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in metal frame with transparent protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Quality Control: Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Provide performance testing of arc energy reduction systems as required by NEC Art. 240.87(C).

3.5 ADJUSTING

A. Contract Closeout: Adjust installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Cleaning: Vacuum dirt and debris from panelboard tubs; do not use compressed air to assist in cleaning.

C. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

D. Adjust circuit breaker trip and time delay settings to values as required by the Coordination Study. Prior to final settings, adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 262416

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SECTION 262419 – MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes MCCs for use with ac circuits rated 600 V and less, with combination controllers.

1.2 Related Requirements:

1. Section 033000 “Cast-In-Place Concrete” specifies Equipment Bases and Foundations referenced by this Section.
2. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
3. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260573 "Power System Studies" for Short-circuit, Overcurrent protective device coordination, arc-flash hazard analysis and arc-flash label requirements.
8. Section 262813 “Fuses” specifies fuses referenced by this Section.
9. Section 264313 “Surge Protective Devices for Low-Voltage Electrical Power Circuits” specifies surge protection referenced by this Section.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCC: Motor control center.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor-circuit protector.

E. OCPD: Overcurrent protective device.

F. PID: Control action; proportional plus integral plus derivative.

G. PT: Potential transformer.

H. SPD: Surge protective device.

I. SCR: Silicon-controlled rectifier.

J. VFC: Variable-frequency controller.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.

B. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

    a. Each installed unit's type and details.
    b. Factory-installed devices.
    c. Enclosure types and details.
    d. Nameplate legends.
    e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
    f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
    g. Specified optional features and accessories.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
3. Nameplate legends.
4. Vertical and horizontal bus capacities.
5. Features, characteristics, ratings, and factory settings of each installed unit.

1.5 INFORMATIONAL SUBMITTALS

A. Standard Drawings: For each MCC, as defined in UL 845.

B. Production Drawings: For each MCC, as defined in UL 845.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Seismic Qualification Data: Certificates, for MCCs, 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.

F. Product Certificates: For each MCC.

G. Source quality-control reports.

H. Field quality-control reports.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

J. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
2. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
3. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
4. Manufacturer's written instructions for setting field-adjustable overload relays.
5. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
6. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
7. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or NICET.

1. Testing Agency's Field Supervisor: Certified by NETA or NICET to supervise on-site testing.

B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.

D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.

B. Handle MCCs according to the following:

1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace MCC that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MOTOR-CONTROL CENTERS

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

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

2.2 SYSTEM DESCRIPTION

A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.

B. Ambient Environment Ratings:

1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.
2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
3. Humidity Rating: Less than 95 percent (noncondensing).
4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.

C. 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.

2.3 PERFORMANCE REQUIREMENTS

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

1. The term "withstand" means "the system 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: 1.5.
3. Component Amplification Factor: 2.5.
4. Component Response Modification Factor: 6.0.

B. Capacities and Characteristics:

1. MCC Enclosure and Assembly:

    a. Nominal System Voltage: 480/277 VAC.
    b. Service Equipment Rated: No.
    c. Enclosure: NEMA 250, Type 1.

2. Integrated Short-Circuit Rating for MCC:
    a. Fully rated; 42 kA or higher if manufacturer’s standard.

3. Integrated Short-Circuit Rating for Each Unit:
    a. Fully rated; 42 kA or higher if manufacturer’s standard.

4. Wiring Class: NEMA ICS 18, Class II, Type C-S.
5. Bus:

    a. Horizontal Bus: 42 kA.
    b. Neutral Bus: 50 percent.

6. Main Disconnect Device:

    a. Main Disconnect: MCCB, UL 489, three pole.

7. VFCs:

    a. Tag Number: See schedule on Drawings.
        1) Overload Relays: Solid state. Class 10.
        2) Isolated Overload Alarm Contact: NO.

8. Controller-Mounted Auxiliary Devices:

    a. Push Buttons and Selector Switches: Heavy-duty, oiltight type.

2.4 MOTOR-CONTROL CENTER ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1 unless otherwise indicated to comply with environmental conditions at installed location.

B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

C. Structure:

1. Comply with UL requirements for service entrance equipment.
2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
3. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.

D. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners.

1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

E. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC.

F. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

G. Wiring Spaces:

1. Minimum 4” Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. 9” Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

H. Provisions for Future:

1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

I. Integrated Short-Circuit Rating:
1. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device; 42 kA.

J. Control Power:

1. 120-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

K. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Wiring Class:
   a. NEMA ICS 18, Class II, Type C-S.

2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

L. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions.
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase- and Neutral-Bus Material:

   a. Hard-drawn copper of 98 percent minimum conductivity or silver-plated alloy, with mechanical connectors for outgoing conductors.

4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with mechanical connectors for outgoing conductors.
5. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.

2.5 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB: Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

   a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals or trip units with field-programmable ratings.
   b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
   c. Time-current adjustments to achieve protective-device coordination as follows:

      1) Adjustable long-time delay.
      2) Adjustable short-time setting and delay to shape the time-current curve.
      3) Adjustable instantaneous setting.
      4) Individually adjustable ground-fault setting and time delay.

d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.
e. Built-in digital ammeter display, showing load current and tripping cause.

B. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD Type 2, 200 kA.

2.6 VFC

A. Controller Units: Combination controllers, consisting of variable-frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 508C, and UL 508E.
1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
3. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.

B. Disconnects:

1. MCCB:

a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

2. Disconnect Rating:
a. Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

C. Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 95 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Line Conditioning And Filtering:
a. Input Line Conditioning: Provide input filtering, as required, to limit THD(V) at input terminals of all VFCs to less than 5 percent.
b. Output Filtering: Provide output reactors for motor loads with more than 75 feet of feeder conductor length from the VFD output terminals to the motor terminal box or local disconnecting means.
c. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3.

7. Overload Capability:

    a. For variable-torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
    b. For constant-torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

8. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
9. Speed Regulation: Plus or minus 5 percent.
10. Output Carrier Frequency: Field selectable.
11. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
12. Internal Adjustability Capabilities:

    a. Minimum Speed: 5 to 25 percent of maximum rpm.
    b. Maximum Speed: 80 to 100 percent of maximum rpm.
    c. Acceleration: 0.1 to 999.9 seconds.
    d. Deceleration: 0.1 to 999.9 seconds.
    e. Current Limit: 30 to a minimum of 150 percent of maximum rating.

13. Self-Protection and Reliability Features:
    a. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
    b. Under- and overvoltage trips.
    c. Inverter overcurrent trips.
    d. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
    e. Critical frequency rejection, with three selectable, adjustable deadbands.
    f. Instantaneous line-to-line and line-to-ground overcurrent trips.
    g. Loss-of-phase protection.
    h. Reverse-phase protection.
    i. Short-circuit protection.
    j. Motor overtemperature fault.

14. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
15. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

D. Coordination with Life Support Systems Automation: Coordinate VFD control with Division 17 requirements.

E. Operator Station:

1. Inverter Logic: Microprocessor based.
2. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
3. Panel-mounted, manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

    a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.

b. Security Access: Electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

F. Displays:

1. Historical Logging Information and Displays:

a. Real-time clock with current time and date.
b. Running log of total power versus time.
c. Total run time.
d. Fault log, maintaining last four faults with time and date stamp for each.

2. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including the following:

a. Output frequency (Hz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percentage).
f. Fault or alarming status (code).
g. PID feedback signal (percentage).
h. DC-link voltage (V dc).
i. Set-point frequency (Hz).
j. Motor output voltage (V ac).

3. Overload Relays: Integral VFD overload protection.

G. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

I. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

J. Communication Port: USB 2.0 port or equivalent connection Capable of connecting a notebook computer.

2.7 CONTROLLER-MOUNTED AUXILIARY DEVICES

A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.

a. Push Buttons: Unguarded types; momentary contact unless otherwise indicated.
b. Pilot Lights: LED types; colors selected with submittals; push to test.

c. Selector Switches: Rotary type.

B. Elapsed-Time Meters: Heavy duty with digital readout in hours; nonresettable.

C. Auxiliary Dry Contacts: Reversible NC/NO.

D. Control Relays:

1. Time Delay: Auxiliary and adjustable solid-state time-delay relays.
2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage protection via VFD onboard voltage protection.

2.8 METERING

A. Provide with a front mounted, digital power quality meter / analyzer package. The metering shall include a lighted LCD display of voltage, current, power, kVA, kVAR, power factor, frequency, total harmonic distortion, kW demand, amperes demand, kWH, kVARH, auxiliary voltage input and neutral current. Phase switching shall be provided and the display shall indicate the phase being displayed. The meter shall have BACnet IP communications for BMS interface. Provide all voltage and current transformers required to provide the above data.

B. Manufacturers: The power quality meter / analyzer package shall be:
1. Eaton PXE Tier 1.
2. General Electric/ABB.
3. Siemens.
4. Square D/Schneider.
5. Substitutions: refer to provisions of the General and supplemental General Conditions and Division 1 specification sections.

C. Install at 60” AFF to bottom of the meter case or, if the meter is to be installed above 60” AFF but no more than 78”AFF, provide an angle adapter to lower the meter viewing angle. Angle adapter shall be acceptable to the Architect/Engineer.

2.9 METERING TRANSFORMERS

A. Current Transformers: ANSI C57.13, 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13, 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.10 SOURCE QUALITY CONTROL

A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.

B. VFC Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to its specified motor.

2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

C. MCCs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION

A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.

B. Floor Mounting: Install MCCs on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible switch.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components.

2. Install required warning signs.
3. Label MCC and each cubicle with engraved nameplate.
4. Label each enclosure-mounted control and pilot device.
5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 INSTALLATION OF CONTROL WIRING

A. Install wiring between master terminal boards and remote devices and facility's life support systems automation control system.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533.13 "Conduits for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Final Acceptance, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Final Acceptance.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

F. MCCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.

3.8 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.

B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect/Engineer before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

E. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Final Acceptance.

F. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 “Power System Studies."

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers.

END OF SECTION 262419

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
5. Section 260573 "Power System Studies" for Short-circuit, Overcurrent protective device coordination, arc-flash hazard analysis and arc-flash label requirements.
6. Section 262813 “Fuses” specifies fuses referenced by this Section.

C. References:

1. NECA - Standard of Installation (published by the National Electrical Contractors Association).
2. NEMA AB 1 - Molded Case Circuit Breakers.
3. NEMA FU1 - Low Voltage Cartridge Fuses.
4. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
5. NFPA 70 - National Electrical Code.

1.2 DEFINITIONS

A. GFEP: Ground-fault circuit-interrupter for equipment protection.

B. GFLS: Ground-fault circuit-interrupter for life safety.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and Insert calculation program format electronic format.
7. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

C. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of enclosed switches in project record documents.

C. Warranty documentation.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain products from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 RATINGS

A. Service Conditions:

1. Temperature: 104°F. (40°C.).
2. Altitude: N/A.
3. Terminal Rating: 75°C. minimum.

2.3 FUSIBLE SWITCHES

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

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Type HD, Heavy Duty:
1. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Hookstick Handle: Allows use of hookstick to operate handle.
7. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120 V(ac).
8. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 NONFUSIBLE SWITCHES

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

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Hookstick Handle: Allows use of hookstick to operate handle.
7. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120 V(ac).
8. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.5 MOLDED-CASE CIRCUIT BREAKERS

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

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Circuit breakers must be fully rated. Series rating is not acceptable.

C. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.

D. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.

E. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker.

F. MCCBs must be equipped with device for locking in isolated position.

G. Lugs must be suitable for 75 deg C rated wire.

H. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.

I. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

J. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

K. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I-squared t response. Provide ground fault alarm where trip is not required.

L. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).

M. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).

N. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
5. Auxiliary Contacts: Four SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
7. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
8. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power: Integrally mounted, self-powered.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: Enclosure must be NEMA-4X.

C. Conduit Entry: UL 50E Type 4X enclosures may not contain knockouts.

D. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

E. Enclosures designated as UL 50E Type 4X stainless steel must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 4X.

B. Outdoor Locations: UL 50E, Type 4X.

C. Wash-Down Areas: UL 50E, Type 4X.

D. Other Wet or Damp, Indoor Locations: UL 50E, Type 4X.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Height: 5 feet AFF to operating handle.
4. Wall-mounted switches and circuit breakers shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems." See Section 260010 “Supplemental Requirements for Electrical”, Paragraph 1.25 for additional requirements.
5. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
6. Install fuses in fusible disconnect switches serving Division 26 equipment.
7. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect and test each circuit breaker to NEMA AB 1.

C. Inspect each circuit breaker visually.

D. Perform several mechanical ON-OFF operations on each circuit breaker.

E. Verify circuit continuity on each pole in closed position.

F. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.

G. Include identification of each enclosed switch and circuit breaker tested and describe test results in test report.

3.6 ADJUSTING

A. Adjust work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

C. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 " Power System Studies." Prior to final settings, adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

3.7 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Final Acceptance, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Final Acceptance.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262816

SECTION 263213.13 – DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diesel-engine-driven generator sets.
2. Diesel engines.
3. Diesel fuel-oil system.
4. Control and monitoring.
5. Generator overcurrent and fault protection.
6. Generator, exciter, and voltage regulator.
7. Exhaust silencer.
8. Batteries.
9. Vibration isolation devices.
10. Day tanks.
11. Remote annunciators.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
4. Section 260548 "Vibration and Seismic Controls for Electrical Systems."
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.
6. Section 260573 "Power System Studies" for Short-circuit, Overcurrent protective device coordination, arc-flash hazard analysis and arc-flash label requirements.
7. Section 263213.14 “Generator Sets On-Board Paralleling Equipment”
8. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

C. References:

1. NEMA AB1 - Molded Case Circuit Breakers.
2. NEMA MG1 - Motors and Generators.
3. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum.)
4. NFPA 30 - Flammable and Combustible Liquids Code.
5. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
6. NFPA 70 - National Electrical Code.
7. NFPA 101 - Life Safety Code.
8. NFPA 110 - Emergency and Standby Power Systems.

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include thermal damage curve for generator.
4. Include time-current characteristic curves for generator protective device.
5. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
7. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
8. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactance, and short-circuit current capability.

C. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Seismic Qualification Data: Certificates, for engine generator, 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: With engine and generator mounted on rails, identify center of gravity and total weight including external silencer, and each piece of equipment not integral to the engine generator, 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. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.
5. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    b. Operating instructions laminated and mounted adjacent to generator location.
    c. Training plan.

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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: Two set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 110.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

C. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept unit on site on skids. Inspect for damage.

B. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.9 WARRANTY

The Contractor shall provide the following minimum manufacturers factory warranty for each engine-generator set and associated equipment.

A. All equipment shall be new and warranted free of faulty workmanship and damage.

B. The warranty shall include all parts, labor (including travel with no travel time or distance limitations), expenses and equipment necessary to perform replacement and/or repairs.

C. The total system (parts and labor) shall be warranted free of defects for a period of five (5) years 3000 hours from date of final acceptance.

D. Replacement of defective materials and repair of faulty workmanship shall take place within 48 hours of notification by Owner and shall be guaranteed at no cost to the Owner during the warranty period.

E. The minimum warranty provisions specified above shall not diminish the terms of individual equipment manufacturer’s warranties.

F. The printed warranty shall be included in the contract documents.

PART 2 - PRODUCTS

2.1 DIESEL-ENGINE-DRIVEN GENERATOR SETS

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

1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.
3. Generac.
4. MTU Onsite Energy Corporation.

B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, day tank, engine generator, batteries, battery racks, silencers, accessories, and components 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. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.
3. Component Importance Factor: 1.5.

B. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.

C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.

E. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 41 to 104 deg F.
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level.

F. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:

1. High salt-dust content in the air due to sea-spray evaporation. Provide special coatings, high corrosion resistant hardware and components, anti-condensation heaters and alternator coatings suitable for the corrosive conditions at the site.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

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 use.

C. EPSS Class: Engine generator shall be classified as a Class 168 according to NFPA 110.

D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

E. Service Load: 1,250 kW / 1,562.5 kVA.

F. Power Factor: 0.8, lagging.

G. Frequency: 60 Hz.

H. Voltage: 277/480-V ac.

I. Phase: Three-phase, four wire, wye.

J. Induction Method: Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

M. Capacities and Characteristics:

1. Power Output Ratings: The generator set shall be capable of accepting a block load equal to the specified kW at 0.8 power factor at rated site conditions and recover to rated voltage and frequency. The alternator shall accept the largest load step with a maximum voltage dip of 20% based on the transient reactance of the alternator proposed. Provide calculations demonstrating compliance to this requirement.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

N. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. The generator set shall be designed and manufactured to be capable of being installed in an NFPA 110 Type 10 compliant EPSS (Emergency Power Supply System).

O. Paralleling Controls: See Section 263213.14.

2.4 DIESEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump. Radiator frame shall be galvanized coated with epoxy cores for the jacket water, aftercooler, and fuel cooler.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Both top and bottom tanks shall be constructed of stainless steel and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer:

1. Critical hockey puck type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 25 dB at 500 Hz.

b. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 78 dBA or less.
c. The silencer, wall thimble, and flex connectors shall be constructed of Type 316 stainless steel.

G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery-Charging Alternator: Factory mounted on engine or wall with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
f. Enclosure and Mounting: NEMA 250, Type 1, installed inside generator enclosure.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Dual fuel water and contaminant separators to enable switching from one bank to the other without shutting down engine.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Fuel-Oil Storage Tank: Comply with requirements in Section 231323 "Facility Aboveground Fuel-Oil Storage Tanks."

1. Fuel Tank Capacity: 96 hours at 70% load of both generators.
2. Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 231213 "Facility Fuel-Oil Pumps."

G. Day Tanks: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled fuel return pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: 150 gallons.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor-control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms. See Section 263213.14 for paralleling operation.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates

engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.
3. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery.

F. Control and Monitoring Panel:

1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3. Instruments: Located on the control and monitoring panel and viewable during operation.

    a. Engine lubricating-oil pressure gage.
    b. Engine-coolant temperature gage.
    c. DC voltmeter (alternator battery charging).
    d. Running-time meter.
    e. AC voltmeter, for each phase.
    f. AC ammeter, for each phase.
    g. AC frequency meter.
    h. Generator-voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

    a. Cranking control equipment.
    b. Run-Off-Auto switch.
    c. Control switch not in automatic position alarm.
    d. Overcrank alarm.
    e. Overcrank shutdown device.
    f. Low-water temperature alarm.
    g. High engine temperature prealarm.
    h. High engine temperature.
    i. High engine temperature shutdown device.
    j. Overspeed alarm.
    k. Overspeed shutdown device.

l. Low fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required for the indicated EPSS class.

m. Coolant low-level alarm.
n. EPS load indicator.
o. Battery high-voltage alarm.
p. Low cranking voltage alarm.
q. Battery-charger malfunction alarm.
r. Battery low-voltage alarm.
s. Lamp test.
t. Contacts for local and remote common alarm.
u. Low-starting air pressure alarm.
v. Low-starting hydraulic pressure alarm.
w. Remote manual stop shutdown device.
x. Air shutdown damper alarm when used.
y. Air shutdown damper shutdown device when used.
z. Generator overcurrent-protective-device not-closed alarm.
aa. Hours of operation.
bb. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
cc. Additional visual indicators and alarms as required by NFPA 110.
dd. Remote Alarm Contacts: Pre wire SPDT contacts to terminal strip for remote alarm functions required by NFPA 110 for a Level 1 system.

G. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via BACnet IP. See Specifications Section 230923.

H. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Low water-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Lamp test.
16. Low-cranking voltage alarm.

17. Generator overcurrent-protective-device not-closed alarm.
18. Emergency stop switch.
19. Additional visual indicators and alarms as required by NFPA 110 for a Level 1 system.

I. Remote Emergency Stop Switch: Weatherproof, surface wall mounted, unless otherwise indicated, adjacent to the engine-generator set and labeled with an engraved, three layer, laminated plastic nameplate “GENERATOR EMERGENCY STOP”. Push button shall be protected from accidental operation. See Drawings for location.

J. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Motor operated, insulated-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.
e. Circuit breaker to have spring charging motor to close upon signal from generator control panel.
f. Auxiliary contacts, under voltage trip and overcurrent fault switch

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.

E. Generator breakers shall have ERMS to enhance safety by reducing instantaneous overcurrent protection settings to reduce the risk of personal injury.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class F.

D. Temperature Rise: 105°C Standby.

E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12-lead alternator.

F. Range: Provide broad range of output voltage by adjusting the excitation level.

G. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

H. Enclosure: Dripproof.

I. Instrument Transformers: Mounted within generator enclosure.

J. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within 20 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 5 percent and stabilize at rated frequency within 2 seconds.

K. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

L. Windings: Two-thirds pitch Form Wound stator winding and fully linked amortisseur winding. Windings and bearings to include RTDs.

M. Subtransient Reactance: 12 percent, maximum.

N. Due to the corrosive environment, the alternator shall include Vacuum Pressure Impregnation to enhance protection of windings

2.9 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch.

C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.

4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

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

3.2 PREPARATION

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

1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
3. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
4. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches of clearance from combustibles.

F. Drain Piping: Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Drain piping valves, connectors, and installation requirements are specified in Section 232116 "Hydronic Piping Specialties."

G. Fuel Piping:

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."
2. Copper and galvanized steel shall not be used in the fuel-oil piping system.

H. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

C. Connect cooling-system water piping to engine generator and with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:
1. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
2. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with Drawings and the Specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify that the unit is clean.

b. Electrical and Mechanical Tests:

1) Perform insulation-resistance tests according to IEEE 43.

a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

2) Test protective relay devices.
3) Verify phase rotation, phasing, and synchronized operation as required by the application.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Perform vibration test for each main bearing cap.
6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Perform and document the following additional testing:

a. Level 1 Acceptance Testing: Refer to NFPA 110 Section 7.13.2.1 Level 1 acceptance testing for requirements.

4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
8. Exhaust Emissions Test: Comply with applicable government test criteria.
9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
10. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
11. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator building, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Final Acceptance, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Final Acceptance.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 DOCUMENTATION

A. Upon final completion of the system, a documentation package shall be provided and shall include three (3) bound (in three ring binders with index tabs) copies of complete manufacturer's operation and instruction manuals. Provide one bound original (no photocopies) and two additional bound copies (photocopies are acceptable) of the total documentation package. The manuals shall include operation and maintenance procedures, complete parts lists, dimensional drawings, unit wiring diagrams and schematics, and interconnection wiring drawings. Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures. The following shall also be provided:

1. System record drawings.
2. Instruction manuals as supplied by the manufacturer for all components and electronics.
3. Product specification sheets for all equipment without instruction manuals.

3.8 CLEANING

A. Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Touch up scratched or marred surfaces to match original finish.

C. Clean engine and generator surfaces. Replace oil and fuel filters.

3.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Final Acceptance, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

3.11 FINAL ACCEPTANCE

The installation shall be supervised, checked and tested by a qualified representative of the engine-generator set manufacturer. Written certification, by the qualified manufacturer's representative, verifying manufacturer's startup procedures were followed and full system functionality was achieved shall be submitted to the Architect and Owner prior to final acceptance.

END OF SECTION 263213.13

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contactor-type automatic transfer switches.
2. Transfer switch accessories.

B. Related Sections:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
4. Section 260548 "Vibration and Seismic Controls for Electrical Systems."
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
6. Section 260573 "Power System Studies" for Short-circuit, Overcurrent protective device coordination, arc-flash hazard analysis and arc-flash label requirements.
7. Section 263213.13 “Diesel-Engine-Driven Generator Sets”
8. Section 263213.14 “Generator Sets On-Board Paralleling Equipment.”

C. References:

1. NEMA ICS 10 - AC Transfer Switch Equipment.
2. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).
3. NFPA 70 - National Electrical Code.

1.2 ACTION SUBMITTALS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data:

1. Contactor-type automatic transfer switches.
2. Transfer switch accessories.

C. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.

2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

D. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, Power sources, and load.
4. Riser Diagram: Show interconnection wiring between transfer switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

C. Qualification Data: For manufacturer-authorized service representative.

D. Seismic Qualification Data: Certificates, for transfer switches, 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.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Features and operating sequences.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA70.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

1.6 MAINTENANCE SERVICE

Provide service and maintenance of transfer switches for one year from Date of Final Acceptance.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from Date of Final Acceptance. The warranty shall include all parts, labor (including travel), expenses and equipment necessary to perform replacement and repairs.

PART 2 - PRODUCTS

2.1 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 NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Short-time withstand capability for 3 cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Neutral Switching: Provide overlapping neutral contacts.

K. Neutral Terminal: Fully rated unless otherwise indicated.

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via front access.

N. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated. Finish shall be Manufacturer's standard gray enamel.

O. Generators Start Circuit Integrity Monitoring for ATS-4LS: Provide start circuit integrity monitoring as required by NFPA 70 Article 700.10 (D)(4). Loss of integrity must start the generators.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

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

1. ABB Electrification Installations Products.
2. ASCO.
3. Caterpillar, Inc.; Electric Power Division.
4. Cummins Power Generation.
5. Eaton.
6. Generac.
7. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: Hard-drawn copper, 98 percent conductivity.
6. Main and Neutral Lugs: Mechanical type.
7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.

1. Fully automatic make-before-break operation when transferring between two available power sources.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
    c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

E. Manual Switch Operation, Load-Breaking: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

F. Manual Switch Operation, Non-Load-Breaking: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

G. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

H. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

I. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at

90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Four (4) normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:

    a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
    b. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

13. Provide BACnet IP communications capability for all conditions and alarms specified in Para. 2.3 below. See Specifications Section 230923.

J. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an

adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.

3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES

A. Remote Annunciator and Control System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:

    a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Indication of switch position.
    c. Indication of switch in test mode.
    d. Indication of failure of digital communication link.
    e. Key-switch or user-code access to control functions of panel.
    f. Control of switch-test initiation.
    g. Control of switch operation in either direction.
    h. Control of time-delay bypass for transfer to normal source.
    i. Lamp Test: Push-to-test or lamp-test switch on front panel.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

    a. Controls and indicating lights grouped together for each transfer switch.
    b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
    c. Digital Communication Capability: Matched to that of transfer switches supervised.
    d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for all systems. Include results of test for the following conditions:

    a. Overvoltage.
    b. Undervoltage.
    c. Loss of supply voltage.
    d. Reduction of supply voltage.
    e. Alternative supply voltage or frequency is at minimum acceptable values.
    f. Temperature rise.
    g. Dielectric voltage-withstand; before and after short-circuit test.
    h. Overload.
    i. Contact opening.
    j. Endurance.
    k. Short circuit.
    l. Short-time current capability.
    m. Receptacle withstand capability.
    n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for seismic control devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

F. Protection of Generators Start Circuit Control Conductors for ATS-4LS: Start circuit conductors must be kept entirely independent of all other wiring and be protected per NEC Articles 700.10(D)(4) and 700.10(D)(2).

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

G. Brace and support equipment according to Section 260548 "Vibration and Seismic Controls for Electrical Systems."

H. Final connections to equipment shall be made with liquidtight, flexible non-metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS, except Section 4.
2. Perform inspections and tests listed in NETA ATS, Section 7.22.3.
3. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify that the unit is clean.
    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Verify that manual transfer warnings are attached and visible.
    g. Verify tightness of all control connections.
    h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

    i. Perform manual transfer operation.
    j. Verify positive mechanical interlocking between normal and alternate sources.
    k. Perform visual and mechanical inspection of surge arresters.
    l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.

4. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.
9) Generator start circuits integrity monitoring.

5. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

6. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

7. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Transfer switches will be considered defective if they do not pass tests and inspections.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Final Acceptance, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Final Acceptance.

3.4 DEMONSTRATION

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

B. Demonstrate operation of transfer switch in normal and emergency modes.

C. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

D. Coordinate this training with that for generator equipment.

END OF SECTION 263600

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SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted surge suppression devices (SPD) for low-voltage (120VAC to 480VAC) power distribution and control equipment:

1. Type 1 surge protective devices (SPDs).
2. Type 2 surge protective devices (SPDs).
3. Type 3, Type 4, and Type 5 surge protective devices (SPDs).
4. Enclosures.
5. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of lighting control devices referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
6. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.2 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. I_n: Nominal discharge current.

C. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.

D. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.

E. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).

F. SCCR: Short-circuit current rating.

G. SVR: Suppressed voltage rating.

H. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

I. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

J. Type 3 SPDs: Point of utilization SPDs.

K. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.

L. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.

M. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPDs.
b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

1) Tested values for VPRs.
2) I_n ratings.
3) MCOV, type designations.
4) OCPD requirements.
5) Manufacturer's model number.
6) System voltage.
7) Modes of protection.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 article 285, by a testing agency, and marked for intended location and application.

C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

D. Comply with NEMA LS 1.

E. Comply with UL 1283 and UL 1449.

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.7 COORDINATION

Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

1.8 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: Ten (10) years from date of Final Acceptance Completion, for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: Ten (10) years from date of Final Acceptance, for materials only, f.o.b. the nearest shipping point to Project site.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs) – Service Entrance and Switchboard EPS

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

1. ABB, Electrification Business.
2. Current Technology Inc.; Danaher Power Solutions.
3. Eaton.
4. Schneider Electric USA, Inc.

5. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. Provide integral devices for switchboards and external devices elsewhere.

D. General Characteristics:

1. Reference Standards: UL 1449, Type 1.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 400 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V.
    b. Line to Line: 2000 V for 480Y/277 V.

5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.
    b. Line to Line: 1200 V.

6. SCCR: Not less than 200 kA.
7. I_n Rating: 20 kA.

E. Options:

1. Include integral disconnect switch.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at 5A and 250VAC, one normally open and one normally closed, for remote monitoring of protection status.
6. Include surge counter.

2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs) – Equipment Downstream from Service Equipment

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

1. ABB, Electrification Business.
2. Current Technology Inc.; Danaher Power Solutions.
3. Eaton.
4. Schneider Electric USA, Inc.
5. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. Provide integral devices for switchboards and external devices elsewhere.

D. General Characteristics:

1. Reference Standards: UL 1449, Type 2.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 320 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
   a. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
   b. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
   c. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
   d. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.
5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
   a. Line to Neutral: 700 V.
   b. Line to Ground: 700 V.
   c. Neutral to Ground: 700 V.
   d. Line to Line: 1200 V.
6. SCCR: Equal or exceed 100 kA.
7. I_n Rating: 20 kA.

E. Options:

1. Include LED indicator lights for power and protection status.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
4. Include surge counter.

2.3 ENCLOSURES

A. Indoor Enclosures: Type 4X.

B. Outdoor Enclosures: Type 4X.

2.4 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Do not exceed manufacturer's recommended lead length.
3. Do not bond neutral and ground.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Engineer.

B. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

C. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support and supervise field tests and inspections.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not energize or connect electrical equipment to their sources until SPD devices are installed and connected.

C. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

D. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain SPD devices.

END OF SECTION 264313

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SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Type OFNP optical fiber cable.
   2. Optical fiber cable hardware.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

B. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.

1.3 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Type OFNP optical fiber cable.
   2. Optical fiber cable hardware.

B. Shop Drawings:

   1. System Labeling Schedules:

      a. Electronic copy of labeling schedules, in software and format selected by Owner.
      b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

   2. Cabling administration drawings and printouts.
   3. Wiring diagrams showing typical schematic arrangement, including the following:

      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Cross-connects.
      f. Patch panels.
      g. Patch cords.

   4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates: For each type of product.

D. Field Quality-Control Reports: Optical fiber cable testing plan.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software service agreement.

B. Maintenance Data: For optical fiber cable, splices, and connectors.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine continuity of strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.1 TYPE OFNP OPTICAL FIBER CABLE

A. Type OFNP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.

d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Type OFNP, Designation OM3, Multimode Optical Fiber Cable.
1. Match Owner's existing.
2. Source Limitations: Obtain products from single manufacturer.
3. Additional Characteristics:

a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm wavelength.

4. Options:

a. Configuration: 6-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: 3.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
c. Jacket Color: Black.

2.2 OPTICAL FIBER CABLE HARDWARE

A. Match Owner's existing.

B. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, dual-fiber cables in 36 inch lengths.

E. Connector Type: Use type in use by the Owner.

F. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to patch panel or faceplate.

2.3 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: Engage qualified testing agency to evaluate cables.

C. Factory Tests and Inspections:

1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
2. Test and inspect pre-terminated optical fiber cable assemblies, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

D. Nonconforming Work:

1. Cables that do not pass tests and inspections will be considered defective.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.2 SELECTION OF OPTICAL FIBER TYPE

A. Installed in Vertical Shaft or Floor-to-Floor Riser:

1. Nonconductive:

a. Type OFNP.

B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:

1. Nonconductive:

a. Type OFNP

C. Installed in Location Other Than Riser or Plenum:

1. Nonconductive: Type OFNP.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:
1. Install cables in raceways, cable trays and on J hooks. Conceal raceway and cables, except in unfinished spaces.
   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Comply with requirements for raceways and boxes specified in Section 270510 "Telecommunications Pathways."
2. If a continuous raceway system is not shown on the Drawings, all cabling not shown in raceway shall be supported with a cable support structure.
   a. Cabling shall be installed in straight paths and exit pathways at ninety-degree angles. Diagonal, beeline and or non-supported cabling are unacceptable. Cabling shall be routed as high as possible and above other building facilities in the path with the least obstructions in the ceiling space while maintaining the separation requirements of ANSI/TIA-568-C, ANSI/TIA/EIA-569-B, and NFPA 70 (NEC). There shall be a minimum distance of 3 inches between the cable and ceiling grid. Any violations of this shall be corrected at the contractor’s expense. Cables shall not be strapped to electrical conduits or pipe.
   b. The cable support structure shall utilize approved cable supports and be sized to accommodate change. J hook type cable supports shall be securely fastened to the building structure and be spaced at a maximum distance of four (4) feet so that sag between supports does not exceed 12 inches. J hooks shall be sized as follows: two inch J hooks rated for 75 cables and shall be used to support cable paths of 50 or less cables, four inch J hooks rated for 150 cables and shall be used to support cable paths of 51 to 100 cables. All cable paths shall be sized with 20% spare capacity. All attachment hardware shall be approved for the type of installation and maximum load rating of the products to be installed.
3. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.

2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
9. In communications equipment room, provide 10 ft long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within 4 inch of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

E. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

B. Field tests and inspections must be witnessed by Architect.

C. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

D. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

E. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.
2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

F. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.7 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for two years.

2. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 271323

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Category 6 twisted pair cable.
2. Cable management system.
3. Identification products.

B. Related Requirements:
1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Category 6 twisted pair cable.
   2. Cable management system.
   3. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.
   1. System Labeling Schedules:
      a. Electronic copy of labeling schedules, in software and format selected by Owner.
      b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.
   2. Cabling administration Drawings and printouts.
   3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Telecommunications conductor drop locations.
      f. Typical telecommunications details.
      g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, cabling administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in

TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
   1. Communications, Plenum Rated:
      a. Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
      b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
   2. Communications, Non-Plenum Rated:
      a. Type CMR complying with UL 1666.
      b. Type CMP or Type CMR in listed plenum or riser communications raceway.
      c. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Category 6 Twisted Pair Cable: Four-pair, balanced -twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP).

E. Cable Rating: Plenum.

F. Jacket: Black thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Match Owner’s existing equipment.

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

E. Connecting Blocks:
1. 110-style IDC for Category 6.
2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Rack mounted, modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables, with adequate capacity for all active and 25% spare circuits.
1. Features:
   a. Universal T568A and T568B wiring labels.
   b. Labeling areas adjacent to conductors.
   c. Replaceable connectors.
   d. 24 or 48 ports.
2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

H. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with an eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.
3. Provide adequate capacity for all active and 25% spare circuits. Provide gray patch cords for all patch panel ports, evenly divided between 5 and 7 foot cords, plus 15% spare of each length. Provide one gray patch cord for all telecommunications outlets throughout the facility, evenly divided into 5, 7 and 10 foot cords, plus 15% spare of each length. All patch cables shall be supplied from one manufacturer. Data cables shall terminate on manufacturer's specified end-to-end Cat 6 UTP solution.
4.

I. Plugs and Plug Assemblies:
1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:
1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

K. Cover Plate:
1. Four port, vertical single gang cover plates designed to mount to single gang wall boxes.

2. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
3. Metal Cover Plate: Nylon, complying with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:
1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CABLE MANAGEMENT SYSTEM

A. Cable Management System: Computer-based cable management system, with integrated database and graphic capabilities.

B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

C. Information shall be presented in database view, schematic plans, or technical drawings.
1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

D. System shall interface with the following testing and recording devices:
1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.6 IDENTIFICATION PRODUCTS

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.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
   a. Install plenum cable in environmental air spaces, including plenum ceilings.
   b. Comply with requirements for raceways and boxes specified in Section 270510 "Telecommunications Pathways."
2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. If a continuous raceway system is not shown on the Drawings, all cabling not shown in raceway shall be supported with a cable support structure.
   a. Cabling shall be installed in straight paths and exit pathways at ninety-degree angles. Diagonal, beeline and or non-supported cabling are unacceptable. Cabling shall be routed as high as possible and above other building facilities in the path with the least obstructions in the ceiling space while maintaining the separation requirements of ANSI/TIA-568-C, ANSI/TIA/EIA-569-B, and NFPA 70 (NEC). There shall be a minimum distance of 3 inches between the cable and ceiling grid and cable pathways shall be clear of all possible EMF and RFI interference. Cables shall be installed at least two feet away from all lighting fixtures and other potential EMF sources. Any violations of this shall be corrected at the contractor's expense. Cables shall not be run parallel with electrical conduits or strapped to them.
   b. The cable support structure shall utilize Cat 6 approved cable supports and be sized to accommodate change. J hook type cable supports shall be securely fastened to the building structure and be spaced at a maximum distance of four (4) feet so that sag between supports does not exceed 12 inches. J hooks shall be sized as follows: two inch J hooks rated for 75 cables and shall be used to support cable paths of 50 or less cables, four inch J hooks rated for 150 cables and shall be used to support cable paths of 51 to 100 cables. All cable paths shall be sized with 20% spare capacity. All attachment hardware shall be approved for the type of installation and maximum load rating of the products to be installed.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 260529 "Hangers and Supports for Electrical Systems."

C. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. Cable shall be installed and terminated per manufacturer's specifications. The installer shall observe the cabling practices described in ANSI/TIA-568-C standards. Standard industry practices guided by ANSI/TIA cabling standards and BICSI installation manuals shall be employed for cable installation, handling, grooming, etc. All cabling will be installed in a manner that will protect the cable from damage during installation, facilitate cable management and identification, and provide a neat and groomed appearance.

C. General Requirements for Cabling:
1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Horizontal station cable shall have 12 inches spare cable at the station outlet and 10 feet of spare at each rack. Provide 25 feet of spare cable at each WAP termination. Cables from building protector blocks shall have 10 feet spare at protector blocks.
5. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
6. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. MUTOA shall not be used as a cross-connect point.
8. Consolidation points may be used only for making a direct connection to equipment outlets:
   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for twisted pair cables at least 49 feet from communications equipment room.
9. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
10. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
11. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
12. Horizontal cables shall be bundled using hook and loop cable ties. Plastic cable ties are not permitted. All cable shall be installed according to ANSI/TIA-568-C and ANSI/TIA/EIA-569-B standards.
13. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
14. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
15. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
16. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

D. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
4. All penetrations through walls and floors shall be sleeved. All sleeves shall have permanently attached bushings. Sleeves shall be sized to accept 50% growth. All sleeves shall be fire-stopped using UL® approved methods and shall maintain assembly fire ratings. All sleeves between floors shall be supported with a conduit riser clamp installed per the manufacturer direction and shall be installed tight to the ceiling with enough sleeve to attach the bushing and rise up three inches above the floor on the

opposite end.

5.

E. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.
   3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:
   1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using the specified grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B, including optional identification requirements of this standard.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List

incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
   4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
      b. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:
   1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Nonconforming Work:
1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:
1. Engage factory-authorized service representative to supervise field tests and inspections.

3.8 MAINTENANCE

A. Software Service Agreement:
1. Technical Support: Beginning at Final Acceptance, verify that software service agreement includes software support for two years.
2. Upgrade Service: At Final Acceptance, update software to latest version. Install and program software upgrades that become available within two years from date of Final Acceptance. Verify that upgrading software includes operating system and new or revised licenses for using software.
   a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

3.9 MANUFACTURER WARRANTY

A. Contractor shall provide a Twenty-Five Year System Warranty and Application Assurance.

B. A Warranty Statement shall be provided by the Manufacturer stating the period of the Warranty for all the products specified for the project, the name and address of the authorized manufacturer's agent and also state who shall honor any and all Warranty claims.

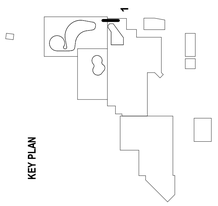
C. Extended Product Warranty shall cover product defects for all passive manufactured channel components. Passive components are defined as those exhibiting no gain or contributing no energy. As from the date of a Registration Certificate the Manufacturer shall Warrant:
1. That the passive products that comprise the registered Channel solution shall be free from manufacturing defects in material or workmanship under normal and proper use;
2. That all channel approved passive cabling products that comprise the registered Channel solution exceed the specification of ANSI/TIA-568-C and exceed ISO/IEC 11801 standards and shall be equal to or exceed the performance specifications of the associated Communication product data sheet in effect at the time the Registration Certificate is issued;
3. Each channel shall be comprised exclusively of a single manufacturer's solution.
4. This extended Product Warranty is applicable to the channel cabling solution products only on the original site of installation. Under the Extended Product Warranty, Manufacturer shall either repair or replace the defective product itself at Manufacturer's cost and, pay an Authorized Cable Installation Reseller for the cost of labor to repair or replace any such defective product on behalf of the Manufacturer;

D. Application Assurance shall cover the failure of the channel structured cabling solution to operate the applications, which the Solution was designed to support, as well as additional application(s) defined below. Manufacturer shall warrant that the registered channel structured cabling solution shall be free from failures which prevent operation of the specific applications for which the original channel structured cabling solution was designed. The Application Assurance Program shall also cover the following additional applications:

1. Those identified in the current (at the time of installation) channel structured cabling solution performance specifications; and
2. In accordance with application standards specifications, any application introduced in the future by recognized standards or user forums that use ANSI/TIA-568-C or ISO/IEC 11801 components and link/channel specifications for cabling.

E. Other Warranties
1. Additional Warranty: The Contractor shall state any additional Contractor supplied warranty.

END OF SECTION 271513



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CONNECTING STAIR - SOUTH - ROOF

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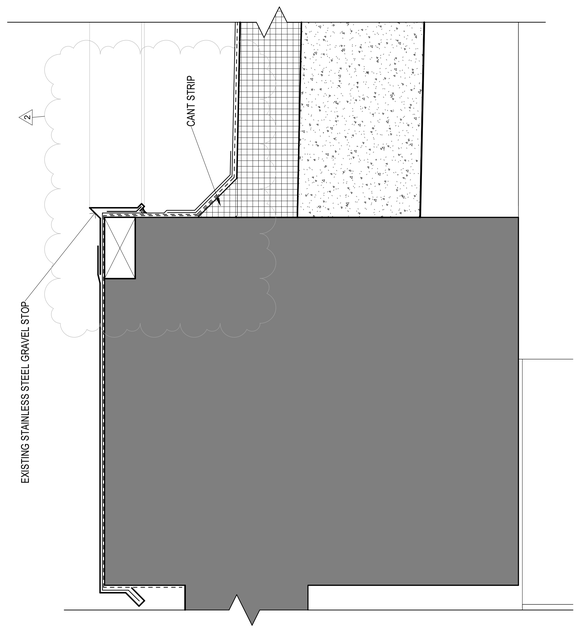

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CONNECTING STAIR - SOUTH

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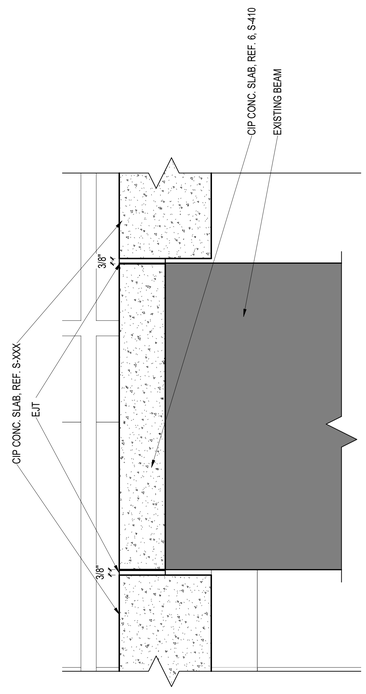

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CONNECTING STAIR - NORTH - ROOF

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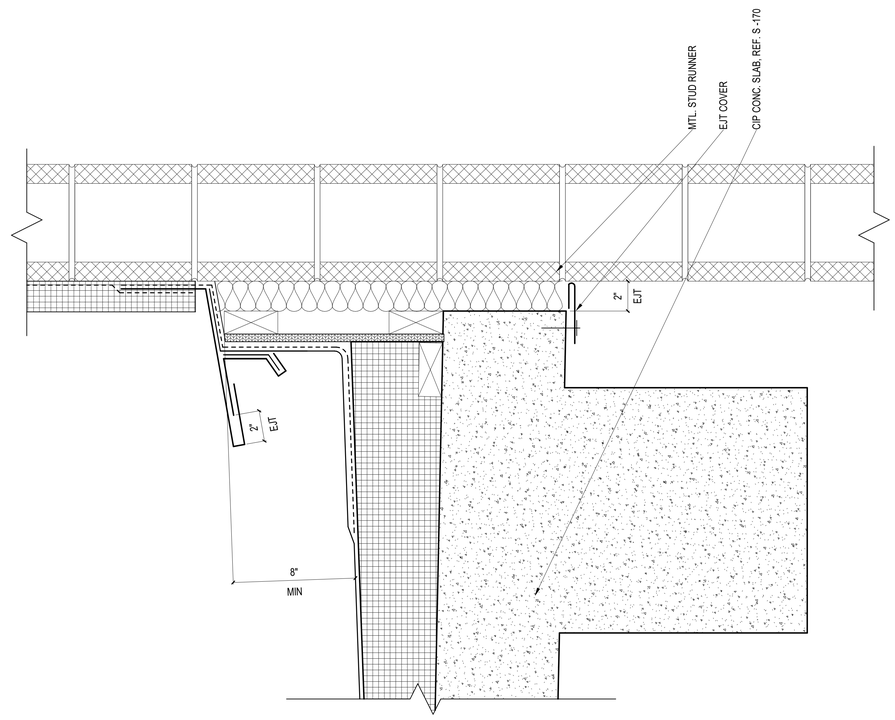

1

SHARK TANK - SE - EXISITNG & ADDITION

SCALE : 1/2" = 1'-0"

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
CODE: 42014-4G02
ITEM: 41414-4Y4A

900 LOGGERHEAD RD,
KURE BEACH, NC 28449

NORTH CAROLINA DEPT. OF
NATURAL & CULTURAL RESOURCES

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LIFE SUPPORT SYSTEMS ENGINEER
56880 VENTURE LANE SUITE 200M
BEND, OR 97707
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LICENSE # C-3505

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TELE: 910.791.4000
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2602 IRON GATE DRIVE SUITE 102
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TELE: 910.343.9653
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SURFACE 678, PA
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FAX: 919.419.1669
WWW.SURFACE678.COM
LICENSE # C-098

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Szostak Design, Incorporated — 51679 — Chapel Hill, NC

PHILIP SZOSTAK — REGISTERED — 3433 — ARCHITECT — NORTH CAROLINA

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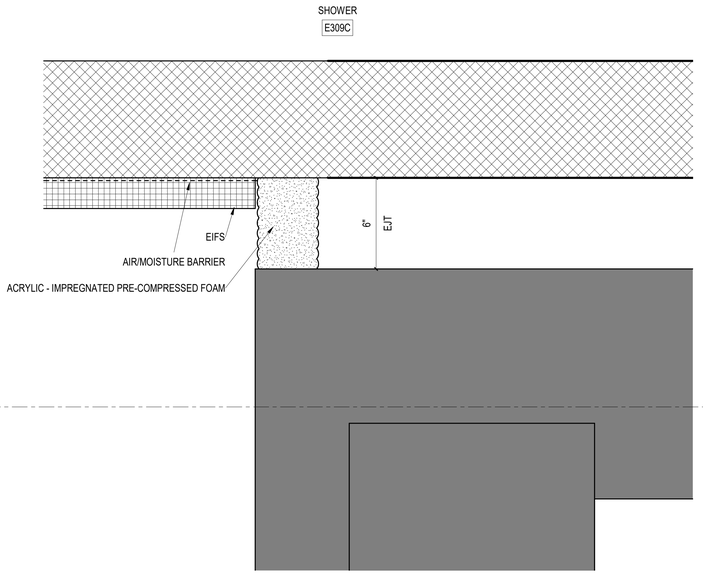
NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

WALL SECTIONS

A-7.8



EJT DETAIL @ SHOWER E309C

SCALE : 3" = 1'-0"

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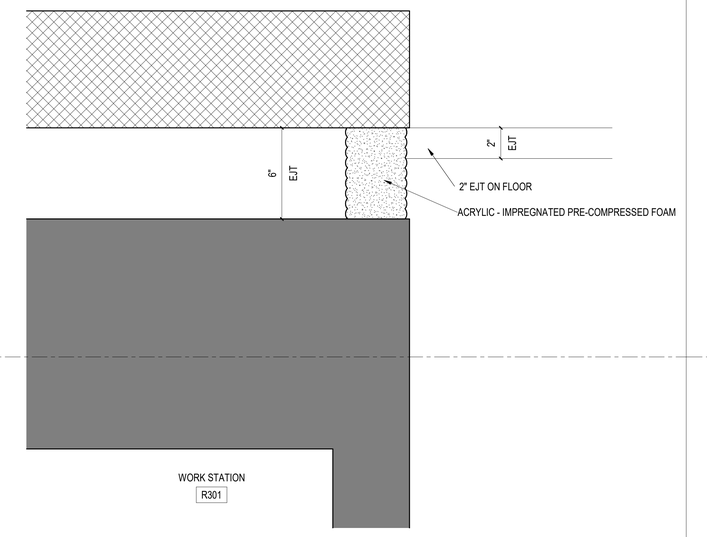

EJT DETAIL @ WORK STATION R301

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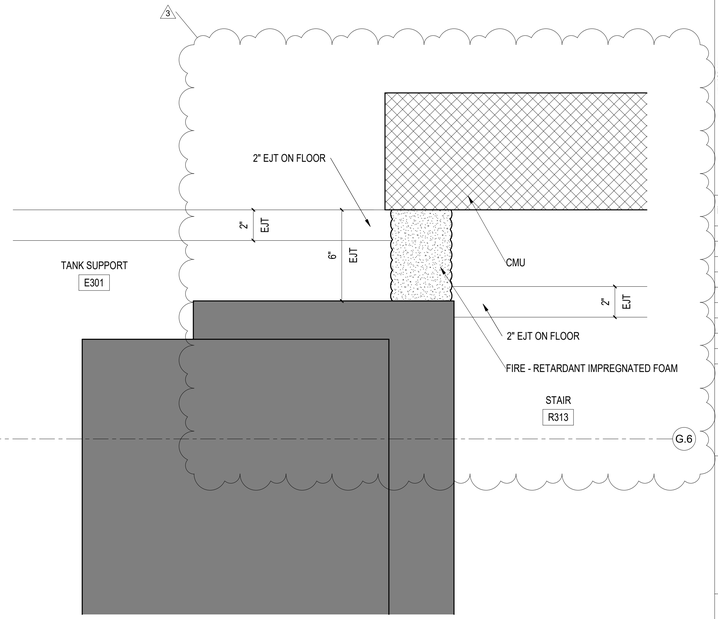

EJT DETAIL @ INTERIOR DOOR E301-A

SCALE : 3" = 1'-0"

1

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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PHILIP SZOSTAK REGISTERED 3433 ARCHITECT NORTH CAROLINA

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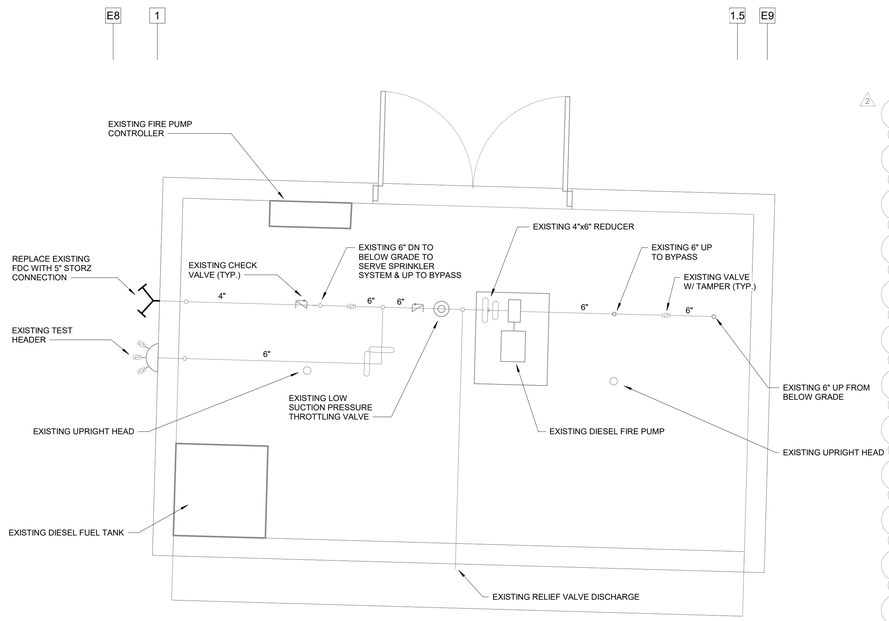
NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

SCALE: 3" = 1'-0" U.O.N.

PLAN DETAILS

ON THIRD FLOOR U.O.N.

A-8.25



1 F-0.1 EXISTING FIRE PUMP BUILDING
SCALE: 1/2" = 1'-0"

EXISTING FIRE PUMP SCHEDULE

SYMBOL	RATING		ELECTRICAL		LOCATION	TYPE	FUEL
	GPM	PSI	HP	VOLTAGE			
FIRE PUMP	500	125	66	110 V., 1Ø	EXG. FIRE PUMP BLDG. 155	CENTRIFUGAL	DIESEL

2

BFPE INTERNATIONAL — FIRE, SAFETY & SECURITY
3300 Highway 421 North
Wilmington, NC, 28401
800-948-5469
BFPE.COM

Rev #3 WIL

Annual Fire Pump Flow Test

Job # or Call Type: 0903721 Date: 3-4-2024
Ticket Number: 2157839 Page:

Customer Name: NC Aquarium - Fort Fisher Address: 900 Loggerhead RD
City: Kure Beach State: NC Zip: 28449
Contact Name: Joanna Phone number: 910-772-0539

Fire Pump:

Type: Split Case Manufacturer: A-C Fire Pump System Serial #: 01-034419-01-01
Model: 8100 Rated GPM: 500 PSI/FT rated RPM: 2350
Rated boost @ 100% flow: 128 Rated boost @ 150% flow: 118

Driver:

Type: Diesel Manufacturer: Clark Serial #: *
Model: 404HF280E,F,G Rated HP: * Rated RPM: * Volts: N/A Amps: N/A

Controller:

Manufacturer: Merton Serial #: HD-01N12039-11 Catalog #: FD2-J

Transfer Switch:

Manufacturer: N/A Serial #: N/A Catalog #: N/A
150% flow with transfer to emergency power? N/A Comments:

Electric Motor							Suction PSI	Discharge PSI	Net Head PSI	Hose Streams							Gallons per minute	Percent of rated capacity
Volts			Amps			RPM				No.	Size	Pitot						
N/A	N/A	N/A	N/A	N/A	N/A	2421	45	175	130	0	0	0	0	0	0	0	0	Churn
N/A	N/A	N/A	N/A	N/A	N/A	2396	40	170	130	1	1-1/8"	46					250	50%
N/A	N/A	N/A	N/A	N/A	N/A	2378	25	150	125	2	1-1/8"	46	46				500	100%
N/A	N/A	N/A	N/A	N/A	N/A	2368	0	110	110	3	1-1/8"	46	46	46			750	150%

Automatic start: Yes Batteries 1 & 2 crank: Yes Run time electric 10mins: N/A Run time diesel 30 mins: Yes
Pump test performed from: Test header (nozzles)
Main pressure relief setting: N/A PSI Returned setting: N/A PSI N/A:
Fire pump supply fed by: City water If tank: height & tank level?
Casing relief setting adequate to cool pump: Yes Fuel tank level: Full
Fire pump alarms to fire alarm panel: Pump run: * Power failure: * Phase reversal: N/A
Jockey Pump Cut In: 160 PSI Cut Out: 180 PSI Comments:
Fire Pump Cut In: 150 PSI Cut Out: 170 PSI Comments:
Comments/Remarks: Cooling line for the motor was running upon arrival and departure Futher investigation is Needed, solenoid could be bad. Tech was unable to read the specs on the driver due to the placard being unreadable. Tech replaced the pumps suction and discharge gauge.
Weather condition: Temp: Tech name: Antawn Campbell
Start time: Finish time: Date: 3-4-2024 Tech signature: Antawn Campbell

Owner must maintain a minimum temperature of 40°F in all areas with water-filled fire sprinkler system components. Signature constitutes acceptance of service performed as being satisfactory. If a service agreement exists between customer and BFPE, all work is subject to that agreement.

Customer name:
Cust. signature:
AHJ name:
AHJ signature:(if present)

NOTES:

1. THE ABOVE ANNUAL FIRE PUMP TEST INFO WAS USED FOR DESIGN OF THE SPRINKLER SYSTEM. CONTRACTOR SHALL USE THE MOST RECENT ANNUAL FIRE PUMP TEST DATA IN THEIR DESIGN. IF FIRE PUMP TEST DATA LESS THAN ONE YEAR OLD IS NOT AVAILABLE, CONTRACTOR SHALL PERFORM THEIR OWN FIRE PUMP TEST.

3

2. ABOVE FIRE PUMP TEST DATA IS MORE THAN ONE YEAR OLD. A NEW FIRE PUMP TEST HAS BEEN PERFORMED, HOWEVER, DUE TO LEAKS IN THE EXACT SYSTEM THE RESULTS ARE NOT ACCURATE. CONTRACTOR SHALL USE FIRE PUMP DATA ACQUIRED AFTER REPAIRS ARE MADE, OR PERFORM THEIR OWN FIRE PUMP TEST AFTER REPAIRS ARE MADE.

2

GENERAL NOTES: (APPLIES TO ALL FIRE PROTECTION DRAWINGS)

1. SPRINKLER CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION WITH BUILDING STRUCTURE AND SYSTEMS, AS WELL AS THE WORK OF OTHER TRADES IN ORDER TO ELIMINATE CONFLICTS.

2. SPRINKLER CONTRACTOR'S DESIGN SHALL BE PER NFPA 13, NFPA 20, AND THE NC STATE FIRE CODE.

3. EXISTING INFORMATION IS BASED ON A FIELD SURVEY AND EXISTING DRAWINGS. SOME INFORMATION PRESENTED IS ESTIMATED OR ASSUMED BASED ON EXPERIENCE. CONTRACTOR SHALL FIELD VERIFY CONDITIONS PRIOR TO STARTING WORK AND ALERT THE ENGINEER OF DIFFERENCES BETWEEN FIELD CONDITIONS AND THE FIRE PROTECTION DRAWINGS THAT WILL PREVENT ANY PORTIONS OF THE FIRE PROTECTION SCOPE OF WORK FROM BEING INSTALLED AS DESIGNED.

4. PIPE SIZES AND EQUIPMENT SHOWN ON PLANS ARE BASED ON ENGINEER'S PRELIMINARY DESIGN, AND ARE INTENDED ONLY TO GIVE A GENERAL IDEA OF EQUIPMENT SIZES FOR THE PURPOSES OF PRICING AND SPACE ALLOCATION. THE SPRINKLER CONTRACTOR IS RESPONSIBLE FOR FINAL SIZING OF PIPING AND EQUIPMENT.

5. PROVIDE AUXILIARY DRAINS WHEREVER WET SYSTEM PIPING IS ROUTED SUCH THAT WATER IS TRAPPED IN EXCESS OF 5 GALLONS, OR WHEREVER DRY SYSTEM PIPING IS ROUTED SUCH THAT ANY AMOUNT OF WATER IS TRAPPED.

6. SLOPE DRY SYSTEM BACK TO RISER OR AUXILIARY DRAINS. MAINS SHALL BE SLOPED AT 1/4" PER 10'-0" AND BRANCHES SHALL BE SLOPED AT 1/2" PER 10 '-0" PER NFPA 13.

7. LIGHT HAZARD OCCUPANCIES (WET SYSTEM): PER NFPA 13, DESIGN DENSITY SHALL BE 0.1 GPM PER SQUARE FOOT OVER THE MOST REMOTE 1,500 SQUARE FEET. SQUARE FOOTAGE MAY BE REDUCED PER NFPA 13 DUE TO THE USE OF QUICK RESPONSE HEADS. HOSE ALLOWANCE FOR LIGHT HAZARD SHALL BE 100 GPM PER NFPA 13.

8. LIGHT HAZARD OCCUPANCIES (DRY SYSTEM): PER NFPA 13, DESIGN DENSITY SHALL BE 0.1 GPM PER SQUARE FOOT OVER THE MOST REMOTE 1,950 SQUARE FEET. HOSE ALLOWANCE FOR LIGHT HAZARD SHALL BE 100 GPM PER NFPA 13.

9. ORDINARY HAZARD I OCCUPANCIES (WET SYSTEM): PER NFPA 13, DESIGN DENSITY SHALL BE 0.15 GPM PER SQUARE FOOT OVER THE MOST REMOTE 1,500 SQUARE FEET. SQUARE FOOTAGE MAY BE REDUCED PER NFPA 13 DUE TO THE USE OF QUICK RESPONSE HEADS. HOSE ALLOWANCE FOR ORDINARY HAZARD I SHALL BE 250 GPM PER NFPA 13.

10. ORDINARY HAZARD I OCCUPANCIES (DRY SYSTEM): PER NFPA 13, DESIGN DENSITY SHALL BE 0.15 GPM PER SQUARE FOOT OVER THE MOST REMOTE 1,950 SQUARE FEET. HOSE ALLOWANCE FOR ORDINARY HAZARD I SHALL BE 250 GPM PER NFPA 13.

11. ORDINARY HAZARD II OCCUPANCIES: PER NFPA 13, DESIGN DENSITY SHALL BE 0.20 GPM PER SQUARE FOOT OVER THE MOST REMOTE 1,500 SQUARE FEET. SQUARE FOOTAGE MAY BE REDUCED PER NFPA 13 DUE TO THE USE OF QUICK RESPONSE HEADS. HOSE ALLOWANCE FOR ORDINARY HAZARD II SHALL BE 250 GPM PER NFPA 13.

12. LOCATE SPRINKLER HEADS IN THE CENTER OF CEILING TILES.

13. SOME STRUCTURAL ELEMENTS HAVE BEEN REPRODUCED ON FIRE PROTECTION DRAWINGS. THIS INFORMATION IS NOT INTENDED TO BE ALL INCLUSIVE, AND IS FOR REFERENCE ONLY. VERIFY ALL STRUCTURE USING THE STRUCTURAL DRAWINGS.

14. PROVIDE CHECK VALVES ON EXISTING INSPECTOR'S TEST CONNECTIONS AND AUXILIARY DRAINS THAT DISCHARGE OUTSIDE OF THE BUILDING. LOCATE CHECK VALVES PER DETAILS ON F-0.2 FOR NEW INSPECTOR'S TEST CONNECTIONS AND AUXILIARY DRAINS.

15. PROVIDE CHECK VALVES ON EXISTING MAIN DRAINS. CHECK VALVES SHALL BE LOCATED INSIDE OF THE BUILDING AND AS CLOSE AS POSSIBLE TO THE OUTLET OF THE MAIN DRAIN.

FIRE FLOW ANALYSIS PER ISO CHAPTER 1, NOTE (1)

COMMERCIAL BUILDING & FULLY SPRINKLERED?	YES
MOST DEMANDING SPRINKLER FLOW:	488.5 GPM (EXISTING ZONE #2B)
HOSE DEMAND:	250 GPM
REQUIRED FIRE FLOW PER CHAPTER 1, NOTE 1:	488.5 GPM + 250 GPM = 738.5 GPM
AVAILABLE FIRE FLOW:	834 GPM @ 20 PSI

NOTE: PER CONVERSATION WITH TOWN OF KURE BEACH FIRE CHIEF ED KENNEDY ON 7/21/25, THE ISO FIRE FLOW IS ACCEPTABLE, WITH THE UNDERSTANDING OF THE FOLLOWING:

1. ATTEMPTS WILL BE MADE TO MODIFY THE EXISTING BACKFLOW PREVENTER AND METER APPROXIMATE 0.75 MILES UPSTREAM OF PROJECT SITE, AND TO REPLACE APROXIMATELY 750 FEET OF 6" WATER MAIN WITH 8" PIPE JJUST UPSTREAM OF THE BACKFLOW PREVENTER DURING ANTICIPATED PHASE 2 TO ALLOW FOR GREATER FIRE FLOWS.

2. IF FIRE FLOWS DO NOT MEET AT LEAST 1,000 GPM AFTER SUCH MODIFICATIONS, AN EMERGENCY DRY HYDRANT CONNECTED TO THE ADJACENT POND WILL BE PROVIDED AND A BDA SYSTEM WILL BE ADDED TO BOTH THE EXISTING AND NEW PORTIONS OF THE AQUARIUM BUILDING AS PART OF ANTICIPATED PHASE 2.

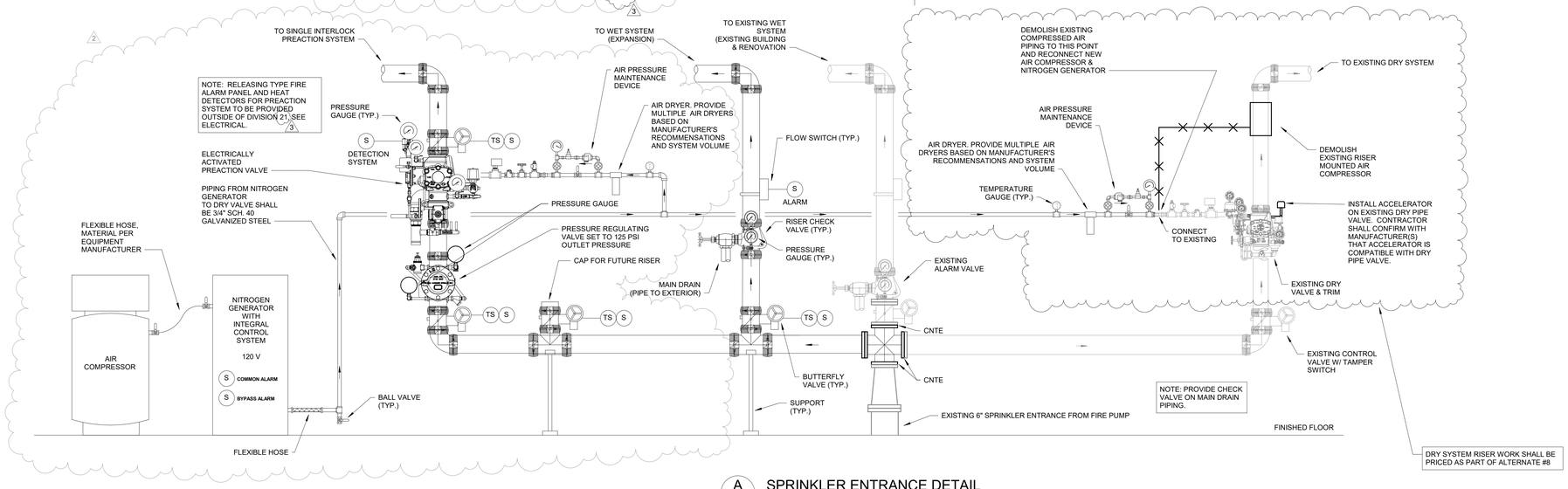
AIR COMPRESSOR SCHEDULE

DESCRIPTION	TANK CAPACITY	FILL TIME	MOTOR HP	ELEC.
TANK-MOUNTED	60 GAL.	30 MIN FILL	3	460V, 3Ø

3

LEGEND

SYMBOL	DESCRIPTION
PS	PRESSURE SWITCH
TS	TAMPER SWITCH
S	SIGNALING SYSTEM INTERFACE



A F-0.1 SPRINKLER ENTRANCE DETAIL
SCALE: NONE

GRAPHIC SCALE
2' 1' 0 2' 4'
SCALE: 1/2"=1'-0"

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
CODE: 42014-4G02
ITEM: 41414-4Y4A

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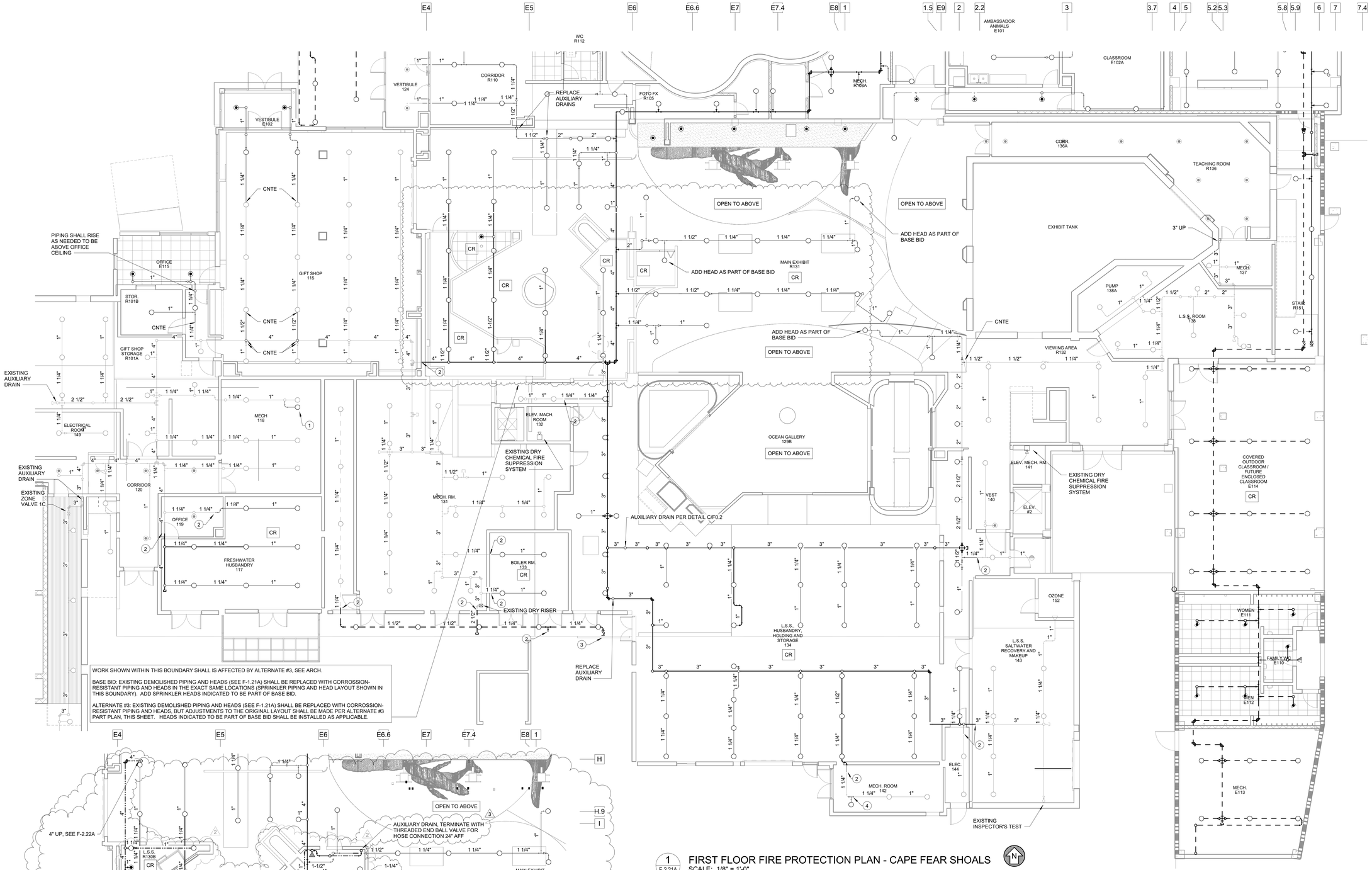
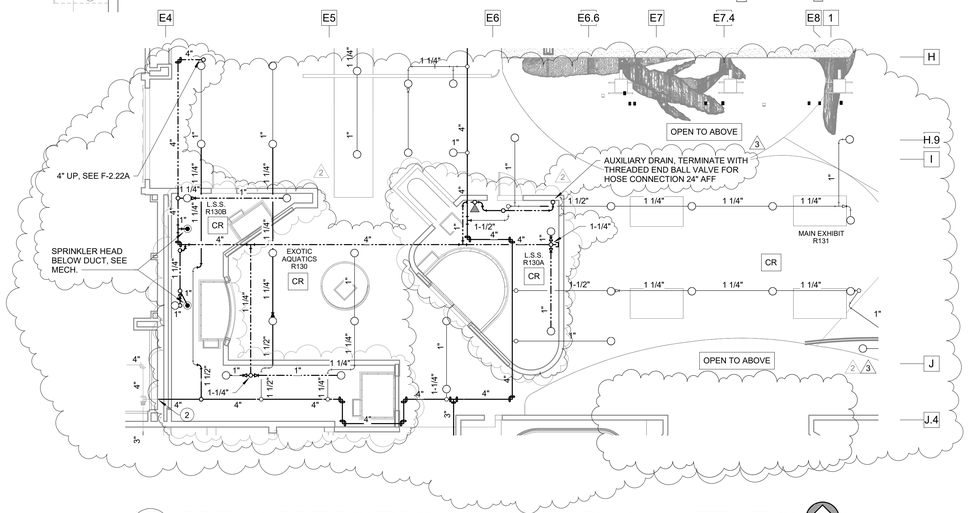
3	10-29-25	ADDENDUM #2

FIRE PROTECTION GENERAL NOTES AND DETAILS

F-0.1



1 F-2.21A FIRST FLOOR FIRE PROTECTION PLAN - CAPE FEAR SHOALS
SCALE: 1/8" = 1'-0"



2 F-2.21A FIRST FLOOR FIRE PROTECTION PLAN - CAPE FEAR SHOALS - ALTERNATE #3
SCALE: 1/8" = 1'-0"

KEYED NOTES: (THIS SHEET ONLY)

1. REPLACE EXISTING SPRINKLER HEAD BELOW DUCT. HEAD SHALL BE UPRIGHT, BRASS, ORDINARY TEMPERATURE, QUICK RESPONSE, STANDARD COVERAGE. INSTALL CONNECTED PIPE LOWER THAN EXISTING SUCH THAT THE SPRINKLER DEFLECTOR IS 1" BELOW THE DUCT.
2. CONNECT NEW PIPING TO EXISTING PIPING AT THIS POINT, WHERE INDICATED. PIPING AND SPRINKLER HEADS SHALL BE CORROSION RESISTANT AS SPECIFIED.
3. REPLACE EXISTING INSPECTOR'S TEST CONNECTION. SEE DETAIL E/F0.1.
4. ROTATE EXISTING TEE AND INSTALL NEW PIPING AND SPRINKLER HEAD BEYOND EXISTING PIPING.

SPRINKLER PIPE LEGEND

- EXISTING WET SPRINKLER PIPING TO REMAIN
- EXISTING DRY SPRINKLER PIPING TO REMAIN
- NEW WET SYSTEM SPRINKLER PIPING
- NEW DRY SYSTEM SPRINKLER PIPING
- NEW SINGLE INTERLOCK PREACTION SYSTEM SPRINKLER PIPING

SPRINKLER LEGEND

- EXISTING PENDENT SPRINKLER HEAD
- EXISTING CONCEALED PENDENT HEAD
- EXISTING DRY PENDENT SPRINKLER HEAD
- EXISTING SIDEWALL SPRINKLER HEAD
- EXISTING UPRIGHT SPRINKLER HEAD
- CR — PIPE, FITTINGS, COUPLINGS, HEADS, ESCUTCHEONS, AND SUPPORTS LOCATED IN THIS ROOM SHALL BE CORROSION RESISTANT PER THE SPECIFICATIONS
- RECESSED PENDENT SPRINKLER HEAD
- CONCEALED PENDENT SPRINKLER HEAD
- RECESSED DRY PENDENT SPRINKLER HEAD
- SIDEWALL SPRINKLER HEAD
- DRY SIDEWALL SPRINKLER HEAD
- EXTENDED COVERAGE SIDEWALL SPRINKLER HEAD (16' X 22')
- UPRIGHT SPRINKLER HEAD
- UPRIGHT SPRINKLER HEAD W/ HEAVY-DUTY GUARD
- UPRIGHT SPRINKLER HEAD W/ SHIELD

5A 6A

KEY PLAN

GRAPHIC SCALE
8' 4' 0 8' 16'
SCALE: 1/8"=1'-0"

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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FIRST FLOOR FIRE PROTECTION PLAN - CAPE FEAR SHOALS

F-2.21A

E4 E5 E6 E6.6 E7 E7.4 E8 1 1.5 E9 2 2.2 3 3.7 4 5 5.2 5.3 5.8 5.9 6 7 7.4 8 8.5 8.7 8.9 9

KEYED NOTES: (THIS SHEET ONLY)

1. CONNECT NEW PIPING TO EXISTING PIPING AT THIS POINT. PIPING AND SPRINKLER HEADS SHALL BE COROSSION RESISTANT AS SPECIFIED.
2. REPLACE EXISTING PAINTED UPRIGHT BRASS STANDARD RESPONSE, ORDINARY TEMPERATURE, STANDARD COVERAGE SPRINKLER HEADS.
3. BASE BID: CONNECT NEW PIPING TO EXISTING PIPING AND UPRIGHT HEAD AT THIS POINT.
   ALT. #5A: PIPING SHALL RISE AS NEEDED TO ABOVE NEW CEILING AND EXTEND TO SERVE NEW PENDENT HEAD.

SPRINKLER PIPE LEGEND

- EXISTING WET SPRINKLER PIPING TO REMAIN
- EXISTING DRY SPRINKLER PIPING TO REMAIN
- NEW WET SYSTEM SPRINKLER PIPING
- NEW DRY SYSTEM SPRINKLER PIPING
- NEW SINGLE INTERLOCK PREACTION SYSTEM SPRINKLER PIPING

SPRINKLER LEGEND

- EXISTING PENDENT SPRINKLER HEAD
- EXISTING CONCEALED PENDENT HEAD
- EXISTING DRY PENDENT SPRINKLER HEAD
- EXISTING SIDEWALL SPRINKLER HEAD
- EXISTING UPRIGHT SPRINKLER HEAD
- CR — PIPE, FITTINGS, COUPLINGS, HEADS, ESCUTCHEONS, AND SUPPORTS LOCATED IN THIS ROOM SHALL BE CORROSION RESISTANT PER THE SPECIFICATIONS
- RECESSED PENDENT SPRINKLER HEAD
- CONCEALED PENDENT SPRINKLER HEAD
- RECESSED DRY PENDENT SPRINKLER HEAD
- SIDEWALL SPRINKLER HEAD
- DRY SIDEWALL SPRINKLER HEAD
- EXTENDED COVERAGE SIDEWALL SPRINKLER HEAD (16' X 22')
- UPRIGHT SPRINKLER HEAD
- UPRIGHT SPRINKLER HEAD W/ HEAVY-DUTY GUARD
- UPRIGHT SPRINKLER HEAD W/ SHIELD

1 F-0.1

EXISTING FIRE PUMP BUILDING 155

6" RESERVOIR DISCHARGE UP TO SECOND FLOOR. CONNECT TO FLANGED CONNECTION 1'-0" ABOVE FINISHED FIRST FLOOR PROVIDED BY SITE CONTRACTOR. SEE SITE PLANS.

6" RESERVOIR FILL UP TO SECOND FLOOR. CONNECT TO FLANGED CONNECTION 1'-0" ABOVE FINISHED FIRST FLOOR PROVIDED BY SITE CONTRACTOR. SEE SITE PLANS.

AUXILIARY DRAIN, SEE DETAIL C/F-0.2

HEAD BELOW LANDING

STAIR #1 E108 | ELECTRICAL E107 | SALTWATER MAKEUP BASIN | FRESHWATER MAKEUP BASIN | CLEAN RECOVERY BASIN | INTERMEDIATE RECOVERY BASIN | DIRTY RECOVERY BASIN | PUMP PIT E106A | LIFE SUPPORT SYSTEM E106 CR | SALT STORAGE AND MIXING E105 CR | SHARK TANK

SHARK TANK AREA OPEN TO ABOVE. SEE F2.22B FOR SPRINKLER HEADS AND PIPING.

DEEP CONCRETE BEAM, SEE STRUCTURAL (TYP.)

EXTENSION OF DRY SPRINKLER SYSTEM DOWNSTREAM OF THIS POINT SHALL BE PRICED AS PART OF ALTERNATE #8

RISE AND INSTALL PIPING WITHIN STRUCTURE ABOVE CATERING KITCHEN

TANK AND STRUCTURE EXTEND TO FLOOR. NO SPRINKLER HEADS NEEDED ON THIS FLOOR WITHIN SHARK TANK FOOTPRINT.

DRY MAIN DN BELOW WET MAIN IN CHASE, OFFSET FOR CLARITY.

AUXILIARY DRAIN. INSTALL TIGHT TO ROOM WALL AND TIGHT TO OUTSIDE OF CHASE WALL. PIPE DRAIN LOW TO FLOOR DRAIN, SEE PLUMBING.

INSTALL DRY MAIN IN CHASE BELOW WET MAIN, SHOWN OFFSET FOR CLARITY. SUPPORT DRY MAIN USING LISTED WALL BRACKETS. MOUNT WALL BRACKETS TO CMU WALL, ANCHORED INTO GROUTED CELLS.

INSTALL DRY MAIN IN CHASE BELOW WET MAIN, SHOWN OFFSET FOR CLARITY. SUPPORT DRY MAIN USING LISTED WALL BRACKETS. MOUNT WALL BRACKETS TO CMU WALL, ANCHORED INTO GROUTED CELLS.

SPRINKLER HEAD BELOW GRATED STAIRS

MEZZANINE. HEADS AND PIPING SHOWN WITHIN MEZZANINE FOOTPRINT TO BE INSTALLED BELOW MEZZANINE. SPACE ABOVE MEZZANINE SHALL BE PROTECTED BY SPRINKLER HEADS AT SECOND FLOOR CEILING.

AUXILIARY DRAIN, SEE DETAIL C/F-0.2

4" UP TO HIGHER CEILING

PROVIDE 4" BUTTERFLY VALVE W/ TAMPER SWITCH AND CAP MAIN FOR FUTURE CONNECTION.

DRY MAIN UP TO HEIGHT OF WET MAIN, AS CLOSE TO BOTTOM OF STRUCTURE AS POSSIBLE.

INSTALL SPRINKLER HEAD BELOW RAMP

SPRINKLER HEADS IN SOFFIT TO BE FED FROM MAIN ABOVE, SEE F-2.22B

SPRINKLER HEAD IN SOFFIT TO BE FED FROM MAIN ABOVE, SEE F-2.22B

1" TO INSPECTOR'S TEST CONNECTION. THE PIPING SHALL BE INSTALLED UNDER BASE BID AND SHALL NOT BE INSTALLED UNDER ALTERNATE #8. SEE F2.21C.

DRY INSPECTOR'S TEST CONNECTION. SEE DETAIL E/F0.2. THIS SHALL BE INSTALLED UNDER BASE BID AND SHALL NOT BE INSTALLED UNDER ALTERNATE #8. SEE F2.21C.

WORK SHOWN WITHIN THIS BOUNDARY SHALL BE PRICED AS PART OF ALTERNATE #5A

NEW 4" SINGLE INTERLOCK PREACTION RISER | NEW 4" CAPPED FUTURE RISER | EXISTING 4" DRY RISER | AIR COMPRESSOR | NITROGEN GENERATOR | 4" UP TO SECOND FLOOR | ZONE CONTROL VALVE W/ TAMPER SWITCH (FIRST FLOOR EXPANSION)

EXISTING SPRINKLER ENTRANCE | EXISTING 4" WET RISER | NEW 4" WET RISER | 4" UP TO SECOND FLOOR

STORAGE 146 | MECH 145 | HUSBANDRY 148 CR | CONCESSION 147 | STOR R110B | DATA/STOR. R104 | MEN R114 | WOMEN R113 | CUSTODIAL CLOSET R103 | WC R112 | VESTIBULE 124 | VESTIBULE E100 | CORRIDOR R110 | GIFT SHOP 115 | FOTO FX R105 | LSS CHASE R108C | DATA R108B | MAIN EXHIBIT R131 | RISER R111 | CORRIDOR R109 | CNTE | WORKSHOP R106 | MOBILE DUST COLLECTOR | 3D PRINTING R106B | NECROPSY R107 | MECH. R106A | CORR. 136A | MECH./ELEC. E103A | CATERING KITCHEN E104 | STORAGE E103B | CLASSROOM E102B | AMBASSADOR ANIMALS E101 | CLASSROOM E102A | TEACHING ROOM R136

KEY PLAN

1 F-2.21B — FIRST FLOOR FIRE PROTECTION PLAN - TOUCH & SHARK TANK
SCALE: 1/8" = 1'-0"

GRAPHIC SCALE
8' 4' 0 8' 16'
SCALE: 1/8"=1'-0"

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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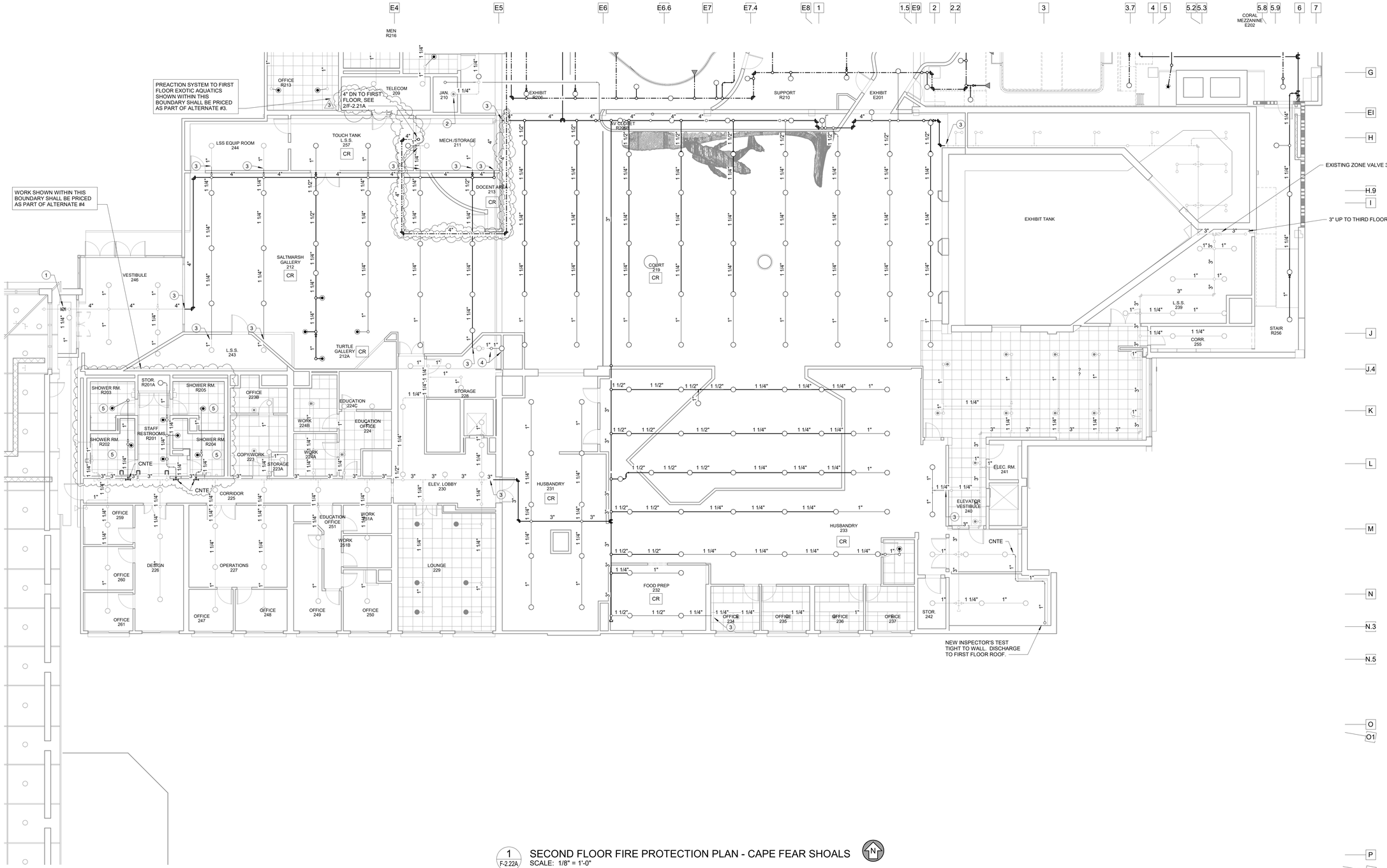
FIRST FLOOR FIRE PROTECTION PLAN - TOUCH & SHARK TANK

F-2.21B



1 / F-2.22A SECOND FLOOR FIRE PROTECTION PLAN - CAPE FEAR SHOALS
SCALE: 1/8" = 1'-0"

KEYED NOTES: (THIS SHEET ONLY)

1. REPLACE EXISTING CONTROL VALVE FOR ZONE 2B. RECONNECT TAMPER SWITCH TO FIRE ALARM SYSTEM.
2. EXISTING SPRINKLER HEAD IS CONCEALED ABOVE CEILING. LOWER SPRINKLER HEAD TO BELOW CEILING AND MOUNT FLUSH WITH CEILING TILE.
3. CONNECT NEW PIPING TO EXISTING PIPING AT THIS POINT. PIPING AND SPRINKLER HEADS SHALL BE COROSSION RESISTANT AS SPECIFIED.
4. CONNECT NEW PIPING TO EXISTING PIPING AT THIS POINT. PROVIDE SPRINKLER HEAD BELOW SOFFIT IN STORAGE SPACE.
5. PROVIDE CORROSION RESISTANT SPRINKLER HEADS AND ESCUCHEONS IN THIS ROOM.

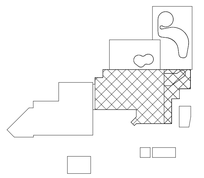
SPRINKLER PIPE LEGEND

- EXISTING WET SPRINKLER PIPING TO REMAIN
- EXISTING DRY SPRINKLER PIPING TO REMAIN
- NEW WET SYSTEM SPRINKLER PIPING
- NEW DRY SYSTEM SPRINKLER PIPING
- NEW SINGLE INTERLOCK PREACTION SYSTEM SPRINKLER PIPING

SPRINKLER LEGEND

- EXISTING PENDENT SPRINKLER HEAD
- EXISTING CONCEALED PENDENT HEAD
- EXISTING DRY PENDENT SPRINKLER HEAD
- EXISTING SIDEWALL SPRINKLER HEAD
- EXISTING UPRIGHT SPRINKLER HEAD
- CR — PIPE, FITTINGS, COUPLINGS, HEADS, ESCUTCHEONS, AND SUPPORTS LOCATED IN THIS ROOM SHALL BE CORROSION RESISTANT PER THE SPECIFICATIONS
- RECESSED PENDENT SPRINKLER HEAD
- CONCEALED PENDENT SPRINKLER HEAD
- RECESSED DRY PENDENT SPRINKLER HEAD
- SIDEWALL SPRINKLER HEAD
- DRY SIDEWALL SPRINKLER HEAD
- EXTENDED COVERAGE SIDEWALL SPRINKLER HEAD (16' X 22')
- UPRIGHT SPRINKLER HEAD
- UPRIGHT SPRINKLER HEAD W/ HEAVY-DUTY GUARD
- UPRIGHT SPRINKLER HEAD W/ SHIELD

KEY PLAN



GRAPHIC SCALE
8' 4' 0 8' 16'
SCALE: 1/8"=1'-0"

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
CODE: 42014-4G02
ITEM: 41414-4Y4A

900 LOGGERHEAD RD.
KURE BEACH, NC 28449

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REGISTERED SEAL 043164 ENGINEER CASEY D. GILMAN

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

SECOND FLOOR FIRE PROTECTION PLAN - CAPE FEAR SHOALS

F-2.22A

E4 E5 E6 E6.6 E7 E7.4 E8 1 1.5 E9 2 2.2 3 3.7 4 5 5.2 5.3 5.8 5.9 6 7 7.4 8 8.5 8.7

KEYED NOTES: (THIS SHEET ONLY)

1. REPLACE MISSING ESCUTCHEON.
2. CONNECT TO EXISTING PIPING AND PROVIDE SPRINKLER HEAD IN EXISTING CLOSET.

SPRINKLER PIPE LEGEND

- EXISTING WET SPRINKLER PIPING TO REMAIN
- EXISTING DRY SPRINKLER PIPING TO REMAIN
- NEW WET SYSTEM SPRINKLER PIPING
- NEW DRY SYSTEM SPRINKLER PIPING
- NEW SINGLE INTERLOCK PREACTION SYSTEM SPRINKLER PIPING

SPRINKLER LEGEND

- EXISTING PENDENT SPRINKLER HEAD
- EXISTING CONCEALED PENDENT HEAD
- EXISTING DRY PENDENT SPRINKLER HEAD
- EXISTING SIDEWALL SPRINKLER HEAD
- EXISTING UPRIGHT SPRINKLER HEAD
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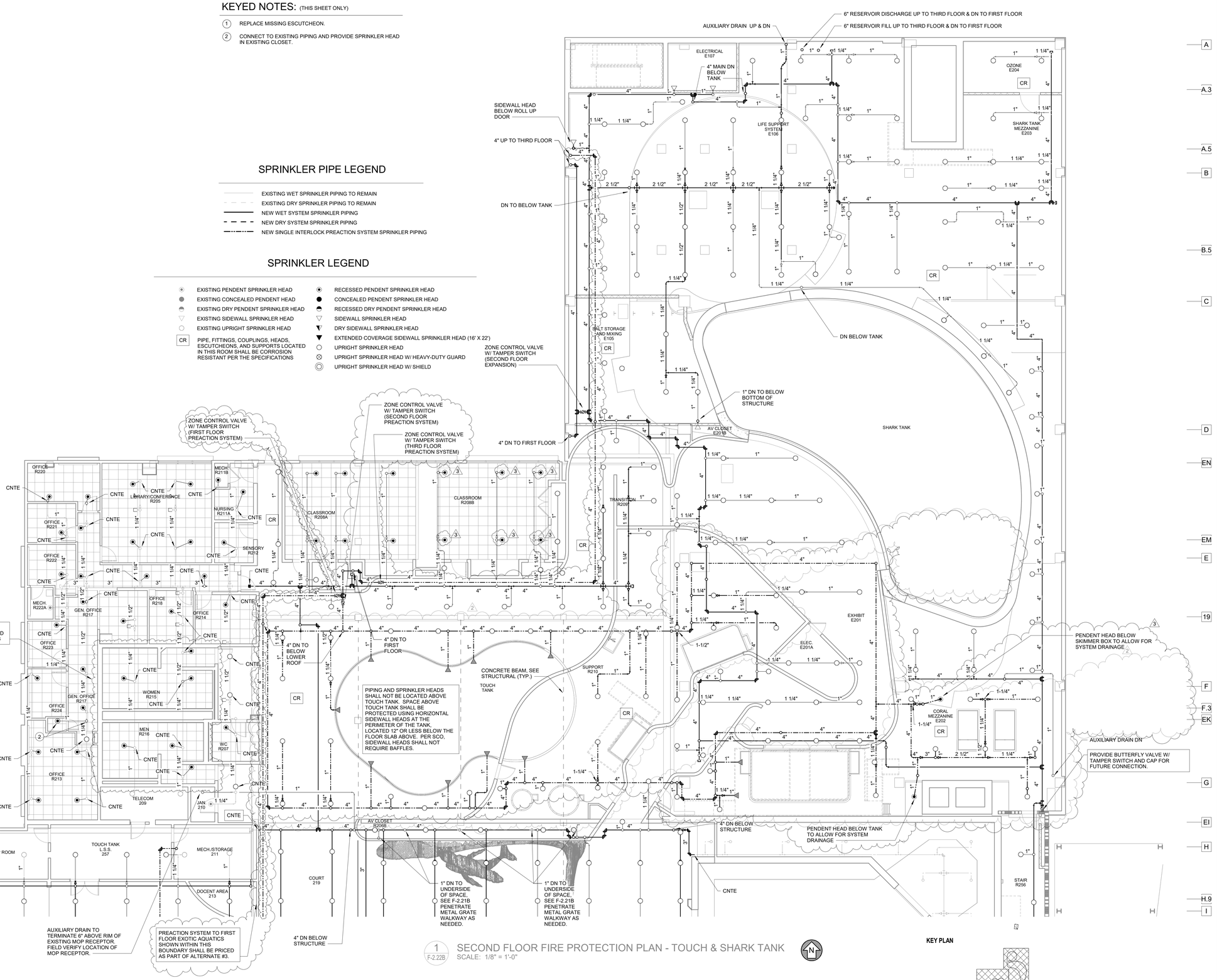
- CONCEALED PENDENT SPRINKLER HEAD
- RECESSED DRY PENDENT SPRINKLER HEAD
- SIDEWALL SPRINKLER HEAD
- DRY SIDEWALL SPRINKLER HEAD
- EXTENDED COVERAGE SIDEWALL SPRINKLER HEAD (16' X 22')
- UPRIGHT SPRINKLER HEAD
- UPRIGHT SPRINKLER HEAD W/ HEAVY-DUTY GUARD
- UPRIGHT SPRINKLER HEAD W/ SHIELD



1 F-2.22B SECOND FLOOR FIRE PROTECTION PLAN - TOUCH & SHARK TANK
SCALE: 1/8" = 1'-0"

KEY PLAN

GRAPHIC SCALE
8' 4' 0 8' 16'
SCALE: 1/8"=1'-0"

A A.3 A.5 B B.5 C D EN EM E 19 F F.3 EK G EI H H.9 I

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
CODE: 42014-4G02
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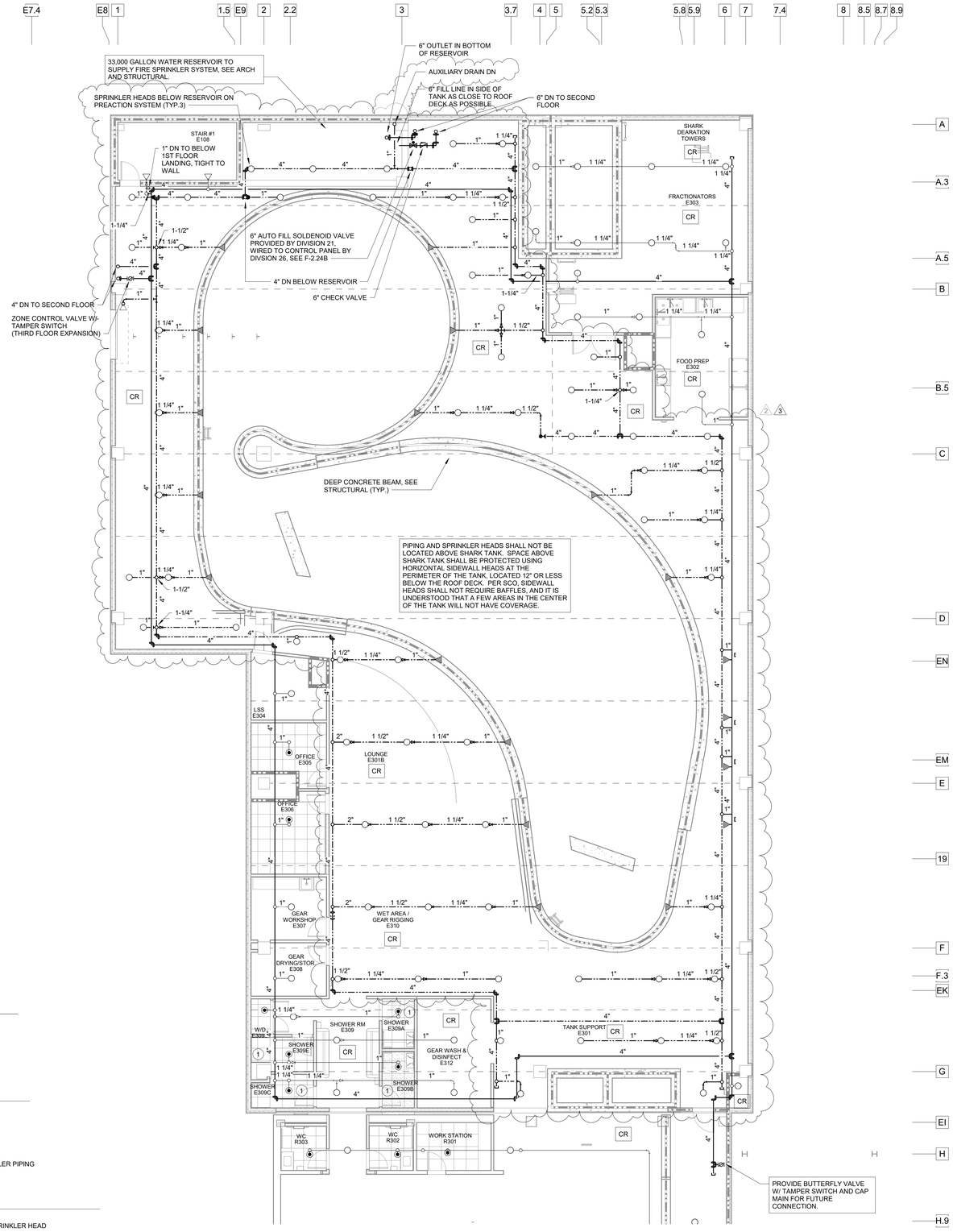
3	10-29-25	ADDENDUM #2

SECOND FLOOR FIRE PROTECTION PLAN - TOUCH & SHARK TANK

F-2.22B



KEYED NOTES: (THIS SHEET ONLY)

1. PROVIDE CORROSION RESISTANT SPRINKLER HEADS AND ESCUCHEONS IN THIS ROOM.

SPRINKLER PIPE LEGEND

- EXISTING WET SPRINKLER PIPING TO REMAIN
- EXISTING DRY SPRINKLER PIPING TO REMAIN
- NEW WET SYSTEM SPRINKLER PIPING
- NEW DRY SYSTEM SPRINKLER PIPING
- NEW SINGLE INTERLOCK PREACTION SYSTEM SPRINKLER PIPING

SPRINKLER LEGEND

- EXISTING PENDENT SPRINKLER HEAD
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- CONCEALED PENDENT SPRINKLER HEAD
- RECESSED DRY PENDENT SPRINKLER HEAD
- SIDEWALL SPRINKLER HEAD
- DRY SIDEWALL SPRINKLER HEAD
- EXTENDED COVERAGE SIDEWALL SPRINKLER HEAD (16' X 22')
- UPRIGHT SPRINKLER HEAD
- UPRIGHT SPRINKLER HEAD W/ HEAVY-DUTY GUARD
- UPRIGHT SPRINKLER HEAD W/ SHIELD

1 / F-2.23B — THIRD FLOOR FIRE PROTECTION PLAN - SHARK TANK
SCALE: 1/8" = 1'-0"

KEY PLAN

GRAPHIC SCALE
8' 4' 0 8' 16'
SCALE: 1/8"=1'-0"

STAIR R313

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
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SEAL 043164 ENGINEER CASEY D. GILMAN

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
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THIRD FLOOR FIRE PROTECTION PLAN - SHARK TANK

F-2.23B

GENERAL:

1. PROVIDE CONSTRUCTION CONFORMING TO THE 2018 NORTH CAROLINA BUILDING CODE. REFERENCE TO LATEST EDITION OR OTHER STANDARDS, SPECIFICATIONS OR CODES SHALL MEET THE LATEST STANDARD OR CODE PUBLISHED AND ADOPTED BY THE LISTED BUILDING CODE.
2. MATERIAL TESTS AND INSPECTIONS ARE REQUIRED PER CHAPTER 17 OF THE 2018 NORTH CAROLINA BUILDING CODE. REFER TO THE PROJECT STATEMENT OF SPECIAL INSPECTIONS FOR REQUIRED TESTS AND INSPECTIONS.
3. THESE NOTES APPLY EXCEPT WHERE OTHERWISE INDICATED BY DRAWINGS OR SPECIFICATIONS.
4. STRUCTURAL DRAWINGS INDICATE TYPICAL AND CERTAIN SPECIFIC CONDITIONS ONLY. SUBMITTED SHOP DRAWINGS DETAIL ALL CONDITIONS IN ACCORDANCE WITH SPECIFIED STANDARDS AND THE SPECIFIC REQUIREMENTS OF THIS PROJECT AS INDICATED ON THE DRAWINGS.
5. COORDINATE THE STRUCTURAL CONTRACT DOCUMENTS WITH ARCHITECTURAL, MECHANICAL, ELECTRICAL, PLUMBING, CIVIL AND ALL OTHER CONSULTANTS. NOTIFY THE ARCHITECT AND STRUCTURAL ENGINEER OF RECORD IN WRITING OF ANY CONFLICT AND/OR OMISSION. WHERE A CONFLICT OCCURS, THE STRICTEST REQUIREMENT SHALL GOVERN UNLESS OTHERWISE DECIDED BY THE DESIGN TEAM.
6. COORDINATE AND VERIFY FLOOR AND ROOF OPENING SIZES AND LOCATIONS SHOWN WITH ARCHITECTURAL, MECHANICAL, PLUMBING AND ELECTRICAL DRAWINGS. FOR ADDITIONAL OPENINGS NOT SHOWN ON THE STRUCTURAL DRAWINGS REFER TO THE ARCHITECTURAL AND MECHANICAL DRAWINGS. OBTAIN WRITTEN APPROVAL OF ADDITIONAL OPENINGS LARGER THAN 12" x 12" FROM THE STRUCTURAL ENGINEER OF RECORD.
7. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR THE DESIGN, ADEQUACY AND SAFETY OF ERECTION BRACING, SHORING, TEMPORARY SUPPORTS AND ALL OTHER MEANS, METHODS, TECHNIQUES, SEQUENCES AND PROCEDURES OF CONSTRUCTION.
8. COORDINATE THE BUILDING ORIENTATION WITH THE ARCHITECTURAL DRAWINGS.
9. COMPLETE SHOP DRAWINGS FOR CONSTRUCTION OF EACH BUILDING COMPONENT NOT DESIGNED BY THE DESIGN TEAM OF RECORD AND NOT SPECIFIED ON THE PROJECT CONSTRUCTION DOCUMENTS SHALL BE SEALED AND SIGNED BY A PROFESSIONAL ENGINEER IN THE STATE WHERE THE PROJECT IS LOCATED AND SHALL BE MADE AVAILABLE AT THE JOB SITE.
10. UNO, FIREPROOFING REQUIREMENTS, METHODS AND MATERIALS FOR STRUCTURAL MEMBERS ARE NOT SHOWN ON STRUCTURAL DRAWINGS, REFER TO ARCHITECTURAL DRAWINGS AND SPECIFICATIONS.
11. DO NOT SCALE OFF OF DRAWINGS, ASK ARCHITECT FOR DIMENSIONS NOT SHOWN.

DESIGN NOTES

1. STRUCTURAL DESIGN IS IN ACCORDANCE WITH THE FOLLOWING CODES AND CRITERIA:
   A. 2018 NORTH CAROLINA BUILDING CODE, BASED UPON 2015 INTERNATIONAL BUILDING CODE
   B. ASCE 7-16, MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES
   C. ASCE 24-14, FLOOD RESISTANT DESIGN AND CONSTRUCTION
2. LIVE LOADS:

	UNIFORM	CONCENTRATED
• STAIR	= 100 PSF	300LB
• ROOF	= 20 PSF	
• SOLAR	= 10 PSF	
• CORRIDORS (FIRST FLOOR)	= 100 PSF	2,000LB
• CORRIDORS/LEARNING COMMONS	= 100 PSF	2,000LB
• CORRIDORS (SECOND FLOOR)	= 80 PSF	2,000LB
• OFFICES	= 80 PSF	2,000LB
• CLASSROOMS	= 60 PSF	1,000LB
• MECHANICAL ROOMS	= 125 PSF	
• TOUCH TANK	= 390 PSF (WATER DEPTH = 6'-0")	
• SHARK TANK	= 1625 PSF (WATER DEPTH = 25'-0")	
• HOLDING TANK	= 260 PSF (WATER DEPTH = 4'-0")	

3. SNOW LOADS:
   - GROUND SNOW LOAD (P_G) = 10 PSF
   - FLAT-ROOF SNOW LOAD (P_F) = 7 PSF
   - SNOW EXPOSURE FACTOR (C_E) = 0.9
   - SNOW LOAD IMPORTANCE FACTOR (I) = 1.10
   - THERMAL FACTOR (C_T) = 1.0
   - MINIMUM SNOW LOAD (P_G) = 11 PSF
4. SEISMIC LOADS:
   - SEISMIC IMPORTANCE FACTOR (II) = 1.25
   - MAPPED SPECTRAL RESPONSE ACCELERATION PARAMETERS
     (S_S) = 0.164g
     (S_1) = 0.071g
   - SITE CLASS = D
   - DESIGN SPECTRAL RESPONSE ACCELERATION PARAMETERS
     (S_{DS}) = 0.175g
     (S_{D1}) = 0.114g
   - SEISMIC DESIGN CATEGORY = B
   - BASIC SEISMIC FORCE RESISTING SYSTEM
     SHARK TANK BUILDING:
     ORDINARY REINFORCED CONCRETE MOMENT FRAMES (ORCMF)
     SOUTHEAST ADDITION:
     ORDINARY REINFORCED MASONRY SHEAR WALL
   - SEISMIC RESPONSE COEFFICIENT (C_S) = 0.08
   - RESPONSE MODIFICATION COEFFICIENT (R) = 3
   - PROCEDURE USED
     = EQUIVALENT LATERAL FORCE PROCEDURE
   - SEISMIC BASE SHEAR IN BOTH DIRECTIONS = 1280K
5. FLOOD DESIGN DATA:
   - FLOOD HAZARD ZONE DESIGNATION = AE (SPECIAL)
   - BASE FLOOD ELEVATION = 10.00'
   - FLOOD DESIGN CLASS = 3
   - FLOOD PROOFED ELEVATION = 14.00'
6. WIND LOADS:
   - BASIC WIND SPEED, V = 160 MPH
   - RISK CATEGORY = III
   - WIND EXPOSURE = D
   - INTERNAL PRESSURE COEFFICIENT = ±0.18
   - WIND BASE SHEAR
     X DIRECTION = 670K
     Y DIRECTION = 270K

COMPONENT AND CLADDING WIND PRESSURES:

WIND LOADS ON COMPONENTS & CLADDING FOR GIVEN TRIBUTARY AREAS (psf)

	ZONE	10 SQ FT	20 SQ FT	50 SQ FT	100 SQ FT	500 SQ FT
ROOF	1	+34/-134	+32/-125	+29/-114	+27/-105	+27/-84
	2	+77/-177	+74/-166	+69/-151	+66/-139	+56/-113
	3	+77/-177	+74/-166	+69/-151	+66/-139	+56/-113
WALL	4	+77/-84	+74/-80	+69/-76	+66/-72	+58/-64
	5	+77/-103	+74/-96	+69/-87	+66/-80	+58/-64
PARAPET	4p	+79/-180	+75/-169	+71/-154	+67/-142	+59/-115
	5p	+79/-180	+75/-169	+71/-154	+67/-142	+59/-115

1. DETERMINE WIND LOADS ON COMPONENTS IN ACCORDANCE WITH THE NCSBC AND ASCE 7 OR WITH THIS TABLE. REFERENCE ASCE 7-16 FIGURES 30.3-2A. TRIBUTARY AREA = GREATER OF LxW OR LxL/3.
2. WIND PRESSURES INDICATED ARE AT STRENGTH-LEVEL (WIND LOAD FACTOR= 1.0). MULTIPLY BY 0.6 TO OBTAIN NOMINAL (ALLOWABLE) WIND PRESSURES
3. DEFLECTIONS MAY BE CALCULATED BASED ON 70% OF THESE LOADS.
4. POSITIVE AND NEGATIVE SIGNS SIGNIFY PRESSURES ACTING TOWARD AND AWAY FROM THE SURFACES, RESPECTIVELY.
5. NET UPLIFT IS EQUAL TO THE GROSS UPLIFT LOAD CALCULATED FROM ASCE 7 OR FROM THIS TABLE MINUS 60% OF THE ROOF DEAD LOAD.
6. FOR WALL PRESSURES, END ZONE WIDTH = 10'-0".
7. BUILDING ZONES ARE DEFINED IN ASCE 7. SEE SHEET S-021 FOR ROOF WIND PRESSURE ZONES. ZONE 2 ROOF WIND LOADS APPLY IN ZONE 3 AREAS WHERE PARAPET HEIGHT EXCEEDS 3 FEET.

EXISTING CONDITIONS:

1. RENOVATION OF EXISTING STRUCTURES REQUIRES THOROUGH COORDINATION OF THE CONTRACT DOCUMENTS WITH EXISTING CONDITIONS. THE CONTRACTOR MUST VERIFY ALL RELEVANT EXISTING CONDITIONS, DIMENSIONS, AND DETAILS PRIOR TO BEGINNING CONSTRUCTION. REPORT ANY DEVIATIONS FROM CONDITIONS OR DIMENSIONS SHOWN ON THE CONTRACT DOCUMENTS TO THE ARCHITECT AND STRUCTURAL ENGINEER OF RECORD FOR REVIEW OF THE DESIGN AND POSSIBLE REVISION OF THE CONTRACT DOCUMENTS.
2. THE NATURE OF STRUCTURAL DEMOLITION AND STABILIZATION IS INHERENTLY UNCERTAIN. THE EXACT CONDITION AND CAPACITY OF EACH STRUCTURAL ELEMENT CANNOT BE VERIFIED PRIOR TO THE COMMENCEMENT OF WORK. AS A RESULT, IT IS IMPERATIVE TO REPORT ANY DISCREPANCIES BETWEEN THE CONTRACT DOCUMENTS AND ACTUAL FIELD CONDITIONS, AS WELL AS ANY ELEMENT OF QUESTIONABLE STRUCTURAL INTEGRITY IMMEDIATELY TO THE ARCHITECT AND STRUCTURAL ENGINEER OF RECORD FOR REVIEW.
3. NO ATTEMPT HAS BEEN MADE TO DEFINE EACH SPECIFIC STRUCTURAL ELEMENT THAT MUST BE REMOVED, ENHANCED, OR REPLACED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO REVIEW THE CONDITION OF INDIVIDUAL ELEMENTS TO DETERMINE WHICH ELEMENTS CAN BE SALVAGED, WHICH ELEMENTS MUST BE REPLACED, AND WHICH ELEMENTS ARE QUESTIONABLE. THE CONTRACTOR SHOULD CONSULT WITH THE ARCHITECT AND STRUCTURAL ENGINEER OF RECORD TO DETERMINE THE APPROPRIATE PROCEDURE FOR HANDLING ELEMENTS IN QUESTIONABLE CONDITION.
4. THE DIMENSIONS AND ELEVATIONS SHOWN FOR THE EXISTING CONSTRUCTION ARE AS-BUILT DIMENSIONS OBTAINED FROM RECORD DRAWINGS DOCUMENTS. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO FIELD VERIFY ALL DIMENSIONS, ELEVATIONS AND MEMBER SIZES AS REQUIRED PRIOR TO BEGINNING CONSTRUCTION, FABRICATION, ETC.
5. CONTRACTOR SHALL TAKE NECESSARY PRECAUTIONS NOT TO DISTURB OR UNDERMINE ANY EXISTING BUILDING FOUNDATIONS OR STRUCTURE AND SHALL PROVIDE SHORING AS REQUIRED.
6. IN AREAS WHERE UNDERMINING OF EXISTING BUILDING FOUNDATION OR STRUCTURE IS REQUIRED BY THE CONSTRUCTION DOCUMENTS, THE CONTRACTOR SHALL PROVIDE UNDERPINNING AND/OR SHORING AS REQUIRED TO SUPPORT THE EXISTING FOUNDATIONS AND STRUCTURES. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS AND SIGNED AND SEALED CALCULATIONS FOR APPROVAL, PRIOR TO CONSTRUCTION. DESIGN SHALL BE COORDINATED WITH GEOTECHNICAL ENGINEERS REPORT AND RECOMMENDATIONS.

FOUNDATION:

1. THE DESIGN OF SHALLOW FOUNDATIONS, RETAINING WALLS, AND SLABS-ON-GRADE IS BASED ON THE FOLLOWING CRITERIA ESTABLISHED IN THE GEOTECHNICAL REPORT BY S&ME, INC. DATED MAY 16, 2024 REPORT NUMBER 23060119
   - ALLOWABLE SOIL BEARING PRESSURE: 3,000 PSF
   - EQUIVALENT LATERAL FLUID PRESSURE - ACTIVE CASE: 39 PSF/FT
   - EQUIVALENT LATERAL FLUID PRESSURE - AT-REST CASE: 60 PSF/FT
   - EQUIVALENT LATERAL FLUID PRESSURE - PASSIVE CASE: 360 PSF/FT
   - COEFFICIENT OF SLIDING FRICTION: 0.36
   - SOIL DENSITY: 120 PCF
   AFTER EXCAVATION, IF THE CONDITION OF THE SOILS DO NOT MEET THE RECOMMENDED DESIGN CRITERIA STATED IN THE GEOTECHNICAL REPORT, NOTIFY THE ARCHITECT AND STRUCTURAL ENGINEER OF RECORD SO THAT THE FOUNDATIONS MAY BE REDESIGNED IF NECESSARY.
2. THE GEOTECHNICAL ENGINEER MUST VERIFY THE CONDITION AND/OR ADEQUACY OF ALL SUB-GRADES, FILLS, AND BACKFILLS PRIOR TO THE PLACEMENT OF FOUNDATIONS, FOOTINGS, SLABS, WALLS, ETC.
3. DESIGN OF SLAB-ON-GRADE IS BASED UPON A MODULUS OF SUBGRADE REACTION OF 175 PCI.
4. CONTACT THE ARCHITECT AND ENGINEER OF RECORD IF, AFTER EXCAVATION, THE CONDITION OF THE SOIL INDICATES A SAFE BEARING CAPACITY OF LESS THAN 3,000 PSF. BEAR ALL FOOTINGS ON ORIGINAL, UNDISTURBED SOIL OR STRUCTURAL FILL.
5. COORDINATE TOP OF PIER ELEVATIONS WITH THE REQUIREMENTS OF OTHER TRADES (PLUMBING, ELECTRICAL, ETC.).
6. BACK FILLING WALLS:
   A. DEPOSIT BACKFILL AGAINST WALLS EVENLY AGAINST BOTH SIDES OF WALL UNTIL THE LOWER FINAL GRADE IS REACHED.
   B. DO NOT PLACE BACKFILL AGAINST WALLS DEPENDENT UPON TOP AND BOTTOM CONCRETE SLABS FOR SUPPORT UNTIL THE CONCRETE SLABS HAVE ATTAINED 65% OF THEIR DESIGN 28 DAY COMPRESSION STRENGTH.
   C. SHORE AND BRACE WALLS SHOWN MONOLITHIC WITH A SLAB-ON-GRADE AT THE TOP OF THE WALL DURING BACKFILLING OPERATIONS.
7. CONSTRUCT COLUMN FOOTINGS AND WALL FOOTINGS MONOLITHICALLY WITH TOPS OF ADJACENT FOOTINGS AT THE SAME ELEVATION.
8. FILLS:
   A. REMOVE ALL UNSUITABLE SOILS AND REPLACE WITH CLEAN STRUCTURAL FILL AT THE DIRECTION OF THE GEOTECHNICAL ENGINEER.
   B. PLACE FILL SOILS IN 8" MAXIMUM LOOSE LIFTS AT MOISTURE CONTENTS AS DESCRIBED IN THE GEOTECHNICAL REPORT.
   C. COMPACT ALL FILL WITHIN 10'-0" OF THE BUILDING LIMIT TO 95% STANDARD PROCTOR.
   D. TEST FIELD DENSITY AS DESCRIBED IN THE GEOTECHNICAL REPORT TO VERIFY ADEQUATE COMPACTION AND DESIGN BEARING PRESSURE.
9. SIDES OF FOUNDATIONS MUST BE FORMED UNLESS CONDITIONS PERMIT EARTH FORMING. FOUNDATIONS PLACED AGAINST THE EARTH REQUIRE THE FOLLOWING PRECAUTIONS: SLOPE SIDES OF EXCAVATIONS AS APPROVED BY THE GEOTECHNICAL ENGINEER AND CLEAN UP SLOUGHING BEFORE AND DURING CONCRETE PLACEMENT.
10. WHERE FOOTING STEPS ARE NECESSARY, SLOPE NO STEEPER THAN ONE VERTICAL TO TWO HORIZONTAL.

AUGER CAST-IN-PLACE (ACIP) REINFORCED CONCRETE PILES:

1. DEEP FOUNDATION ELEMENTS CONSIST OF PILE CAPS SUPPORTED ON AUGURED CAST-IN-PLACE GROUT PILES OF THE DIAMETER AND DEPTH INDICATED.
2. AUGER-CAST GROUT PILES MUST BE 16 INCH NOMINAL (MINIMUM) DIAMETER.
3. DESIGN CAPACITIES OF PILES ARE AS FOLLOWS: 67 TONS IN COMPRESSION, 30 TONS IN TENSION (AT TENSION PILES ONLY), AND 5 TONS LATERAL. BASE BID LENGTH FOR PILES MUST BE (25 FEET) FROM TIP TO BOTTOM OF PILE CAP.
4. A STATIC PILE TEST MUST BE PERFORMED BY THE PILE INSTALLER AND OBSERVED BY THE SPECIAL INSPECTOR. THE PILE TEST MUST BE FOR AXIAL (COMPRESSIVE) CAPACITY AND MUST LOAD THE TEST PILE TO GEOTECHNICAL FAILURE OR THREE TIMES THE DESIGN LOAD, WHICHEVER OCCURS FIRST. THE TEST PILE MUST BE INSTRUMENTED WITH STRAIN GAUGES ALONG ITS LENGTH TO MEASURE PILE STRAINS DURING TESTING. REACTION PILES AND TEST RIG MUST HAVE ADEQUATE CAPACITY FOR THE LOAD INDICATED. THE TEST PILE MUST BE INSTALLED USING THE SAME CONSTRUCTION TECHNIQUES PLANNED FOR THE PRODUCTION PILES.
5. PILES MUST BE CONTINUOUSLY MONITORED DURING AUGURING AND GROUTING OPERATIONS. LOW-STRAIN INTEGRITY TESTING MUST BE PERFORMED ON 7 OF THE FIRST 100 PILES, AND 1 PERCENT OF PILES THEREAFTER, PROVIDED THAT INSTALLATION IS FOUND TO BE ACCEPTABLE. TESTING MUST BE BY THE PILE INSTALLER AND OBSERVED BY THE SPECIAL INSPECTOR.
6. A CERTIFIED SURVEY OF PILE LOCATIONS MUST BE PREPARED AND SUBMITTED FOR APPROVAL. PILES OUT OF ALLOWABLE TOLERANCE (4" ANY DIRECTION) MUST BE CLEARLY MARKED. SURVEY MUST INDICATE DIRECTION AND AMOUNT OF ANY DISCREPANCY. SUBMIT SURVEY PRIOR TO PLACEMENT OF PILE CAPS.
7. ALL ACIP SHALL BE VERTICAL PRE-DRILLED CAST-IN-PLACE REINFORCED CONCRETE PIERS, UNLESS INDICATED OTHERWISE. CONCRETE SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 4000 PSI.
8. ELEVATION OF THE BOTTOM OF ALL ACIP, AS INDICATED, ARE APPROXIMATE. EXCAVATION FOR EACH DRILLED CAISSON SHALL PROCEED TO A DEPTH AS APPROVED BY A PROFESSIONAL GEOTECHNICAL ENGINEER.
9. CASTING OF CONCRETE FOR ALL ACIP SHALL COMMENCE AFTER THE SAFE END BEARING LOAD CAPACITY OF 134 K AND SKIN FRICTION CAPACITY OF 5 KSF IN THE ROCK SOCKET HAS BEEN APPROVED BY A PROFESSIONAL GEOTECHNICAL ENGINEER.
10. ALL ACIP SHALL BE INSTALLED IN ACCORDANCE WITH THE REPORT OF GEOTECHNICAL EXPLORATION NOTED IN THE FOUNDATION NOTES SECTION OF THIS SHEET.
11. STRAIGHT-SIDED PIERS SHALL BE CENTERED ABOUT COLUMN LINES, U.N.O.

CONCRETE WATER TANK NOTES:

1. REINFORCED CONCRETE TANKS ARE DESIGNED IN ACCORDANCE WITH ACI 350-20. SEISMIC DESIGN OF CONCRETE TANKS IS IN ACCORDANCE WITH ACI 350.3.
2. CONCRETE TANKS MUST BE TESTED IN ACCORDANCE WITH ACI 350.1-10. SPECIFICATION FOR TIGHTNESS TESTING OF ENVIRONMENTAL ENGINEERING CONCRETE CONTAINMENT STRUCTURE.
3. DESIGN LOADS FOR TANKS
   A. HYDROSTATIC LOAD (WATER) 65 PCF
4. DESIGN CRITERIA:
   A. RISK CATEGORY III
   B. IMPORTANCE FACTOR, Ie 1.0
   C. CONCRETE STRENGTH, MIN 5000 PSI
   D. COVER ON REINFORCING 3"
   E. ENVIRONMENTAL EXPOSURE (ACI 350) NORMAL
   F. SULFATE EXPOSURE MODERATE
5. ALL TANKS ARE DESIGNED FOR WATER DEPTH EQUAL TO TOP OF RIM ELEVATION.
6. INSTALL CONTINUOUS WATERSTOP IN ALL CONSTRUCTION AND CONTROL JOINTS.
7. REINFORCING LAP SPLICES MUST BE TENSION LAPS, UNLESS OTHERWISE INDICATED. STAGGER SPLICES OF HORIZONTAL REINFORCING IN CIRCULAR TANKS.

MICROPILES (AT TOUCH TANK):

1. MICROPILES MUST BE MINIMUM 8 INCH IN DIAMETER.
2. DESIGN CAPACITIES OF MICROPILES ARE AS FOLLOWS: 27 TONS IN COMPRESSION, 15 TONS IN TENSION (AT TENSION PILES ONLY).
3. DESIGN CAPACITIES OF MICROPILES (BOTH TEST PILE AND PRODUCTION PILES) MUST INCLUDE FACTOR OF SAFETY OF 2.0 FOR COMPRESSION LOAD. THE FACTOR OF SAFETY OF 3.0 MUST BE APPLIED FOR LOADS IN TENSION.
4. MINIMUM LENGTH OF THE PILES MUST BE 25 FEET.
5. A STATIC TEST PILE TEST MUST BE PERFORMED BY THE PILE INSTALLER AND OBSERVED BY THE SPECIAL INSPECTOR.

POST-INSTALLED ANCHORS:

1. GENERAL
   A. PRE-CONSTRUCTION DUTIES OF THE CONTRACTOR:
      1. ARRANGE FOR AN ANCHOR MANUFACTURER'S REPRESENTATIVE TO PROVIDE ONSITE INSTALLATION TRAINING FOR ALL OF THEIR ANCHORING PRODUCTS SPECIFIED.
      2. PROVIDE THE STRUCTURAL ENGINEER OF RECORD MUST RECEIVE DOCUMENTED CONFIRMATION THAT ALL OF THE CONTRACTOR'S PERSONNEL WHO INSTALL ANCHORS ARE TRAINED PRIOR TO THE COMMENCEMENT OF INSTALLING ANCHORS.
   B. INSTALL POST-INSTALLED ANCHORS ONLY WHERE SPECIFIED ON THE CONSTRUCTION DOCUMENTS.
   C. OBTAIN APPROVAL FROM THE ENGINEER-OF-RECORD PRIOR TO INSTALLING POST-INSTALLED ANCHORS IN PLACE OF MISSING OR MISPLACED CAST-IN-PLACE ANCHORS.
   D. ANCHOR CAPACITY IS DEPENDANT UPON SPACING BETWEEN ADJACENT ANCHORS AND PROXIMITY OF ANCHORS TO EDGE OF CONCRETE. INSTALL ANCHORS IN ACCORDANCE WITH SPACING AND EDGE CLEARANCES INDICATED ON THE DRAWINGS OR INDICATED IN THE MANUFACTURER'S LITERATURE.
   E. EXISTING REINFORCING BARS AND OTHER EMBEDDED MATERIAL CONTAINED IN THE CONCRETE STRUCTURE MAY CONFLICT WITH SPECIFIC ANCHOR LOCATIONS.
      1. CONTRACTOR REVIEW THE EXISTING STRUCTURAL DRAWINGS AND UNDERTAKE TO LOCATE THE POSITION OF MATERIAL EMBEDDED IN THE CONCRETE AT THE LOCATIONS OF THE DETAILED ANCHORS, BY HILTI FERROSCAN, GPR, X-RAY, CHIPPING OR OTHER MEANS UNLESS IT IS NOTED ON THE DRAWINGS THAT THE BARS CAN BE CUT.
   F. DRILL AND CLEAN HOLES IN ACCORDANCE WITH THE MANUFACTURER'S WRITTEN INSTRUCTIONS.
   G. SUBMIT SUBSTITUTION REQUESTS, FOR PRODUCTS OTHER THAN THOSE SPECIFIED BELOW TO THE ENGINEER-OF-RECORD PRIOR TO USE ALONG WITH:
      1. PROVIDE CALCULATIONS THAT ARE PREPARED & SEALED BY A REGISTERED PROFESSIONAL ENGINEER.
      2. PROVIDE CALCULATIONS THAT DEMONSTRATE THE SUBSTITUTED PRODUCT IS CAPABLE OF ACHIEVING EQUIVALENT PERFORMANCE VALUES (MINIMUM) OF THE SPECIFIED PRODUCT USING THE APPROPRIATE DESIGN PROCEDURE AND/OR STANDARD(S) AS REQUIRED BY THE BUILDING CODE.
      3. INCLUDE CONSIDERATION OF 50 YEAR SERVICE TEMPERATURE AND INSTALLATION TEMPERATURE IN SUBSTITUTION REQUEST.
      4. EVALUATION OF SUBSTITUTIONS WILL BE BASED ON THEIR HAVING AN ICC ESR SHOWING COMPLIANCE WITH THE RELEVANT BUILDING CODE FOR SEISMIC USES, LOAD RESISTANCE, INSTALLATION CATEGORY, AND AVAILABILITY OF COMPREHENSIVE INSTALLATION INSTRUCTIONS.
2. CONCRETE ANCHORS
   A. MEDIUM DUTY MECHANICAL AND SCREW ANCHORS FOR USE IN CRACKED AND UN-CRACKED CONCRETE THAT HAVE BEEN TESTED AND QUALIFIED FOR USE IN ACCORDANCE WITH ACI 355.2 AND ICC-ES AC193. PRE-APPROVED MECHANICAL AND SCREW ANCHORS INCLUDE:
      1. HILTI KWIK BOLT-TZ EXPANSION ANCHORS (ICC ESR-1917)
      2. HILTI KWIK HUS-EZ AND KWIK HUS-EZ I SCREW ANCHORS (ICC ESR-3027)
      3. SIMPSON STRONG-TIE "TITEN-HD" SCREW ANCHORS (ICC ESR-2713)
      4. SIMPSON STRONG-TIE "STRONG-BOLT 2" EXPANSION ANCHORS (ICC ESR-3037)
      5. DEWALT / POWERS POWER-STUD + SD2 EXPANSION ANCHORS (ICC ESR 2502)
   B. HEAVY DUTY MECHANICAL ANCHORS FOR CRACKED AND UN-CRACKED CONCRETE USE:
      1. HILTI HDA UNDERCUT ANCHORS (ICC ESR 1546)
      2. HILTI HSL-3 EXPANSION ANCHORS (ICC ESR 1545)
      3. DEWALT / POWERS ATOMIC + UNDERCUT ANCHOR (ICC ESR 3067)
   C. ADHESIVE ANCHORS FOR USE IN CRACKED AND UN-CRACKED CONCRETE THAT HAVE BEEN TESTED AND QUALIFIED FOR USE IN ACCORDANCE WITH ICC-ES AC308. PRE-APPROVED ADHESIVE ANCHORS INCLUDE:
      1. HILTI HIT-HY 200 SAFE SET SYSTEM WITH HILTI HIT-Z ROD (ICC ESR-3187)
      2. HILTI HIT-RE 500-V3 EPOXY ADHESIVE ANCHORING SYSTEM WITH HAS-E THREADED ROD (ICC ESR-3814)
      3. DEWALT / POWERS PURE 110 + STANDARD CURE EPOXY (ICC ESR 3298)
3. MASONRY ANCHORS
   A. ANCHORAGE TO SOLID-GROUTED CONCRETE MASONRY
      1. MECHANICAL AND CONCRETE SCREW ANCHORS FOR USE IN SOLID-GROUTED CONCRETE MASONRY SHALL HAVE BEEN TESTED AND QUALIFIED FOR USE IN ACCORDANCE WITH ICC-ES AC01 OR AC106, RESPECTIVELY. PRE-APPROVED MECHANICAL AND CONCRETE SCREW ANCHORS INCLUDE:
         a. HILTI KWIK HUS-EZ SCREW ANCHOR (ICC ESR-3056)
         b. HILTI KWIK BOLT-3 EXPANSION ANCHORS (ICC ESR-1385)
         c. SIMPSON STRONG-TIE "WEDGE-ALL" (ICC ESR-1396)
         d. SIMPSON STRONG-TIE "TITEN-HD" (ICC ESR-1056)
         e. DEWALT / POWERS POWER-STUD + SD1 (ICC ESR 2966)
      2. ADHESIVE ANCHORS FOR USE IN SOLID-GROUTED CONCRETE MASONRY SHALL HAVE BEEN TESTED AND QUALIFIED FOR USE IN ACCORDANCE WITH ICC-ES AC58. PRE-APPROVED ADHESIVE ANCHORS INCLUDE:
         a. HILTI HIT-HY 200 MASONRY ADHESIVE ANCHORING SYSTEM (ICC ESR-3963).
         b. SIMPSON STRONG-TIE "SET-XP" (ICC ESR-1772)
         c. SIMPSON STRONG-TIE "AT" (ICC ESR-1958)
         d. DEWALT / POWERS AC200 + FAST CURE ACRYLIC (ICC ESR-4027)

STRUCTURAL MASONRY:

1. PROVIDE STRUCTURAL MASONRY CONFORMING TO THE FOLLOWING STANDARDS:
   A. ACI 530 / ASCE 5 / TMS 402, BUILDING CODE REQUIREMENTS FOR CONCRETE MASONRY STRUCTURES, LATEST EDITIONS.
   B. ACI 530.1 / ASCE 6 / TMS 602, SPECIFICATIONS FOR CONCRETE MASONRY STRUCTURES, LATEST EDITIONS
2. LOAD BEARING MASONRY WALLS ARE DESIGNED IN ACCORDANCE WITH CHAPTERS 1 AND 2 OF ACI 530.
3. PROVIDE HOLLOW, LOAD BEARING CONCRETE MASONRY UNITS (CMU) CONFORMING TO ASTM C 90 WITH A MINIMUM COMPRESSIVE STRENGTH OF MASONRY (F'M) OF 2000 PSI AND A NET STRENGTH OF 2000 PSI ON THE NET CROSS-SECTIONAL AREA OF CMU DETERMINED IN ACCORDANCE WITH ASTM C 140.
4. PROVIDE BRICK MASONRY UNITS CONSTRUCTED OF CLAY OR SHALE CONFORMING TO ASTM C 652.
5. PROVIDE MORTAR CONFORMING TO ASTM C 270, TYPE S. STANDARD MORTAR BED JOINT THICKNESS IS 3/8" AND MUST NOT VARY OUTSIDE OF THE RANGE BETWEEN ONE QUARTER INCH AND ONE HALF INCH. DO NOT USE AIR ENTRAINED MORTAR.
6. PROVIDE GROUT FOR REINFORCED MASONRY CONFORMING TO ASTM C 476 WITH MINIMUM COMPRESSIVE STRENGTH OF 2500 PSI AND A MINIMUM SLUMP OF 10".
7. PROVIDE STEEL REINFORCEMENT IN MASONRY WALLS CONFORMING TO ASTM A615, GRADE 60.
8. PROVIDE MASONRY TIES AND ANCHORS OF THE TYPE AND SPACING AS DETAILED ON THE STRUCTURAL DRAWINGS AND IN CONFORMANCE WITH ASTM A82.
9. PROVIDE LADDER TYPE HORIZONTAL JOINT REINFORCING CONFORMING TO ASTM A951 IN ALL MASONRY WALLS. UNLESS NOTED OTHERWISE, PLACE 9 GAGE ZINC COATED LADDER TYPE HORIZONTAL JOINT REINFORCING AT 16" ON CENTER. LAP HORIZONTAL JOINT REINFORCING MINIMUM 12". USE PREFABRICATED 'L'S AND 'T'S AT CORNERS AND INTERSECTIONS.
10. LAY ALL MASONRY UNITS IN RUNNING BOND.
11. FOR GROUTED WALLS:
    A. THE MAXIMUM HEIGHT OF GROUT LIFTS MUST NOT EXCEED 5'-0".
    B. THE MAXIMUM UN-GROUTED HEIGHT OF 8" OR THICKER CMU WALLS PRIOR TO GROUTING MUST NOT EXCEED 12'-0"
    C. REFER TO TABLE 7 OF ACI 530.1 FOR THE MAXIMUM UN-GROUTED HEIGHT OF CMU WALLS THINNER THAN 8".
    D. CONSOLIDATE AND RECONSOLIDATE GROUT IN ACCORDANCE WITH PARAGRAPH 3.5.E OF ACI 530.1.
    E. ALL GROUT POURS HIGHER THAN 5'-0" MUST HAVE INSPECTION HOLES AT THE BASE OF THE WALL.
12. REINFORCEMENT:
    A. DETAIL REINFORCEMENT IN LOAD BEARING CMU WALLS IN ELEVATION ON SHOP DRAWINGS.
    B. LAP VERTICAL MASONRY WALL REINFORCING AS SHOWN IN THE MASONRY LAP LENGTH SCHEDULE AND PROVIDE MINIMUM BAR SPLICE LENGTH.
13. PROVIDE VERTICAL CONTROL JOINTS IN ALL MASONRY WALLS NOT RETAINING EARTH. UNLESS NOTED OTHERWISE ON THE ARCHITECTURAL DRAWINGS, PLACE VERTICAL CONTROL JOINTS AT THREE TIMES THE WALL STORY HEIGHT, BUT NOT CLOSER THAN 25'-0" ON CENTER OR FARTHER THAN 40'-0" ON CENTER.
14. UNLESS NOTED OTHERWISE, PROVIDE MINIMUM (1) #5 VERTICAL BAR, GROUTED FULL STORY HEIGHT, AT EACH SIDE OF OPENINGS AND AT ALL CORNERS AND ENDS OF WALLS, INCLUDING BOTH SIDES AT ENDS OF WALL PANELS AT VERTICAL CONTROL JOINTS.
15. UNLESS NOTED OTHERWISE, ANCHOR SIDES AND TOPS OF MASONRY WALL PANELS TO THE STRUCTURE BY DOVETAIL ANCHORS, METAL STRAPS, OR EQUIVALENT.
16. PLACE CONNECTORS FOR MASONRY VENEERS AT NOT MORE THAN 16" ON CENTER VERTICALLY OR 24" ON CENTER HORIZONTALLY.
17. PROVIDE A CONTINUOUS BOND BEAM AT THE TOP OF ALL MASONRY WALLS. UNLESS NOTED OTHERWISE REINFORCE BOND BEAMS WITH (2) #4 CONTINUOUS REINFORCING BARS.
18. PROVIDE LEVEL B QUALITY ASSURANCE AS DESCRIBED IN TABLE 4 OF ACI 530.1 / ASCE 6 / TMS 602, LATEST EDITIONS.
19. SAMPLE AND TEST GROUT IN ACCORDANCE WITH ARTICLES 1.4 B AND 1.6 OF ACI 530.1 / ASCE 6 / TMS 602, LATEST EDITIONS.

REINFORCED CONCRETE:

1. PROVIDE REINFORCED CONCRETE CONFORMING TO THE FOLLOWING STANDARDS.
   A. ACI 301, SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS, LATEST EDITION.
   B. ACI 318, BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE, LATEST EDITION.
   C. ACI 302.1R, GUIDE FOR CONCRETE FLOOR AND SLAB CONSTRUCTION, LATEST EDITION.
   D. ACI 360R, DESIGN OF SLABS-ON-GROUND, LATEST EDITION.
   E. PROJECT SPECIFICATION MANUAL DIVISION 3 (WHEN PROVIDED)
2. FULLY DOCUMENT AND SUBMIT FOR REVIEW THE PROPOSED MATERIALS AND MIX DESIGN FOR ALL CONC

FOUNDATION PLAN LEGEND

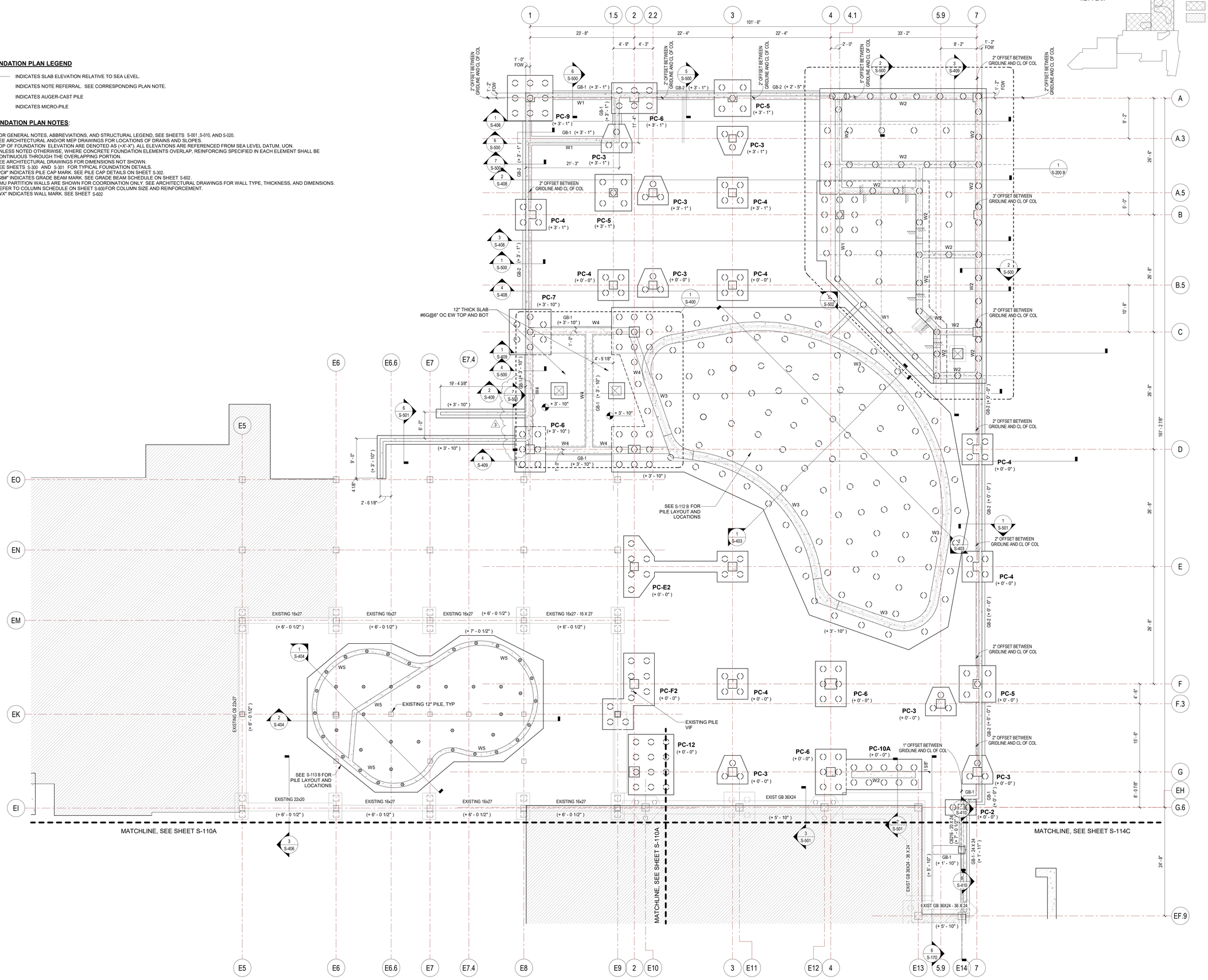
- INDICATES SLAB ELEVATION RELATIVE TO SEA LEVEL.
- (1) INDICATES NOTE REFERRAL. SEE CORRESPONDING PLAN NOTE.
- INDICATES AUGER-CAST PILE
- INDICATES MICRO-PILE

FOUNDATION PLAN NOTES:

1. FOR GENERAL NOTES, ABBREVIATIONS, AND STRUCTURAL LEGEND, SEE SHEETS S-001, S-010, AND S-020.
2. SEE ARCHITECTURAL AND/OR MEP DRAWINGS FOR LOCATIONS OF DRAINS AND SLOPES.
3. TOP OF FOUNDATION ELEVATION ARE DENOTED AS (+X'-X"). ALL ELEVATIONS ARE REFERENCED FROM SEA LEVEL DATUM, UON.
4. UNLESS NOTED OTHERWISE, WHERE CONCRETE FOUNDATION ELEMENTS OVERLAP, REINFORCING SPECIFIED IN EACH ELEMENT SHALL BE CONTINUOUS THROUGH THE OVERLAPPING PORTION.
5. SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
6. SEE SHEETS S-300 AND S-301 FOR TYPICAL FOUNDATION DETAILS.
7. "PC#" INDICATES PILE CAP MARK. SEE PILE CAP DETAILS ON SHEET S-302.
8. "GB#" INDICATES GRADE BEAM MARK. SEE GRADE BEAM SCHEDULE ON SHEET S-602.
9. CMU PARTITION WALLS ARE SHOWN FOR COORDINATION ONLY. SEE ARCHITECTURAL DRAWINGS FOR WALL TYPE, THICKNESS, AND DIMENSIONS.
10. REFER TO COLUMN SCHEDULE ON SHEET S-600 FOR COLUMN SIZE AND REINFORCEMENT.
11. "WX" INDICATES WALL MARK. SEE SHEET S-602

KEY PLAN

PLAN LEGEND
- RENOVATION
- EXISTING BUILDING



1/8" = 1' 0" — 0, 10', 20', 40', 80'

1 S-111 B — FOUNDATION PLAN - TOUCH & SHARK TANK
SCALE: 1/8" = 1'-0"

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
CODE: 42014-4G02
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NOTE: IF THIS DRAWING IS NOT 30" X 42", IT IS A REDUCED PRINT. REFER TO GRAPHIC SCALE.

NORTH CAROLINA REGISTERED LANDSCAPE ARCHITECT SEAL 028371 10-29-25 ENGINEER JAMES L. PERRIN

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

FOUNDATION PLAN - TOUCH & SHARK TANK

S-111 B

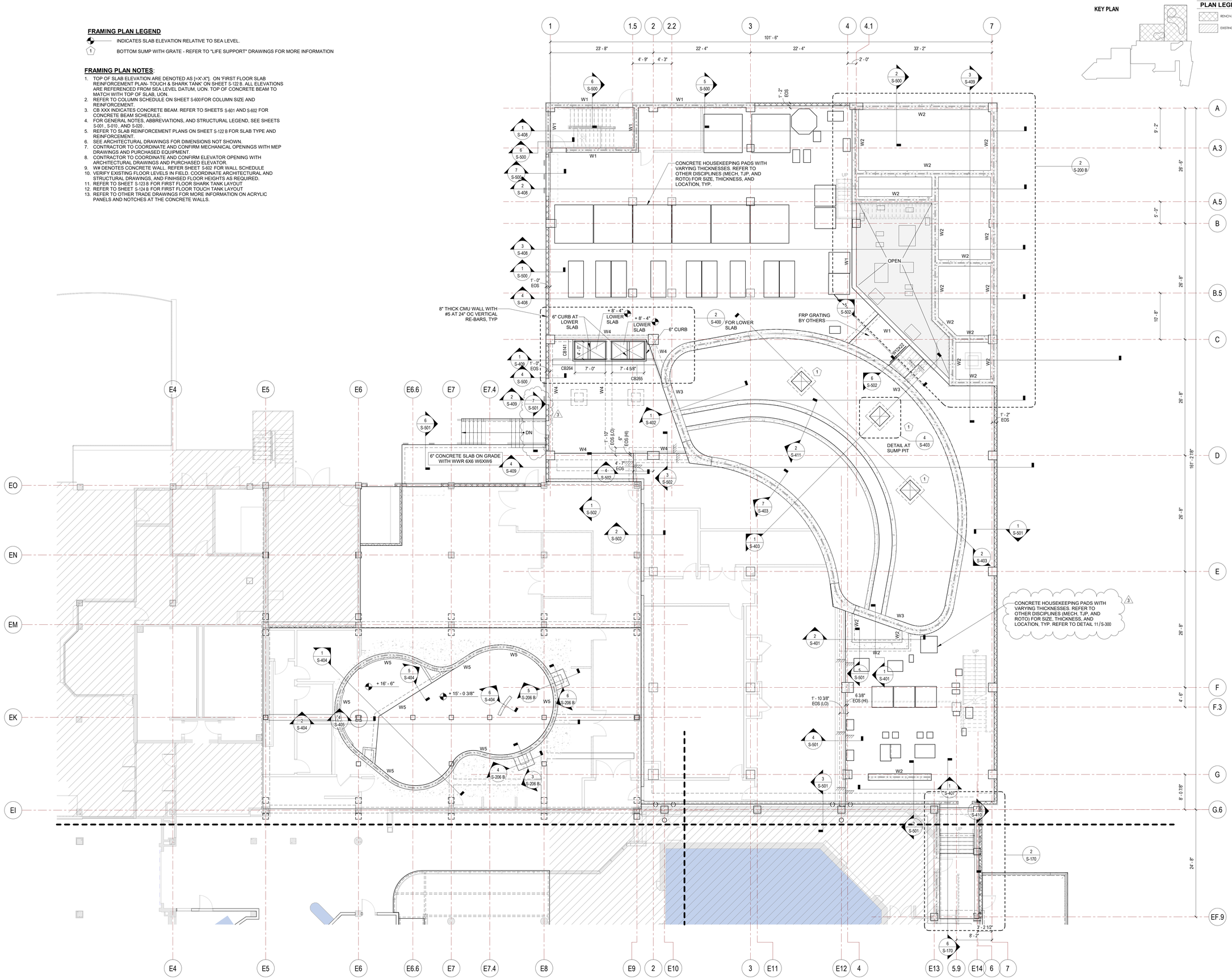
FRAMING PLAN LEGEND

INDICATES SLAB ELEVATION RELATIVE TO SEA LEVEL.

1 BOTTOM SUMP WITH GRATE - REFER TO "LIFE SUPPORT" DRAWINGS FOR MORE INFORMATION

FRAMING PLAN NOTES:

1. TOP OF SLAB ELEVATION ARE DENOTED AS [=X'-X"]. ON 'FIRST FLOOR SLAB REINFORCEMENT PLAN- TOUCH & SHARK TANK' ON SHEET S-122 B. ALL ELEVATIONS ARE REFERENCED FROM SEA LEVEL DATUM, UON. TOP OF CONCRETE BEAM TO MATCH WITH TOP OF SLAB, UON.
2. REFER TO COLUMN SCHEDULE ON SHEET S-600 FOR COLUMN SIZE AND REINFORCEMENT.
3. CB XXX INDICATES CONCRETE BEAM. REFER TO SHEETS S-601 AND S-602 FOR CONCRETE BEAM SCHEDULE.
4. FOR GENERAL NOTES, ABBREVIATIONS, AND STRUCTURAL LEGEND, SEE SHEETS S-001 , S-010 , AND S-020 .
5. REFER TO SLAB REINFORCEMENT PLANS ON SHEET S-122 B FOR SLAB TYPE AND REINFORCEMENT.
6. SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
7. CONTRACTOR TO COORDINATE AND CONFIRM MECHANICAL OPENINGS WITH MEP DRAWINGS AND PURCHASED EQUIPMENT.
8. CONTRACTOR TO COORDINATE AND CONFIRM ELEVATOR OPENING WITH ARCHITECTURAL DRAWINGS AND PURCHASED ELEVATOR.
9. W# DENOTES CONCRETE WALL. REFER SHEET S-602 FOR WALL SCHEDULE
10. VERIFY EXISTING FLOOR LEVELS IN FIELD. COORDINATE ARCHITECTURAL AND STRUCTURAL DRAWINGS, AND FINISHED FLOOR HEIGHTS AS REQUIRED.
11. REFER TO SHEET S-123 B FOR FIRST FLOOR SHARK TANK LAYOUT.
12. REFER TO SHEET S-124 B FOR FIRST FLOOR TOUCH TANK LAYOUT.
13. REFER TO OTHER TRADE DRAWINGS FOR MORE INFORMATION ON ACRYLIC PANELS AND NOTCHES AT THE CONCRETE WALLS.



1/8" = 1' 0" 0 10' 20' 40' 80'

1 S-121 B FIRST FLOOR FRAMING PLAN - TOUCH & SHARK TANK
SCALE: 1/8" = 1'-0"

KEY PLAN

PLAN LEGEND
RENOVATION
EXISTING BUILDING

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
CODE: 42014-4G02
ITEM: 41414-4Y4A

900 LOGGERHEAD RD,
KURE BEACH, NC 28449

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NORTH CAROLINA SEAL 028371 10-29-25 ENGINEER KEVIN J. IDEMA

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

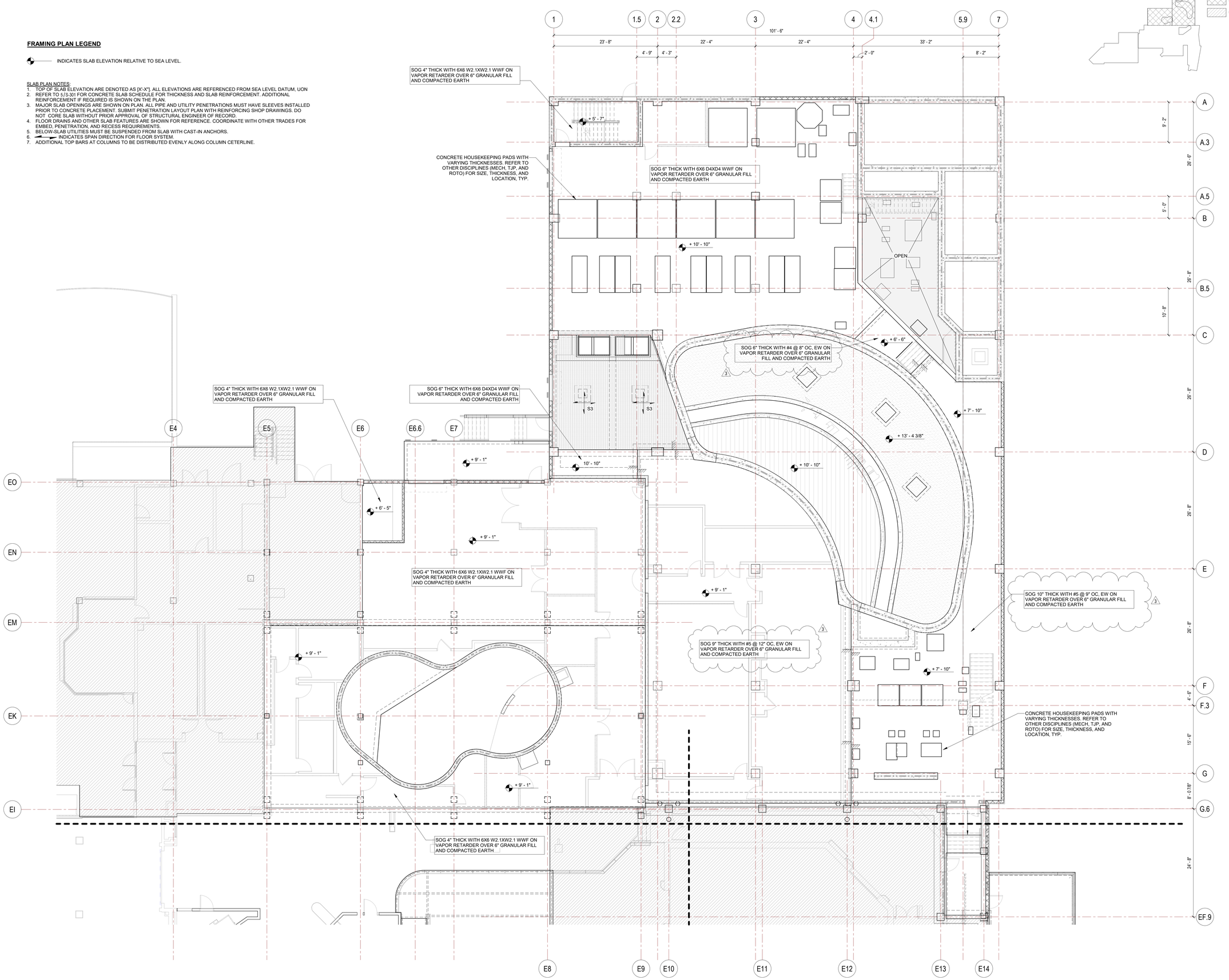
FIRST FLOOR FRAMING PLAN - TOUCH & SHARK TANK

S-121 B

FRAMING PLAN LEGEND

INDICATES SLAB ELEVATION RELATIVE TO SEA LEVEL.

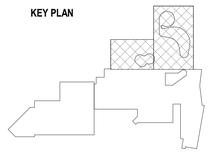
SLAB PLAN NOTES:
1. TOP OF SLAB ELEVATION ARE DENOTED AS [X'-X"]. ALL ELEVATIONS ARE REFERENCED FROM SEA LEVEL DATUM, UON
2. REFER TO S/S-301 FOR CONCRETE SLAB SCHEDULE FOR THICKNESS AND SLAB REINFORCEMENT. ADDITIONAL REINFORCEMENT IF REQUIRED IS SHOWN ON THE PLAN.
3. MAJOR SLAB OPENINGS ARE SHOWN ON PLAN. ALL PIPE AND UTILITY PENETRATIONS MUST HAVE SLEEVES INSTALLED PRIOR TO CONCRETE PLACEMENT. SUBMIT PENETRATION LAYOUT PLAN WITH REINFORCING SHOP DRAWINGS. DO NOT CORE SLAB WITHOUT PRIOR APPROVAL OF STRUCTURAL ENGINEER OF RECORD.
4. FLOOR DRAINS AND OTHER SLAB FEATURES ARE SHOWN FOR REFERENCE. COORDINATE WITH OTHER TRADES FOR EMBED, PENETRATION, AND RECESS REQUIREMENTS.
5. BELOW-SLAB UTILITIES MUST BE SUSPENDED FROM SLAB WITH CAST-IN ANCHORS.
6. INDICATES SPAN DIRECTION FOR FLOOR SYSTEM.
7. ADDITIONAL TOP BARS AT COLUMNS TO BE DISTRIBUTED EVENLY ALONG COLUMN CETERLINE.



1/8" = 1' 0" 0 10' 20' 40' 80'

1 / S-122 B FIRST FLOOR SLAB REINFORCEMENT PLAN - TOUCH & SHARK TANK
SCALE: 1/8" = 1'-0"

KEY PLAN



PLAN LEGEND
- RENOVATION
- EXISTING BUILDING

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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NORTH CAROLINA SEAL 028371 ENGINEER RALPH L. HERRING 10-29-25

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
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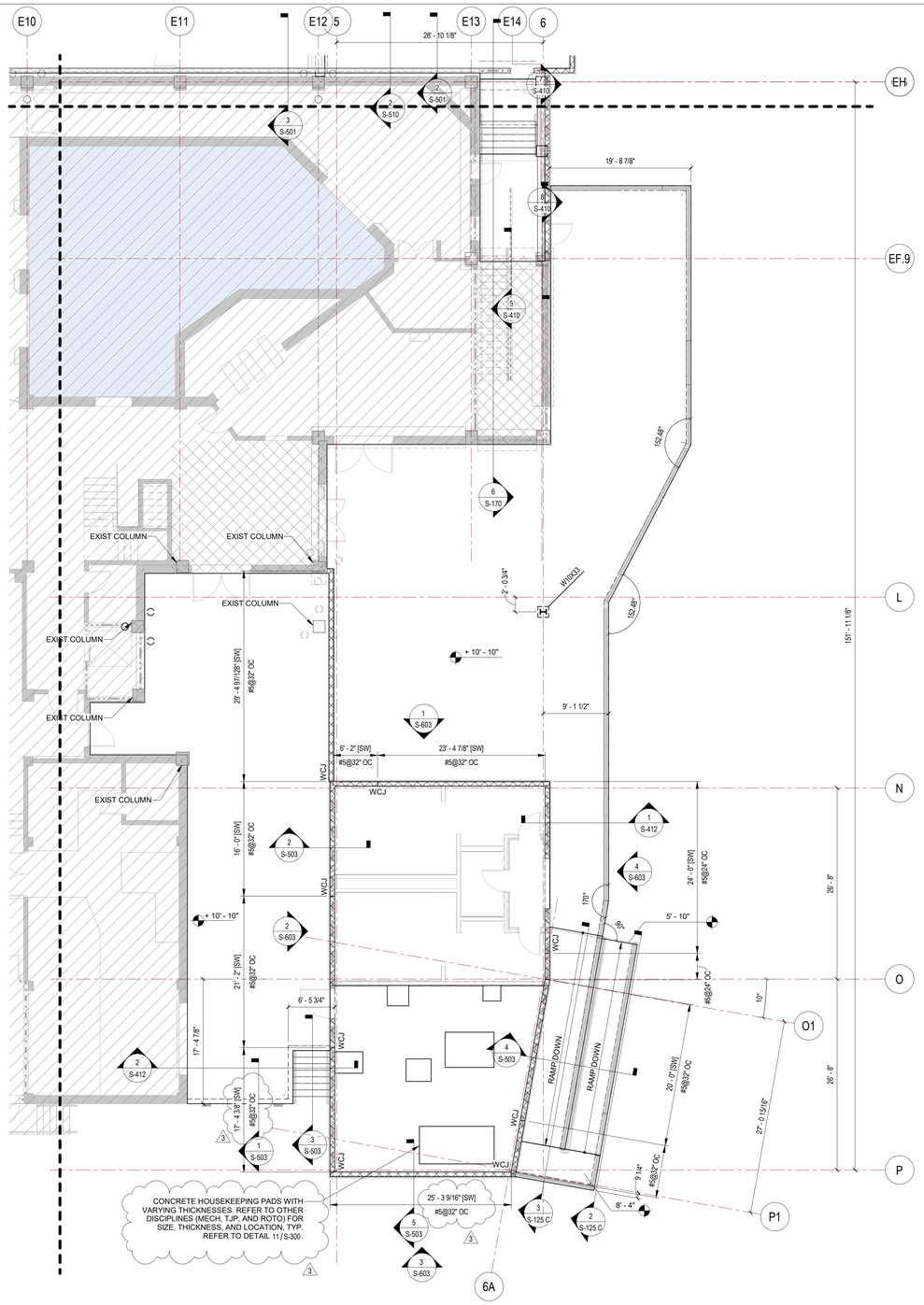
3	10-29-25	ADDENDUM #2

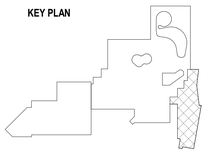
FIRST FLOOR SLAB REINFORCMENT PLAN - TOUCH & SHARK TANK

S-122 B



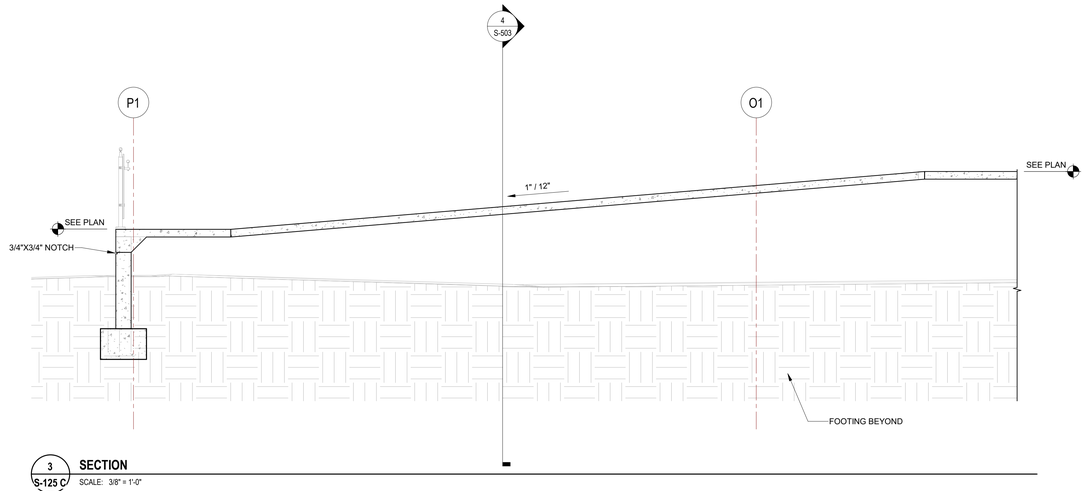
1 S-125 C FIRST FLOOR FRAMING PLAN - SOUTHEAST WING

SCALE: 1/8" = 1'-0"



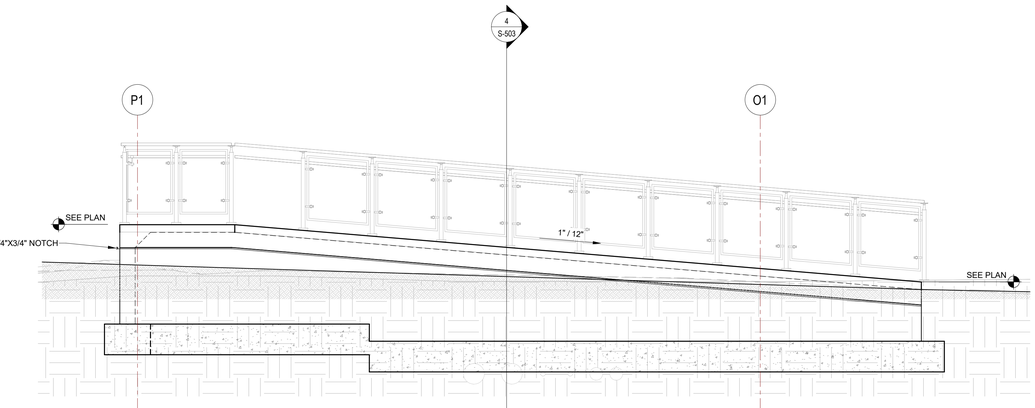
PLAN LEGEND

- RENOVATION
- EXISTING BUILDING



3 S-125 C SECTION

SCALE: 3/8" = 1'-0"



2 S-125 C SECTION

SCALE: 3/8" = 1'-0"

FRAMING PLAN NOTES:

1. TOP OF SLAB ELEVATION ARE DENOTED AS [=X'-X"]. ON 'FIRST FLOOR SLAB REINFORCEMENT PLAN- SOUTHEAST WING' ON SHEET S-126 C. ALL ELEVATIONS ARE REFERENCED FROM SEA LEVEL DATUM, UON.
2. REFER TO COLUMN SCHEDULE ON SHEET S-600 FOR COLUMN SIZE AND REINFORCEMENT.
3. CB XXX INDICATES CONCRETE BEAM. REFER TO SHEETS S-601 AND S-602 FOR CONCRETE BEAM SCHEDULE.
4. FOR GENERAL NOTES, ABBREVIATIONS, AND STRUCTURAL LEGEND, SEE SHEETS S-001, S-010, AND S-020.
5. REFER TO SLAB REINFORCEMENT PLANS ON SHEET S-126 C FOR SLAB TYPE AND REINFORCEMENT.
6. SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
7. CONTRACTOR TO COORDINATE AND CONFIRM MECHANICAL OPENINGS WITH MEP DRAWINGS AND PURCHASED EQUIPMENT.
8. CONTRACTOR TO COORDINATE AND CONFIRM ELEVATOR OPENING WITH ARCHITECTURAL DRAWINGS AND PURCHASED ELEVATOR.
9. "SW" DENOTES SHEAR WALL.

FRAMING PLAN LEGEND

- INDICATES SLAB ELEVATION RELATIVE TO SEA LEVEL.

1/8" = 1' 0" 0 10' 20' 40' 80'

3/8" = 1' 0" 0 1' 2' 4' 6' 8' 10'

3/4" = 1' 0" 0 6" 1' 2' 3' 4' 5'

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
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NORTH CAROLINA SEAL 028371 ENGINEER 10-29-25

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

FIRST FLOOR FRAMING PLAN - SOUTHEAST WING

S-125 C

FRAMING PLAN NOTES:

1. TOP OF SLAB ELEVATION ARE DENOTED AS [=X'-X"]. ON 'SECOND FLOOR SLAB REINFORCEMENT PLAN- TOUCH & SHARK TANK' ON SHEET S-131 B. ALL ELEVATIONS ARE REFERENCED FROM SEA LEVEL DATUM, UON. TOP OF CONCRETE BEAM TO MATCH WITH TOP OF SLAB, UON.
2. REFER TO COLUMN SCHEDULE ON SHEET S-600 FOR COLUMN SIZE AND REINFORCEMENT.
3. CB XXX INDICATES CONCRETE BEAM. REFER TO SHEETS S-601 AND S-602 FOR CONCRETE BEAM SCHEDULE.
4. FOR GENERAL NOTES, ABBREVIATIONS, AND STRUCTURAL LEGEND, SEE SHEETS S-001, S-010, AND S-020.
5. REFER TO SLAB REINFORCEMENT PLANS ON SHEET S-131 B FOR SLAB TYPE AND REINFORCEMENT.
6. SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
7. CONTRACTOR COORDINATE AND CONFIRM MECHANICAL OPENINGS WITH MEP DRAWINGS AND PURCHASED EQUIPMENT.
8. CONTRACTOR COORDINATE AND CONFIRM ELEVATOR OPENING WITH ARCHITECTURAL DRAWINGS AND PURCHASED ELEVATOR.
9. W# DENOTES CONCRETE WALL. REFER SHEET S-602 FOR WALL SCHEDULE
10. VERIFY EXISTING FLOOR LEVELS IN FIELD. COORDINATE ARCHITECTURAL AND STRUCTURAL DRAWINGS, AND FINIHSED FLOOR HEIGHTS AS REQUIRED.
11. REFER TO SHEET S-132 B FOR SECOND FLOOR TOUCH TANK LAYOUT.
12. REFER TO OTHER TRADE DRAWINGS FOR MORE INFORMATION ON ACRYLIC PANELS AND NOTCHES AT THE CONCRETE WALLS.

FRAMING PLAN LEGEND

INDICATES SLAB ELEVATION RELATIVE TO SEA LEVEL.

1/8" = 1' 0" 0 10' 20' 40' 80'

1 S-130 B 2ND FLOOR FRAMING PLAN_TOUCH & SHARK TANK
SCALE: 1/8" = 1'-0"

KEY PLAN

PLAN LEGEND
RENOVATION
EXISTING BUILDING

OPEN

12" THICK SLAB WITH FLOWABLE FILL. REFER TO SHEET S-404 FOR MORE INFORMATION

8" THICK CMU WALL WITH #5 AT 24" OC VERTICAL RE-BARS, TYP

CONCRETE HOUSEKEEPING PADS WITH VARYING THICKNESSES. REFER TO OTHER DISCIPLINES (MECH., TJP, AND ROTO) FOR SIZE, THICKNESS, AND LOCATION, TYP. REFER TO DETAIL 11 / S-300

CONCRETE CURB SEE DETAIL 1 / S-310

SEE SHEET S-206 B FOR ENLARGED SKIMMER PLANS & DETAILS

EXISTING COLUMN

RAMP DOWN

EXISTING 12" ELEV SLAB

REFER TO ARCH FOR LOCATION

CONCRETE CURB SEE DETAIL 1 / S-310

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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NORTH CAROLINA SEAL 028371 ENGINEER KAITLIN L. HERRING 10-29-25

NOT FOR CONSTRUCTION

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SECOND FLOOR FRAMING PLAN - TOUCH & SHARK TANK

S-130 B

FRAMING PLAN NOTES:

1. TOP OF SLAB ELEVATION ARE DENOTED AS [=X'-X"], ON 'REINFORCEMENT PLAN UNDER SHALLOW TANKS AT SHARK TANK' ON SHEET S-141 B. ALL ELEVATIONS ARE REFERENCED FROM SEA LEVEL DATUM, UON. TOP OF CONCRETE BEAM TO MATCH WITH TOP OF SLAB, UON.
2. REFER TO COLUMN SCHEDULE ON SHEET S-600 FOR COLUMN SIZE AND REINFORCEMENT.
3. CB XXX" INDICATES CONCRETE BEAM. REFER TO SHEETS S-601 AND S-602 FOR CONCRETE BEAM SCHEDULE.
4. FOR GENERAL NOTES, ABBREVIATIONS, AND STRUCTURAL LEGEND, SEE SHEETS S-001 , S-010, AND S-020.
5. REFER TO SLAB REINFORCEMENT PLANS ON SHEET S-141 B FOR SLAB TYPE AND REINFORCEMENT.
6. SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
7. CONTRACTOR TO COORDINATE AND CONFIRM MECHANICAL OPENINGS WITH MEP DRAWINGS AND PURCHASED EQUIPMENT.
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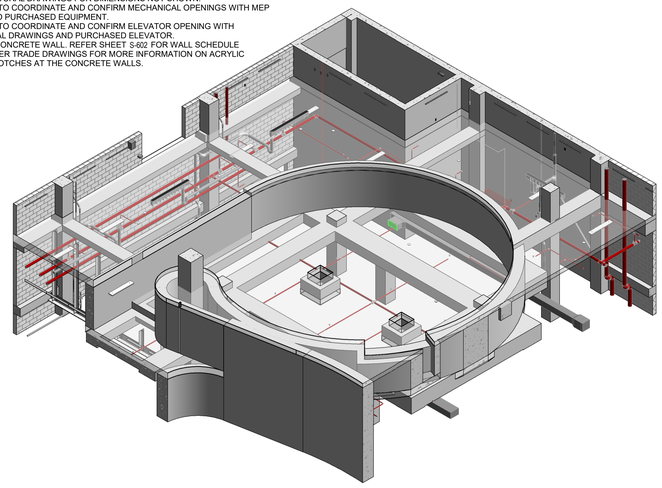
FRAMING PLAN LEGEND

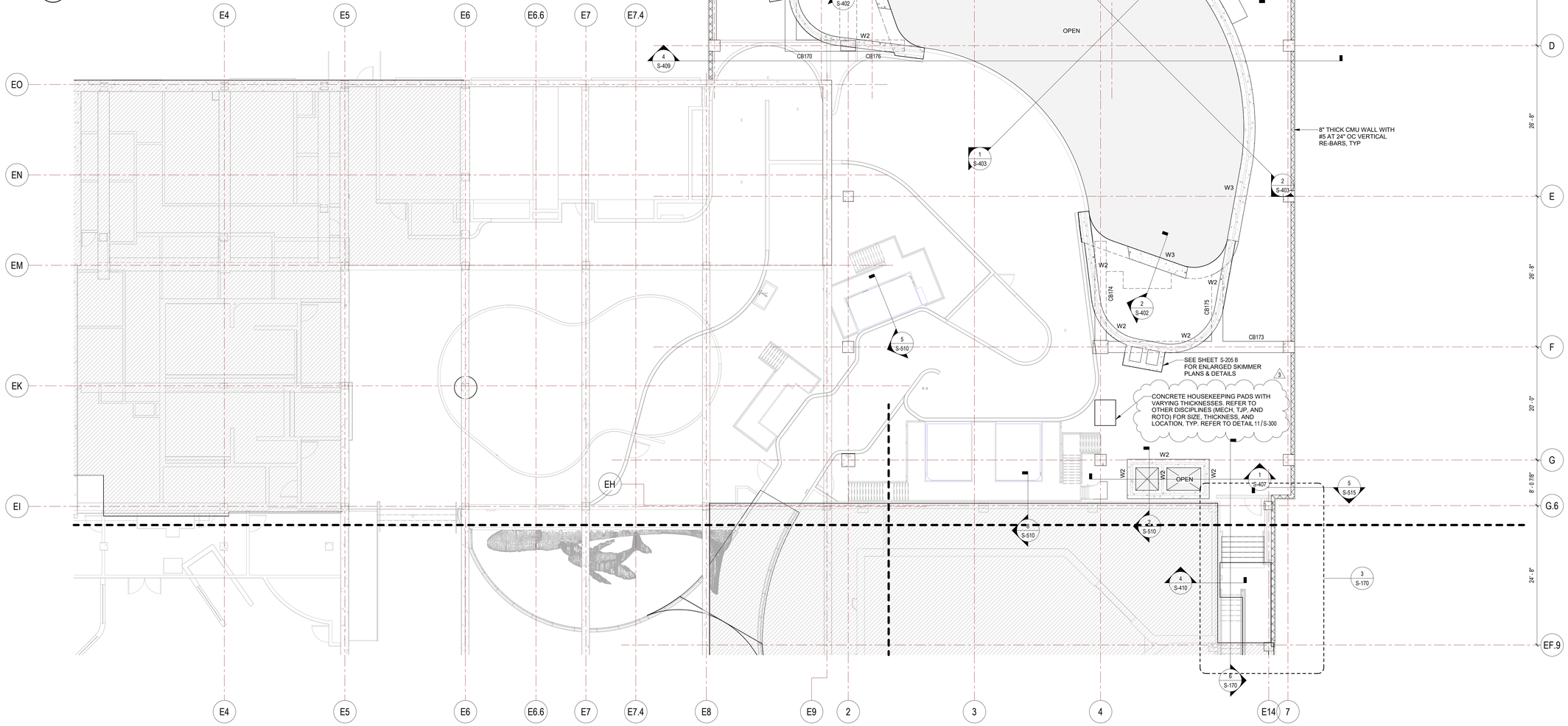
INDICATES SLAB ELEVATION RELATIVE TO SEA LEVEL.

1 BOTTOM SUMP WITH GRATE - REFER TO "LIFE SUPPORT" DRAWINGS FOR MORE INFORMATION



NOTES:
1. ISOMETRIC VIEW SHOWN FOR REFERENCE ONLY AND MAY NOT INCLUDE ALL STRUCTURAL SCOPE. SEE OTHER DETAILS FOR ADDITIONAL INFORMATION.

2 / S-140 B **ISO VIEW - FRAMING UNDER SHALLOW TANK AT SHARK TANK**
SCALE:



1 / S-140 B **FRAMING PLAN UNDER SHALLOW TANKS AT SHARK TANK**
SCALE: 1/8" = 1'-0"

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
CODE: 42014-4G02
ITEM: 41414-4Y4A

900 LOGGERHEAD RD,
KURE BEACH, NC 28449

NORTH CAROLINA DEPT. OF NATURAL & CULTURAL RESOURCES

SZOSTAK DESIGN, INC.
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TJP ENGINEERING, INC.
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ROTO GROUP, LLC.
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LICENSE # C-098

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NOTE: IF THIS DRAWING IS NOT 30" X 42", IT IS A REDUCED PRINT. REFER TO GRAPHIC SCALE.

NORTH CAROLINA REGISTERED SEAL 028371 ENGINEER 10-29-25 PAUL J. IPERIS

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

FRAMING PLAN UNDER SHALLOW TANKS AT SHARK TANK

S-140 B

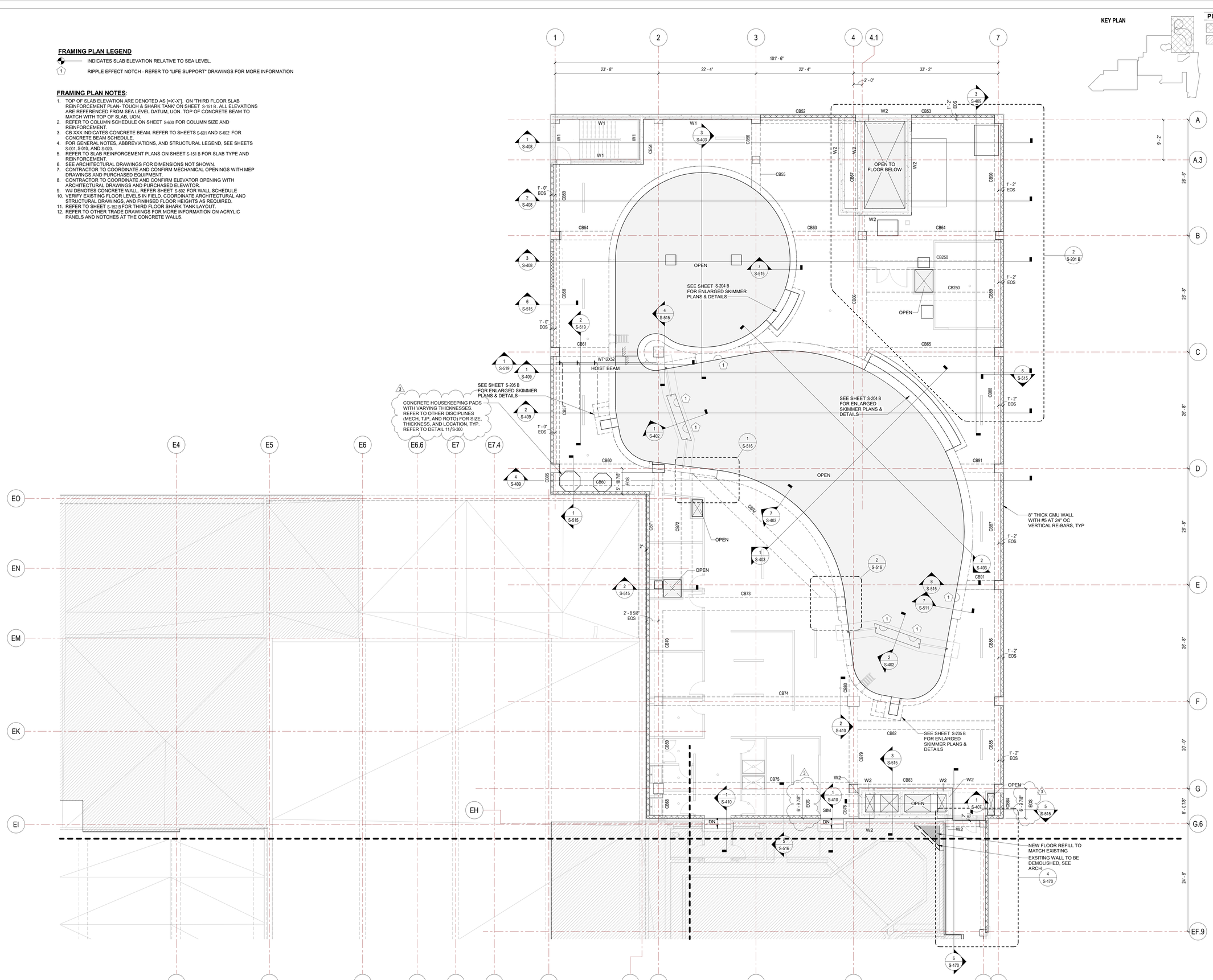
FRAMING PLAN LEGEND

INDICATES SLAB ELEVATION RELATIVE TO SEA LEVEL.

RIPPLE EFFECT NOTCH - REFER TO "LIFE SUPPORT" DRAWINGS FOR MORE INFORMATION

FRAMING PLAN NOTES:

1. TOP OF SLAB ELEVATION ARE DENOTED AS [=X'-X"]. ON 'THIRD FLOOR SLAB REINFORCEMENT PLAN- TOUCH & SHARK TANK' ON SHEET S-151 B. ALL ELEVATIONS ARE REFERENCED FROM SEA LEVEL DATUM, UON. TOP OF CONCRETE BEAM TO MATCH WITH TOP OF SLAB, UON.
2. REFER TO COLUMN SCHEDULE ON SHEET S-600 FOR COLUMN SIZE AND REINFORCEMENT.
3. CB XXX INDICATES CONCRETE BEAM. REFER TO SHEETS S-601 AND S-602 FOR CONCRETE BEAM SCHEDULE.
4. FOR GENERAL NOTES, ABBREVIATIONS, AND STRUCTURAL LEGEND, SEE SHEETS S-001, S-010, AND S-020.
5. REFER TO SLAB REINFORCEMENT PLANS ON SHEET S-151 B FOR SLAB TYPE AND REINFORCEMENT.
6. SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
7. CONTRACTOR TO COORDINATE AND CONFIRM MECHANICAL OPENINGS WITH MEP DRAWINGS AND PURCHASED EQUIPMENT.
8. CONTRACTOR TO COORDINATE AND CONFIRM ELEVATOR OPENING WITH ARCHITECTURAL DRAWINGS AND PURCHASED ELEVATOR.
9. W# DENOTES CONCRETE WALL. REFER SHEET S-602 FOR WALL SCHEDULE
10. VERIFY EXISTING FLOOR LEVELS IN FIELD. COORDINATE ARCHITECTURAL AND STRUCTURAL DRAWINGS, AND FINIHSED FLOOR HEIGHTS AS REQUIRED.
11. REFER TO SHEET S-152 B FOR THIRD FLOOR SHARK TANK LAYOUT.
12. REFER TO OTHER TRADE DRAWINGS FOR MORE INFORMATION ON ACRYLIC PANELS AND NOTCHES AT THE CONCRETE WALLS.



1/8" = 1' 0" 0 10' 20' 40' 80'

1 S-150 B THIRD FLOOR FRAMING PLAN - TOUCH & SHARK TANK
SCALE: 1/8" = 1'-0"

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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WWW.SURFACE678.COM
LICENSE # C-098

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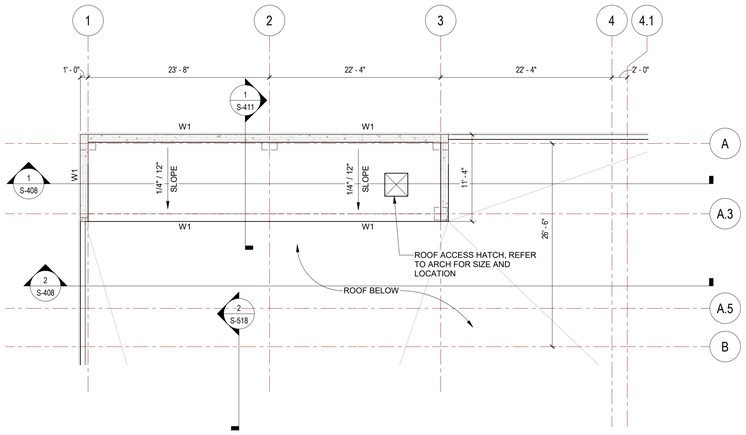
NORTH CAROLINA REGISTERED PROFESSIONAL SEAL 028371 ENGINEER WAYNE L. PERRITT 10-29-25

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

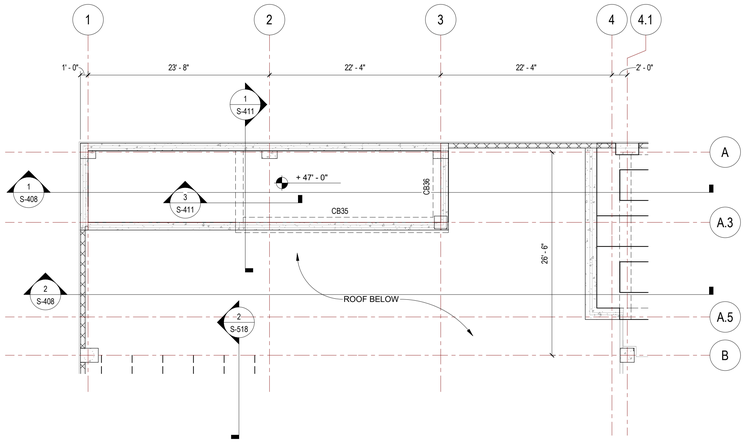
THIRD FLOOR FRAMING PLAN - TOUCH & SHARK TANK

S-150 B



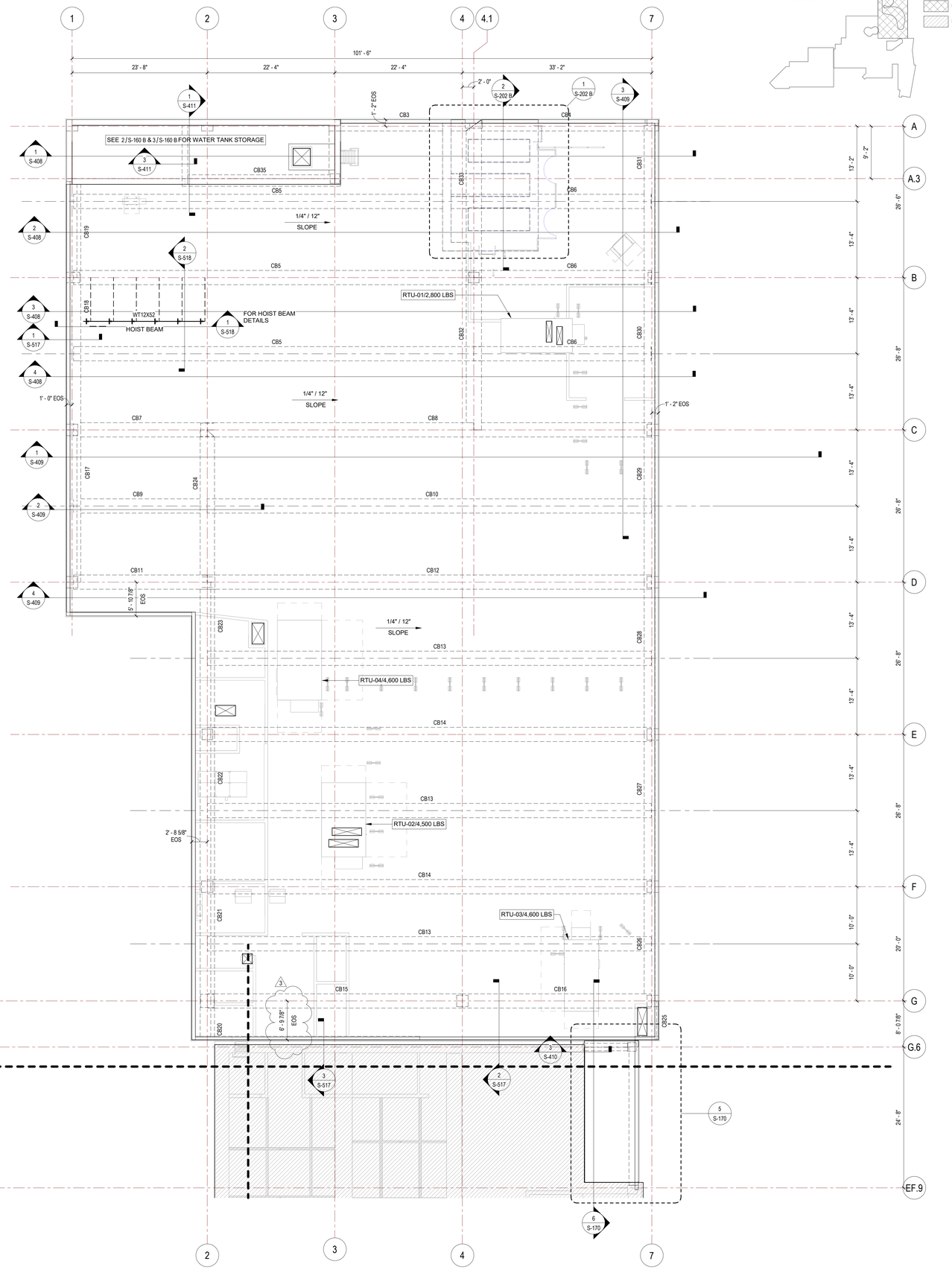
2 / S-160 B **TOP OF WATER TANK**

SCALE: 1/8" = 1'-0"



3 / S-160 B **BOTTOM OF WATER TANK**

SCALE: 1/8" = 1'-0"



FRAMING PLAN NOTES:

1. TOP OF SLAB ELEVATION ARE DENOTED AS [=X'-X"] ON 'ROOF REINFORCEMENT PLAN- TOUCH & SHARK TANK' ON SHEET S-161 B. ALL ELEVATIONS ARE REFERENCED FROM SEA LEVEL DATUM, UON. TOP OF CONCRETE BEAM TO MATCH WITH TOP OF SLAB, UON.
2. REFER TO COLUMN SCHEDULE ON SHEET S-600 FOR COLUMN SIZE AND REINFORCEMENT.
3. CB XXX INDICATES CONCRETE BEAM. REFER TO SHEETS S-601 AND S-602 FOR CONCRETE BEAM SCHEDULE.
4. FOR GENERAL NOTES, ABBREVIATIONS, AND STRUCTURAL LEGEND, SEE SHEETS S-001, S-010, AND S-020.
5. REFER TO SLAB REINFORCEMENT PLANS ON SHEET S-161 B FOR SLAB TYPE AND REINFORCEMENT.
6. SEE ARCHITECTURAL DRAWINGS FOR DIMENSIONS NOT SHOWN.
7. CONTRACTOR COORDINATE AND CONFIRM MECHANICAL OPENINGS WITH MEP DRAWINGS AND PURCHASED EQUIPMENT.
8. CONTRACTOR COORDINATE AND CONFIRM ELEVATOR OPENING WITH ARCHITECTURAL DRAWINGS AND PURCHASED ELEVATOR.
9. W# DENOTES CONCRETE WALL. REFER SHEET S-602 FOR WALL SCHEDULE
10. VERIFY EXISTING FLOOR LEVELS IN FIELD. COORDINATE ARCHITECTURAL AND STRUCTURAL DRAWINGS, AND FINIHSED FLOOR HEIGHTS AS REQUIRED.

FRAMING PLAN LEGEND

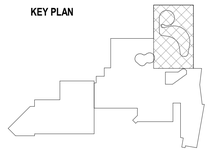
INDICATES SLAB ELEVATION RELATIVE TO SEA LEVEL.

1/8" = 1' 0" 0 10' 20' 40' 80'

1 / S-160 B **ROOF FRAMING PLAN - TOUCH & SHARK TANK**

SCALE: 1/8" = 1'-0"

KEY PLAN



PLAN LEGEND

RENOVATION

EXISTING BUILDING

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
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LICENSE # P-1105

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LICENSE # P-3152

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LICENSE # C-098

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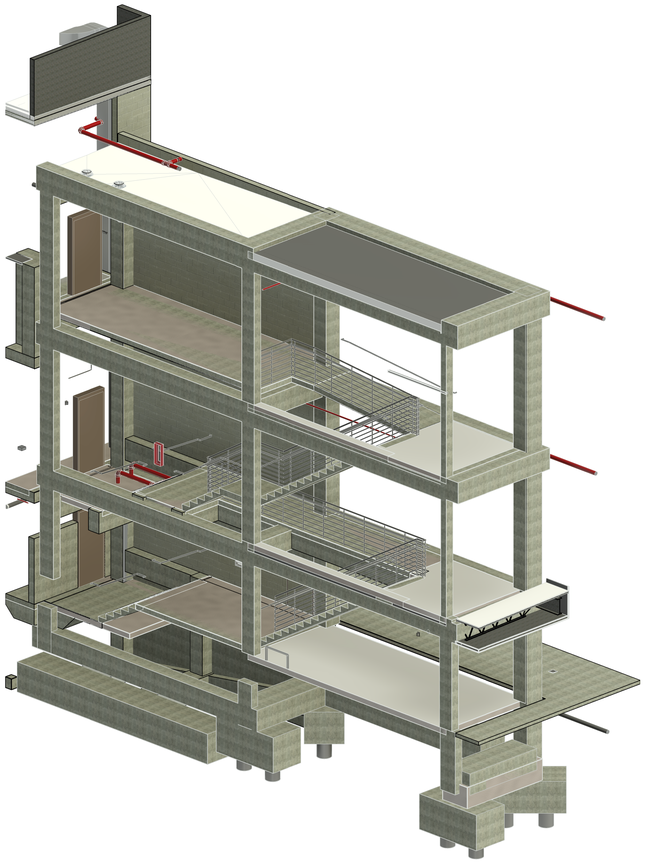
NORTH CAROLINA SEAL 028371 10-29-25 ENGINEER PAUL L. PERKINS

NOT FOR CONSTRUCTION

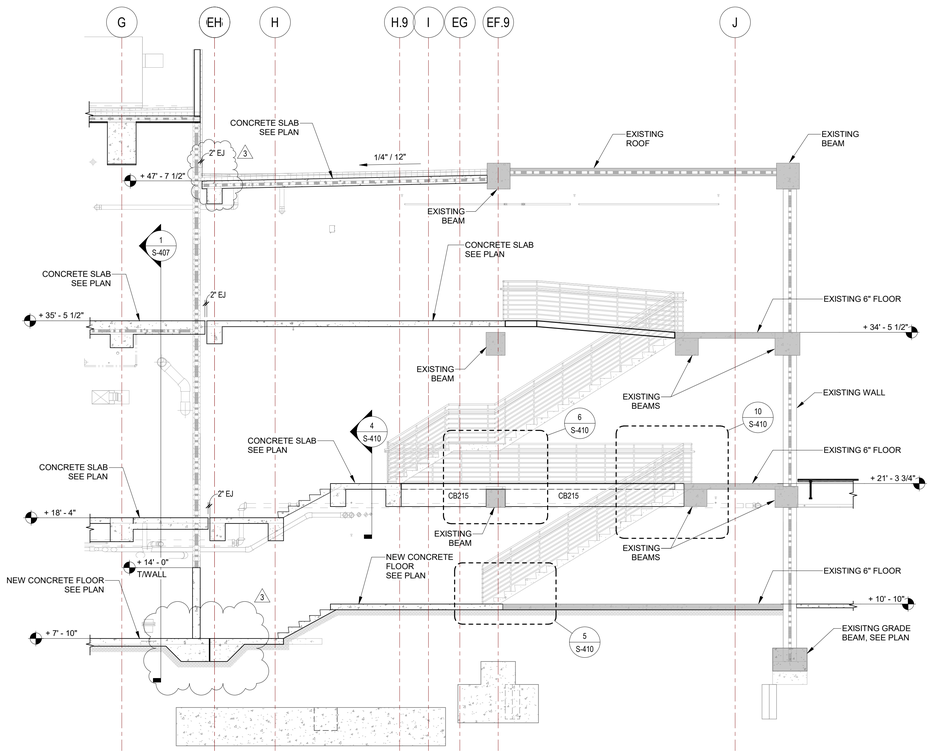
NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

ROOF FRAMING PLAN - TOUCH & SHARK TANK

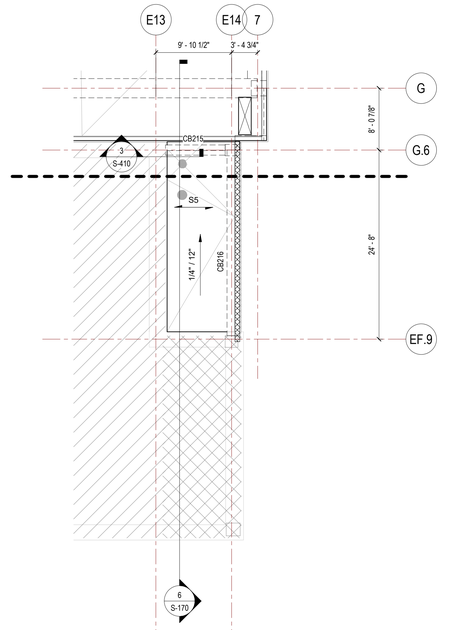
S-160 B



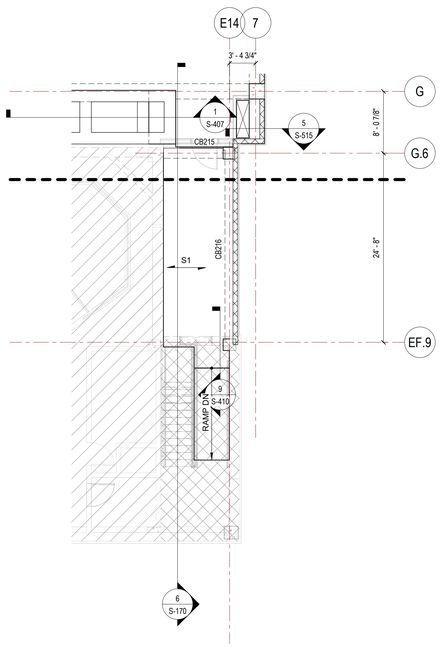
A S-170 **CONNECTOR AREA ISO**
SCALE:



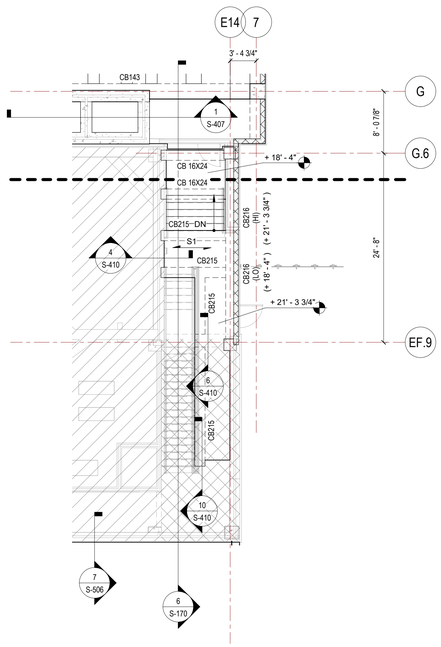
6 S-170 **SECTION IN CONNECTOR AREA**
SCALE: 3/16" = 1'-0"



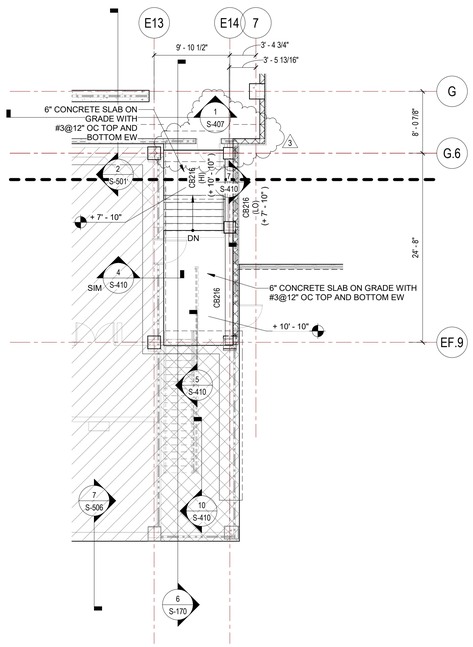
5 S-170 **ROOF FRAMING PLAN - EDUCATION WING**
SCALE: 1/8" = 1'-0"



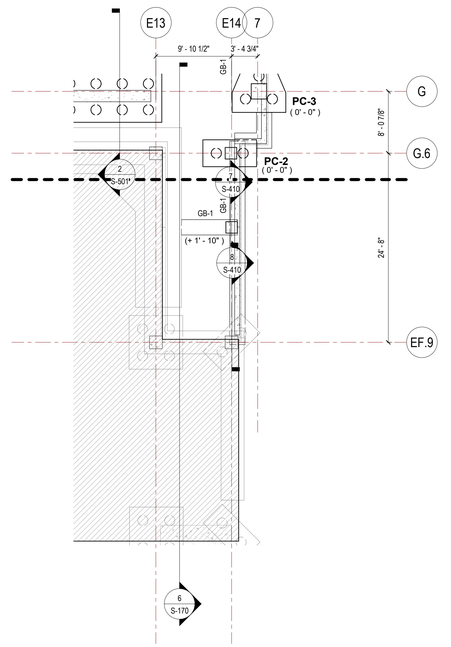
4 S-170 **THIRD FLOOR FRAMING PLAN - TOUCH & SHARK TANK**
SCALE: 1/8" = 1'-0"



3 S-170 **SECOND FLOOR FRAMING PLAN - TOUCH & SHARK TANK**
SCALE: 1/8" = 1'-0"



2 S-170 **FIRST FLOOR FRAMING PLAN - TOUCH & SHARK TANK**
SCALE: 1/8" = 1'-0"



1 S-170 **FOUNDATION PLAN - TOUCH & SHARK TANK**
SCALE: 1/8" = 1'-0"

1/8" = 1' 0" 0 10' 20' 40' 80'

3/16" = 1' 0" 0 1' 4' 8' 12' 16' 20'

PLAN LEGEND
RENOVATION
EXISTING BUILDING

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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NORTH CAROLINA REGISTERED SEAL 028371 10-29-25 ENGINEER KARL L. PERRIN

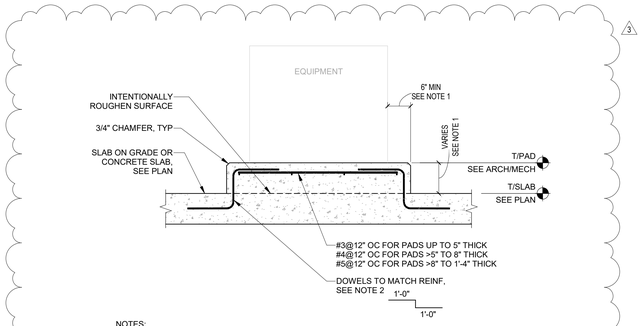
NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

FRAMING PLAN - CONNECTOR AREA

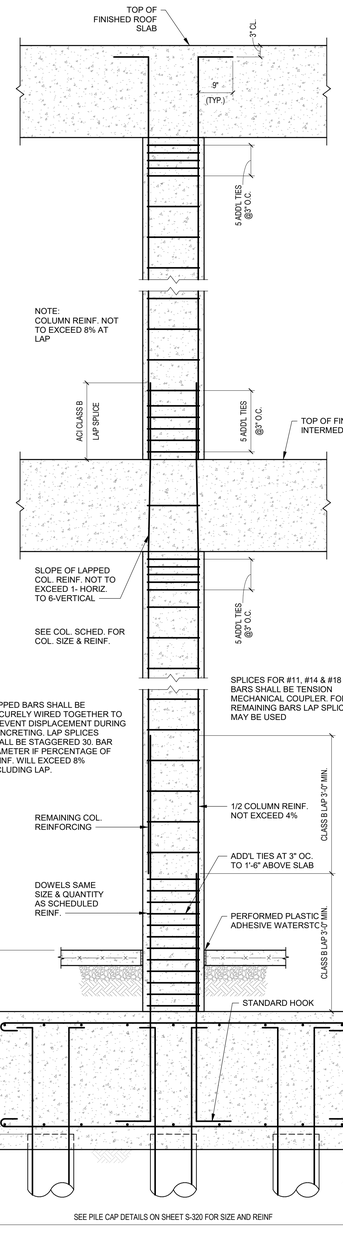
S-170

COLUMN FOOTING SCHEDULE				
MARK	SIZE	DEPTH	REINFORCING	REMARKS
F4	4' - 0" x 4' - 0"	1' - 8"	(5)#5 EW T&B	
F5	5' - 0" x 5' - 0"	1' - 8"	(6)#5 EW T&B	

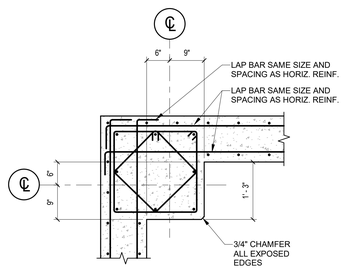


NOTES:
1. CONTRACTOR COORDINATE EQUIPMENT PAD SIZE WITH PURCHASED EQUIPMENT AND REQUIRED CONNECTIONS. CONTRACTOR PROVIDE CONNECTIONS TO PAD PER EQUIPMENT VENDOR.
2. AT CONTRACTOR OPTION, DOWELS MAY BE POST-INSTALLED INTO SLAB. FOR POST-INSTALLED CONDITION, DRILL AND SET VERTICAL PORTION OF DOWEL INTO ADHESIVE WITH 4" EMBED INTO SLAB ON GRADE OR 3" EMBED INTO CONCRETE SLAB. HORIZONTAL PORTION OF DOWEL MAY BE OMITTED FROM BASE SLAB FOR POST-INSTALLED CONDITION.

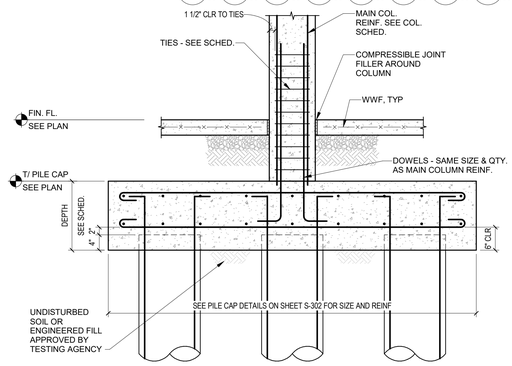
11 / S-300 TYPICAL HOUSEKEEPING PAD
SCALE: 3/4" = 1'-0"



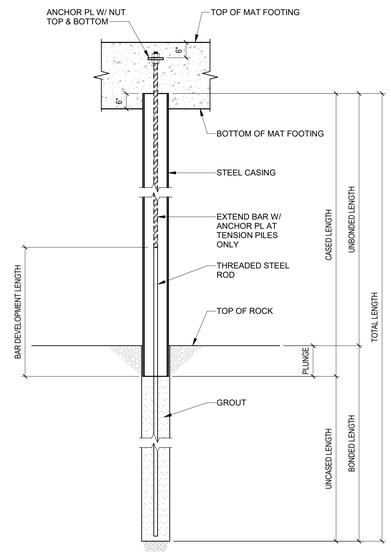
1 / S-300 TYPICAL COLUMN FOOTING
SCALE: 3/4" = 1'-0"



2 / S-300 PILASTER PLAN
SCALE: 3/4" = 1'-0"

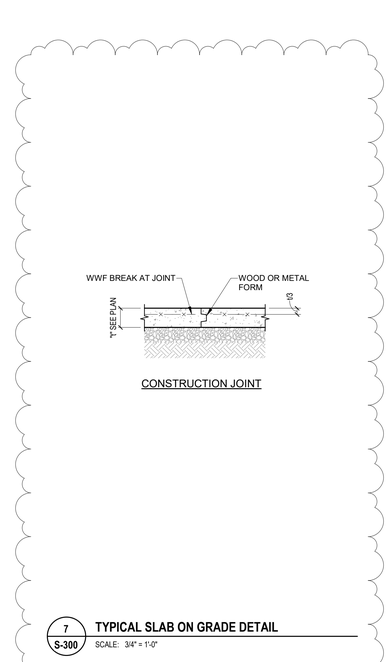


3 / S-300 PILE CAP AT COLUMN
SCALE: 3/4" = 1'-0"



NOTE: REFER TO MICROPILES (AT TOUCH TANK) NOTES ON SHEET S-001

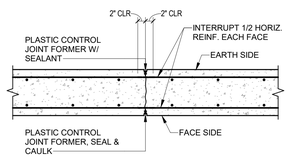
6 / S-300 MICROPILE DETAIL
SCALE: 1/2" = 1'-0"



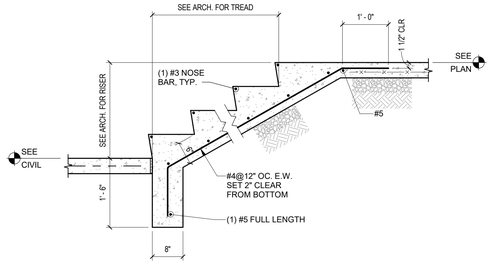
CONSTRUCTION JOINT

7 / S-300 TYPICAL SLAB ON GRADE DETAIL
SCALE: 3/4" = 1'-0"

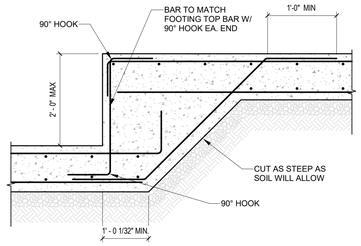
10 / S-300 WALL CONSTRUCTION JOINT DETAIL AT TANK WALL
SCALE: 3/4" = 1'-0"



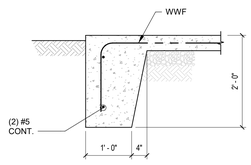
9 / S-300 WALL CONTROL JOINT
SCALE: 3/4" = 1'-0"



8 / S-300 TYPICAL STAIR
SCALE: 3/4" = 1'-0"



5 / S-300 STEPPED FOOTING DETAIL A
SCALE: 3/4" = 1'-0"



4 / S-300 TYPICAL LUG FOOTING
SCALE: 3/4" = 1'-0"

3/4" = 1' 0" 0 6" 1' 2' 3' 4' 5'

1/2" = 1' 0" 0 6" 1' 2' 3' 4' 5' 6'

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

SCO #17-18042-02A
CODE: 42014-4G02
ITEM: 41414-4Y4A

900 LOGGERHEAD RD,
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1	9-8-25	BID SET
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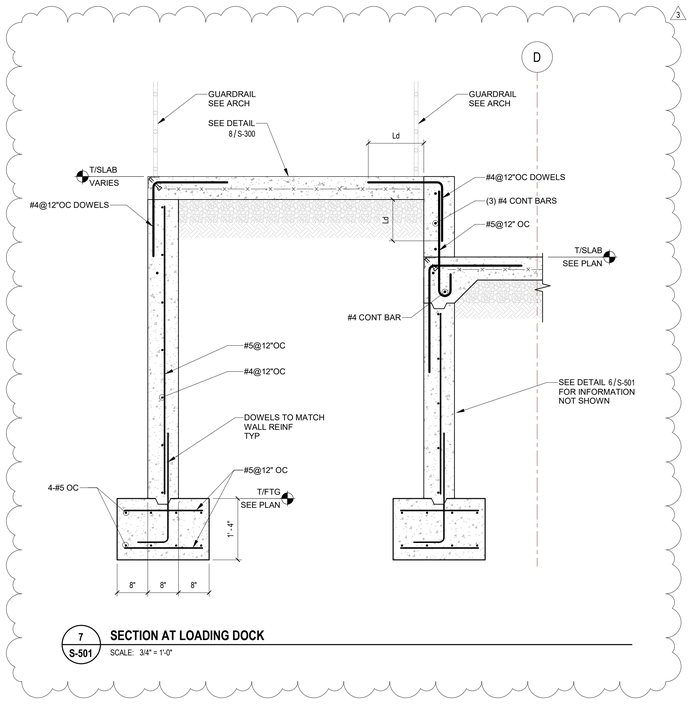
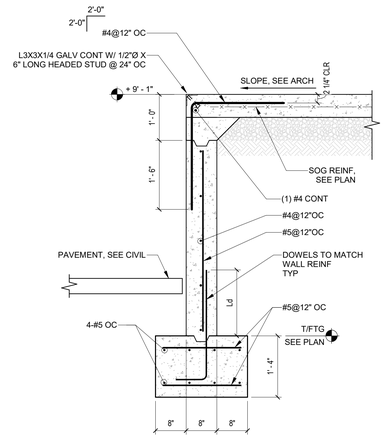
TYPICAL FOUNDATION DETAILS

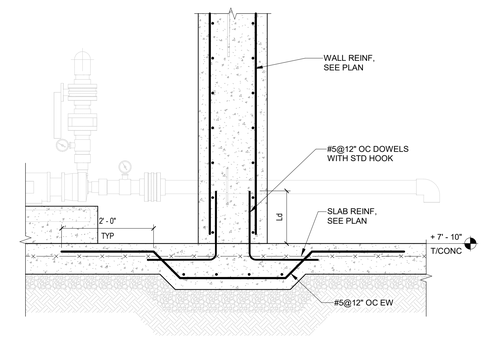
S-300



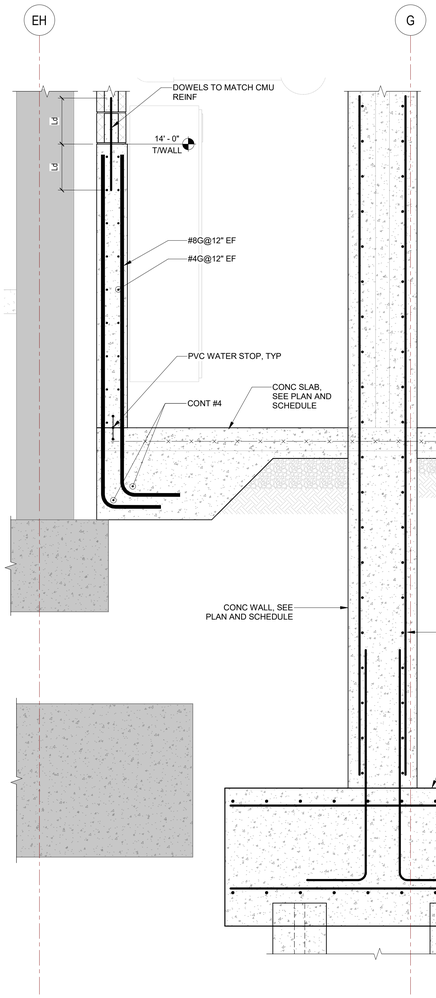
7 **SECTION AT LOADING DOCK**
S-501 SCALE: 3/4" = 1'-0"

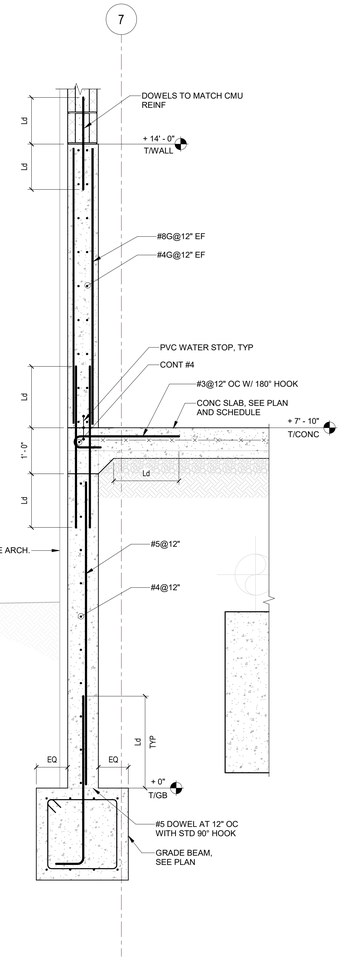


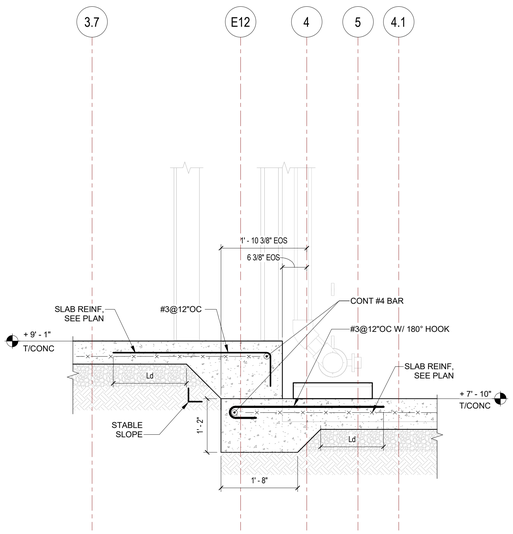
6 **SECTION AT LOADING DOCK**
S-501 SCALE: 3/4" = 1'-0"



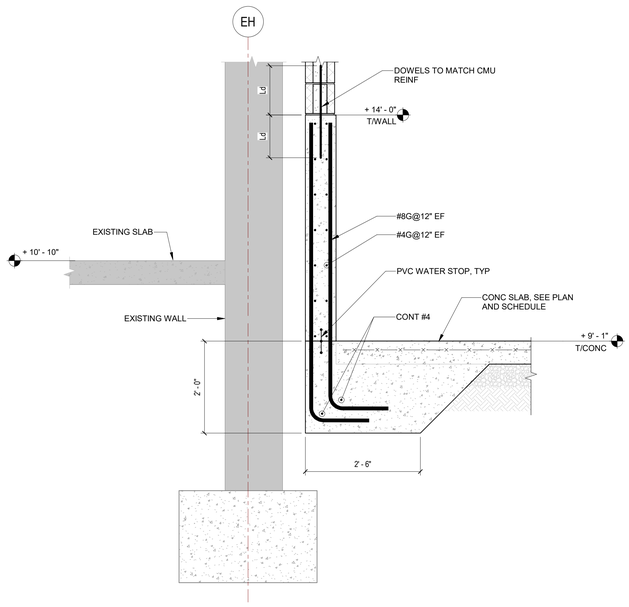
5 **SECTION**
S-501 SCALE: 3/4" = 1'-0"







4 **SECTION**
S-501 SCALE: 3/4" = 1'-0"



3 **SECTION**
S-501 SCALE: 3/4" = 1'-0"

3/4" = 1' 0" 0 6" 1' 2' 3' 4' 5'

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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LICENSE # C-098

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NORTH CAROLINA SEAL 028371 ENGINEER MARK L. PERKINS 10-29-25

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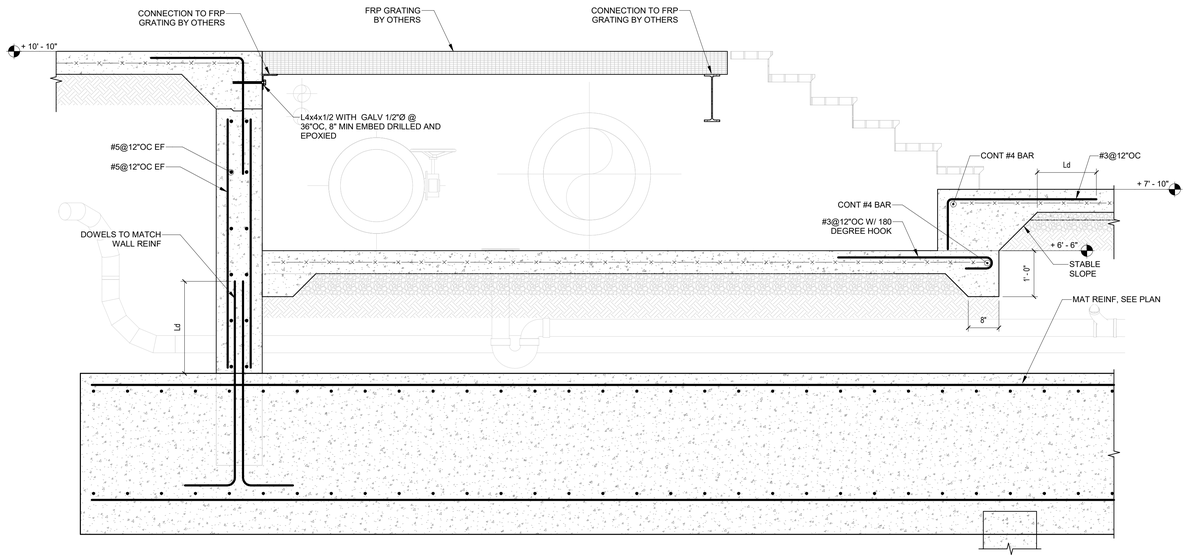
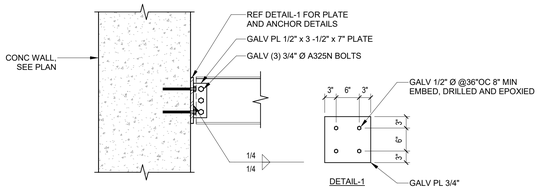
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

FIRST FLOOR SECTIONS

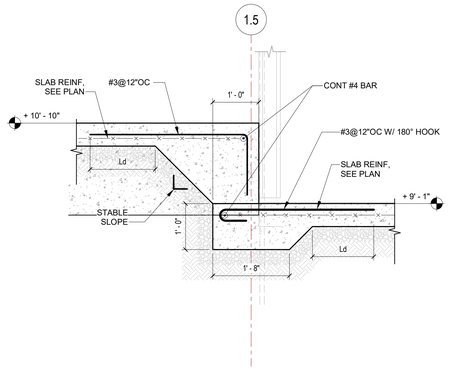
S-501



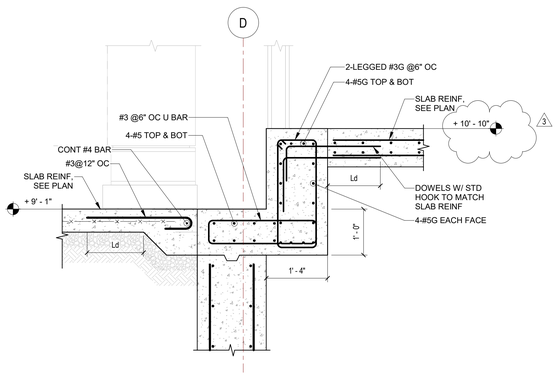
5 **SECTION** S-502
SCALE: 3/4" = 1'-0"



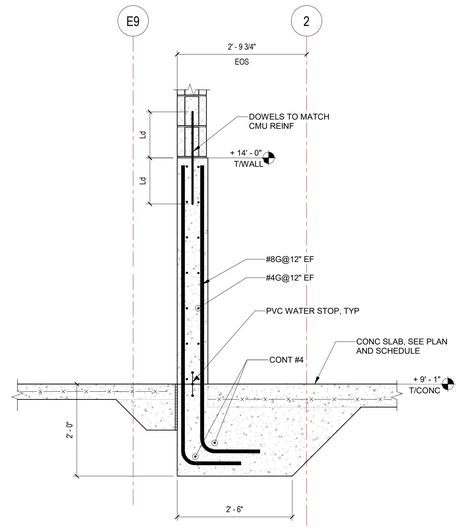
6 **TYPICAL STEEL TO CONCRETE CONNECTION** S-502
SCALE: 3/4" = 1'-0"



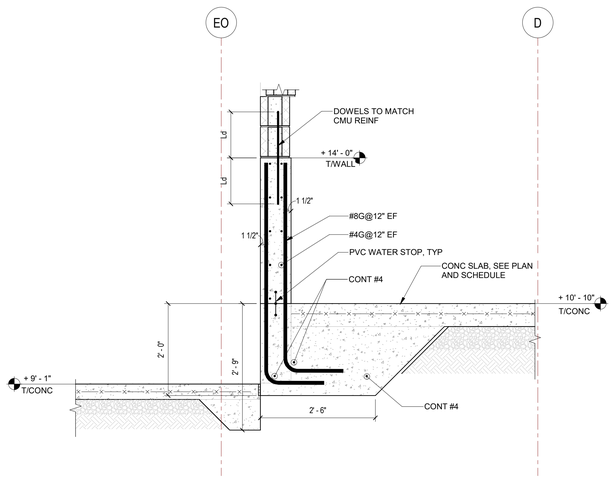
4 **SECTION** S-502
SCALE: 3/4" = 1'-0"



3 **SECTION** S-502
SCALE: 3/4" = 1'-0"



2 **SECTION** S-502
SCALE: 3/4" = 1'-0"



1 **SECTION** S-502
SCALE: 3/4" = 1'-0"

3/4" = 1' 0" 0 6" 1' 2' 3' 4' 5'

SZOSTAK DESIGN

FORT FISHER AQUARIUM RENOVATION & EXPANSION: PHASE 1

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NORTH CAROLINA SEAL 028371 ENGINEER WILLIAM L. PERKINS 10-29-25

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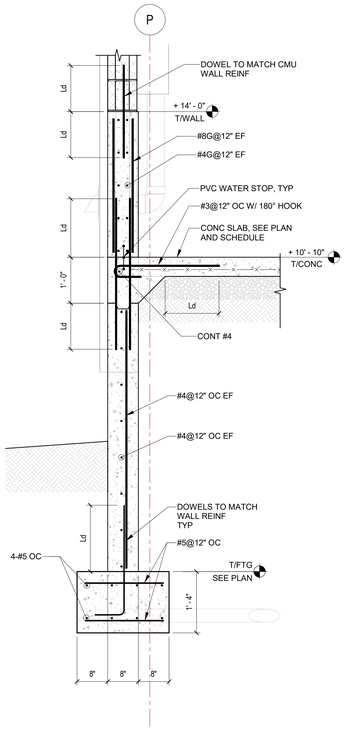
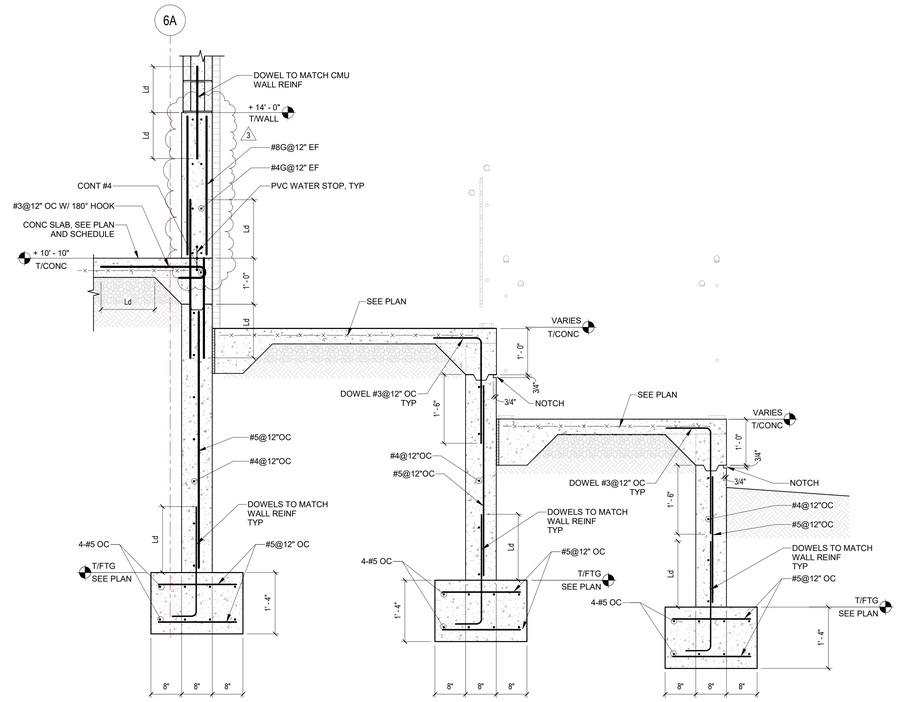
FIRST FLOOR SECTIONS

S-502



NOTES:
1. RETAINING WALLS TO BE FULLY BRACED UNTIL SLAB ON GRADE CONCRETE ACHIEVES SPECIFIED STRENGTH.
2. REFER GEOTECH SPECIFICATIONS FOR BACKFILL AND COMPACTION.
3. CONCRETE WALLS ARE DESIGNED FOR BALANCED FILL CONDITION.

5 / S-503 **SECTION**
SCALE: 3/4" = 1'-0"



NOTES:
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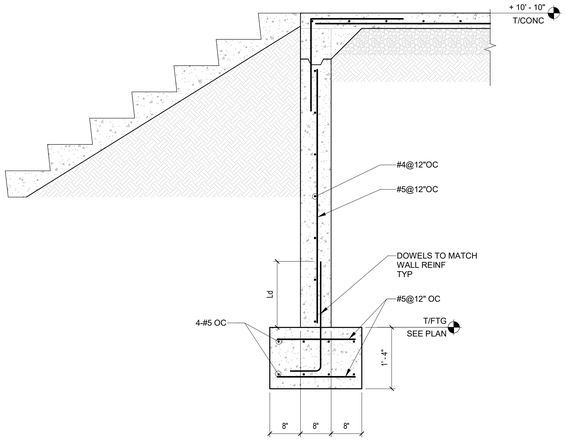
4 / S-503 **SECTION**
SCALE: 3/4" = 1'-0"



NOTES:
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2. REFER GEOTECH SPECIFICATIONS FOR BACKFILL AND COMPACTION.
3. CONCRETE WALLS ARE DESIGNED FOR BALANCED FILL CONDITION.

3 / S-503 **SECTION**
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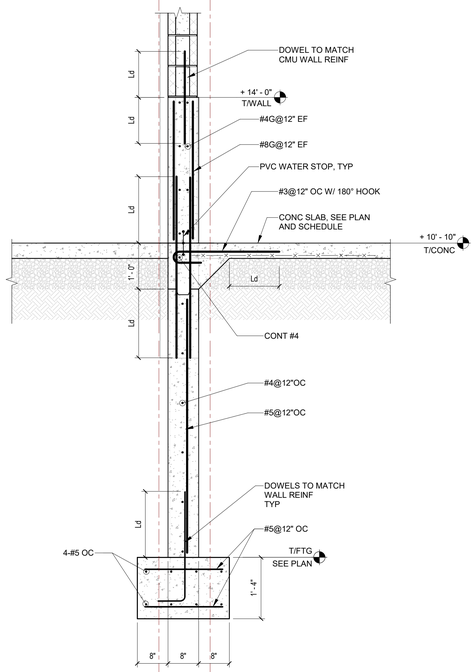

NOTES:
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2 / S-503 **SECTION**
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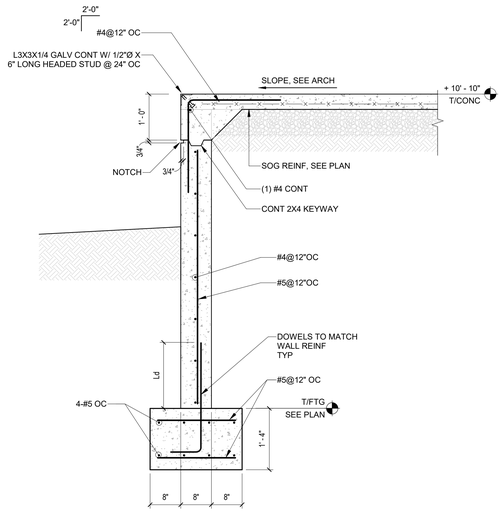

NOTES:
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2. REFER GEOTECH SPECIFICATIONS FOR BACKFILL AND COMPACTION.
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1 / S-503 **SECTION**
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3/4" = 1' 0" 0 6" 1' 2' 3' 4' 5'

SZOSTAK DESIGN

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FAX: 919.960.7947
WWW.SZOSTAKDESIGN.COM
LICENSE # 51679

TJP ENGINEERING, INC.
LIFE SUPPORT SYSTEMS ENGINEER
56880 VENTURE LANE SUITE 2004
BEND, OR 97707
TELE: 619.423.8705
WWW.TJPENGINEERING.COM
LICENSE # C-3505

ROTO GROUP, LLC.
EXHIBIT DESIGNER
7001 DISCOVERY BOULEVARD
DUBLIN, OHIO 43017
TELE: 617.765.8690
WWW.ROTO.COM

BENNETT & PLESS
STRUCTURAL ENGINEER
5430 WADE PARK BOULEVARD SUITE 400
RALEIGH, NC 27607
TELE: 919.832.5587
WWW.BENNETT-PLESS.COM
LICENSE # P-1105

CBHF ENGINEERS, PLLC
MEP ENGINEER
2246 TAUPON DRIVE
WILMINGTON, NC 28401
TELE: 910.791.4000
FAX: 910.791.5266
WWW.CBHFENGINEERS.COM
LICENSE # P-0806

LIGHTSWITCH
LIGHTING DESIGNER
10265 INDIANA COURT
RANCHO CUCAMONGA, CA 91730
TELE: 909.360.2900
WWW.LIGHTSWITCH.NET

TUNSTALL CONSULTING ENGINEERS PLLC
CIVIL ENGINEER
2602 IRON GATE DRIVE SUITE 102
WILMINGTON, NC 28412
TELE: 910.343.9653
FAX: 910.343.9604
WWW.MTEHGINEERS.COM
LICENSE # P-3152

SURFACE 678, PA
LANDSCAPE ARCHITECT
215 MORRIS STREET SUITE 150
DURHAM, NC 27701
TELE: 919.419.1199
FAX: 919.419.1669
WWW.SURFACE678.COM
LICENSE # C-098

CHEATHAM & ASSOCIATES, PA
FIRE PROTECTION ENGINEER
3412 ENTERPRISE DRIVE
WILMINGTON, NC 28405
TELE: 910.452.4210
WWW.CHEATHAMPA.COM
LICENSE # C-1075

PALACIO COLLABORATIVE
COST ESTIMATOR
4819 EMPEROR BOULEVARD SUITE 400
DURHAM, NC 27703
TELE: 919.605.8910
WWW.PALACIOCOLLABORATIVE.COM

NOTE: IF THIS DRAWING IS NOT 30" X 42", IT IS A REDUCED PRINT. REFER TO GRAPHIC SCALE.

NORTH CAROLINA REGISTERED SEAL 028371 10-29-25 ENGINEER WALTER L. PERKINS

NOT FOR CONSTRUCTION

NO.	DATE	DESCRIPTION
1	9-8-25	BID SET
2	10-17-25	ADDENDUM #1
3	10-29-25	ADDENDUM #2

SOUTHEAST WING - FIRST FLOOR SECTIONS

S-503