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.

Q. Enclosures: General-purpose NEMA 250, **Type 3R** complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. 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.

C. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

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: 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: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

G. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

H. 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.

I. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

J. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal 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: Two 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: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: 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.
13. 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.

2.3 TRANSFER SWITCH ACESSORIES

A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
    a. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
    b. Transition: Provide **open**-transition operation when transferring between power sources.
    c. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
    d. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

B. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:

    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

b. Switch position.
c. Switch in test mode.
d. Failure of communication link.

4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

a. Indicating Lights: Grouped for each transfer switch monitored.
b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
d. Lamp Test: Push-to-test or lamp-test switch on front panel.

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 **emergency** 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 on the project plans.
2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

3. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Surface mounted on 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.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, 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 and boxes specified in Section 260533 "Raceways and Boxes 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. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

H. Route and brace conductors according to manufacturer's written instructions**.** Do not obscure manufacturer's markings and labels.

I. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

J. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: **Owner will 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 the following tests and inspections **with the assistance of a factory-authorized service representative**:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. 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.
        3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. 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.

4. 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.

5. 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. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. 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.
   g. 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.

6. 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.

D. Coordinate tests with tests of generator and run them concurrently.

E. 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.

F. Transfer switches will be considered defective if they do not pass tests and inspections.

G. Remove and replace malfunctioning units and retest as specified above.

H. Prepare test and inspection reports.

I. Infrared Scanning: After Substantial Completion, 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 Substantial Completion.

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. 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.

C. Coordinate this training with that for generator equipment.

END OF SECTION 263600

PUBLIC UTILITY COMMISSION OF TEXAS
TEXAS BACKUP POWER PACKAGES FOR CRITICAL FACILITIES
100kW

INDEX OF DRAWINGS

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S0.02	STRUCTURAL GENERAL NOTES	0	01/21/2025
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	ELECTRICAL		
E1.01	LEGENDS AND ABBREVIATIONS	0	01/21/2025
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E2.01	ONE LINE DIAGRAM	0	01/21/2025
E2.02	AGGREGATION SWITCHBOARD	0	01/21/2025
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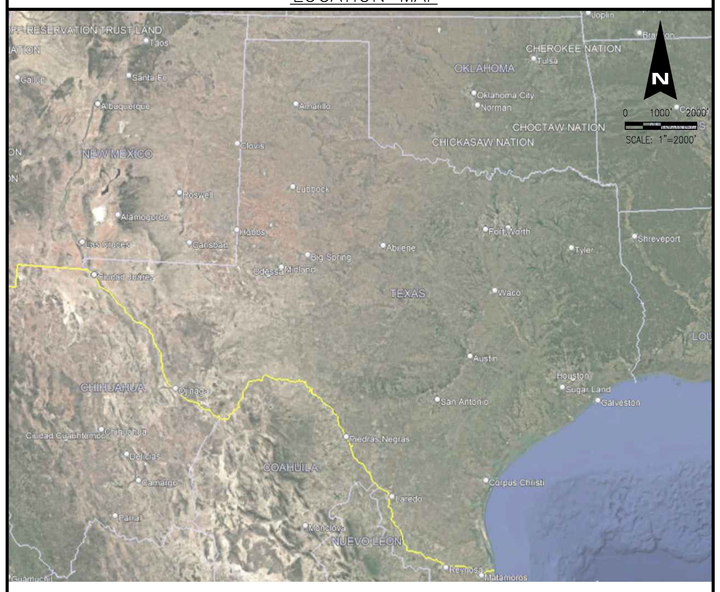
E5.01	GROUNDING PLAN	0	01/21/2025
E5.02	GROUNDING DETAILS	0	01/21/2025
E6.01	ELECTRICAL SIGNAGE	0	01/21/2025

LOCATION MAP



LOCATED IN THE STATE OF TEXAS

NOTIFICATIONS

Texas 811 Know what's below. Call before you dig.

SUMMARY

TEXAS BACKUP POWER PACKAGES (TBPP) ARE TO BE DEVELOPED IN ACCORDANCE WITH PLANS HEREIN. THEY ARE TO BE USED IN ISLAND MODE ONLY TO PROVIDE BACKUP POWER TO CRITICAL FACILITIES IN THE EVENT OF AN ELECTRICAL POWER OUTAGE. THE TBPPs ARE TO BE SUITABLE FOR INSTALLATION THROUGHOUT THE STATE OF TEXAS. THE PLANS HEREIN ARE FOR THE DEVELOPMENT OF THE TBPPS AND ARE NOT SPECIFIC TO ANY PARTICULAR SITE OR LOCATION WITHIN THE STATE OF TEXAS.

FOR STRUCTURAL ONLY

STATE OF TEXAS
CHRISTOPHER WILLIAM ERWIN
140150
LICENSED PROFESSIONAL ENGINEER

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FOR ELECTRICAL ONLY

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PROFESSIONAL DESIGN FIRM
LICENSE NO. 184000409-0014

Owner/Client:

Scale: 1"=2000'

Sheet Size: ARCH D 24"x36"

Designed: AMH

Drawn: LAB

Checked: DJS

Approved: DJS

Rev. No.	Date	Description
A	01/21/2025	ORIGINAL ISSUE

ISSUES & REVISIONS

THE INFORMATION CONTAINED ON THESE DRAWINGS IS FOR USE ON THIS PROJECT ONLY

Project: TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title: TITLE SHEET

Date: 01/21/2025

Proj. No: 22483.005

PROJECT PHASE

XXXX

Sheet No: T0.01

Sheet of

Revision No.: 0

1. GENERAL REQUIREMENTS

A. AS USED IN THESE GENERAL NOTES:
"DRAWINGS" MEANS THE LATEST STRUCTURAL DESIGN DRAWINGS, UON.
"SPECIFICATIONS" MEANS THE LATEST PROJECT SPECIFICATIONS, UON.
"CONTRACT DOCUMENTS" ARE DEFINED AS THE DESIGN DRAWINGS AND THE SPECIFICATIONS
"SER" IS DEFINED AS THE STRUCTURAL ENGINEER OF RECORD FOR THE STRUCTURE IN ITS FINAL CONDITION.
"DESIGN PROFESSIONALS" IS DEFINED AS THE SER.
"OSHA" IS DEFINED AS THE US OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION.
"CONTRACTOR" IS DEFINED TO INCLUDE ANY OF THE FOLLOWING: GENERAL CONTRACTOR AND THEIR SUBCONTRACTORS, CONSTRUCTION MANAGER AND THEIR SUBCONTRACTORS, STRUCTURAL STEEL FABRICATOR OR STRUCTURAL STEEL ERECTOR.
"BASE BUILDING STRUCTURE" IS DEFINED AS THE STRUCTURAL FRAME DESIGNED BY PATRICK ENGINEERING INC.
"STRUCTURE IN ITS FINAL CONDITION" MEANS ALL STRUCTURAL ELEMENTS SHOWN ON THE STRUCTURAL CONTRACT DOCUMENTS ARE INSTALLED AND COMPLETELY CONNECTED AND INSPECTED WITH NO OUTSTANDING NON-COMPLIANCE ISSUES.

B. CONTRACTOR IS RESPONSIBLE FOR COORDINATION OF THE STRUCTURAL WORK WITH THE CIVIL, ELECTRICAL CONTRACT DOCUMENTS, AS WELL AS ANY OTHER APPLICABLE TRADES.

C. CONTRACTOR IS RESPONSIBLE FOR THE STABILITY OF THE STRUCTURE UNTIL THE CONSTRUCTION OF THE STRUCTURE REACHES ITS FINAL CONDITION.

D. CONTRACTOR IS RESPONSIBLE FOR THE DESIGN, INSTALLATION, AND REMOVAL OF TEMPORARY BRACING AND CONSTRUCTION SUPPORTS, FOR NEW AND EXISTING STRUCTURES, AS NECESSARY TO COMPLETE THE PROJECT.

E. CONTRACTOR SHALL VERIFY ALL EXISTING DIMENSIONS AND CONDITIONS AND COORDINATE WITH THE STRUCTURAL DRAWINGS, ELECTRICAL DRAWINGS AND DRAWINGS FROM OTHER CONSULTANTS, PROJECT SHOP DRAWINGS AND FIELD CONDITIONS.

F. IN CASES OF CONFLICT BETWEEN DRAWINGS AND/OR SPECIFICATIONS AND OTHER DISCIPLINES OR EXISTING CONDITIONS, CONTRACTOR SHALL NOTIFY THE DESIGN PROFESSIONALS AND OBTAIN CLARIFICATION PRIOR TO BIDDING AND PROCEEDING WITH WORK.

G. ONLY USE DIMENSIONS INDICATED ON THE DRAWINGS. DO NOT SCALE DRAWINGS.

H. CONTRACTOR SHALL PROTECT EXISTING FACILITIES, STRUCTURES AND UTILITIES FROM DAMAGE.

I. SEE ELECTRICAL CONTRACT DOCUMENTS FOR ADDITIONAL INFORMATION RELATING TO THE COORDINATION OF STRUCTURAL COMPONENTS INCLUDING, BUT NOT LIMITED TO:

(1) ELECTRICAL:
GENERATOR, ENCLOSURE, AND FUEL TANK SIZES AND LOCATION
CONDUIT SIZES FOR OPENING AND SLEEVE COORDINATION

2. CODES AND DESIGN CRITERIA

A. PERFORM ALL CONSTRUCTION IN CONFORMANCE WITH THE BUILDING AND DESIGN CODES REFERENCED WITHIN THESE PROJECT DOCUMENTS. THE PROJECT DOCUMENTS REFER TO THE FOLLOWING CODES AND STANDARDS, UON:

REF: INTERNATIONAL BUILDING CODE, 2015

(1) STRUCTURAL CONCRETE:
"BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE"
THE AMERICAN CONCRETE INSTITUTE (ACI 318-14)

B. LIVE LOADS:
(1) WET GENERATOR WITH STEEL ENCLOSURE, SKID, AND FUEL TANK 44,000 LBS
(2) 2,495 GALLON FUEL 15,300 LBS

C. WIND LOAD DESIGN DATA:
(1) MAIN WIND FORCE RESISTING SYSTEM
(a) BASIC WIND SPEED, V
(b) EXPOSURE TO BE DETERMINED FOR EACH SITE
(c) WIND IMPORTANCE FACTOR (I_W)
(d) OCCUPANCY/RISK CATEGORY
(e) GUST EFFECT FACTOR

D. SEISMIC LOAD DESIGN DATA:
(1) SEISMIC IMPORTANCE FACTOR (I_E)
(2) S_S
(3) S_1
(4) S_{DS} TO BE DETERMINED FOR EACH SITE
(5) S_{D1}
(6) SITE CLASS
(7) SEISMIC DESIGN CATEGORY

E. IN CASES WHERE CONTRACTOR DETERMINES THAT EQUIPMENT LOADS EXIST WHICH EXCEED DESIGN LOADS INDICATED ON CONTRACT DOCUMENTS, CONTRACTOR SHALL SUBMIT LOAD DATA TO DESIGN PROFESSIONALS FOR REVIEW PRIOR TO PROCEEDING WITH WORK.

F. SERVICEABILITY
(1) LATERAL DRIFT DUE TO WIND LOADS IS LESS THAN OR EQUAL TO H/200

4. SUBMITTALS

A. CONTRACTOR SHALL REVIEW EACH SUBMITTAL PRIOR TO FORWARDING TO SER. CONTRACTOR SHALL STAMP EACH SUBMITTAL VERIFYING THAT EACH OF THE FOLLOWING IS ADDRESSED:

(1) SHOP DRAWING IS REQUESTED.
(2) SHOP DRAWING IS BASED ON THE LATEST DESIGN.
(3) WORK IS COORDINATED AMONG ALL CONSTRUCTION TRADES.
(4) REVISIONS FROM PREVIOUS SUBMITTALS ARE CLEARLY MARKED BY CIRCLING OR CLOUDS.
(5) SUBMITTAL IS COMPLETE.
(6) SUBMITTAL DOES NOT INCLUDE SUBSTITUTION REQUEST.
(7) SUBMITTAL STAMP SHALL INDICATE PROJECT NAME AND LOCATION, SUBMITTAL NUMBER.

SER SHALL RETURN, WITHOUT COMMENT, SUBMITTALS WHICH CONTRACTOR HAS NOT STAMPED OR WHICH DO NOT MEET THE ABOVE REQUIREMENTS. SER'S REVIEW OF SUBMITTALS SHALL BE FOR GENERAL CONFORMANCE WITH THE DESIGN INTENT. NO CONSTRUCTION (FABRICATION OR ERECTION) SHALL BE STARTED WITHOUT SUCH REVIEW.

B. FOR CONTRACTOR-ENGINEERED COMPONENTS, PROVIDE A NOTE ON EACH SHOP DRAWING, WRITTEN AND SIGNED BY THE SUPPLIER'S ENGINEER, INDICATING THAT THE SHOP DRAWING IS IN CONFORMANCE WITH THE CALCULATIONS OF CONTRACTOR'S ENGINEER.

C. THE FOLLOWING ITEMS REQUIRE SUBMITTALS FOR STRUCTURAL REVIEW AS OUTLINED IN THE SPECIFICATIONS:

(1)	S	CALC	CONCRETE FORMWORK
(2)	S		CONCRETE REINFORCING LAYOUT
(3)		CALC	CONCRETE MIX DESIGNS
(4)	S		CONCRETE CONSTRUCTION JOINT LAYOUT

S = SHOP DRAWINGS REQUIRED

CALC = SUPPORTING CALCULATIONS REQUIRED, SIGNED AND SEALED BY A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF OHIO.

5. FOUNDATIONS

A. THE FOUNDATION DESIGN IS BASED ON THE FOLLOWING IBC MINIMUM DESIGN VALUES:

(1) NET ALLOWABLE BEARING CAPACITY: 1,500 PSF

DESIGN VALUES SHALL BE FIELD VERIFIED BY QUALIFIED GEOTECHNICAL ENGINEER RETAINED BY THE OWNER.

B. ALL EXCAVATIONS SHALL BE IN ACCORDANCE WITH OSHA REGULATIONS. WHERE NECESSARY, SHEET AND SHORE THE EXCAVATION WITH ALL REQUIRED TIEBACKS AND BRACING AS DETERMINED BY CONTRACTOR'S STRUCTURAL ENGINEER.

C. EXISTING SUBBASE SHALL BE COMPACTED TO AT LEAST 95% OF THE MODIFIED PROCTORS MAXIMUM DRY DENSITY. REMOVE AND REPLACE UNSUITABLE MATERIAL WITH STRUCTURAL FILL COMPACTED TO AT LEAST 95% MODIFIED PROCTOR DENSITY. (ASTM D-1557)

D. GENERAL FILL SHALL BE INORGANIC SOIL, FREE OF WASTE, DEBRIS, DELETERIOUS MATERIAL, AND EXCESS MOISTURE. GENERAL FILL SHALL BE COMPACTED TO AT LEAST OF 90% OF THE MODIFIED PROCTORS MAXIMUM DRY DENSITY.

6. CONCRETE MATERIALS

A. CONCRETE STRENGTH SHALL MEET THE FOLLOWING 28-DAY COMPRESSIVE STRENGTH (f'c), UON:

(1) STRENGTH, f'c 4,500 PSI

B. PROVIDE NORMALWEIGHT CONCRETE WITH CURED DENSITY OF 145 +/- 5 PCF, AND AGGREGATE CONFORMING TO ASTM C33 CLASS 3S, UON. MAXIMUM COARSE-AGGREGATE SIZE SHALL BE 3/4" NOMINAL. FINE-AGGREGATE SHALL BE FREE OF MATERIALS WITH DELETERIOUS REACTIVITY TO ALKALI IN CEMENT.

C. FOR CONCRETE EXPOSED TO FREEZE THAW CYCLES, AND/OR DE-ICING CHEMICALS, AND CONCRETE INTENDED TO BE WATER TIGHT, PROVIDE ENTRAINED AIR CONTENT OF 6% +/- 1.5%

D. THE USE OF CALCIUM CHLORIDE AND OTHER CHLORIDE CONTAINING AGENTS IS PROHIBITED. THE USE OF RECYCLED CONCRETE IS PROHIBITED. PLACEMENT WITHIN AND CONTACT BETWEEN ALUMINUM ITEMS, INCLUDING ALUMINUM CONDUIT, AND CONCRETE IS PROHIBITED.

E. PROVIDE A 1" BEVEL ON ALL EXPOSED CONCRETE PROJECTIONS UNLESS NOTED OTHERWISE ON THE DRAWINGS. NO BEVEL IS REQUIRED ON CONCRETE EDGES BELOW FINISHED GRADE.

F. FOLLOW ACI 306R RECOMMENDATIONS FOR COLD WEATHER CONCRETE PLACEMENT AND CURING.

7. CONCRETE REINFORCEMENT

A. ALL CONCRETE SHALL INCLUDE REINFORCEMENT. IF REINFORCEMENT IS NOT SPECIFICALLY INDICATED ON THE DRAWINGS VERIFY REQUIREMENT WITH THE SER.

B. REINFORCEMENT SHALL CONFORM TO THE FOLLOWING STANDARDS AND MATERIAL PROPERTIES, UON:

(1) DEFORMED BARS: ASTM A615 Grade 60
(2) WELDABLE DEFORMED BARS: ASTM A706
(3) EPOXY COATED DEFORMED BARS: ASTM A615 / A775

C. DETAIL REINFORCEMENT BASED ON THE PROJECT REQUIREMENTS, ACI-318 AND ACI-315, UON.

D. WHERE A 90-DEG, 135-DEG OR 180-DEG HOOK IS GRAPHICALLY INDICATED, PROVIDE CORRESPONDING ACI STANDARD HOOKS, UON.

E. DOWELS SHALL MATCH SIZE AND SPACING OF MAIN REINFORCEMENT, UON.

F. REINFORCEMENT SHALL HAVE CONCRETE PROTECTION (CLEAR COVER) PER ACI 318 UNLESS OTHERWISE INDICATED ON THE DRAWINGS.

G. LAP REINFORCEMENT ONLY AT LOCATIONS AS SPECIFICALLY DETAILED ON THE DRAWINGS EXCEPT REINFORCEMENT MARKED AS CONTINUOUS CAN BE SPLICED AT LOCATIONS DETERMINED BY CONTRACTOR USING TENSION LAP SPLICES (LS). SEE LAP SPLICE AND EMBEDMENT SCHEDULE.

H. UNLESS OTHERWISE NOTED, ALL LAP SPLICES ARE TO BE TENSION LAP SPLICES PER LAP SPLICE AND EMBEDMENT SCHEDULE.

I. PLACE REINFORCING BARS IN ACCORDANCE WITH THE APPROVED SHOP DRAWINGS AND WITHIN THE TOLERANCES SPECIFIED IN ACI 117. SUPPORT REINFORCEMENT BY METAL CHAIRS, RUNNER, BOLSTERS, SPACERS, HANGERS AND OTHER APPROVED ACCESSORIES IN A MANNER TO PREVENT DISPLACEMENT DURING PLACEMENT OF CONCRETE.

J. DO NOT HEAT OR FLAME CUT BARS. BEND BARS COLD. DO NOT BEND BARS WHICH ARE EMBEDDED IN CONCRETE UNLESS SPECIFICALLY APPROVED BY THE SER.

8. SPECIAL INSPECTIONS

A. THE FOLLOWING STRUCTURAL ITEMS REQUIRE SPECIAL TESTING AND/OR INSPECTIONS:

CONCRETE CONSTRUCTION
SOILS

9. POST-INSTALLED ANCHORS

A. ADHESIVE ANCHOR SYSTEMS USED FOR DESIGN:

(1) SEISMIC DESIGN CATEGORY A - F

(a) ADHESIVE: HILTI HIT-HY 200 HILTI, TULSA, OK
(b) THREADED ROD: HILTI HAS-E HILTI, TULSA OK

(2) OVERHEAD AND/OR CONSTANT TENSION ADHESIVE ANCHOR INSTALLATIONS NOT SHOWN ON THE DRAWINGS SHALL NOT BE PERMITTED UNLESS EACH CONDITION IS REVIEWED AND APPROVED IN WRITING BY THE SER.

B. PROOF TESTING OF ADHESIVE ANCHORS SHALL BE PERFORMED IN ACCORDANCE WITH THE MANUFACTURER RECOMMENDAITONS. UNLESS NOTED OTHERWISE, ADHESIVE ANCHOR PROOF TENSION LOADS SHALL BE PER ICC-ES ACCEPTANCE CIRTERIA AC308.

C. FIELD DRILLED EXPANSION ANCHOR SYSTEMS USED FOR DESIGN:

(1) SEISMIC DESIGN CATEGORY A - F
(a) KWIK BOLT TZ HILTI, TULSA, OK
(2) SEISMIC DESIGN CATEGORY A - B AT LOCATIONS SPECIFICALLY NOTED IN DETAILS ONLY
(a) KWIK BOLT 3 HILTI, TULSA, OK

D. PROOF TESTING OF EXPANSION ANCHORS SHALL BE PERFORMED IN ACCORDANCE WITH THE MANUFACTURER RECOMMENDAIOTNS. UNLESS NOTED OTHERWISE, EXPANSION ANCHOR PROOF TORQUE LOADS SHALL BE PER THE EXPANSION ANCHOR PROOF TORQUE SCHEDULES.

E. FIELD DRILLED THREADED SCREW ANCHOR SYSTEMS USED FOR DESIGN:

(1) HUS-EZ HILTI, TULSA, OK

F. ALTERNATIVE SYSTEM EQUIVALENT TO OR EXCEEDING THE PROPERTIES OF THE SYSTEMS ABOVE WILL BE CONSIDERED AS A SUBSTITUTION REQUEST.

G. ANCHORS ARE TO BE MINIMUM 3/4-INCH DIAMETER WITH A MINIMUM EMBEDMENT OF 6-INCH, UON.

H. INSTALL ANCHORS TO MEET THE REQUIREMENTS INDICATED IN THE CONTRACT DOCUMENTS AND THE CURRENT MANUFACTURER'S PUBLISHED INSTALLATION INSTRUCTIONS (MPII).

I. LOCATE, BY NON-DESTRUCTIVE MEANS, AND AVOID ALL EXISTING REINFORCEMENT PRIOR TO INSTALLATION OF ANCHORS. IF EXISTING REINFORCING LAYOUT PROHIBITS THE INSTALLATION OF ANCHORS AS INDICATED IN THE DRAWINGS, CONTRACTOR SHALL NOTIFY THE DESIGN PROFESSIONALS IMMEDIATELY.

J. SEE REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION FOR POST-INSTALLED ANCHOR INSPECTION REQUIREMENTS.

10. ABBREVIATIONS

ADDL	ADDITIONAL	F/F	FACE TO FACE	OF	OUTSIDE FACE
ADJ	ADJACENT	FND	FOUNDATION	OH	OPPOSITE HAND
ALT	ALTERNATE	FS	FAR SIDE	OSL	OUT-STANDING LEG
APPROX	APPROXIMATE	FTG	FOOTING	OVS	OVERSIZED
B/	BOTTOM OF	GA	GAGE OR GAUGE	PL	PLATE
B/B	BACK TO BACK	GALV	GALVANIZED	PSF	POUNDS PER SQUARE FOOT
BC	BOLT CIRCLE	GEN	GENERAL	PSI	POUNDS PER SQUARE INCH
BM	BEAM	GPR	GROUND PENETRATING RADAR	PT	POINT
BOT	BOTTOM			RAD	RADIUS
BRDG	BRIDGING	GR	GRADE	REF	REFERENCE
BRG	BEARING	HORZ	HORIZONTAL	REINF	REINFORCEING
BTWN	BETWEEN	HP	HIGH POINT	REQD	REQUIRED
C	COMPRESSION	HT	HEIGHT	SCHED	SCHEDULE(D)
C/C	CENTER TO CENTER	ID	INSIDE DIAMETER	SDL	SUPERIMPOSED DEAD LOAD
CIP	CAST-IN-PLACE	IF	INSIDE FACE	SECT	SECTION
CL	CENTER LINE	INFO	INFORMATION	SF	SQUARE FOOT (FEET)
CLR	CLEAR OR CLEARANCE	INT	INTERIOR	SHT	SHEET
COL	COLUMN	JT	JOINT	SIM	SIMILAR
COMP	COMPRESSION	K	KIPS (OR 1000 POUNDS)	SOG	SLAB ON GRADE
CONC	CONCRETE	KLF	KIP PER LINER FOOT	SP	SPACE
CONN	CONNECTION(S)	KSF	KIP PER SQUARE FOOT	STIFF	STIFFENER
CONST	CONSTRUCTION	kV	KILOVOLT	SPEC(S)	SPECIFICATION(S)
CONT	CONTINUOUS	LL	LIVE LOAD	SSL	SHORT SLOTTED
CY	CUBIC YARD	LLH	LONG LEG HORIZONTAL	LSL	LONG SLOTTED
DBL	DOUBLE	LLV	LONG LEG VERTICAL	STD	STANDARD
DEG	DEGREE(S)	LONG	LONGITUDINAL	STL	STEEL
DET	DETAIL	LP	LOW POINT	SYM	SYMMETRICAL
DIA	DIAMETER	LWC	LIGHTWEIGHT CONCRETE	T	TENSION
DIAG	DIAGONAL	LWT	LIGHTWEIGHT	T/	TOP OF
DIM(S)	DIMENSION(S)	M	MOMENT	T&B	TOP AND BOTTOM
DL	DEAD LOAD	MATL	MATERIAL	TEN	TENSION
ECC	ECCENTRICITY	MAX	MAXIMUM	TH	THICK OR THICKNESS
EA	EACH	MECH	MECHANICAL	TYP	TYPICAL
EF	EACH FACE	MEZZ	MEZZANINE	UON	UNLESS OTHERWISE NOTED
EL	ELEVATION	MIN	MINIMUM	V	SHEAR
ENGR	ENGINEER	MISC	MISCELLANEOUS	VERT	VERTICAL
EOD	EDGE OF DECK	NS	NEAR SIDE	VIF	VERIFY IN FIELD
EOS	EDGE OF SLAB	NTS	NOT TO SCALE	W/	WITH
EQ	EQUAL	NWC	NORMAL WEIGHT CONCRETE	W/O	WITHOUT
EW	EACH WAY	NWT	NORMAL WEIGHT	WP	WORK POINT
EXIST	EXISTING	OC	ON CENTER	WS	WATERSTOP
EXP	EXPANSION	OD	OUTSIDE DIAMETER	WWF	WELDED WIRE FABRIC
EXT	EXTERIOR				

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ISSUES & REVISIONS

THE INFORMATION CONTAINED ON THESE DRAWINGS IS FOR USE ON THIS PROJECT ONLY

Project:
TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
STRUCTURAL GENERAL NOTES

Date: 01/21/2025 Proj No: 22483.005

PROJECT PHASE

XXXX

Sheet No:
S0.01

Sheet of

Revision No.: 0

CIVIL PROJECT SPECIFICATIONS

1. GENERAL REQUIREMENTS

A. REFERENCE SPECIFICATIONS
(1) SITE DEVELOPMENT ACTIVITIES AND IMPROVEMENTS, INCLUDING SITE PREPARATION AND DEMOLITION, EARTHWORK, PAVEMENT, AND EROSION/SEDIMENT CONTROL MEASURES SHALL BE IN ACCORDANCE WITH THE REFERENCE SPECIFICATIONS INDICATED THROUGHOUT THESE PROJECT SPECIFICATIONS. ALL REFERENCE SPECIFICATIONS SHALL BE INCORPORATED INTO AND MADE A PART OF THE PROJECT SPECIFICATIONS, EXCEPT WHEN THE REFERENCE SPECIFICATIONS CONFLICT WITH THESE PROJECT SPECIFICATIONS, CONTRACTOR SHALL COMPLY WITH THE PROJECT SPECIFICATIONS.

B. GOVERNING REGULATIONS
(1) ALL PROJECT ACTIVITIES AND IMPROVEMENTS SHALL BE IN ACCORDANCE WITH THE GOVERNING AGENCY REGULATIONS. IN THE EVENT OF CONFLICT WITH THE INDICATED REFERENCE SPECIFICATIONS OR THESE PROJECT SPECIFICATIONS, THE GOVERNING AGENCY REGULATIONS SHALL APPLY.

C. DEFINITIONS
(1) WHENEVER IN THESE SPECIFICATIONS OR OTHER CONTRACT DOCUMENTS THE FOLLOWING TERMS, OR PRONOUNS IN PLACE OF THEM ARE USED, THE INTENT AND MEANING SHALL BE INTERPRETED AS FOLLOWS:
(a) GOVERNING AGENCY: GOVERNMENT OR REGULATORY ENTITY WITH AUTHORITY TO IMPLEMENT AND ENFORCE SPECIFIC LAWS AND PERMIT REQUIREMENTS.
(b) OWNER: ENTITY OR INDIVIDUAL FOR WHOM THE PROJECT IS BEING PERFORMED.
(c) CONTRACTOR: ENTITY OR INDIVIDUAL RESPONSIBLE FOR PERFORMING ALL CONSTRUCTION ACTIVITIES AND FURNISHING ALL LABOR, MATERIALS, EQUIPMENT AND OTHER INCIDENTALS NECESSARY FOR THE SUCCESSFUL COMPLETION OF THE PROJECT AND FOR CARRYING OUT ALL DUTIES AND OBLIGATIONS IMPOSED BY THE CONTRACT.
(d) ENGINEER: LICENSED PROFESSIONAL ENGINEERING ENTITY OR LICENSED PROFESSIONAL ENGINEER, ACTING THROUGH ITS/HIS/HER AUTHORIZED AGENTS, WHO REPRESENTS THE OWNER DURING THE CONSTRUCTION PHASE OF THE PRESCRIBED PROJECT WORK.
(e) GEOTECHNICAL ENGINEER: LICENSED PROFESSIONAL ENGINEERING ENTITY OR LICENSED PROFESSIONAL ENGINEER, ACTING THROUGH ITS/HIS/HER AUTHORIZED AGENTS, WHO REPRESENTING THE OWNER IS INVOLVED WITH THE PRINCIPLES, PROPERTIES AND BEHAVIOR OF EARTH MATERIALS WITH REGARD TO THE PRESCRIBED PROJECT WORK.

D. CONTRACT GENERAL CONDITIONS
(1) THESE PROJECT SPECIFICATIONS SUPPLEMENT THE ENGINEERING PLANS, THE AGREEMENT BETWEEN OWNER AND CONTRACTOR, AND OTHER SUPPLEMENTAL DOCUMENTS THAT COMPRISE THE OVERALL PROJECT CONTRACT. THESE PROJECT SPECIFICATIONS ADDRESS THE TECHNICAL REQUIREMENTS OF THE PROJECT DESIGN AS INDICATED ON THE PROJECT DRAWINGS (PLANS). GENERAL CONDITIONS SUCH AS BID ITEMS, QUANTITIES, UNIT PRICES, CHANGE MANAGEMENT, CONSTRUCTION SCHEDULE, SUBMITTALS, AND OTHER CONDITIONS ARE DEFINED IN THE AGREEMENT AND ARE NOT ADDRESSED WITHIN THESE PROJECT SPECIFICATIONS.

E. EXISTING UTILITIES
(1) CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING ALL AGENCIES, UTILITY COMPANIES, AND PIPELINE COMPANIES KNOWN OR SUSPECTED TO HAVE BURIED CABLE, DUCT, SEWER, PIPES, ETC., WHICH MAY CONFLICT WITH THE PROJECT IMPROVEMENTS TO DETERMINE THE LOCATION AND DEPTH OF THE EXISTING UTILITIES.
(2) IF CONFLICTS OCCUR AFTER THE EXISTING UTILITY CONDITIONS HAVE BEEN DETERMINED BY FIELD INVESTIGATIONS, CONTRACTOR SHALL IMMEDIATELY NOTIFY ENGINEER:
(a) CONTRACTOR SHALL WORK WITH OWNER AND ENGINEER TO MAKE ARRANGEMENTS WITH THE AFFECTED UTILITY COMPANIES TO HAVE THEIR UTILITIES PROTECTED OR RELOCATED.

F. EROSION / SEDIMENTATION CONTROL
(1) EROSION/SEDIMENTATION CONTROL MEASURES, AS REQUIRED SHALL BE EMPLOYED DURING THE COURSE OF CONSTRUCTION OPERATIONS AND UNTIL SUITABLE GROUND COVERS ARE ESTABLISHED ON ALL CONSTRUCTION SITE AREAS.

G. MATERIAL DISPOSAL
(1) THE FOLLOWING SHALL BE REMOVED FROM THE CONSTRUCTION SITE AND PROPERLY DISPOSED OF IN A LEGAL MANNER. UNLESS OTHERWISE STATED IN THE AGREEMENT BETWEEN OWNER AND CONTRACTOR, THE COST OF REMOVAL AND DISPOSAL SHALL BE INCLUDED IN THE FIXED OR UNIT PRICES FOR THE VARIOUS CONTRACT PAY ITEMS AND NO ADDITIONAL PAYMENT WILL BE ALLOWED THEREFOR.
(a) ALL SURPLUS EXCAVATED MATERIALS.
(b) CONSTRUCTION AND DEMOLITION DEBRIS SUCH AS BUILDING MATERIALS, ASPHALT AND CONCRETE PAVEMENT MATERIALS, AND MISCELLANEOUS LANDSCAPE FEATURES REMOVED DURING THE INSTALLATION OF THE PROJECT IMPROVEMENTS.
(2) IF CONTRACTOR INTENDS TO DISPOSE OF GENERATED CONSTRUCTION / DEMOLITION DEBRIS MATERIALS OR EXCAVATED SOILS AT A REGULATED CLEAN CONSTRUCTION / DEMOLITION DEBRIS (CCDD) OR UNCONTAMINATED SOIL FILL OPERATION, THE CONTRACTOR SHALL BE RESPONSIBLE FOR TAKING ALL ACTIONS AND PREPARING ALL DOCUMENTS PRIOR TO TRANSPORT OF THE MATERIALS / SOIL TO THE DISPOSAL FACILITY. MATERIALS AND SOILS THAT DO NOT MEET CCDD AND UNCONTAMINATED SOIL CONSTITUENT LIMIT REQUIREMENTS SHALL BE DISPOSED OF AT A PERMITTED LANDFILL FACILITY. THE COST OF TESTING AND DOCUMENTATION TO EVALUATE THE MATERIALS / SOILS AND DETERMINE PROPER DISPOSAL REQUIREMENTS SHALL BE AS DEFINED IN THE AGREEMENT BETWEEN OWNER AND CONTRACTOR.

2. EARTHWORK OPERATIONS

A. SITE CLEARING
(1) ALL CONSTRUCTION SITE FEATURES AND ITEMS SUCH AS STRUCTURES, FOUNDATIONS, FENCES, PAVEMENTS, RUBBISH/DEBRIS, AND SURFACE VEGETATION SHALL BE REMOVED WHERE NECESSARY AND AS INDICATED BY ENGINEER FOR THE CONSTRUCTION OF THE PROJECT IMPROVEMENTS.

B. EXCAVATION
(1) EXISTING EARTH AND FILL MATERIALS WITHIN THE PROJECT CONSTRUCTION LIMITS SHALL BE EXCAVATED AS NECESSARY TO ESTABLISH THE ELEVATIONS INDICATED ON THE PLANS. EXCAVATED MATERIALS CLASSIFIED BY GEOTECHNICAL ENGINEER AS SUITABLE STRUCTURAL FILL MATERIAL SHALL BE USED TO CONSTRUCT COMPACTED SUBGRADES WITHIN THE PROPOSED STRUCTURAL AREAS. EXCESS MATERIALS SHALL BE REMOVED FROM THE SITE AND LEGALLY DISPOSED OF, UNLESS DIRECTED BY THE OWNER TO STOCKPILE ON-SITE FOR FUTURE USE. STOCKPILE LOCATIONS SHALL BE AS AUTHORIZED BY THE OWNER.
(2) EXCAVATED MATERIALS CLASSIFIED BY GEOTECHNICAL ENGINEER AS UNSTABLE OR UNSUITABLE FOR STRUCTURAL FILL PURPOSES AND NOT NEEDED FOR NON-STRUCTURAL FILL, SHALL BE REMOVED FROM THE SITE AND LEGALLY DISPOSED OF, UNLESS DIRECTED BY THE OWNER TO STOCKPILE ON-SITE FOR FUTURE USE. STOCKPILE LOCATIONS SHALL BE AS AUTHORIZED BY THE OWNER.
(3) EXCAVATIONS SHALL BE MAINTAINED IN A WELL-DRAINED CONDITION AT ALL TIMES. TEMPORARY DRAINAGE (DEWATERING) FACILITIES SHALL BE PROVIDED WHERE SURFACE RUNOFF IS NOT POSSIBLE OR EFFECTIVE. SUCH FACILITIES SHALL BE OPERATED DURING THE ENTIRE COURSE OF EARTHWORK OPERATIONS. DEWATERING FACILITIES SHALL INCLUDE EROSION AND SEDIMENT CONTROL MEASURES, AS INDICATED ELSEWHERE IN THESE PROJECT SPECIFICATIONS. UNLESS OTHERWISE STATED IN THE AGREEMENT BETWEEN OWNER AND CONTRACTOR, THE COST OF TEMPORARY DRAINAGE FACILITIES AND DEWATERING ACTIVITIES SHALL BE CONSIDERED INCIDENTAL TO THE VARIOUS PAY ITEMS OF THE WORK.

C. FILL PLACEMENT
(1) BEFORE PLACING ANY FILL WITHIN STRUCTURAL AREAS, THE EXISTING SUBGRADE SHALL BE COMPACTED AS INDICATED IN THE "COMPACTION" SECTION OF THESE SPECIFICATIONS. BELOW-GRADE FOUNDATION AREAS SHALL BE INSPECTED BY A GEOTECHNICAL ENGINEER PRIOR TO FOUNDATION INSTALLATION. SOFT, UNSTABLE, OR OTHERWISE UNSUITABLE MATERIALS SHALL BE REMOVED AND REPLACED AS DIRECTED BY GEOTECHNICAL ENGINEER.
(2) STRUCTURAL FILL MATERIALS SHALL BE NON-FROST SUSCEPTIBLE GRANULAR FILL THAT CAN BE COMPACTED TO DEVELOP A STABILITY SATISFACTORY TO GEOTECHNICAL ENGINEER. STRUCTURAL FILL MATERIALS SHALL NOT CONTAIN FROZEN MATERIAL OR ANY MATERIAL WHICH, BY DECAY OR OTHERWISE, MIGHT RESULT IN AREA OR FOUNDATION SETTLEMENT.

D. FILL COMPACTION
(1) FILL MATERIALS SHALL BE PLACED IN LAYERS (LIFTS) AND COMPACTED IN ACCORDANCE WITH THE FOLLOWING SPECIFIED REQUIREMENTS. LIFT THICKNESS SHALL NOT EXCEED 8 INCHES (LOOSE CONDITION) AND THE FILL MATERIAL (WHEN COMPACTED) SHALL HAVE A MOISTURE CONTENT WITHIN THE LIMITS OF −1 TO +3 PERCENTAGE POINTS OF OPTIMUM VALUE. SPECIFIC LIFT THICKNESS AND MOISTURE CONTENT SHALL BE AS DETERMINED BY GEOTECHNICAL ENGINEER TO OBTAIN THE REQUIRED COMPACTION AND STRENGTH OF MATERIAL IN PLACE.
(2) WELL-GRADED AGGREGATE MIXTURES SHALL BE SAMPLED AND TESTED TO DETERMINE THE LABORATORY MAXIMUM DENSITY AND OPTIMUM MOISTURE CONTENT (CONTROL VALUES) OF THE MATERIAL. THE TEST METHOD SHALL BE THE ASTM STANDARD AS INDICATED BELOW.
(3) STRUCTURAL AREAS: THE TOP 6 INCHES OF EXISTING SUBGRADE AND WELL-GRADED GRANULAR FILL MATERIALS SHALL BE COMPACTED TO AT LEAST 95% MAXIMUM DRY DENSITY, AS DETERMINED BY THE MODIFIED PROCTOR METHOD (ASTM D1557). FREE-DRAINING AGGREGATE AND SOIL MATERIALS (ASTM D4253 & D4254) SHALL BE PLACED AND COMPACTED AS SPECIFIED BY GEOTECHNICAL ENGINEER.
(4) SOIL AND AGGREGATE FILL MATERIALS COMPACTED IN PLACE SHALL BE FIELD TESTED TO DETERMINE IN-PLACE DENSITY AND MOISTURE VALUES. A NUCLEAR DENSITY GAUGE SHALL BE USED (IN ACCORDANCE WITH ASTM D6938) TO MEASURE IN-PLACE DENSITY/MOISTURE VALUES OF COHESIVE SOILS AND WELL-GRADED AGGREGATE MATERIALS, UNLESS GEOTECHNICAL ENGINEER DETERMINES OTHER TESTING EQUIPMENT IS MORE SUITABLE FOR THE TYPE OF MATERIAL BEING TESTED. THE DRY UNIT WEIGHT OF THE IN-PLACE COMPACTED MATERIAL SHALL BE COMPARED TO ITS CONTROL VALUE TO DETERMINE THE PERCENT COMPACTION ACHIEVED.
(5) FREQUENCY OF FILL MATERIAL MOISTURE CONTENT AND COMPACTION TESTS SHALL BE AS FOLLOWS, UNLESS OTHERWISE ADJUSTED BY GEOTECHNICAL ENGINEER.
(a) UNDER STRUCTURE GROUND SLABS AND MAT FOUNDATIONS, ONE IN-PLACE DENSITY TEST SHALL BE PERFORMED FOR EACH 3,000 SQUARE FEET, OR FRACTION THEREOF, OF EACH LIFT OF MATERIAL PLACED DURING EACH DAY.
(b) UNDER STRUCTURE COLUMN FOOTINGS, ONE IN-PLACE DENSITY TEST SHALL BE PERFORMED FOR EACH FOOTING, OF EACH LIFT OF MATERIAL PLACED DURING EACH DAY.

E. GRADING TOLERANCES
(1) SURFACE ELEVATIONS SHALL BE WITHIN THE FOLLOWING INDICATED TOLERANCES.
(a) UNDER STRUCTURAL AREAS: ±0.08ℓ TO +0.04ℓ

F. RESTORATION
1. AREAS THAT ARE DAMAGED BY MOVEMENT OR STORAGE OF CONSTRUCTION VEHICLES, EQUIPMENT, OR MATERIALS, OR OTHER CONSTRUCTION ACTIVITIES SUCH AS THE DISCHARGE OF WATER FROM THE CONSTRUCTION SITE, SHALL BE RESTORED TO ORIGINAL CONDITIONS.

3. SOIL EROSION / SEDIMENT CONTROL AND SITE RESTORATION MEASURES

A. GENERAL
(1) CONTRACTOR SHALL TAKE SUITABLE AND SUFFICIENT MEASURES TO CONTROL SOIL EROSION AND SEDIMENTATION DUE TO CONSTRUCTION AND SITE DEVELOPMENT ACTIVITIES. THESE MEASURES SHALL FOLLOW ALL FEDERAL, STATE AND LOCAL CODE REQUIREMENTS. THE MOST STRINGENT REQUIREMENT SHALL BE FOLLOWED WHERE CODE REQUIREMENTS DIFFER.
(2) CONTRACTOR RESPONSIBILITIES SHALL INCLUDE THE MAINTENANCE AND REPAIR OF ALL SEEDED, SODDED, AND PLANTED SURFACES UNTIL ALL SPECIFIED VEGETATIVE COVERS WITHIN THE PROJECT AREA ARE SUITABLY ESTABLISHED AND EROSION POTENTIAL HAS CEASED.

B. STABILIZATION PRACTICES
(1) CONTRACTOR SHALL LIMIT REMOVAL OF EXISTING VEGETATED GROUND COVERS TO ONLY AREAS ABSOLUTELY REQUIRED TO PERFORM THE PROJECT WORK. EXPOSED SOIL SURFACES SHALL BE STABILIZED WITH PROTECTIVE MULCHES OR BLANKETS. IF CONDITIONS PREVENT EFFECTIVE USE OR PLACEMENT OF SUCH MEASURES, THEN THE INSTALLATION OF STRUCTURAL CONTROLS SUCH AS SEDIMENT BARRIER FENCING AND SEDIMENT TRAPS WILL BE REQUIRED.
(2) SURFACE STABILIZATION MEASURES SHALL BE INITIATED IMMEDIATELY (WITHIN 1 DAY) AFTER EARTHWORK OPERATIONS HAVE TEMPORARILY CEASED FOR A PERIOD THAT WILL EXCEED 14 DAYS AND AFTER FINAL GRADES ARE ESTABLISHED.

C. SEDIMENT BARRIERS
(1) TEMPORARY SEDIMENT BARRIERS SHALL BE INSTALLED AS DIRECTED BY ENGINEER AND MAINTAINED UNTIL SOIL SURFACES HAVE BEEN STABILIZED WITH GRASS OR OTHER TYPES OF PERMANENT COVER. SUCH BARRIERS SHALL BE SILT FENCES, COMPOST FILTER SOCKS, OR OTHER DEVICES.
(2) TEMPORARY SEDIMENT BARRIERS SHALL BE INSTALLED PRIOR TO THE START OF SITE DISTURBANCE AND EARTHWORK OPERATIONS.
(3) GEOTEXTILE FILTER FABRIC SEDIMENT BARRIERS SHALL BE INSTALLED OVER CASTING GRATES OF DRAINAGE STRUCTURES THAT RECEIVE SURFACE RUNOFF. SILT FENCE OR COMPOST FILTER SOCK BARRIERS SHALL BE PLACED AROUND DRAINAGE STRUCTURES WHERE THE USE OF FILTER FABRIC BARRIERS OVER THE GRATE IS INEFFECTIVE OR NOT FEASIBLE AND WHERE SILT FENCES OR FILTER SOCKS AS DIRECTED BY ENGINEER.
(4) ALL SEDIMENT BARRIERS SHALL BE REPLACED OR CLEANED AS NECESSARY DURING CONSTRUCTION WHEN THEY BECOME CLOGGED OR INEFFECTIVE. ALL SEDIMENT TRAPS SHALL BE CLEANED PERIODICALLY DURING CONSTRUCTION TO ALLOW THEM TO OPERATE EFFECTIVELY.

REQUIRED SPECIAL INSPECTIONS AND TESTS OF SOILS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. VERIFY MATERIALS BELOW SHALLOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY.	–	X
2. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL.	–	X
3. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS.	–	X
4. VERIFY USE OF PROPER MATERIALS, DENSITIES, AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL.	X	–
5. PRIOR TO PLACEMENT OF COMPACTED FILL, INSPECT SUBGRADE AND VERIFY THAT SITE HAS BEEN PREPARED PROPERLY.	–	X

REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD[a]	IBC 2015 REFERENCE
1. INSPECT REINFORCEMENT, INCLUDING PRESTRESSING TENDONS, AND VERIFY PLACEMENT.	–	X	ACI 318 CH 20, 25.2 25.3, 26.6.1–26.6.3	1908.4
2. REINFORCING BAR WELDING:				
A. VERIFY WELDABILITY OF REINFORCING BARS OTHER THAN ASTM A706;	–	X	AWS D1.4 ACI 318: 26.6.4	–
B. INSPECT SINGLE-PASS FILLET WELDS, MAXIMUM 5/16"; AND		X		
C. INSPECT ALL OTHER WELDS.	X			
3. INSPECT ANCHORS CAST IN CONCRETE.	–	X	ACI 318: 17.8.2	–
4. INSPECT ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS:[b]				
A. ADHESIVE ANCHORS INSTALLED IN HORIZONTALLY OR UPWARDLY INCLINED ORIENTATIONS TO RESIST SUSTAINED TENSION LOADS.	X		ACI 318: 17.8.2.4	–
B. MECHANICAL ANCHORS AND ADHESIVE ANCHORS NOT DEFINED IN 4.A.		X	ACI 318: 17.8.2	
5. VERIFYING USE OF REQUIRED DESIGN MIX.	–	X	ACI 318: CH. 19, 26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
6. PRIOR TO CONCRETE PLACEMENT, FABRICATE SPECIMENS FOR STRENGTH TESTES, PERFORM SLUMP AND AIR CONTENT TESTS, AND DETERMINE THE TEMPERATURE OF THE CONCRETE.	X	–	ASTM C 172 ASTM C31 ACI 318: 26.4, 26.12	1908.10
7. INSPECT CONCRETE AND SHOTCRETE PLACEMENT FOR PROPER APPLICATION TECHNIQUES.	X	–	ACI 318: 26.5	1908.6, 1908.7, 1908.8
8. VERIFY MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES.	–	X	ACI 318: 26.5.3–26.5.5	1908.9
9. INSPECT PRESTRESSED CONCRETE FOR:				
A. APPLICATION OF PRESTRESSING FORCES; AND	X	–	ACI 318: 2610	–
B. GROUTING OF BONDED PRESTRESSING TENDONS.	X	–		
10. INSPECT ERECTION OF PRECAST CONCRETE MEMBERS.	–	X	ACI 318: CH. 26.8	–
11. VERIFY IN-SITU CONCRETE STRENGTH, PRIOR TO STRESSING OF TENDONS IN POST-TENSIONED CONCRETE AND PRIOR TO REMOVAL OF SHORES AND FORMS FROM BEAMS AND STRUCTURAL SLABS.	–	X	ACI 318: 26.11.2	–
12. INSPECT FORMWORK FOR SHAPE, LOCATION AND DIMENSIONS OF THE CONCRETE MEMBER BEING FORMED.	–	X	ACI 318: 26.11.1.2(b)	–

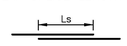
a. WHERE APPLICABLE, SEE ALSO SECTION 1705.12, SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE.
b. SPECIFIC REQUIREMENTS FOR SPECIAL INSPECTION SHALL BE INCLUDED IN THE RESEARCH REPORT FOR THE ANCHOR ISSUED BY AN APPROVED SOURCE IN ACCORDANCE WITH 17.8.2 IN ACI 318, OR OTHER QUALIFICATION PROCEDURES. WHERE SPECIFIC REQUIREMENTS ARE NOT PROVIDED, SPECIAL INSPECTION REQUIREMENTS SHALL BE SPECIFIED BY THE REGISTERED DESIGN PROFESSIONAL AND SHALL BE APPROVED BY THE BUILDING OFFICIAL PRIOR TO THE COMMENCEMENT OF THE WORK.

DEVELOPMENT LENGTH SCHEDULE (f'c=4,500psi)

BAR SIZE	MINIMUM BAR SPACING	LAP SPLICE LENGTH (ls)		DEVELOPMENT LENGTH (ld)		HOOKED BAR DEVELOPMENT LENGTH (ldh)	
		TOP BARS	OTHER	TOP BARS	OTHER	TOP BARS	OTHER
#3	1.875	24	18	18	14	8	8
#4	2.000	32	25	25	19	10	10
#5	2.125	40	31	31	24	12	12
#6	2.250	48	37	37	28	15	15
#7	2.375	70	54	54	42	17	17
#8	2.500	80	62	62	47	19	19
#9	2.875	90	70	70	54	22	22
#10	3.250	102	78	78	60	25	25
#11	3.625	113	87	87	67	27	27

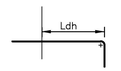
NOTES:
1. ALL TABLE DIMENSIONS ARE IN INCHES
2. TOP BARS INDICATE HORIZONTAL BARS WITH MORE THAN 12" OF CONCRETE CAST BENEATH.
3. CLEAR COVER – PROVIDE PER DETAILS OR ACI MINIMUMS WHERE NOT INDICATED.
4. WHERE BARS OF DIFFERENT SIZES ARE LAP SPLICED IN TENSION, THE LAP LENGTH SHALL BE THE LENGTH OF THE SMALLER BAR.
5. WHERE ACTUAL CONDITIONS DIFFER FROM THE PROVIDED SCHEDULE AND/OR NOTES, LENGTHS SHALL BE ADJUSTED ONLY WITH THE APPROVAL OF THE STRUCTURAL ENGINEER.
6. LAP SPLICE AND DEVELOPMENT LENGTH VALUES ASSUME NON COATED BARS. FOR EPOXY COATED BARS, LAP SPLICE AND DEVELOPMENT LENGTH VALUES MUST BE INCREASED BASED ON THE FOLLOWING RULES:
6.1. FOR CLEAR COVER LESS THAN 3 TIMES THE BAR DIAMETER OR CLEAR SPACING LESS THAN 6 TIMES THE BAR DIAMETER, INCREASE THE LAP SPLICE LENGTH (ls) AND DEVELOPMENT LENGTH (ld) BY 50%.
6.2. FOR ALL OTHER EPOXY COATED BAR, INCREASE THE LAP SPLICE LENGTH (ls) AND DEVELOPMENT LENGTH (ld) BY 20%.
6.3. HOOKED DEVELOPMENT LENGTHS (ldh) ARE UNCHANGED BY EPOXY COATINGS.

LAP SPLICE LENGTH



DEVELOPMENT LENGTH

HOOKED BAR DEVELOPMENT



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Project:
TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
STRUCTURAL GENERAL NOTES

Date: 01/21/2025 Proj. No: 22483.005

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S0.02

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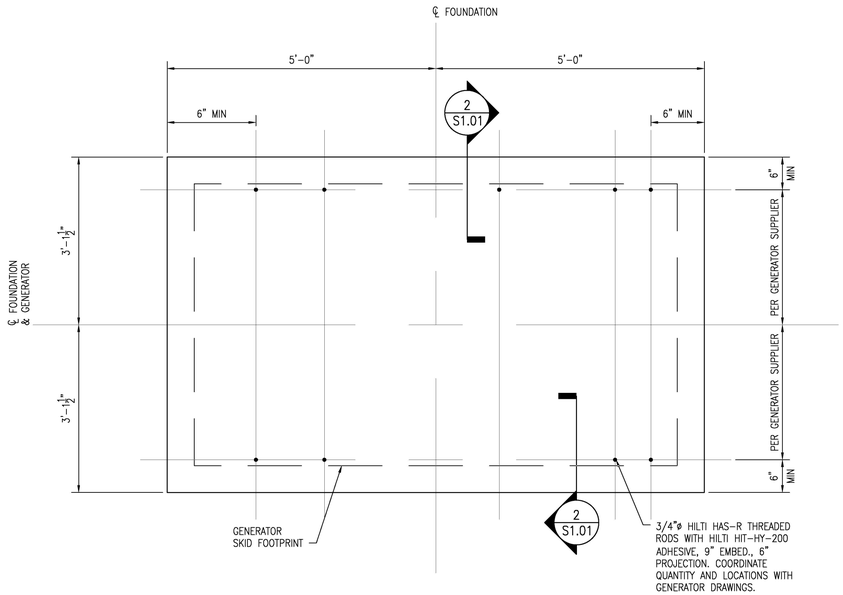
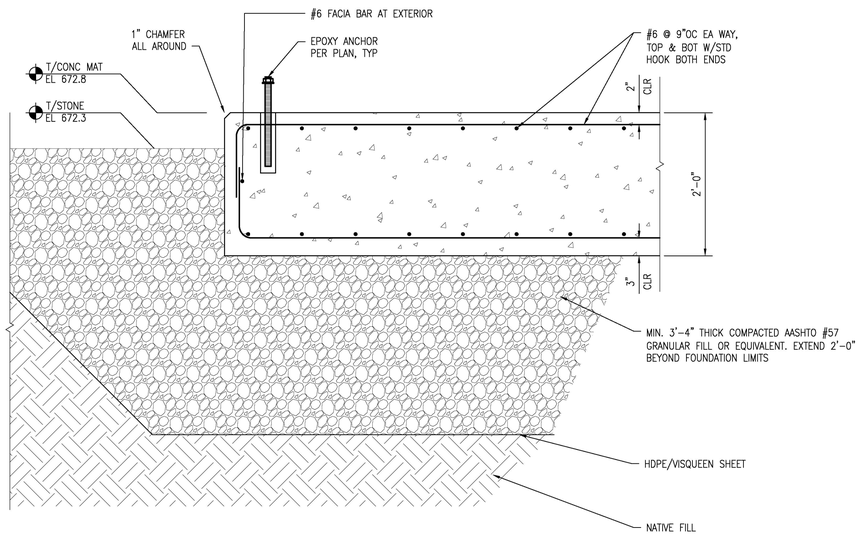


1 S1.01 GENERATOR FOUNDATION PLAN DETAIL

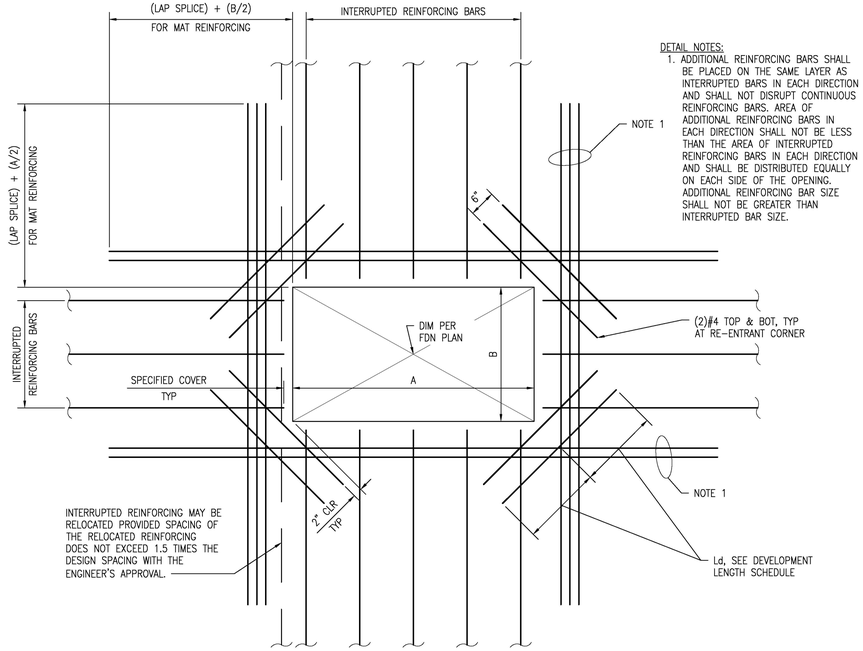
SCALE: 3/4"=1'-0"

NOTES:
1. TOTAL DESIGN WEIGHT IS 51703 LBS INCLUDING GENSET WET WEIGHT, STEEL ENCLOSURE, FUEL TANK, AND 2400 GAL OF FUEL. PER GIVEN ADM-RESEARCH 1000 kW PRODUCT DATA SHEET BY CUMMINS, PATRICK ENGINEERING RECEIVED ON 09 AUGUST 2021.



2 S1.01 SECTION AT GENERATOR FOUNDATION

SCALE: 1"=1'-0"



DETAIL NOTES:
1. ADDITIONAL REINFORCING BARS SHALL BE PLACED ON THE SAME LAYER AS INTERRUPTED BARS IN EACH DIRECTION AND SHALL NOT DISRUPT CONTINUOUS REINFORCING BARS. AREA OF ADDITIONAL REINFORCING BARS IN EACH DIRECTION SHALL NOT BE LESS THAN THE AREA OF INTERRUPTED REINFORCING BARS IN EACH DIRECTION AND SHALL BE DISTRIBUTED EQUALLY ON EACH SIDE OF THE OPENING. ADDITIONAL REINFORCING BAR SIZE SHALL NOT BE GREATER THAN INTERRUPTED BAR SIZE.

3 S1.01 TYPICAL REINFORCING FOR RETANGULAR MAT PENETRATION

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Project:
TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
FOUNDATION DETAILS

Date: 01/21/2025 Proj. No: 22483.005

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Sheet No:
S1.01

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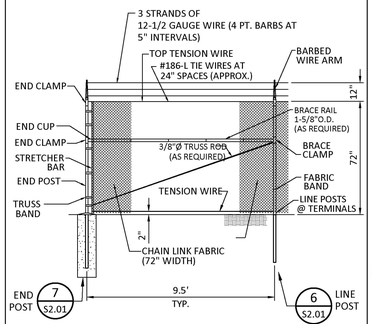
CHAIN LINK FENCE WITH BARBED WIRE

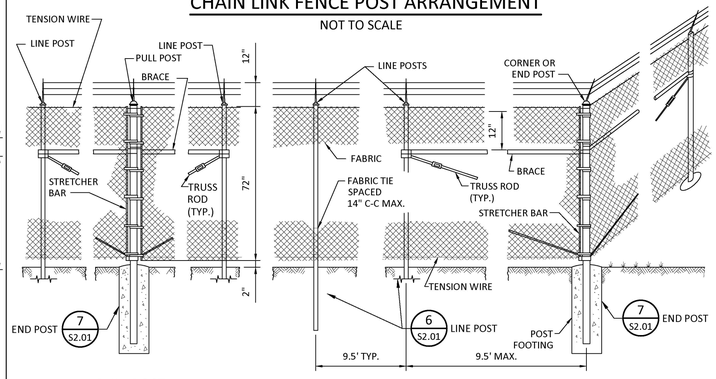


NOTES:
1. BARBED WIRE ARM AT 45° ANGLE (TYP.), DIRECTED TOWARD EXTERIOR OF FACILITY.
2. CHAIN LINK FABRIC SHALL BE MINIMUM NO. 9 GAGE 2" MESH.
3. TENSION WIRE SHALL BE MINIMUM NO. 7 GAGE WIRE.
4. SEE SHEET E4.01 FOR FENCE MATERIAL AND INSTALLATION SPECIFICATIONS.

3
52.01

CHAIN LINK FENCE POST ARRANGEMENT

NOT TO SCALE

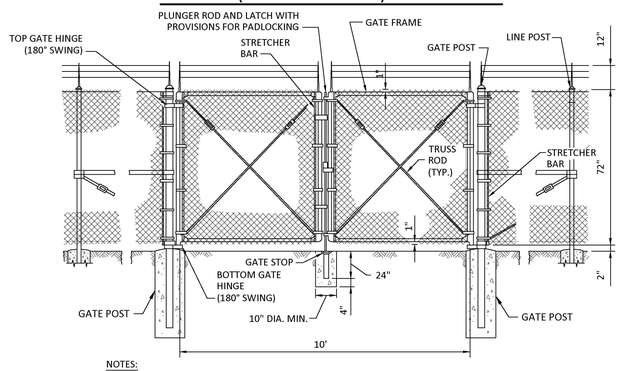


PULL POST ARRANGEMENT | LINE POST ARRANGEMENT | CORNER OR END POST ARRANGEMENT

NOTES:
1. LINE POSTS SHALL BE 2-3/8" O.D. PIPE.
2. CORNER/END/PULL POSTS SHALL BE 2-7/8" O.D. PIPE.
3. SEE SHEET E4.01 FOR FENCE MATERIAL AND INSTALLATION SPECIFICATIONS.

4
52.01

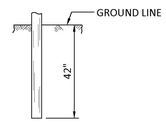
VEHICLE (DOUBLE SWING) GATE DETAIL



NOTES:
1. PROVIDE COMMERCIAL DOUBLE GATE LATCH.
2. PROVIDE KEEPER FOR ALL VEHICLE GATES WHICH AUTOMATICALLY ENGAGES THE GATE LEAF AND HOLDS IT IN THE OPEN POSITION UNTIL MANUALLY RELEASED.
3. FERROUS-METAL COMPONENTS AND ACCESSORIES SHALL BE HOT-DIP GALVANIZED (SEE SHEET C0.03 FOR MATERIAL SPECIFICATIONS).
4. CHAIN LINK FABRIC SHALL BE MINIMUM NO. 9 GAGE 2" MESH.
5. TENSION WIRE SHALL BE MINIMUM NO. 7 GAGE WIRE.
6. SEE SHEET E4.01 FOR FENCE MATERIAL AND INSTALLATION SPECIFICATIONS.

5
52.01

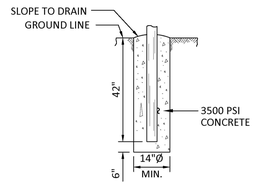
FOOTING FOR LINE POST



NOTE:
1. LINE POSTS SHALL BE DIRECT-DRIVEN INTO SOIL TO MINIMUM DEPTH SHOWN.

6
52.01

FOOTING FOR GATE & END POSTS



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52.01

CHAIN LINK FENCE

A. GENERAL
1) FENCE SHALL BE NOMINAL 6 FEET HIGH WITH THREE-STRAND BARBED WIRE SECTION (1-FOOT HEIGHT) ABOVE FENCE FABRIC.
2) GATES SHALL BE SWING TYPE AS SPECIFIED, COMPLETE WITH LATCHES, STOPS, KEEPERS, HINGES, AND WITH THREE-STRAND BARBED WIRE SECTION (1-FOOT HEIGHT) ABOVE FENCE FABRIC.

B. MATERIALS
1) FABRIC
a) CHAIN LINK FABRIC SHALL BE MINIMUM 72 INCH WIDE, WOVEN FROM 9 GAUGE (COATED STEEL) SIZE WIRE IN A 2-INCH MESH WITH SELVAGE KNUCKLED AT THE TOP AND TWISTED AT THE BOTTOM.
b) FABRIC SHALL BE GALVANIZED COATED A MINIMUM 2.0 OZ/SQ FT CONFORMING TO ASTM A392, CLASS 2.
c) FABRIC TIE WIRE SHALL BE 9 GAUGE ALUMINUM.
2) FRAMEWORK
a) ALL POSTS AND RAILS SHALL COMPLY WITH THE HEAVY INDUSTRIAL FENCE STRENGTH REQUIREMENTS OF ASTM F669, GROUPS IA, II AND III.

GROUP IA STEEL PIPE, STANDARD WEIGHT (SCH40)

DESCRIPTION	NPS
TOP AND BRACE RAILS	1–5/8 (1.660 INCH OD)
GATE FRAMES (WITH WELDED CORNERS)	1–7/8 (1.900 INCH OD)
LINE POSTS	2–3/8 (2.375 INCH OD)
END, CORNER AND PULL POSTS	2–7/8 (2.875 INCH OD)

NOTE: SEE ASTM-F1043 DIMENSION REQUIREMENTS FOR:
GROUP II ROLL FORMED STEEL SHAPES ("C" SECTIONS)
GROUP III HOT-ROLLED STEEL SHAPES ("H" BEAMS)

b) PIPE POSTS AND RAILS SHALL BE GALVANIZED WITH 2 OZ/SQ FT OF HOT-DIPPED ZINC IN ACCORDANCE WITH ASTM A1083.
c) ROLL FORMED AND HOT-ROLLED STEEL POSTS AND RAILS SHALL BE GALVANIZED WITH 2 OZ/SQ FT OF HOT-DIPPED ZINC IN ACCORDANCE WITH ASTM A1083.
d) ALL POSTS AND GATE SUPPORTS FOR GATE OPENING LESS THAN 18 FEET WIDE SHALL BE OF SUFFICIENT LENGTH TO ALLOW FOR A MINIMUM 36 INCHES DEPTH BELOW GRADE; FOR GATE OPENING 18 FEET OR WIDER, THE SUPPORT POST LENGTH SHALL ALLOW FOR A MINIMUM 48 INCHES DEPTH BELOW GRADE.
e) IF USED, TOP RAIL SHALL FORM A CONTINUOUS BRACE FROM END TO END OF EACH STRETCH OF FENCE. TOP RAIL COUPLINGS SHALL BE SPACED AT MAXIMUM 21 FEET CENTERS.
3) WIRE, FITTINGS AND HARDWARE
a) ALL TENSION WIRE SHALL BE 7 GAUGE MARCELLED WIRE COMPLYING WITH ASTM A824. MATCH COATING TO THAT OF CHAIN LINK FABRIC.
b) ALL BARBED WIRE SHALL BE DESIGN NO. 12-4-5-14R, COMPLYING WITH ASTM A121. MATCH COATING TO THAT OF CHAIN LINK FABRIC.
c) ALL FITTINGS AND HARDWARE (TENSION AND BRACE BANDS, POST CAPS, RAIL AND BRACE ENDS, CLAMPS, SLEEVES, TRUSS ROD ASSEMBLY, TENSION BARDS, BARBED WIRE ARMS) SHALL BE PRESSED STEEL IN COMPLIANCE WITH ASTM F626.
d) TIE WIRE AND HOG RINGS SHALL BE IN COMPLIANCE WITH ASTM F626.
e) ALL BOLTS SHALL BE 3/8 INCH DIAMETER AND 1 ¼ INCH LONG WITH STANDARD HEX NUT.
f) LATCHES WILL BE FORKED TYPE FOR SINGLE SWING GATES, AND PLUNGER ROD TYPE FOR DOUBLE SWING GATES. LATCHES SHALL HAVE A PADLOCK EYE AND PERMIT OPERATION FROM EITHER SIDE OF GATE.
4) CONCRETE
a) CONCRETE FOOTINGS FOR POSTS SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4000 PSI AND BE AIR ENTRAINED 5% TO 7%.
5) GATES
a) SWING GATES AND GATE POST SIZES

GATE	WIDTH (FT)	TYPE	NPS	OD (INCHES)
MAN	3	SINGLE SWING	2-7/8	2.875
VEHICLE	20	DOUBLE SWING	4	4.5

C. INSTALLATION
1) FENCE INSTALLATION SHALL BE IN ACCORDANCE WITH ASTM F567 UNLESS OTHERWISE NOTED HEREIN OR ON DRAWINGS.
2) FENCE SHALL FOLLOW GROUND LINE UNLESS OTHERWISE APPROVED. FENCE CLEARANCE ABOVE GROUND SHALL BE 2 INCHES WITH A TOLERANCE OF 1 INCH.
3) LINE POST SPACING SHALL BE 10 FOOT MAXIMUM CENTERS.
4) CONCRETE FOOTINGS:

ITEM	NPS	FTG. DIA.	MIN. DEPTH BELOW GRADE
LINE POSTS	2	12"	48"
CORNER, END AND PULL POSTS		2-7/8	14" 48"
MAN GATE POSTS	2-7/8	14"	48"
VEHICLE GATE POSTS	4	14"	48"

5) THE CROWN OF CONCRETE FOOTING SHALL NOT BE LESS THAN ONE INCH ABOVE GRADE AND SHALL BE SLOPED TOWARD THE EDGES TO SHED WATER.
6) BRACES AND TRUSS RODS SHALL BE FURNISHED ON GATES, TERMINAL POST TO ADJACENT LINE POST, AND OTHER LOCATIONS AS REQUIRED TO PREVENT SAGGING.
7) GATE POSTS SHALL BE CAPPED WITH WATERTIGHT DOME TOPS.
8) EACH SWING GATE LEAF OVER 5 FEET WIDE SHALL BE PROVIDED WITH A GATE KEEPER FOR SECURING THE FREE END OF GATE WHEN IN FULL OPEN POSITION.
9) CHAIN LINK SHALL BE ATTACHED AS FOLLOWS:

LOCATION	ATTACHMENT
CORNER AND TERMINAL POSTS	TENSION BARS & TENSION BAR BANDS
LINE POSTS	TIE WIRE AT 12 INCH CENTERS
TOP AND BRACE RAILS	TIE WIRE AT 18 INCH CENTERS
GATE SIDE FRAME	TENSION BARS & TENSION BAR BANDS
TOP AND BOTTOM FRAME	TIE WIRE AT 12 INCH CENTERS
TENSION WIRE	HOG RINGS AT 18 INCH CENTERS

10) SWING GATES SHALL BE HUNG BY MINIMUM TWO TUBULAR POST HINGES SECURELY FASTENED TO THE GATE POSTS. HINGES SHALL NOT TWIST OR TURN UNDER ACTION OF THE GATE, SHALL BE CAPABLE OF ALLOWING A FULL 180 DEGREE OPENING TURN FOR VEHICLE GATES AND 90 DEGREE OPENING TURN FOR MAN GATES, AND SHALL BE EASILY OPERATED BY ONE PERSON.
11) GATE KEEPERS SHALL BE INSTALLED FOR SWING GATE LEAFS.

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TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
FENCE AND FENCE DETAILS

Date: 01/21/2025 Proj. No: 22483.005

PROJECT PHASE
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Sheet No:
S2.01

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FIRE ALARM SYMBOLS

SYMBOL		DESCRIPTION
WALL	CEILING	
		KNOX BOX
GAP		GENERATOR REMOTE ANNUNCIATOR PANEL
FAAP		FIRE ALARM ANNUNCIATOR PANEL
FACP		FIRE ALARM CONTROL PANEL

ELECTRICAL LIGHTING SYMBOLS

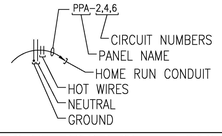
SYMBOL		DESCRIPTION
WALL	CEILING	
		DOWN LIGHT OR WALL WASH LIGHTING FIXTURE
		FLUORESCENT LIGHTING FIXTURE
EM	EM	EMERGENCY FLUORESCENT LIGHTING FIXTURE
NL	NL	NIGHT LIGHTING FLUORESCENT FIXTURE
EM	EM	DOWN LIGHT OR WALL WASH LIGHTING FIXTURE CONNECTED TO EMERGENCY LIGHTING SYSTEM
		BATTERY EMERGENCY LIGHTING UNIT, TWO-WAY THROW, UL APPROVED. WALL MOUNTED 1'-0" BELOW CEILING OR MAX OF 8'-0" AFF. CEILING MOUNTED-RECESSED IN CEILING
		BATTERY EMERGENCY LIGHTING UNIT, TWO-WAY THROW, UL APPROVED. WALL MOUNTED 1'-0" BELOW CEILING OR MAX OF 8'-0" AFF. SINGLE HEAD EXTENDED THROUGH WALL.
		BATTERY EMERGENCY LIGHTING UNIT, SINGLE HEAD ONE-WAY THROW
		EXIT SIGN (TYPE AS NOTED ON EXIT SIGN LEGEND)
S OS	OS	OCCUPANCY SENSOR
TC		TIME CLOCK
S b		SINGLE POLE TOGGLE SWITCH +42" AFF, LOWERCASE LETTER DENOTES LIGHTING CONTROL
S 3W		3-WAY TOGGLE SWITCH +42" AFF
S 4W		4-WAY TOGGLE SWITCH +42" AFF
S M		MOMENTARY CONTACT SWITCH +42" AFF
S K		KEY OPERATED SINGLE POLE TOGGLE SWITCH
S D		DIMMER SWITCH +42" AFF
S P		TOGGLE SWITCH W/ PILOT NEON LIGHT +42" AFF

NOTE:
1. THIS IS A COMPOSITE LIST AND ALL SYMBOLS MAY NOT BE USED ON THIS PROJECT.
2. SEE LIGHTING FIXTURE SCHEDULE FOR LIGHTING FIXTURE TYPE DESCRIPTIONS AND PLANS FOR FIXTURE TYPE TAGS.

ELECTRICAL POWER SYMBOLS

SYMBOL			DESCRIPTION
FLOOR	WALL	CEILING	
			SIMPLEX CONVENIENCE OUTLET +18" AFF (UNLESS NOTED OTHERWISE)
	WP		DUPLEX CONVENIENCE OUTLET, WEATHERPROOF
			JUNCTION BOX - SIZE AS REQUIRED - MINIMUM 4" SQUARE
	PB	PB	PULL BOX - SIZE AS REQUIRED
M	M	M	MOTOR OUTLET, HORSEPOWER AS NOTED
			DISCONNECT SWITCH - HORSEPOWER RATED, FUSED OR UNFUSED, AS REQUIRED OR NOTED. WP DENOTES WEATHERPROOF TYPE
	ATS		AUTOMATIC TRANSFER SWITCH
			UTILITY METER
			DISTRIBUTION PANEL: 208V: PROVIDE 36" FRONT CLEARANCE 480V: PROVIDE 42" FRONT CLEARANCE
			NEW PANELBOARD-SURFACE MOUNTED 208V: PROVIDE 36" FRONT CLEARANCE 480V: PROVIDE 42" FRONT CLEARANCE
			NEW PANELBOARD-RECESSED 208V: PROVIDE 36" FRONT CLEARANCE 480V: PROVIDE 42" FRONT CLEARANCE
			EMERGENCY PANEL - EM 208V: PROVIDE 36" FRONT CLEARANCE 480V: PROVIDE 42" FRONT CLEARANCE
	E		EXISTING PANEL 208V: MAINTAIN 36" FRONT CLEARANCE 480V: MAINTAIN 42" FRONT CLEARANCE
	DPM		DIGITAL POWER METERING
	SPD		SURGE PROTECTION DEVICE
			CONCEALED CONDUIT AND WIRE. RUN DASH WIRE DENOTES GROUND CONDUCTOR
			EXPOSED CONDUIT RUN. SUBMIT SHOP DWG FOR PROPOSED ROUTING.
			CONDUIT RUN (UNDERFLOOR OR UNDERGROUND)
			WIREWAY RACEWAY - SURFACE MOUNTED SAFETY SWITCHES AS NOTED ON PLANS
			FLEXIBLE CONDUIT CONNECTION
			CONDUIT ROUTED UP
			CONDUIT ROUTED DOWN
			GROUND PER CODE
	PB		EMERGENCY SHUT DOWN PUSH BUTTON (RED MUSHROOM TYPE)
	T		TRANSFORMER

ELECTRICAL IDENTIFICATIONS



ELECTRICAL RISER DIAGRAM LINETYPES

PROPOSED
EXISTING TO REMAIN ——— EXISTING TO BE REMOVED ———

E	ADJACENT TO DEVICE OR EQUIPMENT, DENOTES EXISTING TO REMAIN
X	ADJACENT TO DEVICE OR EQUIPMENT, DENOTES EXISTING TO BE REMOVED COMPLETELY, INCLUDING ALL CONDUIT AND WIRE. WHERE BOX REMAINS IN EXISTING WALL PROVIDE SUITABLE BLANK COVER.
ER	ADJACENT TO DEVICE OR EQUIPMENT, DENOTES EXISTING TO BE RELOCATED. EXTEND OR ADD WIRING AS SHOWN ON PLAN OR AS REQUIRED.
R	EXISTING DEVICE TO BE REPLACED WITH NEW
N	ADJACENT TO DEVICE OR EQUIPMENT, DENOTES NEW, WIRE SAME AS SHOWN ON PLAN.

ONE-LINE DIAGRAM SYMBOLS

SYMBOL	DESCRIPTION
PANEL NAME / AMPS / VOLTS	POWER DISTRIBUTION PANELBOARD
CONTROL PANEL / VOLTS	CONTROL PANEL
MCC XX / AMPS / VOLTS	MOTOR CONTROL CENTER
	CAPACITOR
	FUSE
	GROUND SYMBOL
	LOW VOLTAGE CIRCUIT BREAKER
	MEDIUM VOLTAGE CIRCUIT BREAKER Fxxx - DENOTES FEEDER BREAKER Uxxx - DENOTES UTILITY BREAKER Txxx - DENOTES TRANSFORMER BREAKER Gxxx - DENOTES GENERATOR BREAKER BTxx - DENOTES BUS TIE BREAKER "XX" DENOTES BUSSES BEING TIED
	NORMALLY OPEN DISCONNECT SWITCH
	NORMALLY OPEN FUSED DISCONNECT
	SEPARABLE DISCONNECTS
	NORMALLY CLOSED CONTACT
	NORMALLY OPEN CONTACT
CC	CLOSE CIRCUIT COIL
TC	TRIP CIRCUIT COIL
	TRANSFORMER WITH DELTA/WYE WIRING CONVENTION
	TRANSFORMER WITH WYE/WYE WIRING CONVENTION
	AC WIRING
M	MOTOR, HORSEPOWER AS NOTED
G	GENERATOR, RATING AS NOTED
	MOTOR STARTER
	RELAY
VFI	MEDIUM VOLTAGE VACUUM FAULT INTERRUPTER
PR	PHASE RELAY
CAP TRIP	CAPACITOR TRIP
	UTILITY POLE
SW	SWITCHGEAR
	TRANSFORMER
M	PRIMARY METER
R	RECLOSER
	SOLAR PANEL
	OPTIMIZER
	INVERTER

NOTE: THIS IS A COMPOSITE LIST AND ALL SYMBOLS MAY NOT BE USED ON THIS PROJECT.

ELECTRICAL ABBREVIATIONS

ABBREV	DESCRIPTION
A	AMPERE
AC	ALTERNATING CURRENT
A/C	AIR CONDITIONING
ACL	ACROSS THE LINE
ACS	AUXILIARY CONTACTS
AF	FUSED AMPS
AFCI	ARC FAULT CIRCUIT INTERRUPTER
AFF	ABOVE FINISHED FLOOR
AHJ	AUTHORITY HAVING JURISDICTION
AHU	AIR HANDLING UNIT
AI	ANALOG INPUT
AIC	AMPERES INTERRUPTING CAPACITY
AL	ALUMINUM
ALM	ALARM
AMP	AMPERE
ANN	ANNUNCIATOR
AO	ANALOG OUTPUT
ARCH	ARCHITECT, ARCHITECTURAL
AS	SWITCH AMPS
AT	AMPS TRIP
ATS	AUTOMATIC TRANSFER SWITCH
AVG	AVERAGE
AWG	AMERICAN WIRE GAUGE
BAL	BALLAST
BAS	BUILDING AUTOMATION SYSTEM
BESS	BATTERY ENERGY STORAGE SYSTEM
BFC	BELOW FINISHED CEILING
BGB	BUILDING GROUND BOX
BHP	BRAKE HORSEPOWER
BMNT	BASEMENT
BPS	BOLTED PRESSURE SWITCH
BR	BRANCH
BRKR	BREAKER
C	CONDUIT
CAB	CABINET
CAP	CAPACITY
CATV	CABLE TELEVISION
CB	CIRCUIT BREAKER
CCT	CIRCUIT
CCTV	CLOSED CIRCUIT TELEVISION
CEC	CHICAGO ELECTRIC CODE
CECO	COMMONWEALTH EDISON COMPANY
CLG	CEILING
CLO	CLOSET
CMB	COMBINER BOX
CO	CARBON MONOXIDE DETECTOR
COAX	COAXIAL
COMED	COMMONWEALTH EDISON COMPANY
CONN	CONNECTION
CONV	CONVENIENCE
CP	CONTROL PANEL
CT	CURRENT TRANSFORMER
CU	COPPER
C.U.	COEFFICIENT OF UTILIZATION
CUH	CABINET UNIT HEATER
DC	DIRECT CURRENT
DGR	DUPLEX GROUNDED RECEPTACLE
DIA	DIAMETER
DISC	DISCONNECT
DIST	DISTRIBUTION
DIV	DIVISION
DN	DOWN
DO	DRAWOUT
DPDT	DOUBLE POLE DOUBLE THROW
DPST	DOUBLE POLE SINGLE THROW
DS	DISCONNECT SWITCH
DT	DUST TIGHT
DWG	DRAWING
E	EXISTING TO REMAIN
EC	ELECTRICAL CONTRACTOR
EF	EXHAUST FAN
ELEC	ELECTRIC
EM	EMERGENCY
EMT	ELECTRIC METALLIC TUBING
EP	EXPLOSION PROOF
EPO	EMERGENCY POWER OFF DEVICE
EQ	EQUAL
EQUIP	EQUIPMENT
ER	EXISTING TO BE RELOCATED
ESS	ENERGY STORAGE SYSTEM
EUH	ELECTRIC UNIT HEATER
EWC	ELECTRIC WATER COOLER
EWH	ELECTRIC WATER HEATER
EX	EXISTING
F	FUSE
F&I	FURNISH AND INSTALL
FA	FIRE ALARM
FAAP	FIRE ALARM ANNUNCIATOR PANEL
FACP	FIRE ALARM CONTROL PANEL
FB	FLOORBOX
FBO	FURNISHED BY OTHERS
FCU	FAN COIL UNIT
FDC	FIRE DEPARTMENT CONNECTION
FDR	FEEDER
FIXT	FIXTURE
FLA	FULL LOAD AMPS
FLR	FLOOR
FLUOR	FLUORESCENT
FPB	FAN POWERED BOX
FPC	FIRE PUMP CONTROLLER
F.S.	FUSED SWITCH
FT	FOOT/FEET
FU	FUSE
FVNR	FULL VOLTAGE, NON REVERSING (MAGNETIC STARTER)
G	GROUND
GEN	GENERATOR
GFI	GROUND FAULT INTERRUPTER
GFP	GROUND FAULT PROTECTION
GHW	GALVANIZED HEAVY STEEL CONDUIT
GND	GROUND
GRD	GROUND
GRS	GALVANIZED RIGID STEEL CONDUIT
H	HEIGHT-MOUNTED ABOVE COUNTER
HOA	HAND-OFF-AUTO
HP	HORSE POWER
HPS	HIGH PRESSURE SODIUM
HR	HOUR
HV	HIGH VOLTAGE
HZ	HERTZ
IC	INTERRUPTING CAPACITY
IG	ISOLATED GROUND
IMC	INTERMEDIATE STEEL CONDUIT
IN	INCH(ES)
INC	INCANDESCENT
INV	INVERTER
JB	JUNCTION BOX
JPC	JOCKEY PUMP CONTROLLER
KCMIL	THOUSAND CIRCULAR MILS WIRE CROSS SECTION AREA
KO	KNOCKOUT
KVA	KILOVOLT-AMPERE
KW	KILOWATT
KWH	KILOWATT-HOUR
LB	POUND
LCP	LIGHTING CONTROL PANEL
LL	LOW LIMIT RELAY
LS	LOUD SPEAKER
LTG	LIGHTING
LV	LOW VOLTAGE
M	MOTOR
MAX	MAXIMUM
MC	MECHANICAL CONTRACTOR
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCP	MAXIMUM CIRCUIT PROTECTION
MDF	MAIN DISTRIBUTION FRAME
MECH	MECHANICAL
MED	MEDIUM
MERC	MERCURY VAPOR
MFR	MANUFACTURER
MH	MANHOLE
MIN	MINIMUM
MLO	MAIN LUGS ONLY
MOCP	MAXIMUM OVERCURRENT PROTECTION
MSB	MAIN SWITCHBOARD
MTD	MOUNTED
MTR	MOTOR
MV	MULTI-VAPOR
N	NEUTRAL
N/A	NOT APPLICABLE
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRIC CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION
NEUT	NEUTRAL
NF	NON-FUSED
NIC	NOT IN CONTRACT
NL	NIGHT LIGHT
NO	NORMALLY OPEN
NTS	NOT TO SCALE
O/H	OVERHEAD
OL	OVERLOAD
OPT	OPTIMIZER
P	POLE
PA	PUBLIC ADDRESS
PB	PULL BOX
PF	POWER FACTOR
PH	PHASE
PNL	PANEL
PR	PAIR
PRI	PRIMARY
PROT	PROTECTION/PROTECTIVE
PRV	POWER ROOF VENTILATOR
PT	POTENTIAL TRANSFORMER
PWR	POWER
R	RESISTANCE
RC	REMOTE CONTROL
RECP	RECEPTACLE
REQ'D	REQUIRED
RLP	RELAY LIGHTING PANEL
RT	RAINTIGHT
S	SWITCH
SC	SHORT CIRCUIT
SE	SWITCH EMERGENCY
SEC	SECONDARY
SF	SQUARE FOOT/FEET
SGR	SINGLE GROUNDED RECEPTACLE
SP	SINGLE POLE
SPD	SURGE PROTECTIVE DEVICE
SPDT	SINGLE POLE DOUBLE THROW
SPEC	SPECIFICATION
SPKR	SPEAKER
SPO	SPECIAL PURPOSE OUTLET
SPST	SINGLE POLE SINGLE THROW
SQ FT	SQUARE FOOT/FEET
SS	STAINLESS STEEL
STA	STATION
STD	STANDARD
SW	SWITCH
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYM	SYMMETRICAL
SYS	SYSTEM
TBPP	TEXAS BACKUP POWER PACKAGE
TTC	TERMINAL CABINET
TCP	TEMP. CONTROL PANEL
TEL	TELEPHONE
TEL CL	TELEPHONE CLOSET
TEMP	TEMPERATURE
TERM	TERMINAL
TL	TWIST LOCK
TR	TRANSFORMER
TTC	TELEPHONE TERMINAL CABINET
TV	TELEVISION
TX	TRANSFORMER
TYP	TYPICAL
UC	UNDER COUNTER
UE	UNDERGROUND ELECTRICAL
UG	UNDERGROUND
UH	UNIT HEATER
UL	UNDERWRITER'S LABORATORY
UNG	UNGROUNDED
UNO	UNLESS NOTED OTHERWISE
UPS	UNINTERRUPTIBLE POWER SOURCE
V	VOLT
VA	VOLT-AMPERE
VDT	VIDEO DISPLAY TERMINAL
VERT	VERTICAL
VFD	VARIABLE FREQUENCY DRIVE
VIF	VERIFY IN FIELD
VOL	VOLUME
VP	VAPOR PROOF
VT	VAPOR TIGHT
W	WATT
W/	WITH
WP	WEATHERPROOF
WT	WATER TIGHT
XFMR	TRANSFORMER
XR	EXISTING TO BE REMOVED
XRL	EXISTING TO BE RELOCATED
30cd	"30cd" INDICATES VISUAL STROBE LIGHT CANDELA

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ISSUES & REVISIONS

THE INFORMATION CONTAINED ON THESE DRAWINGS IS FOR USE ON THIS PROJECT ONLY

Project:
TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
LEGENDS AND ABBREVIATIONS

Date: 01/21/2025 Proj. No: 22483.005

PROJECT PHASE

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Sheet No:
E1.01

Sheet of

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FILE NAME: P:\Jobs\Public Utility Commission of Texas (PUCT)\22483.005 Backup Power Package Design\11_Drawings\11.3_Electrical\1.01 Legends and Abbreviations.dwg LAYOUT NAME: E1.01 PLOTTED: Monday, January 20, 2025 - 8:24am USER: AMOO4

SPECIFICATIONS

GENERAL NOTES:

THE CONTRACTOR SHALL:

1. PROVIDE ALL LABOR, MATERIALS, EQUIPMENT AND TOOLS REQUIRED FOR THE COMPLETE EXECUTION OF THE ELECTRICAL WORK AS SHOWN ON THE DRAWINGS.
2. PROVIDE ALL ADDITIONAL WORK NOT SPECIFICALLY SHOWN OR SPECIFIED YET REQUIRED TO ENSURE PROPER AND COMPLETE OPERATION OF ALL SYSTEMS, TO SATISFY THE DESIGN INTENT, AND TO COMPLY WITH ALL APPLICABLE CODES AND REGULATIONS.
3. ENSURE ALL LABOR IS PERFORMED BY EXPERIENCED PERSONS OF THE PROPER TRADE. ALL WORKMANSHIP SHALL BE FIRST CLASS, AND SHALL BE IN COMPLIANCE WITH THE SPECIFIC REQUIREMENTS OF THE CONTRACT DRAWINGS, AS WELL AS ALL APPLICABLE SAFETY CODES AND STANDARDS.
4. NOTIFY THE ENGINEER IN WRITING OF ALL DRAWING DISCREPANCIES PRIOR TO SUBMISSION OF BIDS.
5. PERFORM ALL WORK IN ACCORDANCE WITH THE LATEST ADOPTED EDITION OF THE CODES INDICATED ON T1.01, AS WELL AS THE FOLLOWING:
   - ALL LOCAL CODES, ORDINANCES, REGULATIONS;
   - THE AUTHORITY HAVING JURISDICTION.
6. ENSURE ALL MATERIALS PROVIDED ARE NEW, FREE OF DEFECTS, AND ARE UL LISTED FOR THE INTENDED APPLICATION. ALL ELECTRICAL MATERIALS, INSTALLATION AND SYSTEMS SHALL MEET THE REQUIREMENTS OF THE FOLLOWING STANDARDS, INCLUDING THE LATEST ADDENDA AND AMENDMENTS:
   - AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
   - ELECTRONIC INDUSTRY ASSOCIATION (EIA)
   - INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
   - NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION, (NECA)
   - NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATIONS (NEMA)
   - NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
   - OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA)
   - TELECOMMUNICATION INDUSTRY ASSOCIATION (TIA)
   - UNDERWRITER'S LABORATORIES, INC. (UL)
7. ENSURE THE ELECTRICAL DRAWINGS ARE NOT TO BE SCALED. CONTRACTOR SHALL TAKE MEASUREMENTS AND MAKE LAYOUTS AS REQUIRED FOR THE PROPER INSTALLATION AND COMPLETION OF THE WORK. WHERE SPECIFIC DETAILS AND DIMENSIONS ARE NOT SHOWN ON THE DRAWINGS,
8. OBTAIN ALL NECESSARY PERMITS, ARRANGE ALL REQUIRED INSPECTIONS, AND PAY ALL FEES AND CHARGES INCIDENTAL THERETO.
9. INSPECT SITE FOR FIELD VERIFICATION OF ALL ASPECTS OF THE PROJECT PRIOR TO BIDDING. SUBMISSION OF A BID CONSTITUTES ACCEPTANCE OF FIELD CONDITIONS.
10. INSTALL WORK AS REQUIRED TO FIT STRUCTURE, AVOID OBSTRUCTIONS, AVOID OR PROVIDE PROTECTION IN AREAS SUBJECT TO DAMAGE, RETAIN CLEARANCE, HEADROOM, OPENINGS AND PASSAGEWAYS.
11. INSTALL ALL MATERIALS AND EQUIPMENT AND COMPLETE ALL WORK IN A NEAT AND WORKMANLIKE MANNER, AND IN ACCORDANCE WITH BEST-IN-CLASS MODERN METHODS AND PRACTICES. ANY MATERIALS INSTALLED WHICH DO NOT PRESENT AN ORDERLY AND REASONABLY NEAT AND/OR WORKMANLIKE APPEARANCE, OR DO NOT ALLOW ADEQUATE SPACE FOR MAINTENANCE, SHALL BE REMOVED AND REPLACED WHEN SO DIRECTED BY THE ENGINEER.
12. COMMISSION EACH ITEM OF EQUIPMENT IN STRICT ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS; OR WHERE NOTED UNDER EQUIPMENT SPECIFICATION. COMMISSIONING SHALL BE PERFORMED BY QUALIFIED MANUFACTURER'S REPRESENTATIVE.
13. THE CONTRACT DRAWINGS ARE DIAGRAMMATIC IN NATURE AND INDICATE THE GENERAL ARRANGEMENT OF CIRCUITS AND OUTLETS, LOCATION OF SWITCHES, PANELBOARDS, CONDUITS, AND OTHER WORK. CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS AND LOCATIONS PRIOR TO INSTALLATION OF WORK.
14. THE ELECTRICAL CIRCUITS, COMPONENTS, AND CONTROLS ARE SELECTED AND SIZED FOR THE EQUIPMENT SPECIFIED AND OR SHOWN. IF SUBSTITUTIONS AND/OR EQUIVALENT EQUIPMENT ARE FURNISHED, IT SHALL BE THE RESPONSIBILITIES OF ALL PARTIES CONCERNED, INVOLVED IN AND FURNISHING THE SUBSTITUTE AND/OR EQUIVALENT EQUIPMENT TO VERIFY AND COMPARE THE ELECTRICAL CHARACTERISTICS OF THAT FURNISHED TO THAT SHOWN.
15. FIELD COORDINATE EXACT ELECTRICAL CONNECTION POINTS TO EQUIPMENT PRIOR TO ROUGH IN OF ELECTRICAL COMPONENTS.
16. FIELD COORDINATE EXACT ROUTING OF CONDUIT. SPECIFIED CONDUIT RUNS ARE SHOWN DIAGRAMMATICALLY ONLY.
17. FURNISH AND INSTALL ALL RACEWAYS, BOXES, ENCLOSURES, AND CABINETS IN ACCORDANCE WITH MANUFACTURER'S WRITTEN INSTRUCTIONS.
16. FURNISH AND INSTALL ALL CHANNEL AND ANGLE SUPPORTING SYSTEMS, HANGERS, ANCHORS, SLEEVES, BRACKETS, FABRICATED ITEMS, AND HARDWARE AS REQUIRED TO PROVIDE SECURE SUPPORT, PER NATIONAL ELECTRICAL CODE.
17. MAINTAIN, ON THE JOBSITE, ONE SET OF UP TO DATE AS-BUILT ELECTRICAL DRAWINGS. AS-BUILTS SHALL BE KEPT IN GOOD CONDITION. CONTRACTOR SHALL PROGRESSIVELY, NEATLY, LEGIBLY AND EXACTLY RECORD ON THESE DRAWINGS ALL DEVIATIONS FROM THE ORIGINAL DRAWINGS, INCLUDING THE ROUTING OF ALL CONCEALED CONDUIT RUNS, AND ALL WORK WHICH IS INSTALLED IN A DIFFERENT LOCATION OR MANNER THAN INDICATED ON THE DRAWINGS. RECORD COPIES OF THESE PLANS SHALL BE SUBMITTED TO THE ENGINEER AND THE OWNER UPON PROJECT CLOSE-OUT.
18. PROVIDE A FULL ONE YEAR WARRANTY ON ALL ELECTRICAL LABOR, EQUIPMENT AND MATERIALS INSTALLED ON THIS PROJECT, STARTING FROM THE ISSUANCE OF THE OWNER'S CERTIFICATE OF COMPLETION, EXCEPT AS FOLLOWS:
   - 18.1. SOLAR MODULES
     - 18.1.1. 15 YEARS MATERIALS AND WORKMANSHIP
     - 18.1.2. 25 YEARS LINEAR POWER PRODUCTION
   - 18.2. INVERTERS
     - 18.2.1. 12 YEARS MATERIALS AND WORKMANSHIP
   - 18.3. DC DISCONNECT SWITCHES
     - 18.3.1. 5 YEARS MATERIALS AND WORKMANSHIP
19. ALL CONNECTIONS OF DISSIMILAR METALS SHALL BE MADE TO MINIMIZE GALVANIC ACTION, CORROSION OR ELECTROLYSIS. ALL CONNECTORS, CONNECTION HARDWARE, CONDUCTORS, AND CONNECTION METHODS SHALL ENSURE THAT METALS IN DIRECT CONTACT ARE GALVANICALLY COMPATIBLE.
20. AFTER INSTALLATION OF ALL CONDUCTORS, CONTRACTOR SHALL COMPLETELY SEAL OFF ALL CONDUIT ENDS TO PREVENT THE POSSIBILITY OF ANY MOISTURE FROM ENTERING ANY ELECTRICAL ENCLOSURE. ALL USED AND UNUSED OPENINGS IN ALL EQUIPMENT, BOXES, AND ENCLOSURES SHALL BE SEALED WEATHERTIGHT WITH A MATERIAL THAT WILL ALSO PREVENT INSECT INCURSION.

SUBMITTALS:

1. CONTRACTOR SHALL SUBMIT MANUFACTURER CUT SHEETS AND CATALOG DATA FOR ALL MATERIALS, CLEARLY INDICATING THE SPECIFIC PART OR PRODUCT CATALOG NUMBER(S) TO BE USED. ITEMS REQUIRING SIGNIFICANT LEAD TIME SHOULD BE SUBMITTED AS SOON AS POSSIBLE. ELECTRONICALLY SUBMIT 1 COPY OF ALL REQUESTED INFORMATION TO THE ENGINEER, NEATLY INDEXED PER CATEGORY, FOR THE FOLLOWING ITEMS:
   - A. SWITCHBOARDS, PANELBOARDS, AC DISCONNECT SWITCHES.
   - B. CONDUIT, RACEWAYS, WIREWAYS, ENCLOSURES, BOXES, FITTINGS, SUPPORTS AND HARDWARE.
   - C. CONDUCTORS, BOTH DC AND AC.
   - D. LIGHT FIXTURES, RECEPTACLES, SWITCHES AND ASSOCIATED ACCESSORIES.
   - E. EV CHARGING STATION(S) AND ACCESSORIES.
   - F. PHOTOVOLTAIC INVERTERS AND ASSOCIATED CONTROL SYSTEMS.
   - G. PHOTOVOLTAIC MODULES.
   - H. DC PHOTOVOLTAIC COMBINER BOXES, SPLICE BOXES AND DISCONNECT SWITCHES.
   - I. METERING AND COMMUNICATIONS EQUIPMENT.
2. FOR ALL OWNER-FURNISHED EQUIPMENT, CONTRACTOR SHALL SUBMIT A COPY OF ALL INSTALLATION, COMMISSIONING AND PROGRAMMING DATA AND/OR SETTINGS, INCLUDING PASSWORD AND LOGIN DATA. CONTRACTOR SHALL ELECTRONICALLY SUBMIT 1 COPY TO THE ENGINEER.

MODULES:

1. CONTRACTOR SHALL RECEIVE, INSPECT, UNLOAD AND INSTALL ALL SOLAR PHOTOVOLTAIC MODULES. ALL MODULES DAMAGED DURING SHIPPING SHALL BE REFUSED AND SHALL NOT BE INSTALLED. COORDINATE SPECIFIC SCOPE REQUIREMENTS DURING BIDDING.
2. MODULES SHALL BE INSTALLED, SECURED, AND MECHANICALLY GROUNDED TO THE RACKING SYSTEM AND EACH OTHER PER THE MANUFACTURER'S WRITTEN INSTALLATION INSTRUCTIONS AND PER UL LISTING TO ENSURE ELECTRICAL CONTINUITY.
3. CONTRACTOR SHALL NOT PLACE ANY TOOLS, EQUIPMENT OR OTHER WEIGHT (INCLUDING BODYWEIGHT) ON THE SURFACE PORTION OF ANY MODULE. CONTRACTOR SHALL PROMPTLY REPORT MODULE DAMAGE, INCLUDING MICRO-FRACTURES, AND SHALL IMMEDIATELY REPLACE THE DAMAGED MODULE WITH A NEW, UNDAMAGED MODULE AT CONTRACTOR'S EXPENSE.

INVERTERS:

1. CONTRACTOR SHALL RECEIVE, UNLOAD AND INSTALL ALL INVERTERS, ASSOCIATED EQUIPMENT AND ACCESSORIES. COORDINATE SPECIFIC SCOPE REQUIREMENTS DURING BIDDING.
2. INVERTERS SHALL BE NEW, UTILITY GRADE, FROM A REPUTABLE MANUFACTURER, AND SHALL BE SPECIFICALLY DESIGNED FOR GRID-TIED PHOTOVOLTAIC INSTALLATIONS.
3. INVERTERS SHALL MEET THE FOLLOWING MINIMUM STANDARDS: UL 1741 SA STANDARD FOR INVERTERS, CONVERTERS, CONTROLLERS AND INTERCONNECTION SYSTEM EQUIPMENT FOR USE WITH DISTRIBUTED ENERGY RESOURCES. IEEE 929-2000 - RECOMMENDED PRACTICE FOR UTILITY INTERFACE OF PHOTOVOLTAIC (PV) SYSTEMS.
4. COORDINATE SPECIFIC SCOPE REQUIREMENTS DURING BIDDING.
5. INVERTERS SHALL BE INSTALLED, SECURED, WIRED, TESTED AND GROUNDED PER THE MANUFACTURER'S WRITTEN INSTALLATION INSTRUCTIONS.
6. CONTRACTOR SHALL CONFIGURE ALL INVERTER PROTECTION AND COMMUNICATIONS SETTINGS IN COMPLIANCE WITH LOCAL UTILITY STANDARDS, AHJ REQUIREMENTS, AND SHALL COORDINATE WITH OWNER'S REPRESENTATIVE TO PROVIDE MONITORING ACCESS.

ENCLOSURES:

1. ALL ELECTRICAL EQUIPMENT ENCLOSURES SHALL BE SPECIFIED AND INSTALLED IN ACCORDANCE WITH NEMA STANDARDS AND TYPE NUMBER AND SHALL BE SUITABLE FOR THE LOCATION CONDITIONS.
2. ALL EXTERIOR ELECTRICAL EQUIPMENT ENCLOSURES SHALL BE MINIMUM TYPE NEMA 4X. THIS SHALL INCLUDE BUT NOT BE LIMITED TO SWITCHBOARDS, DISTRIBUTION PANELS, CONTROL CABINETS, PULL BOXES, JUNCTION BOXES, DISCONNECT SWITCHES, COMBINER BOXES, WIREWAYS, ETC.
3. ALL ENCLOSURES SHALL BE PROVIDED WITH PADLOCKING PROVISIONS OR EQUIVALENT.
4. ALL SOLAR PHOTOVOLTAIC MODULES AND OTHER MATERIALS ENCLOSURES, INCLUDING LARGE CONTRACTOR INSTALLED ELECTRICAL EQUIPMENT (INCLUDING SWITCHBOARDS, DISTRIBUTION PANELS, CONTROL CABINETS, PULL BOXES, JUNCTIONS BOXES, COMBINER BOXES, AND INVERTERS) SHALL BE ENTIRELY LOCATED AT OR ABOVE THE EQUIPMENT ELEVATION SHOWN, UNLESS OTHERWISE APPROVED BY OWNER. CONTRACTOR SHALL PROVIDE SAFE EGRESS IN COMPLIANCE WITH OSHA AND CUSTOMER STANDARDS TO ALLOW FOR ACCESS TO SUCH EQUIPMENT ENCLOSURES FOR OPERATIONS AND MAINTENANCE RESPONSIBILITIES. SUCH EGRESS FEATURES SHALL INCLUDE BUT NOT BE LIMITED TO STAIRS, LADDERS, HANDRAILS, TIE-OFF POINTS, ETC.

AC SYSTEM WIRING:

1. ALL CONDUCTORS, LUGS AND CABLE ACCESSORIES SHALL BE NRTL LISTED TO APPLICABLE UL STANDARDS.
2. ALL LOW VOLTAGE AC WIRING SHALL UTILIZE COPPER CONDUCTORS WITH INSULATION AS NOTED ON THE PLANS.
3. AC WIRING FROM INVERTERS TO AC COMBINER SHALL BE XHHW-2 AND AC LOW VOLTAGE WIRING BETWEEN AC MAIN CB AND EQUIPMENT LOW VOLTAGE TERMINALS SHALL BE COPPER TYPE XHHW-2, 600V.
4. ALL CONDUCTORS INSTALLED BELOW THE EQUIPMENT ELEVATION (AND THEREFORE INCLUDES CONDUCTORS BELOW GRADE) MUST BE LISTED FOR USE IN WET LOCATIONS (PER NEC AND UL DEFINITIONS, INCLUDING SUBMERSION), AND BE OF A CORROSION RESISTANT DESIGN.
5. ALL CONDUCTORS SHALL BE SIZED IN ACCORDANCE WITH CURRENT NEC CODE REQUIREMENTS.
6. CONDUCTORS SHALL HAVE INTEGRAL COLORING OR COLORED HEAT SHRINK SLEEVE AT ALL TERMINATIONS TO INDICATE GROUNDED CONDUCTORS, EQUIPMENT GROUNDING CONDUCTORS, AND AC PHASE CONDUCTORS. COLOR CODING SHALL BE AS FOLLOWS:
   - PHASE A: BROWN (480VAC), BLACK (208VAC)
   - PHASE B: ORANGE (480VAC), RED (208VAC)
   - PHASE C: YELLOW (480VAC), BLUE (208VAC)
   - NEUTRAL: GRAY (480VAC), WHITE (120-208VAC)
   - GROUND: GREEN WITH STRIPE OR BARE
6. ALL LUGS AND CONNECTORS SHALL BE 90C RATED, UL LISTED AND DESIGNATED FOR USE WITH THE CONDUCTOR BEING CONNECTED.
7. LUGS AND CONNECTORS USED TO TRANSITION FROM COPPER TO ALUMINUM WIRE SHALL BE LISTED AND RATED FOR SUCH USE. APPLY ANTI-OXIDANT COATING MATERIAL TO ALL ALUMINUM TERMINATIONS.
8. ALL AC POWER CONDUCTOR TERMINATIONS SHALL BE IRREVERSIBLE, DOUBLE CRIMP, LONG BARREL, TWO BOLT COMPRESSION TYPE LUGS RATED AT 90C AND APPROVED BY THE EQUIPMENT MANUFACTURER OR SUPPLIER. WHERE NOT POSSIBLE, SINGLE BOLT COMPRESSION LUGS MAY BE USED. MECHANICAL SET SCREW TERMINATIONS ARE APPROVED FOR EQUIPMENT TERMINATIONS WITH FACTORY INSTALLED MECHANICAL LUGS. ALL CRIMPED CONNECTIONS MUST BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS. COAT CONDUCTOR WITH DIELECTRIC GREASE PRIOR TO CRIMPING.
9. PROVIDE A MAXIMUM OF TWO STACKABLE COMPRESSION LUGS WHEN MORE THAN ONE COMPRESSION LUG NEEDS TO BE TERMINATED AT A SINGLE SET OF BUS BAR HOLES.
10. NO SPLICING OF ANY WIRES WITHOUT WRITTEN CONSENT OF OWNER. ALL UNDERGROUND WIRING SHALL BE CONTINUOUS WITHOUT SPLICES.
11. ALL SINGLE PHASE POWER CIRCUITS SHALL HAVE A DEDICATED NEUTRAL.
12. CLASS 1 AND CLASS 2 CONTROL CIRCUITS SHALL BE TYPE THHN/THWN, INSTALLED IN RACEWAY.
13. TERMINAL SCREW TORQUE SPECS PER MANUFACTURER TO BE FOLLOWED AND WITNESSED BY QA.

DC SYSTEM WIRING:

1. ALL CONDUCTORS SHALL BE SIZED IN ACCORDANCE WITH CURRENT NEC CODE REQUIREMENTS, INCLUDING TEMPERATURE RATING, AND OWNER SPECIFIED VOLTAGE DROP.
2. ALL CONDUCTORS INSTALLED BELOW THE EQUIPMENT ELEVATION (AND THEREFORE INCLUDES CONDUCTORS BELOW GRADE) MUST BE LISTED FOR USE IN WET LOCATIONS (PER NEC AND UL DEFINITIONS, INCLUDING SUBMERSION), AND BE OF A CORROSION RESISTANT DESIGN.
3. ALL SOLAR DC STRING AND STRING TO DC COMBINER BOXES, AND BESS DC CONDUCTORS AND CABLES SHALL BE COPPER TYPE "PV-2", 2000VDC, 90'C (WET OR DRY), UV RESISTANT, COPPER WIRE, UL 4703. DC CONDUCTORS FROM DC BOXES TO INVERTERS SHALL BE COPPER.
4. FURNISH STRANDED WIRE FOR SIZES #8 AND LARGER UNLESS OTHERWISE NOTED. MINIMUM CONDUCTOR SIZE SHALL BE AWG #12.
5. ALL WIRES AND CABLE SHALL HAVE UV RESISTANT AND OUTDOOR RATED WRAP-AROUND LAMINATING VINYL MACHINE PRINTED ID LABELS OR OTHER APPROVED LABELING METHOD INDICATING DESIGNATION AND POLARITY. CONDUCTORS SHALL HAVE INTEGRAL COLORING OR A COLORED OUTDOOR RATED HEAT SHRINK SLEEVE AT ALL TERMINATIONS TO INDICATE GROUNDED CONDUCTORS, EQUIPMENT GROUNDING CONDUCTORS AND CURRENT-CARRYING CONDUCTORS, PER NEC REQUIREMENTS AND INDUSTRY STANDARDS. COLOR CODING SHALL BE AS FOLLOWS:
   - PV POSITIVE (+): RED
   - PV NEGATIVE (-): BLACK
   - GROUND: GREEN WITH STRIPE OR BARE
6. SERIES STRING CONNECTIONS BETWEEN SOLAR PHOTOVOLTAIC MODULES SHALL BE VIA FACTORY-SUPPLIED TYPE "MC4" QUICK CONNECT CONNECTORS. FIELD INSTALLED QUICK CONNECT CONNECTORS SHALL BE OF THE SAME MAKE AND MODEL AS THOSE FACTORY SUPPLIED WITH THE MODULES. ALL MODULE CONNECTORS SHALL BE UL LISTED, NEC 690 COMPLIANT, LATCHING TYPE WITH POSITIVE LATCHING INDICATOR. CONNECTORS SHALL BE POLARIZED SUCH THAT POSITIVE AND NEGATIVE TERMINALS ARE NOT INTERCHANGEABLE.
7. STRING WIRING SHALL BE RATED FOR DIRECT SUNLIGHT EXPOSURE. STRING WIRING SHALL BE PROPERLY SUPPORTED TO RACK AND/OR MODULE FRAMES USING STAINLESS STEEL PV CABLE CLIPS, AND/OR OTHER OWNER-APPROVED WIRE MANAGEMENT METHOD. NYLON CABLE TIES SHALL NOT BE ALLOWED. PV CABLE CLIPS AND WIRE MANAGEMENT METHOD MUST BE APPROVED BY OWNER BEFORE INSTALLATION. ALL CABLES SHALL BE SECURED MINIMUM 24" ON CENTER AND 6" AT EACH END WHEN CHANGING DIRECTION. NO CABLE SHALL BE ALLOWED TO TOUCH THE SURFACE OF THE GROUND.
8. RUN WIRING UNDERNEATH MODULE FRAMES.
9. STRING WIRING SHALL ENTER ENCLOSURES THROUGH CONDUIT, CORD GRIPS, OR OTHER APPROVED METHOD THAT WILL PROPERLY SEAL THE PENETRATION AND UPHOLD THE WEATHERPROOF RATING OF THE ENCLOSURE OR BOX.
10. ON PROJECTS WITH COMBINERS, COMBINER OUTPUT FEEDERS SHALL BE COPPER, WITH THERMOSET XLPE INSULATION AND JACKET MATERIALS, NON-THERMOPLASTIC INSULATION. CABLE SHALL BE 2000V RATED, WET LOCATION, 90 C OR BETTER.
11. ALL POWER CONDUCTOR TERMINATIONS SHALL BE IRREVERSIBLE, DOUBLE CRIMP, LONG BARREL, TWO BOLT COMPRESSION TYPE LUGS RATED AT 90C WHERE APPROVED BY THE EQUIPMENT MANUFACTURER OR SUPPLIER. WHERE NOT POSSIBLE, SINGLE BOLT COMPRESSION LUGS MAY BE USED. MECHANICAL SET SCREW TERMINATIONS ARE APPROVED FOR COMBINER BOX TERMINATIONS ONLY. ALL CRIMPED CONNECTIONS MUST BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS.
12. ALL CONTROL AND INSTRUMENTATION CONDUCTORS SHALL BE TERMINATED BY CONTRACTOR.
13. ALL LUGS AND CONNECTORS SHALL BE 90C RATED, UL LISTED AND DESIGNATED FOR USE WITH THE CONDUCTOR BEING CONNECTED.
14. NO SPLICING OF ANY WIRES SHALL BE PERFORMED WITHOUT WRITTEN CONSENT FROM OWNER.
15. TERMINAL SCREW TORQUE SPECS PER MANUFACTURER TO BE FOLLOWED AND WITNESSED BY QA.

GROUNDING:

1. SOLAR MODULE EQUIPMENT GROUNDING CONNECTION SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S GUIDELINES AND APPLICABLE LISTINGS. MODULE FRAME GROUNDING HARDWARE SHALL BE LISTED TO UL3703 AND SPECIFIED BY MODULE MANUFACTURER AS ACCEPTABLE FOR USE WITH THE MODULE MODEL. WEEBS WILL BE CONSIDERED AN ACCEPTABLE MEANS OF GROUNDING BUT THEIR USE MUST BE AN APPROVED USE BY THE APPLICABLE MANUFACTURER(S). MANUFACTURER'S APPROVAL LETTER FOR THE SPECIFIC CASE MUST BE PROVIDED TO OWNER AND APPROVED BY OWNER, OTHERWISE A CONTINUOUS GROUND LOOP MUST BE INSTALLED.
2. METHODS THAT GROUND MODULE FRAMES BY UTILIZING THE RACKING AS THE GROUNDING MEANS SHALL BE LISTED TO UL 3703.
3. ALL BRANCH AND FEEDER CIRCUITS SHALL CONTAIN A GROUNDING CONDUCTOR, UNLESS OTHERWISE NOTED, AND BE SIZED AND BONDED IN ACCORDANCE WITH NEC ART. 250.
4. UNLESS OTHERWISE NOTED, GROUNDING CONDUCTORS SHALL BE COPPER. EQUIPMENT GROUNDING CONDUCTORS SHALL BE INSULATED WITH GREEN-COLORED INSULATION. UNDERGROUND CONDUCTORS SHALL BE BARE, TINNED, AND STRANDED. USE ONLY COPPER CONDUCTORS FOR BOTH INSULATED AND BARE GROUNDING CONDUCTORS IN DIRECT CONTACT WITH EARTH, CONCRETE, MASONRY, CRUSHED STONE AND SIMILAR MATERIALS. IN RACEWAYS, USE INSULATED EQUIPMENT GROUNDING CONDUCTORS. EXPOSED BARE EQUIPMENT GROUNDING CONDUCTORS WILL BE MINIMUM 6 AWG COPPER.
5. INSTALL INSULATED EQUIPMENT GROUNDING CONDUCTORS WITH CIRCUIT CONDUCTORS FOR THE FOLLOWING ITEMS, IN ADDITION TO THOSE REQUIRED BY NEC: FEEDERS AND BRANCH CIRCUITS; RECEPTACLE CIRCUITS; SINGLE-PHASE MOTOR AND APPLIANCE BRANCH CIRCUITS; THREE-PHASE MOTOR AND APPLIANCE BRANCH CIRCUITS; FLEXIBLE RACEWAY RUNS.
6. ALL NON-CURRENT CARRYING EXPOSED METAL PARTS OF SYSTEM JUNCTION BOXES, EQUIPMENT, MODULE FRAMES, SUPPORT RACKING, INVERTER CASES AND APPLIANCES IN THE ENTIRE ELECTRICAL SYSTEM THAT MAY BE ACCIDENTALLY ENERGIZED SHALL BE GROUNDED PER NEC 690.43 AND 690.45 AND SIZED PER 250.122.
7. GROUND LUGS SHALL BE MECHANICAL AND ACCEPTABLE FOR COPPER CONDUCTOR TERMINATION. LUGS SHALL BE SELECTED SO AS TO PREVENT GALVANIC CORROSION AND DISSIMILAR THERMAL EXPANSION OF LUGS AND CONDUCTORS.
8. TIN-PLATED COPPER LAY-IN GROUND LUGS OR CONDUIT GROUND CLAMPS SHALL BE PROVIDED FOR ALL METALLIC CONDUIT CARRYING POWER CONDUCTORS. SUCH MEANS OF GROUNDING SHALL NOT BE REQUIRED FOR METALLIC CONDUIT CARRYING COMMUNICATION CONDUCTORS.
9. ALL GROUND LUGS NOT INSTALLED IN AN ENCLOSURE MUST BE UL LISTED FOR DIRECT BURIAL.
10. ALL EQUIPMENT GROUNDING CONDUCTORS (EGC) AND GROUNDING ELECTRODE CONDUCTORS (GEC) SHALL BE SIZED IN ACCORDANCE WITH THE PROPER SECTIONS OF THE NEC.
11. METALLIC CONDUIT CONTAINING A GROUNDING ELECTRODE CONDUCTOR MUST BE BONDED AT BOTH ENDS.
12. ALL SOLAR AND BESS INVERTERS AND INTERCONNECTION SWITCHBOARDS SHALL UTILIZE A GROUNDING ELECTRODE SYSTEM CONSISTING OF A GROUND RING/GRID SIZED AND INSTALLED TO COMPLY WITH NEC AND IEEE STANDARDS. IF THE APPLICABLE GOVERNMENTAL AUTHORITY REQUIRES A GROUNDING CONDUCTOR TO BE EXTENDED FROM THE GROUND GRID TO THE EXISTING BUILDING STRUCTURE, SUCH WORK WILL BE INCLUDED IN SCOPE AT NO EXTRA COST TO OWNER.
13. EQUIPMENT GROUNDING CONDUCTORS SHALL BE ROUTED WITH ALL CIRCUIT AND PHASE CONDUCTORS.
14. ALL BELOW GRADE CONNECTIONS SHALL BE CRIMPED AND UL LISTED FOR DIRECT BURIAL APPLICATIONS.
15. GROUND RODS, IF REQUIRED, SHALL BE SECTIONAL TYPE; COPPER-CLAD STEEL, 3/4" IN DIAMETER BY 10' DRIVEN VERTICALLY.
16. PROVIDE MECHANICAL CONNECTIONS FOR CONNECTIONS TO STRUCTURAL STEEL AND FOR UNDERGROUND CONNECTIONS.
17. ALL EXPOSED GROUND CONNECTIONS TO EQUIPMENT SHALL BE CABLE LUGS WITH BOLTED/MECHANICAL ATTACHMENTS.
18. USE INSULATED COPPER EQUIPMENT GROUNDING CONDUCTORS FOR GROUNDING RACKING SYSTEMS WHEN ALUMINUM RACKING IS USED. BOND TO RACKING WITH CU-AL RATED LUGS PER RACKING MANUFACTURER'S REQUIREMENTS.
19. INSTALL #6 CU INSULATED BONDING JUMPERS BETWEEN ADJACENT RACKS PER MANUFACTURERS GROUNDING AND INSTALLATION DETAILS.
20. GROUNDING SCREWS SHOULD BE THREAD-FORMING OR HOT DIPPED, NOT THREAD CUTTING.

CONDUCTOR PROTECTION:

1. ALL ABOVE GROUND AC CABLES SHALL BE PROTECTED IN CONDUIT OR CABLE TRAYS, AS NOTED ON THE PLANS.
2. PULL AND JUNCTION BOXES SHALL BE PROVIDED WHERE REQUIRED TO FACILITATE THE INSTALLATION OF WIRING. BENDS IN CONDUITS BETWEEN PULL BOXES SHALL NOT EXCEED THE EQUIVALENT OF FOUR 90 DEGREE BENDS.
3. CONDUITS REQUIRING FIELD CUTTING SHALL BE CUT SQUARE AND DE-BURRED. CONDUIT END BELLS OR BUSHINGS SHALL BE PROVIDED TO PREVENT CABLE DAMAGE.
4. BENDS IN CONDUITS SHALL NOT DAMAGE RACEWAYS OR SIGNIFICANTLY CHANGE THE INTERNAL DIAMETER OF RACEWAYS (NO KINKS).
5. COMMUNICATIONS WIRING SHALL BE RUN IN SEPARATE CONDUITS FROM POWER CIRCUIT WIRING.
6. ALL AC BRANCH CIRCUIT WIRE SHALL BE INSTALLED IN RACEWAY, UNLESS OTHERWISE NOTED. MINIMUM SIZE SHALL BE 3/4".
7. ALL EXPOSED CONDUITS INSTALLED IN EXTERIOR LOCATIONS SHALL BE RGSC TYPE. RACEWAYS SHALL BE SUPPORTED BY APPROVED TYPES OF GALVANIZED SUPPORTS. USE STAINLESS STEEL HARDWARE AND CONDUIT STRAPS OUTDOORS. PAINT ALL EXPOSED MATERIALS TO MATCH EXISTING COLORS.
8. JOB CUT THREADS SHALL BE GIVEN A COAT OF RUST RESISTANT PAINT SUCH AS ZINC CHROMATE OR EQUAL.
9. WIRE TERMINATIONS AND SPLICES SHALL BE COMPLETED WITH THE APPROPRIATE UL LISTED HEAVY DUTY RATCHETING TYPE JAWS AND INTERCHANGEABLE DIES FOR PROPER CRIMPING OF TERMINALS. TERMINALS SHALL BE UN-INSULATED TYPE AND CORRECTLY SIZED FOR THE WIRE USED.
10. BLOCKS AND TERMINAL LUGS SHALL BE LISTED FOR THE APPROPRIATE CONDUCTOR MATERIAL.
11. AFTER INSTALLATION OF CONDUCTORS, ALL RACEWAYS SHALL BE SEALED WITH DUCTSEAL.

NOTE:

THESE SPECIFICATIONS ARE PROVIDED FOR GENERAL INSTALLATION AND EQUIPMENT REQUIREMENTS. REFER TO TBPP TECHNICAL SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS. SHOULD THERE BE ANY CONFLICTS BETWEEN THE SPECIFICATIONS HEREIN AND THAT OF THE TBPP, THE TBPP SPECIFICATIONS SHALL TAKE PRECEDENCE.

MONITORING:

THE CONTRACTOR SHALL:

1. FURNISH AND INSTALL ALL COMMUNICATIONS DEVICES NECESSARY TO BRING ALL TBPP AS WELL AS ALL PV SYSTEM DATA TO THE OWNER'S IT EQUIPMENT RACK. FINAL SYSTEM CONNECTIVITY TO BE DETERMINED BY OWNER.
2. FURNISH AND INSTALL AN RS485, 2C#16, SHIELDED, TWISTED PAIR CABLE BETWEEN EACH INVERTER AND A SYSTEM COMMUNICATIONS GATEWAY. (GATEWAY TO BE COMPATIBLE WITH SUPPLIED INVERTERS). GROUND SHIELD PER INVERTER MANUFACTURER'S REQUIREMENTS.
3. CONNECT COMMUNICATIONS GATEWAY ETHERNET OUTPUT TO OWNERS LAN SWITCH, IF AVAILABLE. ETHERNET CABLE SHALL HAVE RJ45 CONNECTORS AT EACH END. ETHERNET CABLE SHALL BE CONSISTENT WITH OWNERS LAN (CAT5e OR CAT6).
4. A TBPP CONTROLLER SHALL BE PROVIDED AND SHALL CONTROL THE ENTIRE TBPP PACKAGE IN A COORDINATED MICROGRID FASHION INCLUDING CONTROLLING THE OUTPUT OF GENSET, SOLAR PV ARRAY AND BESS TO MINIMZE FUEL USAGE AT THE GENSET AND MAXIMIZE THE USE OF THE SOLAR AND BESS TO POWER THE CF. THE CONTROLLER SHALL MAINTAIN POWER OUTPUT TO THE CF FOR A PERIOD OF 48 HOURS.

MISCELLANEOUS:

1. ALL EXTERIOR MOUNTING HARDWARE USED SHALL BE STAINLESS STEEL, SIZED PER SYSTEM MANUFACTURER'S RECOMMENDATIONS. USE ANTI-SEIZE FOR EACH CONNECTION.
2. STRUT TYPE SWITCH RACKS AND SUPPORTS MAY BE GALVANIZED STEEL OR ALUMINUM.
3. PANELBOARDS SHALL BE FULLY RATED TO INTERRUPT SYMMETRICAL SHORT-CIRCUIT CURRENT AVAILABLE AT TERMINALS. PANELBOARDS SHALL UTILIZE CIRCUIT-BREAKER TYPE OCPD's AND ALL PHASE AND GROUND BUSSES SHALL BE COPPER.
4. UNLESS OTHERWISE NOTED, ALL ENCLOSURES FOR OUTDOOR EQUIPMENT SHALL BE NEMA 3R RATED. ENCLOSURES. ENCLOSURES FOR INDOOR EQUIPMENT SHALL BE NEMA 1 RATED.
5. CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL SPOILS FROM THE PROJECT SITE. CONTRACTOR SHALL PROVIDE DUMPSTERS OR OTHER CONTAINERS AS REQUIRED, AND SHALL COORDINATE LOCATIONS AND PICKUP SCHEDULES WITH THE OWNER TO MINIMIZE INTERRUPTION.

COMMISSIONING:

1. CONTRACTOR SHALL PERFORM START-UP AND COMMISSIONING UPON COMPLETION OF INSTALLATION OF THE TBPP AT THE CRITICAL FACILITY. TO SUCCESSFULLY COMMISSION THE TBPP, CONTRACTOR MUST ENSURE A COMPLETE INSTALLATION, APPROPRIATE CONFIGURATION, AND MUST DEMONSTRATE THAT THE TBPP PERFORMS IN ITS FULL, PROPER OPERATING CONDITION. CONTRACTOR SHALL RECORD ALL MEASURED DATA AND PROVIDE OWNER AND ENGINEER WITH A DETAILED REPORT REGARDING ANY ISSUES THAT CONTRACTOR DISCOVERS DURING SUCH PERFORMANCE TESTING.
2. PROVIDE FINAL CLEANUP AND CONDUCT FIELD TESTS AFTER INSTALLATION OF ALL ELECTRICAL WORK. ADJUST ITEMS TO THE SATISFACTION OF THE OWNER AND ENGINEER. LEAVE ALL EQUIPMENT INTERIORS CLEAN AND FREE FROM CONSTRUCTION DEBRIS. NEATLY DRESS ALL WIRING, AND RE-TIGHTEN ALL TERMINATIONS PER MANUFACTURERS' RECOMMENDATIONS.
3. AS A CONDITION OF ACHIEVING SUBSTANTIAL COMPLETION, CONTRACTOR SHALL COMPLETE ALL ITEMS IDENTIFIED IN THE PUNCHLIST. PUNCHLIST SHALL BE PREPARED BY OWNER AND OWNER'S ENGINEER.

REQUESTS FOR INFORMATION:

UNLESS SPECIFIED DIFFERENTLY IN THE CONTRACT DOCUMENTS:

FOR THOSE PROJECTS WHERE TBPP VENDOR IS THE PRIME CONSULTANT, ALL QUESTIONS OR REQUESTS FOR INFORMATION (RFI) SHALL BE SUBMITTED IN WRITING DIRECTLY TO THE VENDOR. PLEASE INCLUDE: 1) DATE; 2) THE PROJECT NAME; 3) FIRM NAME; 4) YOUR NAME ; 5) DRAWING NUMBER, DATE AND REVISION NUMBER &/OR SPECIFICATION SECTION REFERENCE; AND 6) ADEQUATE SPACE FOR REPLY.

UNDOCUMENTED PHONE CALLS TO VENDOR SHALL NOT BE USED AS A BASIS FOR ANY FUTURE CLAIMS.

WIRING AND WIRING METHODS:

1. IF APPLICABLE, PV MODULES SHALL FOLLOW SKIP STRINGING WITH TYPICAL WIRE MANAGEMENT PRACTICES. ALL CONNECTORS SHALL BE MANUFACTURER & ENGINEER APPROVED.
2. HOMERUNS FROM THE STRINGS BACK TO THE DC COMBINERS, AND FROM THE COMBINERS BACK TO THE INVERTERS, SHALL BE SIZED AS NOTED ON THE PLANS. ALL HOMERUNS SHALL BE MINIMUM #10 AWG. PROVIDE #10 AWG GREEN GROUNDING CONDUCTOR WITH EACH STRING. NO STRING CABLE LENGTH (ROUND-TRIP) SHALL EXCEED 1000'.

UTILITY COORDINATION

1. IT WILL BE THE RESPONSIBILITY OF THE CONTRACTOR TO COORDINATE ITS WORK WITH THE CF OWNER AND SERVING UTILITY.
2. IT MAY BE NECESSARY FOR THE SERVING UTILITY TO INSTALL REVENUE METERING AND UTILITY RELAYING AND RECLOSER. THE CONTRACTOR SHALL COORDINATE ITS WORK WITH THIS EFFORT WITH THE SEERVING UTILITY AND OWNER.

MARKING OR LABELING

1. SHALL COMPLY WITH NEC 2023, PART VI OF SECTION 690, FOR SOLAR PV SYSTEMS.
2. FOR LOW VOLTAGE AC AND ALL DC MAIN DISCONNECTS, PROVIDE LABELS:

   WARNING
ELECTRIC SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH THE LINE AND LOAD SIDES
MAY BE ENERGIZED IN THE OPEN POSITION

3. FOR MAIN AC DISCONNECT, ALSO PROVIDE THE FOLLOWING LABEL:

   PLACE THIS SWITCH IN THE
"OFF" POSITION TO SHUTDOWN PV
SYSTEM AND REDUCE SHOCK HAZARD
IN THE ARRAY.

4. FOR NEW AC COMBINER AND OCPD PANELS, PROVIDE LABEL:

   WARNING
MULTIPLE POWER SOURCES

TYPICAL TBPP EQUIPMENT LIST:

1. EQUIPMENT SHALL BE AS INDICATED BELOW UNLESS OTHERWISE APPROVED BY OWNER:
   - 1.1. TRANSFORMER (IF REQUIRED TO MEET CF OPERATING VOLTAGE
   - 1.2. INVERTERS
   - 1.3. DC COMBINERS
   - 1.4. AC SWITCHBOARDS
   - 1.5. RELAYS
   - 1.6. SOLAR PV MODULES
   - 1.7. FIXED GROUND MOUNT BALLASTED SOLAR RACKING
   - 1.8. SOLAR ARRAY AND SYSTEM GROUNDING

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ISSUES & REVISIONS

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Project: TEXAS BACKUP POWER PACKAGE PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title: GENERAL SPECIFICATIONS

Date: 01/21/2025 Proj. No: 22483.005

PROJECT PHASE

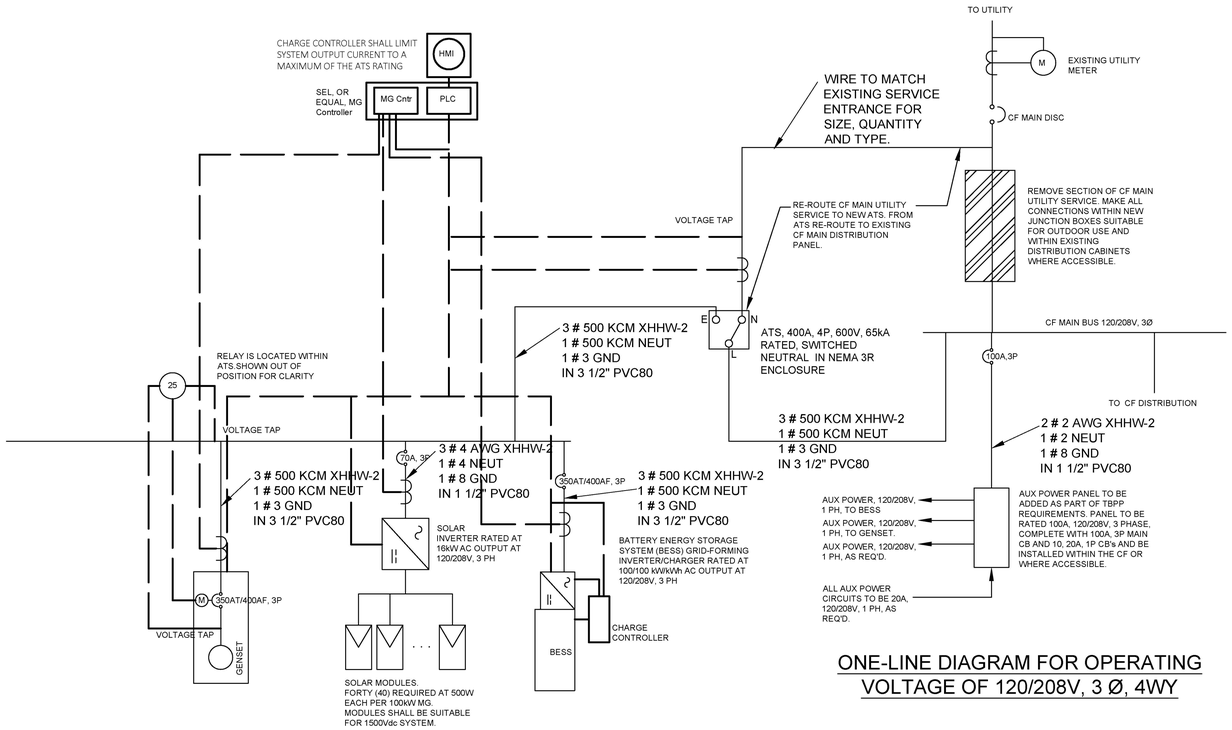
XXXX

Sheet No: E1.02

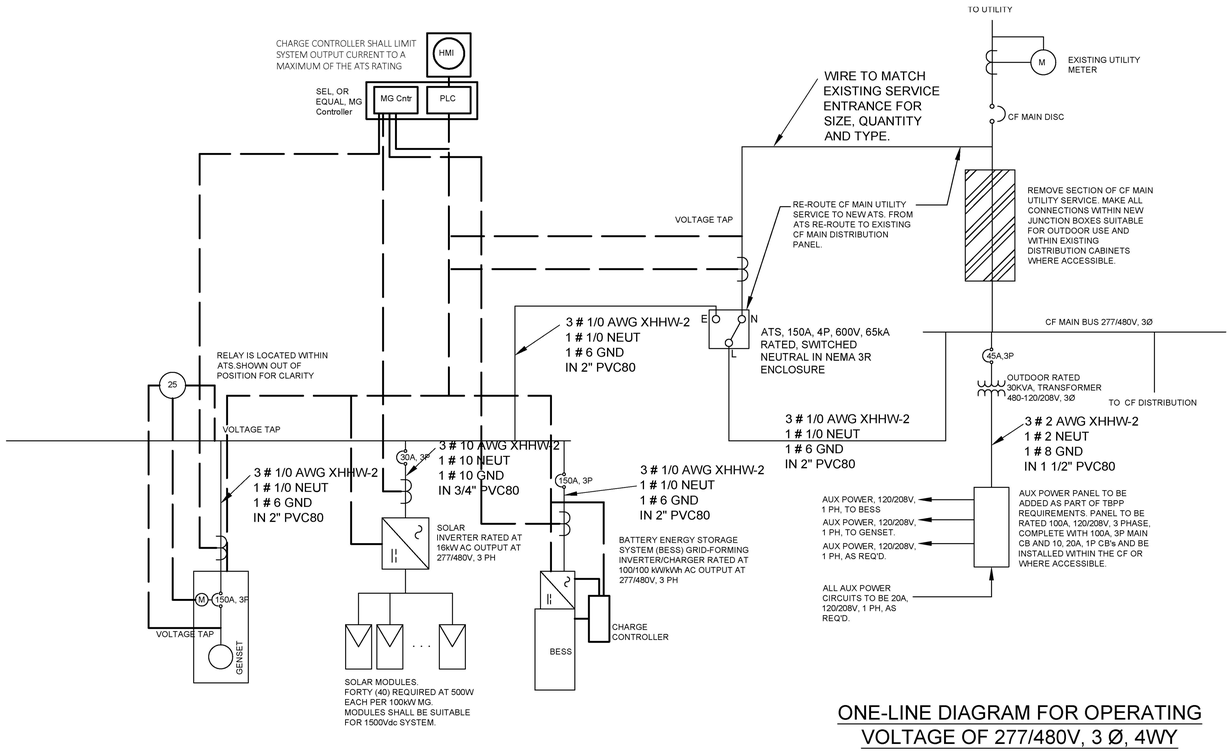
Sheet of

Revision No.: 0

FILE NAME: P:\Lisle\Public Utility Commission of Texas (PUCT)\22483.005 Backup Power Package Design\11_Drawings\11.5_Electrical\100kW\E1.02 General Specifications.dwg LAYOUT NAME: E1.02 PLOTTED: Monday, January 20, 2025 - 8:26pm USER: AH004



ONE-LINE DIAGRAM FOR OPERATING VOLTAGE OF 120/208V, 3 Ø, 4WY



ONE-LINE DIAGRAM FOR OPERATING VOLTAGE OF 277/480V, 3 Ø, 4WY

General Notes:

1. Equipment sizing is schematic and is representative of actual minimum desired kW, A, watts required for a coordinated system. Actual ratings of equipment are allowed to meet standard offerings from vendor/s that equal or exceed those minimums. All equipment associated with the proposed offering shall be adjusted to meet the actual power generation equipment being offered. For example if a 100kW genset is being offered in lieu of a required 80kW genset the main CB and other associated equipment shall also be upsized to handle the larger power package output.
2. One-line is a schematic representation of the component layout of the microgrid. Component sizing requirements can be found in the sizing charts accompanying the plans for the specific TBPP being installed.
3. Actual component sizing shall meet the TBPP rating required as a minimum but may be in the range of 0 to +10%.
4. Overall basic TBPP sizes shall be 10kW, 25 kW, 100kW, 500 kW, and 1000 kW. Required ratings of installed packages that do not fall into one of these sizes shall be considered as meeting the installed kW rating by aggregating multiple gensets of the base rating together . Other components shall be upsized as listed in the sizing charts.
5. Communication standard shall be RS485. Fiber optic may be used at suppliers option. Communications protocols shall be ethernet, CAN, or other approved vendor standard offering.
6. All equipment including wire is for the existing 100kW Critical Facility and is assumed to be served and operated at either 120/208V, 3 phase, 200A or 277/480V, 3 phase. See appropriate one-line for equipment and wire sizing required.
7. Solar array sizing is based on a DC/AC ratio of 1.25 with a design AC output equal to 16% of the TBPP kW rating. This should be able to fully charge a 1 hour BESS in 6 hours from a discharge state of 20% charge left on the BESS.

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ISSUES & REVISIONS

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Project:
TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
ONE-LINE DIAGRAM

Date: 01/21/2025

Proj. No: 22483.005

PROJECT PHASE

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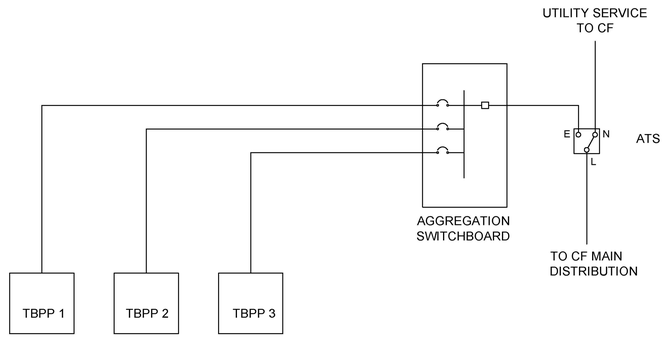
Sheet No:

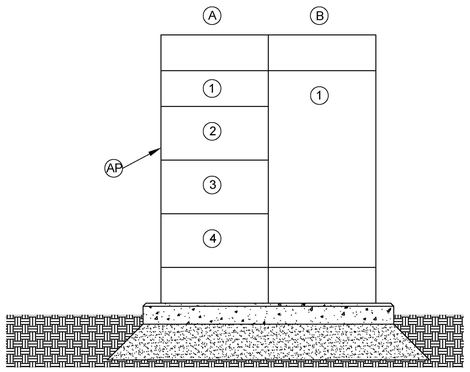
E2.01

Sheet of

Revision No.: 0

FILE NAME: P:\Jobs\Public Utility Commission of Texas (PUCT)\22483.005 Backup Power Package Design\11-Drawings\11.5_Electrical\100kW\12.01 ONE-LINE DIAGRAM ISLAND ALL.dwg LAYOUT NAME: E2.01 PLOTTED: Tuesday, January 21, 2025 - 10:44am USER: AMH





AGGREGATION
SWITCHBOARD 1
120/208V SYSTEMS
100kW thru 499kW

EQUIPMENT NOMENCLATURE (#)

ITEM AP
NEMA 3R ENCLOSURE, 30"Wx24"Dx90" TALL WITH THERMOSTICALLY CONTROLLED HEATERS FOR HUMIDITY CONTROL.

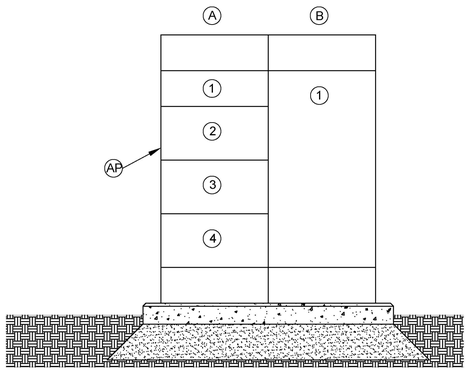
SECTION A

1. SPACE
2. 400A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 400A MAX. ADJUST TO MATCH TBPP RATING.
3. 400A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 400A MAX. ADJUST TO MATCH TBPP RATING.
4. 400A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 400A MAX. ADJUST TO MATCH TBPP RATING.

SECTION B

1. 1600A, 3Ø, 600V BUS FOR CABLE CONNECTION TO 400A RATED ATS.

1. MAXIMUM RATING OF SWITCHBOARD TO BE 500kW, 600V, 3Ø TO ALLOW FOR AGGREGATING AT LEAST THREE 100kW TBPPs.
2. EQUIPMENT SIZING BASED ON OPERATING VOLTAGE OF120/208V, 3Ø. ADJUST CB AND BUS SIZING FOR USE AT OTHER VOLTAGES.



AGGREGATION
SWITCHBOARD 2
277/480V SYSTEMS
100kW thru 499kW

EQUIPMENT NOMENCLATURE (#)

ITEM AP
NEMA 3R ENCLOSURE, 30"Wx24"Dx90" TALL WITH THERMOSTICALLY CONTROLLED HEATERS FOR HUMIDITY CONTROL.

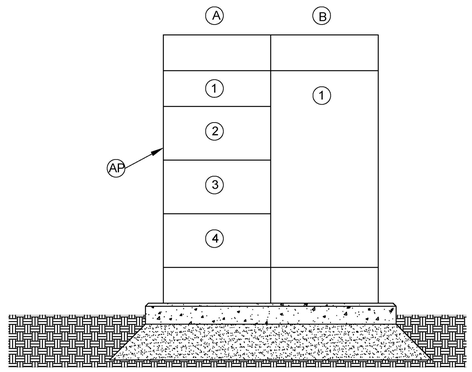
SECTION A

1. SPACE
2. 150A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 150A MAX. ADJUST TO MATCH TBPP RATING.
3. 150A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 150A MAX. ADJUST TO MATCH TBPP RATING.
4. 150A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 150A MAX. ADJUST TO MATCH TBPP RATING.

SECTION B

1. 600A, 3Ø, 600V BUS FOR CABLE CONNECTION TO 150A RATED ATS.

1. MAXIMUM RATING OF SWITCHBOARD TO BE 500kW, 600V, 3Ø TO ALLOW FOR AGGREGATING AT LEAST THREE 100kW TBPPs.
2. EQUIPMENT SIZING BASED ON OPERATING VOLTAGE OF 480V, 3Ø. ADJUST CB AND BUS SIZING FOR USE AT OTHER VOLTAGES.



AGGREGATION
SWITCHBOARD 3
500kW thru 999kW

EQUIPMENT NOMENCLATURE (#)

ITEM AP
NEMA 3R ENCLOSURE, 30"Wx24"Dx90" TALL WITH THERMOSTICALLY CONTROLLED HEATERS FOR HUMIDITY CONTROL.

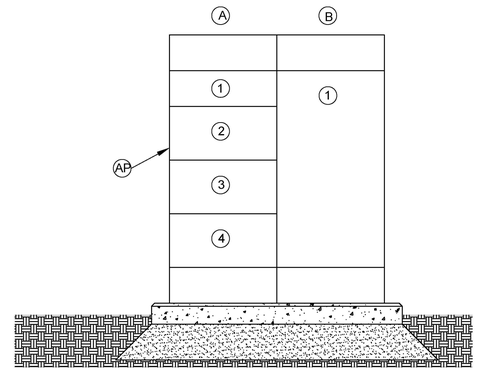
SECTION A

1. SPACE
2. 800A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 750A MAX. ADJUST TO MATCH TBPP RATING.
3. 800A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 750A MAX. ADJUST TO MATCH TBPP RATING.
4. 800A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 750A MAX. ADJUST TO MATCH TBPP RATING.

SECTION B

1. 3000A, 3Ø, 600V BUS FOR CABLE CONNECTION TO 3000A RATED ATS.

1. MAXIMUM RATING OF SWITCHBOARD TO BE 1000kW, 600V, 3Ø TO ALLOW FOR AGGREGATING AT LEAST ONE 500kW AND TWO 100kW TBPPs.
2. EQUIPMENT SIZING BASED ON OPERATING VOLTAGE OF 480V, 3Ø.



AGGREGATION
SWITCHBOARD 4
1000kW thru 2500kW

EQUIPMENT NOMENCLATURE (#)

ITEM AP
NEMA 3R ENCLOSURE, 30"Wx24"Dx90" TALL WITH THERMOSTICALLY CONTROLLED HEATERS FOR HUMIDITY CONTROL.

SECTION A

1. SPACE
2. 1600A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 1500A MAX. ADJUST TO MATCH TBPP RATING.
3. 1600A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 1500A MAX. ADJUST TO MATCH TBPP RATING.
4. 1600A, 3Ø, 600V, LSIG WITH ADJUSTABLE TRIP, SET TO 800A MAX. ADJUST TO MATCH TBPP RATING.

SECTION B

1. 4000A, 3Ø, 600V BUS FOR CABLE CONNECTION TO 4000A RATED ATS.

1. MAXIMUM RATING OF SWITCHBOARD TO BE 2500kW, 600V, 3Ø TO ALLOW FOR AGGREGATING AT LEAST TWO 1000kW AND ONE 500kW TBPPs.
2. EQUIPMENT SIZING BASED ON OPERATING VOLTAGE OF 480V, 3Ø.

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ISSUES & REVISIONS

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Project:
TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
AGGREGATION SWITCHBOARD

Date: 01/21/2025

Proj. No: 22483.005

PROJECT PHASE

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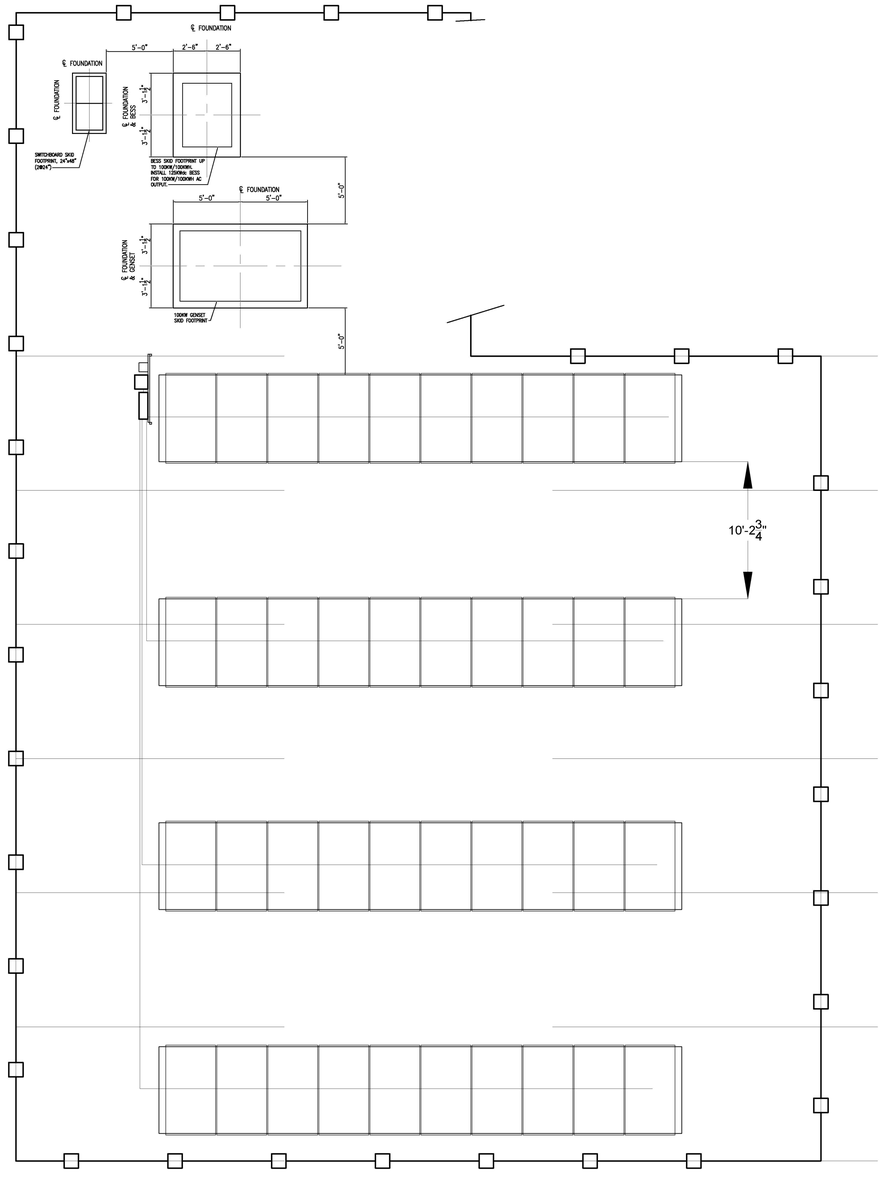
Sheet No:

E2.02

Sheet of

Revision No.: 0



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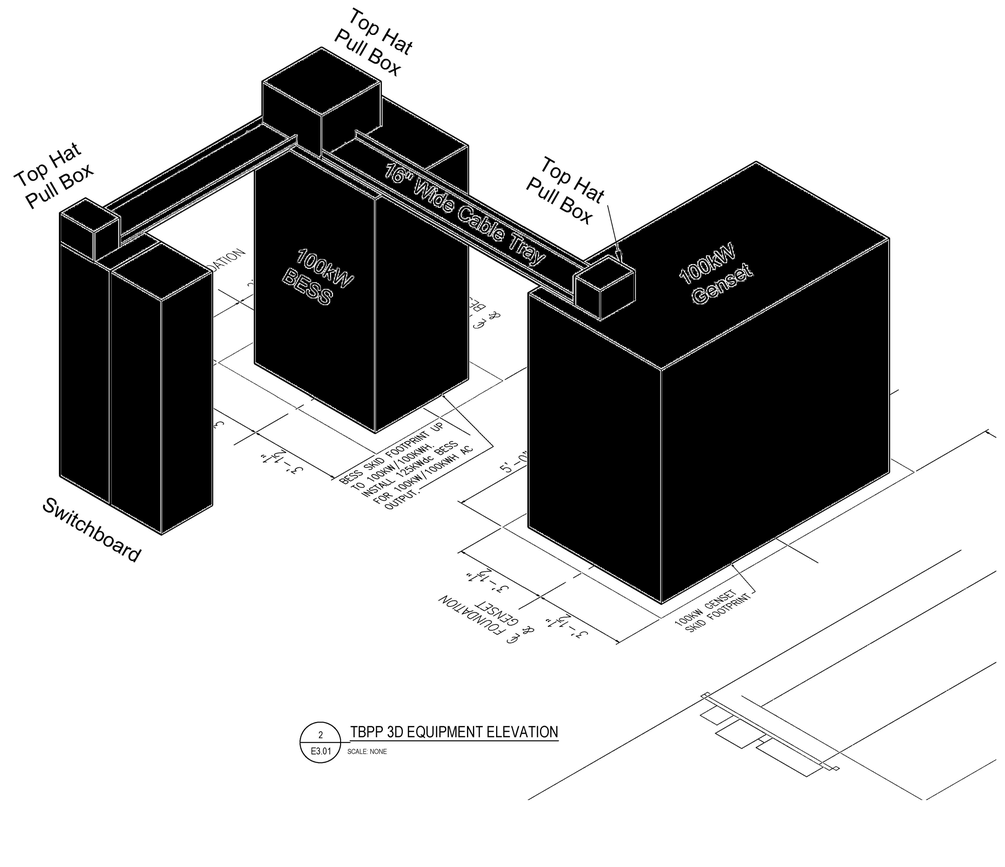

2 E3.01 TBPP 3D EQUIPMENT ELEVATION
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Project:
TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
100kW TBPP LAYOUT

Date: 01/21/2025

Proj. No: 22483.005

PROJECT PHASE

XXXX

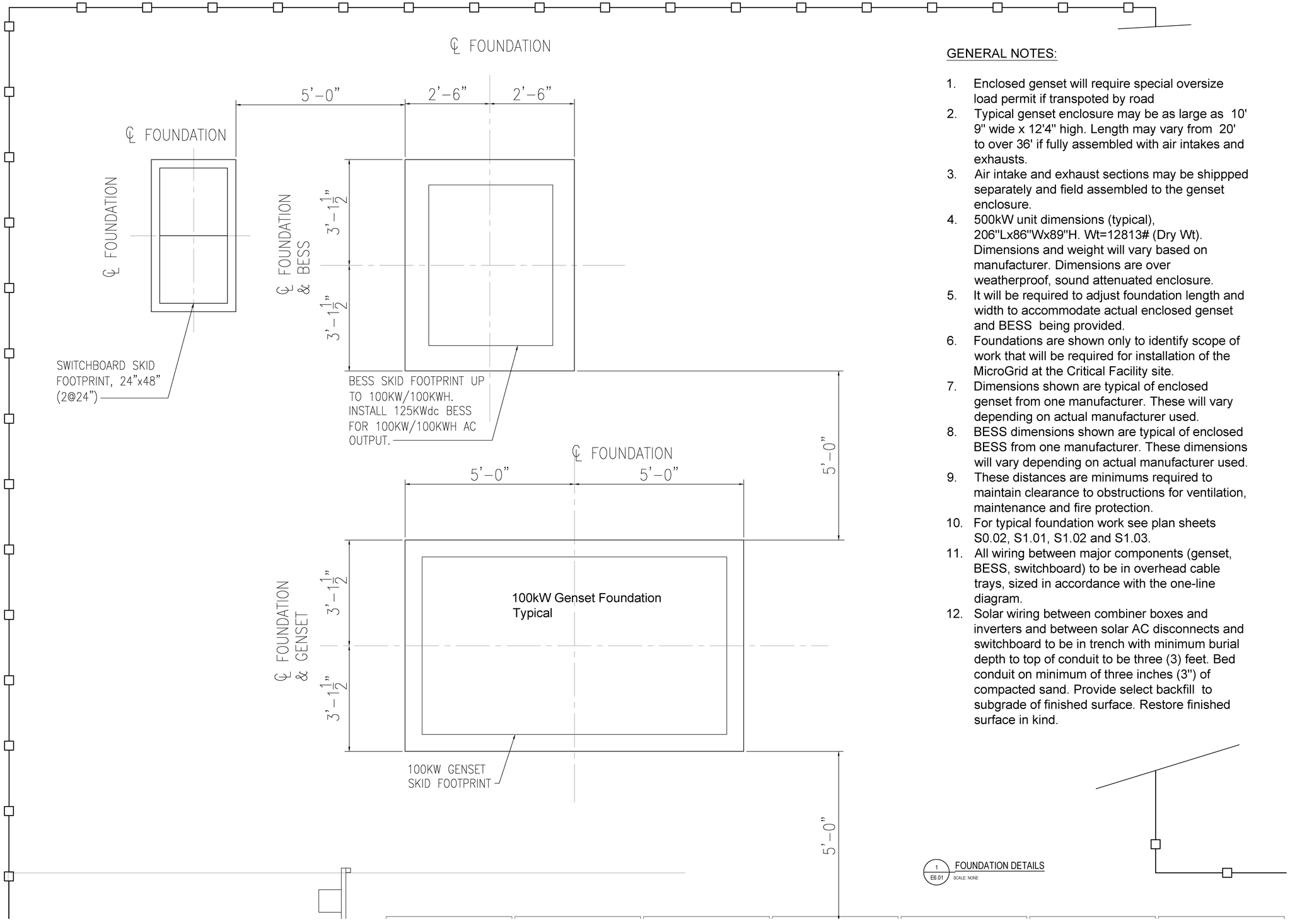
Sheet No:

E3.01

Sheet of

Revision No.: 0

FILE NAME: P:\Jobs\Public Utility Commission of Texas (PUCT)\22483.005 Backup Power Package Design\11_Drawings\11.5_Electrical\100kW\E3.01 - E3.04 100kW layout.dwg LAYOUT NAME: E3.01 100kW MC Layout PLOTTED: Tuesday, January 21, 2025 - 3:58pm USER: AHIDA



1 E6.01 FOUNDATION DETAILS
SCALE: NONE

GENERAL NOTES:

1. Enclosed genset will require special oversize load permit if transpoted by road
2. Typical genset enclosure may be as large as 10' 9'' wide x 12'4'' high. Length may vary from 20' to over 36' if fully assembled with air intakes and exhausts.
3. Air intake and exhaust sections may be shippped separately and field assembled to the genset enclosure.
4. 500kW unit dimensions (typical), 206''Lx86''Wx89''H. Wt=12813# (Dry Wt). Dimensions and weight will vary based on manufacturer. Dimensions are over weatherproof, sound attenuated enclosure.
5. It will be required to adjust foundation length and width to accommodate actual enclosed genset and BESS being provided.
6. Foundations are shown only to identify scope of work that will be required for installation of the MicroGrid at the Critical Facility site.
7. Dimensions shown are typical of enclosed genset from one manufacturer. These will vary depending on actual manufacturer used.
8. BESS dimensions shown are typical of enclosed BESS from one manufacturer. These dimensions will vary depending on actual manufacturer used.
9. These distances are minimums required to maintain clearance to obstructions for ventilation, maintenance and fire protection.
10. For typical foundation work see plan sheets S0.02, S1.01, S1.02 and S1.03.
11. All wiring between major components (genset, BESS, switchboard) to be in overhead cable trays, sized in accordance with the one-line diagram.
12. Solar wiring between combiner boxes and inverters and between solar AC disconnects and switchboard to be in trench with minimum burial depth to top of conduit to be three (3) feet. Bed conduit on minimum of three inches (3'') of compacted sand. Provide select backfill to subgrade of finished surface. Restore finished surface in kind.

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Rev. No.	Date	Description
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ISSUES & REVISIONS

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Project:
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PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
100kW FOUNDATION PLAN

Date: 01/21/2025 | Proj. No: 22483.005

PROJECT PHASE

XXXX

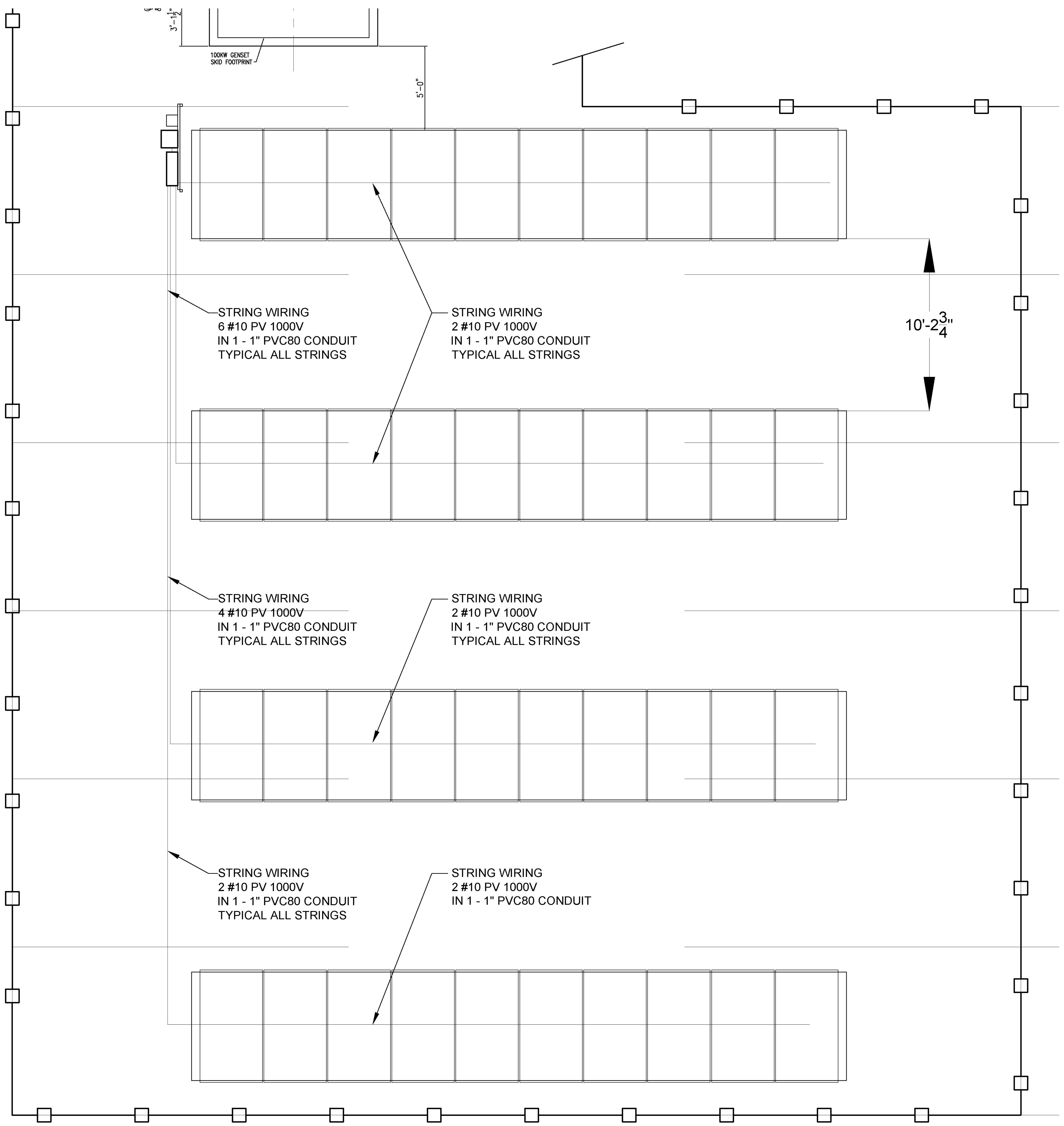
Sheet No:

E3.02

Sheet of

Revision No.: 0

FILE NAME: P:\Work\Public Utility Commission of Texas (PUCT)\22483.005 Backup Power Package Design\11_Drawings\11.5_Electrical\100kW\E3.01-E3.04 100kW layout.dwg LAYOUT NAME: E3.02 100kW Foundation PLOTTED: Tuesday, January 21, 2025 - 3:58pm USER: AVOH



1 / E3.03 SOLAR LAYOUT
SCALE: 1/4" = 1'-0"

SITE PARAMETERS	
MINIMUM TEMP (°C)	-19.4
MAXIMUM TEMP (°C)	42
PROJECT PARAMETERS	
SYSTEM VOLTAGE (DC)	600
DC SYSTEM SIZE (kWp)	20.00
AC SYSTEM SIZE (kW AC) @ 45°C	16.00
AC SYSTEM SIZE (kW AC) @ 20°C	N/A
DC/AC RATIO	1.25
POI RATING (MVA)	N/A
MODULE PARAMETERS	
MODULE TYPE	Mono PERC (c-Si)
MODULE	Can_Solar CS6.2-54TM500
MODULE NAMEPLATE (Wp)	500
QUANTITY OF MODULES	40
MODULES PER STRING	10
TOTAL NUMBER OF STRINGS	4
INVERTER PARAMETERS	
INVERTER SPECIFICATIONS	Solar_Edge SE17.3KUS
SIZE, AC Kw/Type	17.3 / String
QUANTITY OF INVERTERS	1
RACKING PARAMETERS	
RACKING TYPE	Fixed Ground Mount
AZIMUTH/TILT ANGLE (°)	+/-33
ROW PITCH (ft/m)	16.67/5.09
ROW SPACING (GAP) (ft/m)	10.24/3.13
LOCATION	
LATITUDE (°) N	32.77
LONGITUDE (°) W	-96.78

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Date: 01/21/2025 Proj. No: 22483.005

PROJECT PHASE

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Sheet No:

E3.03

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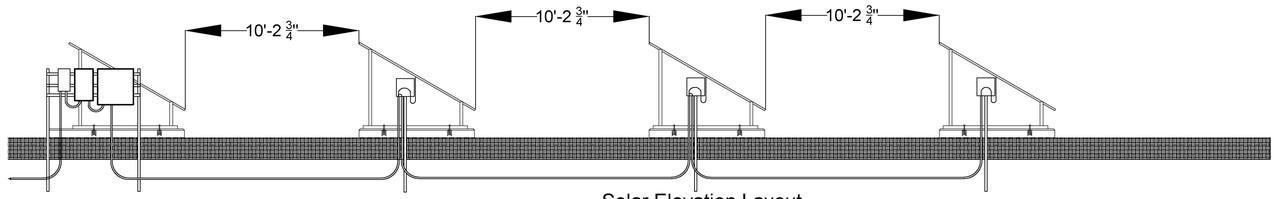
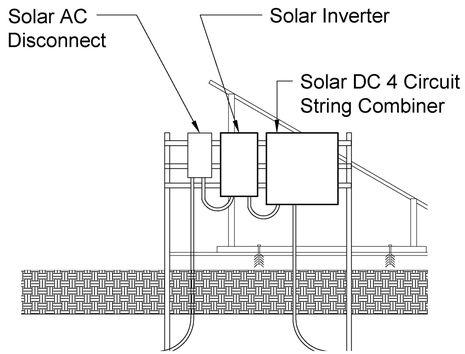
Revision No.: 0

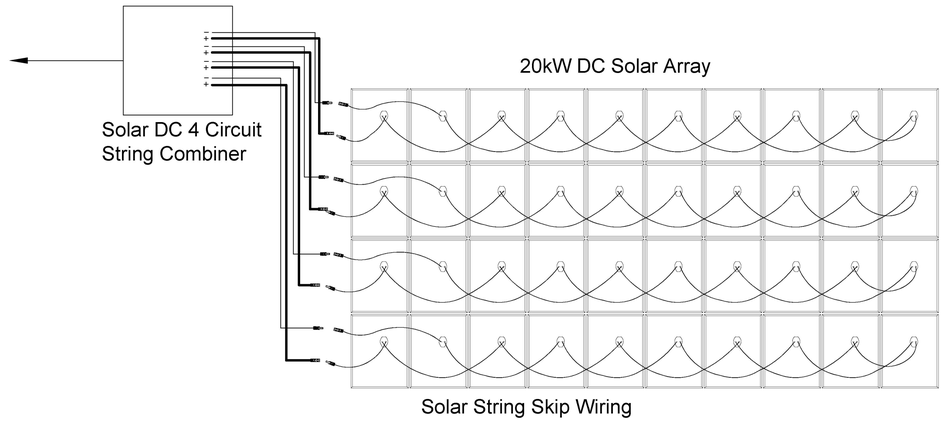


Solar Elevation Layout
Looking East

1 / E3.04 SOLAR ELEVATION
SCALE: NONE



2 / E3.04 SOLAR EQUIPMENT ELEVATION
SCALE: NONE



Solar String Skip Wiring

3 / E3.04 SOLAR WIRING
SCALE: NONE

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PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
SOLAR DETAILS

Date: 01/21/2025 Proj. No: 22483.005

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Sheet No:
E3.04

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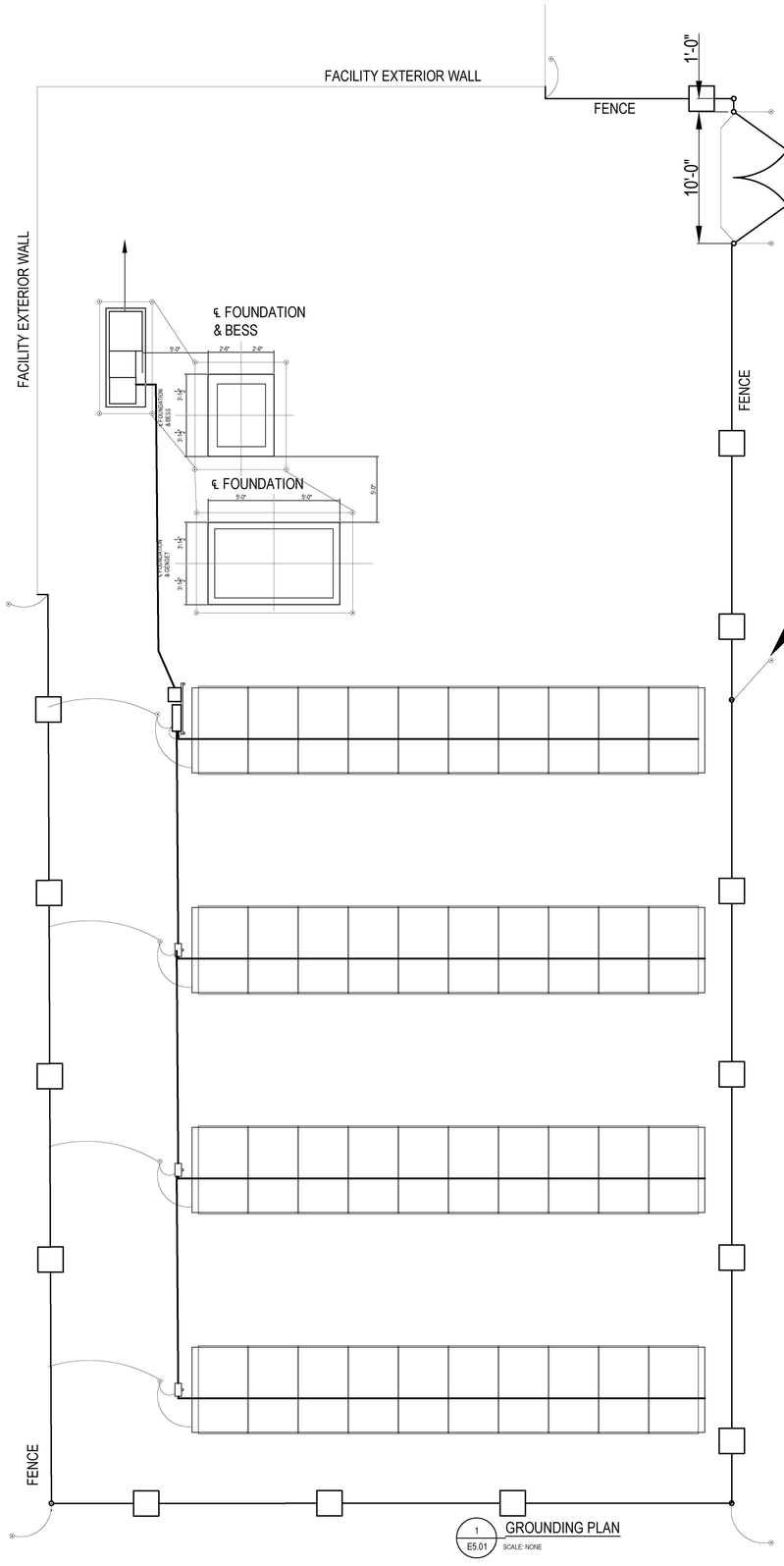
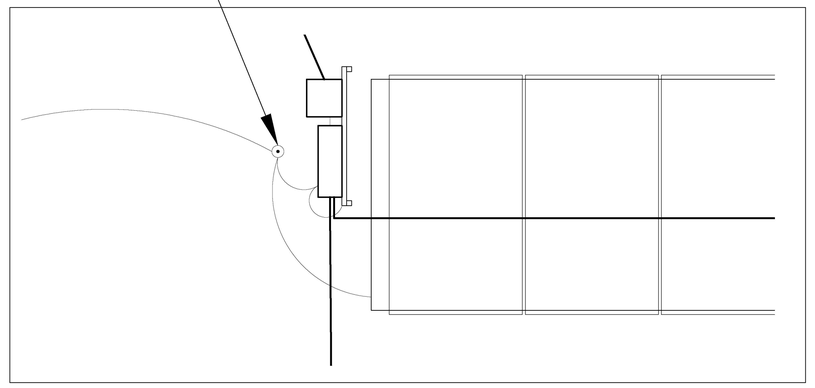
Revision No.: 0



1 E5.01 GROUNDING PLAN
SCALE: NONE



2 E5.01 GROUNDING DETAIL
SCALE: NONE

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GROUNDING PLAN

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Sheet No:
E5.01

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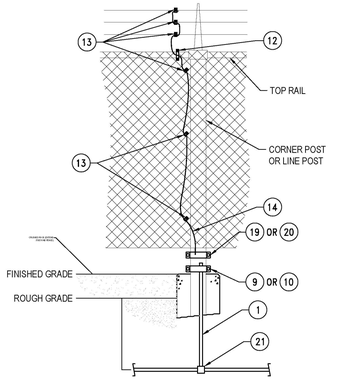
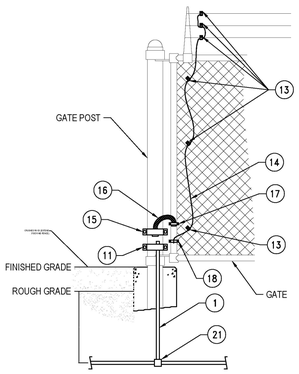
Revision No.: 0

FILE NAME: P:\Jobs\Public Utility Commission of Texas (PUCT)\22483.005 Backup Power Package Design\11_Drawings\11.5_Electrical\1.1DGN\E5.01 - E5.02 Grounding 1.1DGN.dwg LAYOUT NAME: E5.01 PLOTTED: Monday, January 20, 2025 - 9:18pm USER: AHO24



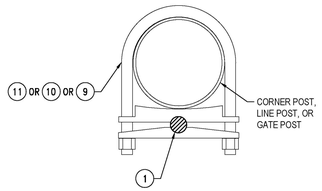
ITEM	DESCRIPTION
1	WIRE, BARE CU, #4/0 AWG SD 7 STR
9	FENCE POST GROUND CLAMP, CORNER POST-2.875" OD PIPE, #4/0 AWG WIRE BURNDY TYPE GD
10	FENCE POST GROUND CLAMP, LINE POST-2.375" OD PIPE, #4/0 AWG WIRE BURNDY TYPE GD
12	GROUND CLAMP, FENCE TOP RAIL-1.625" OD PIPE, 2 SOL TO 250 MCM
13	TAP CONNECTOR, SPLIT BOLT TYPE, BRONZE, #2 AWG
14	GROUND WIRE, STEEL, 0.25" DIA., 7 STR
19	FENCE POST GROUND CLAMP, CORNER POST - 2.875' OD PIPE, #4-#2/0 AWG CONDUCTOR BURNDY TPE GD
20	FENCE POST GROUND CLAMP, LINE POST - 2.375' OD PIPE, #4-#2/0 AWG CONDUCTOR BURNDY TPE GD
21	GROUND WIRE TO GROUND WIRE IRREVERSIBLE COMPRESSION CONNECTOR BURNDY YGHC29C29

A E5.02 GROUNDING FENCE POST
SCALE: NONE



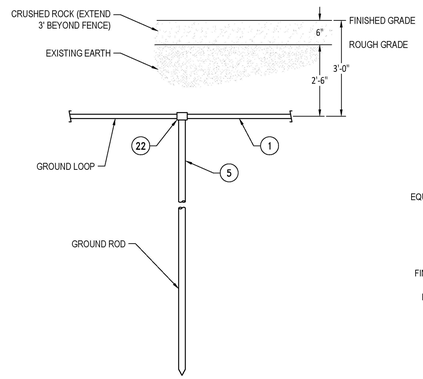
ITEM	DESCRIPTION
1	WIRE, BARE CU, #4/0 AWG SD 7 STR
11	FENCE POST GROUND CLAMP, GATE POST-4" OD PIPE, #4/0 AWG WIRE BURNDY TPE GD
13	TAP CONNECTOR, SPLIT BOLT TYPE, BRONZE, #2 AWG
14	GROUND WIRE, STEEL, 0.25" DIA., 7 STR
15	FENCE POST GROUND CLAMP, GATE POST-4" OD PIPE, 2" COPPER BRAID
16	COPPER BRAID, 1.5" X 18" WITH 3/8" STUD HOLE, 2 HOLE TERMINALS EACH END BURNDY TPE B
17	GROUND CLAMP, GATE POST-1.875" OD PIPE, 2" COPPER BRAID
18	GROUND CLAMP, GATE POST-1.875" OD PIPE, #4-#2/0 AWG CONDUCTOR BURNDY TPE GD
21	GROUND WIRE TO GROUND WIRE IRREVERSIBLE COMPRESSION CONNECTOR BURNDY YGHC29C29

B E5.02 GROUNDING FENCE GATE
SCALE: NONE



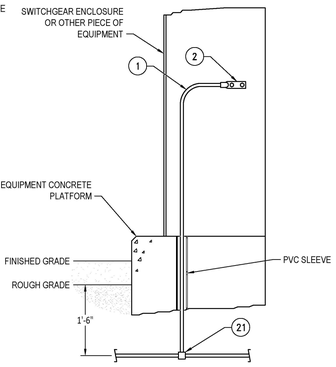
ITEM	DESCRIPTION
1	WIRE, BARE CU, #4/0 AWG SD 7 STR
9	FENCE POST GROUND CLAMP, CORNER POST-2.875" OD PIPE, #4/0 AWG WIRE
10	FENCE POST GROUND CLAMP, LINE POST-2.375" OD PIPE, #4/0 AWG WIRE
11	FENCE POST GROUND CLAMP, GATE POST-3.5" OD PIPE, #4/0 AWG WIRE

C E5.02 GROUNDING FENCE POST
SCALE: NONE



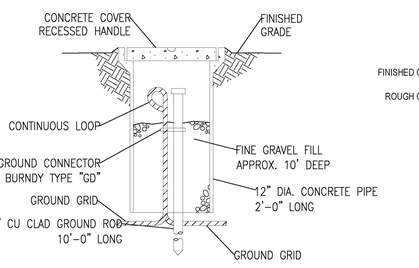
ITEM	DESCRIPTION
1	WIRE, BARE CU, #4/0 AWG SD 7 STR
5	GROUND ROD, CU-CLAD STEEL 3/4" DIA x 10'-0"
22	GROUND WIRE TO GROUND ROD CLAMP IRREVERSIBLE COMPRESSION CONNECTOR BURNDY YGLR29C34

D E5.02 GROUND ROD
SCALE: NONE

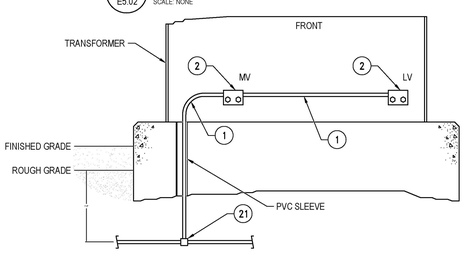


ITEM	DESCRIPTION
1	WIRE, BARE CU, 4/0 SD 7 STR
2	CONNECTOR, COMPRESSION, 4/0 STR CU, CABLE TO FLAT, 2 HOLE, BURNDY CAT. YGHA28-2N
21	GROUND WIRE TO GROUND WIRE IRREVERSIBLE COMPRESSION CONNECTOR BURNDY YGHC29C29

E E5.02 SWITCHBOARD GROUND
SCALE: NONE

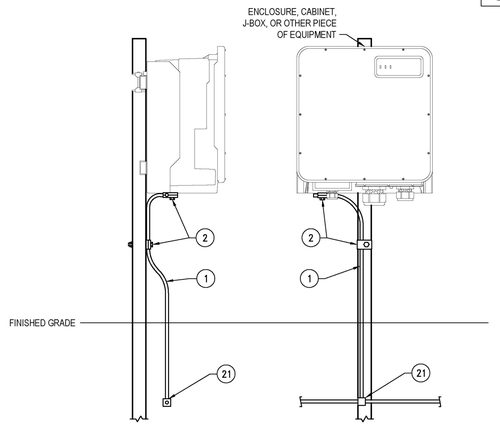


F E5.02 GROUNDING TEST WELL
SCALE: NONE



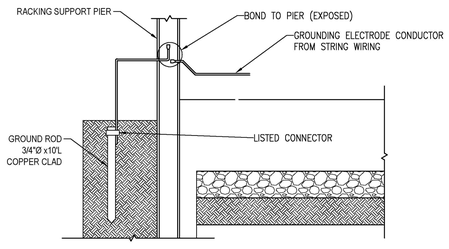
ITEM	DESCRIPTION
1	WIRE, BARE CU, 4/0 SD 7 STR
2	CONNECTOR, CLAMP, 4/0 STR CU, CABLE TO FLAT, 2 BOLT
21	GROUND WIRE TO GROUND WIRE IRREVERSIBLE COMPRESSION CONNECTOR BURNDY YGHC29C29

G E5.02 GROUNDING TRANSFORMER
SCALE: NONE



ITEM	DESCRIPTION
1	WIRE, BARE CU, #6 SOLID CU
2	CONNECTOR, CLAMP, #6 SOLID CU, CABLE TO FLAT, 1 BOLT
21	GROUND WIRE TO GROUND WIRE IRREVERSIBLE COMPRESSION CONNECTOR BURNDY YGHC29C29

H E5.02 GROUNDING ENCLOSURE
SCALE: NONE



I E5.02 GROUNDING BOND TO STRUCTURAL STEEL AT RACKING SUPPORTS
SCALE: NONE

NOTES

1. RUN GROUND WIRE IN GROUND RING AS DETAILED AROUND PLATFORM. GROUND WIRE SIZE TO BE #4/0 AWG. GROUND WIRE TO BE BARE COPPER.
2. INSTALL GROUND TEST WELLS WHERE NOTED AND AS DETAILED.
3. INSTALL GROUND WIRES FROM GROUND RING TO ALL BUILDING STEEL COLUMNS, PIPE RACK STEEL COLUMNS.
4. EXOTHERMIC WELD STYLE GROUND CONNECTIONS SHALL NOT BE USED FOR ANY GROUNDING CONNECTIONS.
5. EXTEND SWITCHBOARD GROUND WIRES TO GROUND RING. THESE GROUNDS SHALL BE SIZED IN ACCORDANCE WITH THE 2023 NEC.

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PUBLIC UTILITY COMMISSION OF TEXAS

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GROUNDING DETAILS

Date: 01/21/2025
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PROJECT PHASE
XXXX

Sheet No:
E5.02

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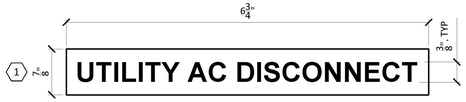
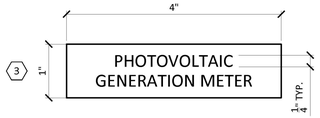
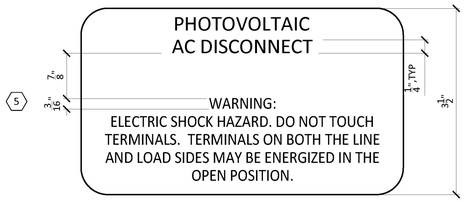
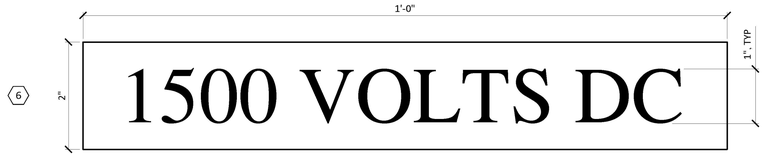
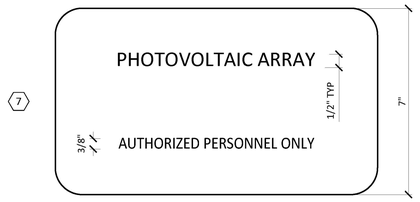
Revision No.: 0

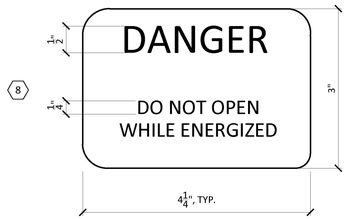


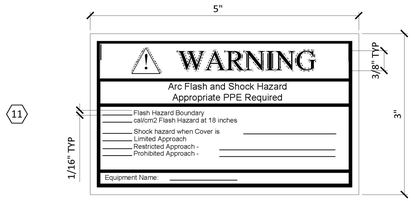


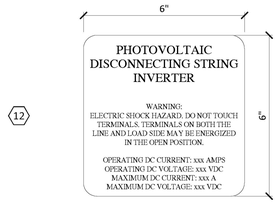


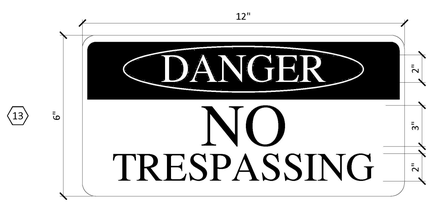


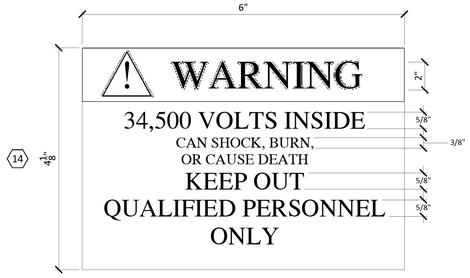


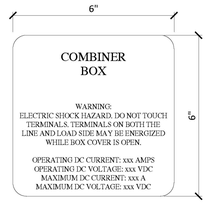












LABEL AND MARKINGS LEGEND

1. LABEL FOR UTILITY AC DISCONNECT; 1 PER AC DISCONNECT
2. INVERTER IDENTIFICATION LABEL TO BE PLACED ON EACH STRING INVERTER (34 TOTAL)
3. LABEL FOR SYSTEM OWNER'S KWH GENERATION METER; 1 PER OWNER METER (1 TOTAL)
4. LABEL FOR REQUIRED UTILITY METER SOCKET; 1 PER UTILITY METER (1 TOTAL)
5. PHOTOVOLTAIC AC DISCONNECT GENERIC WARNING LABEL APPLIED TO ALL AC DISCONNECTS
6. AT COMBINER AND INVERTER RUNS.
7. LABEL FOR CHAIN LINK SECURITY FENCE; SPACED EVERY 150 FEET AROUND PERIMETER OF ARRAY
8. CT WIRING WARNING LABEL TO BE PLACED ON OUTSIDE OF EACH CT METERING BOX.
9. ROW DESIGNATION LABEL TO BE PLACED ON THE END OF EACH ROW FACING THE ROAD
10. ARC FLASH LABEL TO BE PLACED ON EACH INVERTER.
11. ARC FLASH WARNING LABEL. TO BE PLACED ON ALL ELECTRICAL EQUIPMENT COVERS AS REQUIRED BY NFPA 70 AND NFPA 70E.
12. TO BE PLACED ON EACH INVERTER. OPERATING AND MAXIMUM VOLTAGES AND CURRENTS TO BE VERIFIED BASED ON LOCATION.
13. TO BE PLACED ON SITE FENCE AND FENCE GATES. SPACED AS REQUIRED
14. TO BE PLACED ON TRANSFORMERS AT EACH INVERTER PAD.
15. TO BE INSTALLED ON EACH COMBINER BOX LOCATED WITHIN ARRAY. BOX TRANSITIONS WIRING FROM STRING WIRING TO INVERTER FEEDER WIRING. OPERATING AND MAXIMUM VOLTAGES AND CURRENTS TO BE VERIFIED BASED ON LOCATION.

1 E5.04 ELECTRICAL SIGNAGE DETAILS
SCALE: NONE

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ISSUES & REVISIONS

THE INFORMATION CONTAINED ON THESE DRAWINGS IS FOR USE ON THIS PROJECT ONLY

Project:
TEXAS BACKUP POWER PACKAGE
PUBLIC UTILITY COMMISSION OF TEXAS

Sheet Title:
ELECTRICAL SIGNANGE DETAILS

Date: 01/21/2025 Proj. No: 22483.005

PROJECT PHASE

XXXX

Sheet No:
E6.01

Sheet 1 of 3

Revision No.:
0

TECHNICAL SPECIFICATIONS FOR THE SUPPLY AND INSTALLATION

OF

500KW TEXAS BACKUP POWER PACKAGE (TBPP)

Table of Contents

Project summary

These specifications provide the technical requirements and specifations for the components to be employed in the Texas Backup Power Packages (TBPP). These components consist of, as a minimum, the following:

1. Gaseous fueled (natural gas or propane) engine generator set in sound attenuated, weatherproof enclosure
2. Battery Energy Storage System (BESS) in weatherproof enclosure
3. Photovoltaic Solar Modules
4. Fixed, ground mount, ballasted solar racking
5. Solar inverters
6. Solar Combiner Boxes
7. DC disconnects
8. AC Disconnects
9. Switchboards
10. Panelboards
11. Automatic Transfer Switches (ATS)
12. Cable Tray
13. Wire and Cable
14. Micro Grid controller
15. Metering

Design Basis

The design basis has been outlined as follows and provides design requirements overview and intended operating sequences of the Texas Backup Power Packages (TBPP).

DESIGN REQUIREMENTS

1. Genset fueled by natural gas or propane
2. Must use solar with batteries
3. Can use V2G with electric school buses
4. Must operate for 48 hours without refueling
    a. Utilizing natural gas from existing underground pipelines is acceptable
    b. Propane should be provided utilizing skid mounted tankage
5. Low cost operation
6. Easy to install and maintain
7. Operate only islanded with grid failure. NO GRID CONNECTION IS ALLOWED
8. Connect to Critical Facility (CF) main electric service through use of Automatic Transfer

Switch

a. This provides for rapid transfer of power to BESS at time of grid failure
b. This transfer could be delayed to prevent rapid cycling in the event of short interval intermittent grid failures

9. TBPPs are rated in a minimum of five AC kW output range capacities
    a. 10kW
    b. 25kW
    c. 100kW
    d. 500kW
    e. 1000kW

DESIGN ASSUMPTIONS

1. Upon grid failure there is to be no delay transfer to backup power bus
    a. BESS to pick up Critical Facility load immediately
    b. Genset to start after 10 second delay
2. Genset and BESS to share load
    a. BESS kW rating to be 100% of anticipated CF kW rating with production capacity sizing at 1 hour
        i. 10kW TBPP-BESS = 10kW/10kWh
        ii. 25kW TBPP – BESS = 25kW/25kWh
        iii. 100kW TBPP - BESS = 100kW/100kWh
        iv. 500 kW BESS = 500kW/500kWh
        v. 1000 kW BESS = 1000kW/1000kWh
    b. Genset to be rated at 100% of TBPP Rating
    c. Consider load factor of site critical facility when sizing TBPP – to be determined from billing data when available; o'e use typical LF of 60%.
3. Propane will be for small TBPP only. NG for rest.
    a. Provide propane piping connections to allow if CF has existing on site propane storage that could be utilized
4. BPP components to be individually skid mounted
5. BPP components to be transportable over existing roads with flatbeds or other trucking.
6. All BPP components to be factory installed in individual containers, fully installed ready for field interconnection, startup and use
7. Solar to be used for BESS charging in daytime and for genset auxiliary power
    a. Solar kW sizing to be based on allowing BESS recharge during a 6 hour daylight period. This equates to the solar size being 16% of the TBPP rating.
    b. Example 1: BESS rated at 1000kWh AC output.
        i. DC/AC ratio = 1.25
        ii. Solar size = (1000*1.25*.16) = 200 kw DC

iii. With 500w solar modules = 400 modules
iv. Space required assumes one module roughly needs 21.5 sf or for the full rating = 8600 sf. (this is approximately 46-50 average car parking spaces)

c. Example 2: BESS rated at 25kWh
i. Solar size = 25*1.25*.16 = 5kW
ii. With 500w solar modules = 10 modules
iii. Space required = 215 sf (or approx 2 parking spaces)

8. Solar is to be designed for fixed tilt ground mount utilizing available existing lot space. Small systems may utilize rooftop deployment.
9. Systems to be plug and play. This assumes components containers are within close proximity to one another where premade cables can be placed in ground mounted wireways and overhead cable trays and the containers plugged into one another.

EQUIPMENT (See TBPP report appendices for full list of approved vendors)

1. PV Modules
2. Inverters - String
3. Gas Gensets
4. BESS

<u>OPERATING SEQUENCES</u>

A. NORMAL – GRID AVAILABLE
a. Grid operation is normal providing full power to the site
b. TBPP is monitoring grid availability on a continuous basis
c. BESS
i. connected to the solar through bi-directional inverter (BDI)
ii. BESS on solar maintaining charge
iii. no power is being furnished to the grid by the BESS for any reason
d. GENSET
i. Not on the grid
ii. Available on standby mode through automatic transfer switch (ATS)
e. SOLAR
i. Fixed tilt, ground mounted
ii. Connected to the TBPP grid for on-site TBPP auxiliary power needs
1. Genset convenience outlets
2. Genset controls incl Remote Annunciator
3. TBPP container lighting
4. BESS charging/trickle charging
5. Genset battery charging
6. Genset container and engine coolant heating (winter thermostat)

B. STORM ANTICIPATION
    a. This is a MANUAL mode of operation that can be initiated if there is an approaching storm that may result in electrical grid failure.
    b. This mode will switch the CF load over to the TBPP and cause the CF to go into island operation
    c. Return to normal after the storm will be a manual operation as well.
C. GRID FAILURE (for any reason)
    a. Operates islanded through operation of ATS
    b. BESS and genset share CF load based on control programming
    c. BESS
        i. ATS operates separating CF from grid
        ii. Instantaneously picks up CF load in its entirety through BESS
        iii. Minimal power interuption to CF power services
    d. GENSET
        i. Signaled to start from ATS
        ii. Generator output comes up to voltage and frequency
        iii. genset syncs to BESS grid
        iv. sync check signal gen circuit breaker to close
        v. genset on CF system within 10 seconds of grid failure
    e. SOLAR
        i. Continues to provide auxiliary power and BESS charging during daylight hours
        ii. Extends availability of BESS and helps reduce run time of genset
D. GRID RETURN TO NORMAL
    a. Genset gets shutdown signal, genset goes into cool down mode and turns off. BESS remains powering CF until signaled to switch back to utility grid by ATS.
    b. BESS maintains CF load during genset shut down cycle.
    c. BESS verifies sync with grid, then ATS recloses for grid to again provide power to CF.
    d. BESS returns off grid to charge mode

<u>TBPP INSTALLATION REQUIREMENTS</u>

The following will be required in order to install a TBPP at any Critical Facility site:

A. FOUNDATIONS will be required at each CF site. See project plans.
    a. Gensets
    b. BESS
    c. Solar

d. Propane Tanks (If Required)
e. Switchgear/boards

B. TBPP CONTAINERS
   a. Weatherproof – All, gensets, BESS, Switchgear/boards
   b. Sound attenuated – All, gensets, BESS

C. PROPANE FUEL TANKS (IF REQUIRED)
   a. Fuel piping
   b. Tank, piping heaters
   c. Regulators
   d. Valving
   e. Connection to genset fuel pipe train

D. NATURAL GAS FUEL PIPING (IF REQUIRED)
   a. Fuel piping
   b. Tank, piping heaters
   c. Regulators
   d. Valving
   e. Connection to genset fuel pipe train

E. CONTAINER INTERCONNECT CABLING

F. BPP POWER OUTPUT CABLING TO CRITICAL FACILITY

G. CRITICAL FACILITY SERVICE UPGRADES

H. COMMUNICATIONS WIRING

DOCUMENT 000107 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Structural Engineer:

1. Christopher William Erwin
2. 140150
3. Responsible for the following plan sheets

S0.01 Structural General Notes
S0.02 Structural General Notes
S1.01 Foundation Details
S2.01 Fencing

B. Electrical Engineer:

1. David J. Swoch
2. 150971
3. Responsible for the following specification sections:

Project Summary

END OF DOCUMENT 000107

DOCUMENT 000115 - LIST OF DRAWING SHEETS

1.1 LIST OF DRAWINGS

A. Drawings: Drawings consist of the Contract Drawings and other drawings listed on the Table of Contents page of the separately bound drawing set titled "PUBLIC UTILITY COMMISION OF TEXAS TEXAS BACKUP POWER PACKAGES FOR CRITICAL FACILITIES 500kW, dated January 21, 2025, as modified by subsequent Addenda and Contract modifications.

B. List of Drawings: Drawings consist of the following Contract Drawings and other drawings of type indicated:

T0.01 TITLE SHEET

STRUCTURAL

S0.01 STRUCTURAL SPECIFICATIONS 1
S0.02 STRUCTURAL SPECIFICATIONS 2
S1.01 FOUNDATION
S2.01 FENCING

ELECTRICAL

E1.01 LEGENDS AND ABBREVIATIONS
E1.02 GENERAL SPECIFICATIONS
E2.01 ONE LINE DIAGRAM
E2.02 AGGREGATION SWITCHBOARD
E3.01 TBPP LAYOUT
E3.02 FOUNDATION PLAN
E3.03 SOLAR LAYOUT
E3.04 SOLAR DETAILS
E4.01 NOT USED
E5.01 GROUNDING
E5.02 GROUNDING DETAILS
E6.01 ELECTRICAL SIGNAGE

END OF DOCUMENT 000115

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by Owner, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect[**or Construction Manager**].

1.4 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within **10** days of **Notice to Proceed**, and not less than **five** days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager **may also serve as Project superintendent**

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
3. Owner-performed tests and inspections indicated in the Contract Documents.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.

6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to **[ASTM E 329]** **<Insert standard>**; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.

e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
f. When testing is complete, remove test specimens and test assemblies, do not reuse products on Project.

Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Owner**, through Construction Manager**, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.11 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Payment for these services will be made from testing and inspection allowances, as authorized by Change Orders.
3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least **24** hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with **Construction Manager,** and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify **Construction Manager** and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, **Construction Manager,** testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: **Engage** a qualified **testing agency** to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying **Construction Manager,** and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service **through Construction Manager,** with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 ACCEPTABLE TESTING AGENCIES

A. Testing agencies shall local, Texas based agencies approved by Owner or Owner's representative.

3.2 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Owner **and Construction Manager's** reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.3 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory manuals.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Owner will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. Submit **on digital media acceptable to Owner**. Enable reviewer comments on draft submittals.
2. Submit **three p**aper copies**, through Construction Manager who** will return **two** copies.

C. Initial Manual Submittal: Submit draft copy of each manual at least **30** days before commencing demonstration and training. **Commissioning Authority** will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least **15** days before commencing demonstration and training. **Commissioning Authority** will return copy with comments.

1. Correct or revise each manual to comply with **Commissioning Authority's** comments. Submit copies of each corrected manual within **15** days of receipt of **Commissioning Authority's** comments and prior to commencing demonstration and training..

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Architect.
8. Name and contact information for Commissioning Authority.

9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:

1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.8 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent,

and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

    a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.11 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site**.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."
2) Intertek Group in its "Directory of Listed Building Products."
3) FM Global in its "Building Materials Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of

penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Listed Building Products" under "Firestop Systems."

C. Where FM Global-approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."

END OF SECTION 078413

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Aluminum building wire rated 600 V or less.
3. Metal-clad cable, Type MC, rated 600 V or less.
4. Armored cable, Type AC, rated 600 V or less.
5. Photovoltaic cable, Type PV, rated 2000 V or less.
6. Mineral-insulated cable, Type MI, rated 600 V or less.
7. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS

A. PV: Photovoltaic.

B. RoHS: Restriction of Hazardous Substances.

C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

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

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

D. Conductor Insulation:

1. Type NM: Comply with UL 83 and UL 719.
2. Type USE-2 and Type SE: Comply with UL 854.
3. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
4. Type THHN and Type THWN-2: Comply with UL 83.
5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
6. Type UF: Comply with UL 83 and UL 493.
7. Type XHHW-2: Comply with UL 44.

2.2 ALUMINUM BUILDING WIRE

A. Aluminum building wire shall not be used on this project.

2.3 METAL-CLAD CABLE, TYPE MC

A. Metal-clad cable shall not be required on this project.

2.4 ARMORED CABLE, TYPE AC

A. Armored cable shall not be required on this project.

2.5 PHOTOVOLTAIC CABLE, TYPE PV

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 2000 V.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

D. Conductor Insulation: Comply with UL 44 and UL 4703.

2.6 MINERAL-INSULATED CABLE, TYPE MI

A. Mineral insulated cable shall not be required for this project.

2.7 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Bronze.
2. Type: One hole with standard barrels.
3. Termination: Compression

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

F. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

G. PV Circuits: **Copper**. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway or Type USE, single conductor in raceway.

B. Exposed Feeders: Type XHHW-2, single conductors in raceway

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

E. Feeders in Cable Tray Type XHHW-2, single conductors larger than No. 1/0

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

I. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway and Type XHHW-2, single conductors larger than No. 1/0 .

J. PV Circuits: Type PV for all PV source circuits rated at 600 through 2000 V.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

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

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

D. Perform tests and inspections **with the assistance of a factory-authorized service representative**.

1. After installing conductors and cables and before electrical circuitry has been energized, test **service entrance and feeder conductors and conductors** feeding the following critical equipment and services for compliance with requirements:
    a. interconnect wiring between genset and switchboard
    b. interconnect wiring between BESS and switchboard
    c. interconnect wiring between solar inverters and switchboard
    d. solar string wiring between solar modules and combiner boxes and/or junction/pull boxes
    e. other interconnect wiring between components of TBPP.

2. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    b. 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.

4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backboards.
2. Category 5e twisted pair cable.
3. Category 6 twisted pair cable.
4. Category 6a twisted pair cable.
5. Twisted pair cabling hardware.
6. RS-485 cabling.
7. Low-voltage control cabling.
8. Control-circuit conductors.
9. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

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

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

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

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. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches (1520 mm) or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

2.2 BACKBOARDS

A. Description: Plywood, **fire-retardant treated,** 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with **eggshell, latex** paint. Comply with requirements in Section 099123 "Interior Painting."

2.3 CATEGORY 5e TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

C. Conductors: 100-ohm, 24 AWG solid copper.

D. Shielding/Screening: **Shielded twisted pairs (FTP**

E. Cable Rating: **Riser**

F. Jacket: **Gray t**hermoplastic.

2.4 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

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: **Shielded twisted pairs (FTP)**

E. Cable Rating: **Riser**.

F. Jacket: **Yellow** thermoplastic.

2.5 CATEGORY 6a TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Standard: Comply with TIA-568-C.2 for Category 6a cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: **Shielded twisted pairs (FTP)**

E. Cable Rating: **Riser**.

F. Jacket: B**lue** thermoplastic.

2.6 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of **Category 5e, Category 6, Category 6a**.

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.

C. Source Limitations: **Obtain twisted pair cable hardware from single source from single manufacturer**.

D. Connecting Blocks: **110-style IDC for Category 5e, 110-style IDC for Category 6**. 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.

E. 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.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

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 (483 mm) equipment racks.
3. Number of Jacks per Field: One for each four-pair **cable indicated**.

G. Patch Cords: Factory-made, four-pair cables in **48-inch (1200-mm)** 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.

H. 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. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

I. 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 faceplate.
3. Standards:

a. Category 5e, unshielded twisted pair cable shall comply with IEC 60603-7-2.
b. Category 5e, shielded twisted pair cable shall comply with IEC 60603-7-3.
c. Category 6, unshielded twisted pair cable shall comply with IEC 60603-7-4.
d. Category 6, shielded twisted pair cable shall comply with IEC 60603-7.5.
e. Category 6a, unshielded twisted pair cable shall comply with IEC 60603-7-41.
f. Category 6a, shielded twisted pair cable shall comply with IEC 60603-7.51.

4. Marked to indicate transmission performance.

J. Faceplate:

1. **Four** port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
3. Metal Faceplate: **Stainless steel**, complying with requirements in Section 262726 "Wiring Devices."
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.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 TWIN-AXIAL DATA HIGHWAY CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 4 pairs, **No. 20** AWG, stranded **7x28** tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 4 pairs, **No. 20** AWG, stranded **7x28** tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.8 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, **two pairs**, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

2.9 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. Two pair, twisted, **No. 16 AWG, stranded (19x29)** tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

2.10 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, **Type THHN/THWN-2, complying with UL 83 in raceway or Type XHHW-2, complying with UL 44 in raceway or Type TC, complying with UL 1277 in raceway**.

B. Class 2 Control Circuits: Stranded copper, **Type THHN/THWN-2, complying with UL 83 in raceway or Type XHHW-2, complying with UL 44 in raceway**.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, **Type THHN/THWN-2, complying with UL 83 in raceway or Type XHHW-2, complying with UL 44 in raceway**.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency **Engage** a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
2. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square **2-1/8 inches (53 mm)** deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits **3 inches (75 mm)** above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install 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. Do not use heat lamps for heating.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
10. Support: Do not allow cables to lie on removable ceiling tiles.
11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware.
3. Do not untwist UTP cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than **30 inches (760 mm)** apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. 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. Below each feed point, neatly coil a minimum of **72 inches (1830 mm)** of cable in a coil not less than **12 inches (305 mm)** in diameter.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; **No 14** AWG.
2. Class 2 low-energy, remote-control, and signal circuits; **No. 16** AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; **No 12** AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.9 FIELD QUALITY CONTROL

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

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

D. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

E. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm 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 cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after 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 its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and

adapters that are qualified by test equipment manufacturer for channel or link test configuration.

F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Foundation steel electrodes.
3. Solar racking

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding 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. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1) Test wells.
2) Ground rods.
3) Ground rings.

b. Instructions for periodic testing and inspection of grounding features at **test wells, ground rings,** based on **NFPA 70B**.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

2.3 CONDUCTORS

A. Insulated Conductors: **Copper** wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
8. Conductors shall be sized as noted on the plans or as noted in 1 through 7 above when not detailed on the plans.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, **1/4 by 4 inches (6.3 by 100 mm)** in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

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

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless **compression**-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

H. Conduit Hubs: Mechanical type, terminal with threaded hub.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with [**hex head bolt**] [**socket set screw**].

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, **copper rated for direct burial** terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper,. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal [**one**] [**two**]-piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:

1. Mechanical type, two pieces with **stainless-steel** bolts.

a. Material: **Die-cast zinc alloy**.
b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and **copper ground connector rated for direct burial**.

2.5 GROUNDING ELECTRODES

A. Ground Rods: **Copper-clad** steel; **3/4 inch by 10 feet (19 mm by 3 m).**

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for **No. 10** AWG and smaller, and stranded conductors for **No. 8** AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, **No. 4/0 or as noted on the plans** AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

C. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

F. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare copper, not less than **No. 8**

2. AWG.
3. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
4. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.5 FENCE GROUNDING

A. Fence Grounding: Install at maximum intervals of **50 feet (15 m)** except as follows:

1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of **50 feet (15 m)**.

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 6 inches (150 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. For grounding electrode system, install at least **three** rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor at the main service entrance or at the automatic transfer switch for the TBPP.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Ground Ring: Install a grounding conductor, electrically connected to each electrical structure ground rod and to each TBPP electrical component (genset, BESS, solar array, switchboards) extending around the perimeter of **area or item indicated**.

1. Install tinned-copper conductor not less than **No. 4/0** AWG for ground ring and for taps to electrical equipment.
2. Bury ground ring not less than **24 inches (600 mm)** from electrical equipment foundation.

G. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

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

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

D. Perform tests and inspections **with the assistance of a factory-authorized service representative**.

E. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal**[, at ground test wells][, and at individual ground rods]**. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

F. Grounding system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: **10** ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: **3** ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: **3** ohm(s).
5. Substations and Pad-Mounted Equipment: **5** ohms.

I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.

3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

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

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

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: **Galvanized steel**.
3. Channel Width: **1-5/8 inches (41.25 mm)**.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

2. Channel Material: 6063-T5 aluminum alloy.
3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
4. Channel Width**1-5/8 inches (41.25 mm)] [1-1/4 inches (31.75 mm)**.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Width**1-5/8 inches (41.25 mm)**.
3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
4. Fitting and Accessory Materials: Same as those for channels and angles**, except metal items may be stainless steel**.
5. Rated Strength: Selected to suit applicable load criteria.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: **Steel and malleable-iron** hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, [**zinc-coated**] [**stainless**] steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: [**All**] [**Stainless**]-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 102.
4. NECA 105.
5. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as **required by NF**PA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted **or other** support system, sized so capacity can be increased by at least **25** percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with **two-bolt conduit clamps**.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, **EMT, IMC, and RMC** may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: **Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.**
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use **3000-psi (20.7-MPa)**, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in the project plans.

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal 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.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. GRC: Comply with ANSI C80.1 and UL 6.
3. ARC: Comply with ANSI C80.5 and UL 6A.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated **rigid steel conduit**.

a. Comply with NEMA RN 1.
b. Coating Thickness: 0.040 inch (1 mm), minimum.

6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; **zinc-coated steel**.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
5. Fittings for EMT:

a. Material: **Steel or die cast**.
b. Type: **Setscrew or compression**.

6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Fiberglass:
    a. Comply with NEMA TC 14.
    b. Comply with UL 2515 for aboveground raceways.
    c. Comply with UL 2420 for belowground raceways.
3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: **Type EPC-40-PVC**, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. Continuous HDPE: Comply with UL 651A.
8. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
9. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:
1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
    a. Fittings for LFNC: Comply with UL 514B.
3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, **Type 3R** unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: **Hinged type** unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. **Prime coated, ready for field painting**.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected from **manufacturer's standard** colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, **ferrous alloy**, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Metal Floor Boxes:

1. Material: **sheet metal**.
2. Type: **Fully adjustable**.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes: Nonadjustable, **rectangular**.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, **galvanized, cast iron** with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: **4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)**.

K. Gangable boxes **are prohibited**.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, **Type 3R** with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: **Fiberglass**.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, **Type 1** for interior and **Type 3R for exterior** galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: **GRC**
2. Concealed Conduit, Aboveground: **IMC**.
3. Underground Conduit: RNC, **Type EPC-80-PVC**.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): **LFMC**.
5. Boxes and Enclosures, Aboveground: NEMA 250, **Type 3R**.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: **EMT**.
2. Exposed and Subject to Severe Physical Damage: **GRC.** Raceway locations include the following:

   a. Loading dock.
   b. Mechanical and Electrical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: **EMT**.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: **GRC**.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 **stainless steel** in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: **3/4-inch (21-mm)** trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds **120 deg F (49 deg C)**.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm)of enclosures to which attached.

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m)intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of **1 inch (25 mm)** of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to **GRC or IMC** before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm)radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:

1. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: **125 deg F (70 deg C)** temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: **155 deg F (86 deg C)** temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: **125 deg F (70 deg C)** temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

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

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

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

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install select backfill.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

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

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ladder cable tray.
2. Cable tray accessories.
3. Warning signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to sides of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer who is licensed in the state where Project is located and who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.