

OWNER

Electrical Installation in Hazardous Locations



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ISSUE SUMMARY AND APPROVAL

This page records each issue of SPC-SPC-013. The preparer, reviewer and approver sign for each revision.

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Contributors

Rev.	Discipline	Prepared by	Reviewed by	Approved by
A	Specifications			

SECTION PC-SPC-013

ELECTRICAL INSTALLATION IN HAZARDOUS LOCATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes the furnishing of Contractor-furnished bulk materials, and the installation, testing and documentation of all electrical work between the utility service point at transformer XF-101 and every electrical load, instrument and control device inside the station fence:
1. Service entrance: pad and primary and secondary conduit for XF-101 to the electric cooperative's standard (HOLD H-10), service entrance conductors, metering provisions, main disconnect, and the automatic transfer switch (ATS) connection to standby generator G-101.
 2. Power distribution: feeders and branch circuits from the Owner-furnished panelboards in B-102 to H-101 (burner management system BMS-150 and burner controls), FG-101, T-101 instruments, B-101, the SK-110 motor-operated valves MOV-111, MOV-112, MOV-115, MOV-121 and MOV-122, control valves FCV-131 and FCV-132, shutdown valves SDV-101, SDV-102, SDV-103, SDV-106, SDV-141 and SDV-165, dump valve LCV-104 (fed from the 120 VAC uninterruptible power supply), the E-161 electric fuel gas preheater and its controller HCP-161, site lighting, receptacles, heat tracing and the building heating and cooling units UH-101 and AC-102A.
 3. Control and instrument wiring: 24 VDC and 120 VAC control circuits, analog and discrete signal cable, safety programmable logic controller (PLC) wiring for PT-133A, PT-133B, PT-133C and SDV-102, fire and gas detection wiring (GD-205, GD-206, GD-207), emergency shutdown pushbuttons HS-201 to HS-204, and communication cable between B-101, B-102, the receiving pipeline operator's demarcation panel and field devices.
 4. Raceways: rigid galvanized steel (RGS) conduit, PVC-coated RGS conduit, Schedule 80 PVC underground duct, cable tray, explosionproof fittings, seals, drains and breathers.
 5. Cable: MC-HL and TC-ER-HL cable in classified areas, THHN/THWN-2 and XHHW-2 in conduit, and ITC-ER or PLTC-ER instrument cable.
 6. Grounding and bonding: ground grid, rods, bonding of equipment, structures, fences and gates, building grounding electrode systems, and grounding tests.
 7. Lightning protection to NFPA 780 for B-101, B-102, the H-101 stack, VS-101, T-101 and the SK-110 canopy.
 8. Area lighting.
 9. Acceptance testing to ANSI/NETA ATS, labeling including arc flash labels, and electrical as-built records.
 10. Testing of the 24 VDC battery system and of UPS-101 (1.5 kVA, 120 VAC, 8 hour battery) in B-102, the ATS and the G-101 integration, including the restart time-delay relays.



B. Related sections:

1. SPC-SPC-001, General Requirements and Definitions.
2. SPC-SPC-014, Instrumentation Installation, Tubing and Calibration.
3. SPC-SPC-015, Cathodic Protection Installation and Testing.
4. SPC-SPC-016, Prefabricated Buildings B-101 and B-102.
5. SPC-SPC-018, Pre-commissioning, Commissioning and Startup.
6. SPC-SPC-019, Inspection and Test Plan; SPC-SPC-020, Construction Records and Turnover.

C. Work by others:

1. Transformer XF-101, primary conductors and utility metering, by the electric cooperative (HOLD H-10). The Contractor provides the pad, primary conduit, grounding and secondary conduit to the cooperative's standard.
2. Internal wiring of Owner-furnished packages (B-101, B-102, the H-101 burner management system, FG-101, G-101 and the SK-110 junction boxes) up to the vendor's terminal strips. The Contractor terminates field wiring at these terminals.
3. Cathodic protection cable and anodes, under SPC-SPC-015. The AC supply to the rectifier is in this section.
4. Instrument installation, calibration and loop checks, under SPC-SPC-014. This section covers the cable and raceway to each instrument.
5. Programming of the remote terminal unit, safety PLC and flow computer, by the Owner's systems integrator. The Contractor supports point-to-point checks under SPC-SPC-018.

D. Where this section and NFPA 70 differ, the more stringent requirement governs. Where the area classification and field conditions differ, for example because a release source moved during construction, the Contractor shall stop work in the affected area and submit a request for information.

1.02 REFERENCES

A. Codes and standards:

1. NFPA 70-2023, National Electrical Code (NEC), including Articles 250, 300, 310, 344, 392, 480, 500, 501, 725 and 760.
2. NFPA 70E-2024, Standard for Electrical Safety in the Workplace, Article 130 (arc flash labeling).
3. NFPA 780-2023, Standard for the Installation of Lightning Protection Systems.
4. NFPA 496-2024, Purged and Pressurized Enclosures for Electrical Equipment (where a vendor package uses it).
5. API RP 500, 3rd Edition, Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2.

6. API RP 540, Electrical Installations in Petroleum Processing Plants (guidance).
7. IEEE 80-2013, IEEE 81-2012, IEEE 142-2007 and IEEE 1100-2005 (grounding); IEEE 43-2013 (insulation resistance of rotating machinery).
8. ANSI/NETA ATS-2021, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
9. UL 6, UL 514B, UL 886, UL 1203, UL 2225 (conduit, fittings and hazardous-location equipment); UL 1569 and UL 2250 (MC and instrument tray cable); UL 467 (grounding); UL 943 (ground-fault circuit interrupters).
10. NEMA VE 1 and VE 2 (cable tray); NEMA 250 (enclosures); ANSI C84.1 (voltage ranges); ANSI Z535.4 (safety signs).
11. 29 CFR 1910 Subpart S and 29 CFR 1926 Subpart K.

B. Project documents:

1. GEN-DB-001, Basis of Design.
2. ELE-RPT-001, Hazardous Area Classification, and ELE-DWG-002, Hazardous Area Classification Plan.
3. ELE-DWG-001, One-Line Diagram; ELE-CAL-001, Electrical Load List and Load Analysis; ELE-CAL-002, Standby Generator G-101 Sizing and ATS; ELE-CAL-003, UPS and Battery Sizing.
4. ELE-LST-001, Cable Schedule; ELE-LST-002, Panel Schedules.
5. ELE-CAL-005, Station Grounding and Bonding Design; ELE-CAL-006, Lightning Risk Assessment and Protection Design; ELE-DWG-004, Grounding and Lightning Protection Plan.
6. ELE-CAL-007, Lighting Design; ELE-DWG-005, Lighting Plan.
7. INS-LST-001, Instrument Index; INS-LST-002, I/O List.
8. SAF-RPT-003, Fire and Gas Detection Philosophy and Layout; SAF-DWG-001, Fire and Gas Detector Layout.
9. CP-CAL-001, Cathodic Protection Design; PRO-DS-012, E-161 Electric Fuel Gas Preheater.
10. PRO-DWG-101 to PRO-DWG-111, Piping and Instrumentation Diagrams.

1.03 DEFINITIONS

- A. Class I, Division 1 and Division 2: locations as defined in NEC 500.5(B), with the boundaries shown in ELE-DWG-002. Unclassified: outside all Division 1 and Division 2 boundaries.
- B. Seal: a listed sealing fitting filled with listed compound under NEC 501.15.
- C. MC-HL: metal-clad cable listed for hazardous locations, with a continuous corrugated aluminum sheath and an overall jacket. TC-ER-HL: tray cable listed for exposed runs and for hazardous locations under NEC 501.10.

D. ITC-ER and PLTC-ER: instrumentation tray cable and power-limited tray cable listed for exposed runs.

E. Uninterruptible power supply (UPS): the 24 VDC battery and charger system, and UPS-101, a 1.5 kVA on-line double-conversion 120 VAC unit with an 8 hour battery, both in B-102.

1.04 SUBMITTALS

A. The Contractor shall submit the items in Table 1-1.

Table 1-1: Submittal Schedule

No.	Submittal	Timing	Action
13-01	Electrical execution plan: sequence, crews, licensed electricians, energization and lockout procedure	21 days before mobilization	EOR and Owner approval
13-02	Product data for all Contractor-furnished materials, with listing and hazardous-location marking	30 days before purchase	EOR approval
13-03	Hazardous location compliance matrix: every device and fitting in Division 1 and 2 with its class, division, group and temperature code against the area classification	30 days before installation	EOR approval
13-04	Conduit and cable routing drawings where they differ from ELE-LST-001 (trench sections, stub-ups, tray layout)	21 days before trenching	EOR approval
13-05	Seal pour procedure, compound manufacturer's instructions and crew training record	Before the first pour	Owner review
13-06	Qualifications of the NETA-certified testing agency (Level III or IV lead technician)	30 days before testing	Owner approval
13-07	Calibration certificates of test instruments	Before testing	Owner review
13-08	Ground resistance and grid continuity test reports	Within 5 days of the test	EOR and Owner review
13-09	Insulation resistance and continuity test reports (QF-13-02)	Within 5 days of the test	Owner review
13-10	NETA ATS test reports for panelboards, ATS, dry-type transformers, UPS and the G-101 connection	Before energizing that system	EOR and Owner approval
13-11	Arc flash labels with the short-circuit and coordination data used (from ELE-CAL-001, or the Contractor's study if assigned)	Before energization	EOR review
13-12	Lightning protection installation certificate, where the Owner requires one	At mechanical completion	Owner review
13-13	Electrical as-built red-lines: one-line, routing, grounding, seal locations, surveyed underground duct	Weekly; final at turnover	EOR and Owner review
13-14	Cable pulling tension calculations for pulls over 200 ft or with more than 270° of bends	Before the pull	EOR review

1.05 QUALITY ASSURANCE

- A. Work shall be performed by electricians licensed by the Construction Industries Board, under a licensed electrical contractor, with no more than two apprentices per journeyman.
- B. Acceptance testing shall be performed by a NETA-accredited testing agency led by a NETA Level III or IV technician.
- C. Hold and witness points shall be as listed in 3.12 and in SPC-SPC-019.

1.06 MEASUREMENT AND PAYMENT

- A. Pay item 13.01, Power, control and hazardous-location electrical installation: lump sum. The price shall include all Contractor-furnished raceway, cable, seals, fittings, supports, tray, terminations, labels and arc flash labels, insulation resistance and continuity testing, NETA ATS testing, UPS and ATS tests, service entrance work, the XF-101 pad and conduit, and red-line as-builts. It excludes Owner-furnished equipment, the cooperative's primary work, cathodic protection (pay item 15.01) and instrument installation (pay item 14.01). Progress payment shall be by milestone: 40 % with underground work complete and accepted (WP-13-01), 30 % with above-grade raceway and cable complete, 20 % with terminations and tests complete (HP-13-04), and 10 % at acceptance of the classified-area walkdown (HP-13-05).
- B. Pay item 13.02, Grounding and lightning protection: lump sum, including the ground grid, rods, bonds, test wells, lightning protection, surge protective devices, testing, and up to 10 additional rods to reach the 5 ohm target. Rods beyond 10 shall be paid as force-account work under pay item 01.06. Decouplers are furnished under pay item 15.01.
- C. Pay item 13.03, Lighting: lump sum, including fixtures, poles, photocells, circuits and illuminance verification.

PART 2 PRODUCTS

2.01 GENERAL

- A. Materials shall be new, listed by a nationally recognized testing laboratory for the use and location, and marked for Class I, Group D (minimum) and the temperature code required by ELE-RPT-001, T3 minimum where none is stated. Equipment in Division 1 shall be explosionproof or otherwise listed for Division 1; equipment in Division 2 shall be listed for Division 2 or Division 1.
- B. Owner-furnished packages arrive with their own listed equipment. The Contractor shall not modify listed enclosures and shall not field-drill explosionproof enclosures; only listed entries shall be used.
- C. The Owner-furnished equipment connected under this section is the B-102 panelboards, UPS, remote terminal unit and safety PLC cabinets; G-101 and the ATS; the H-101 burner management panel; the SK-110 junction boxes and valve actuators; the SDV electro-hydraulic actuators; the FG-101 junction boxes and E-161; and the B-101 analyzer panel. The Contractor shall check

nameplate voltage, phase, full-load current and protective device data against ELE-DWG-001 on receipt and report any discrepancy before termination.

2.02 RACEWAYS

A. Raceways shall meet Table 2-1.

Table 2-1: Raceway Requirements

Item	Requirement
Above-grade conduit	Hot-dip galvanized RGS to UL 6 and ANSI C80.1, threaded, 3/4 in trade size minimum (1/2 in only at device entries)
Conduit within 18 in of grade, at soil-to-air transitions, at the T-101 containment and within 10 ft of H-101	PVC-coated RGS with 40 mil exterior and 2 mil urethane interior coating, coated fittings and overlap sleeves, installed by a crew certified by the manufacturer
Underground	Schedule 80 PVC to UL 651, direct buried or concrete encased where shown, with PVC-coated RGS elbows and risers at least 24 in below grade before rising (NEC 501.10(A)(1)(a) exception)
Fittings in classified areas	Explosionproof, threaded, cast iron or copper-free aluminum (under 0.4 % copper), Class I, Division 1, Group D, with at least five full threads engaged (NEC 500.8(E))
Flexible connections	Listed explosionproof flexible couplings at vibration points (valve actuators); liquid-tight flexible metal conduit not permitted in Division 1
Seals	Listed sealing fittings with listed compound and fiber dam; drain and breather seals where condensation is possible
Cable tray	Aluminum 6063-T6 ladder tray, NEMA VE 1 Class 12B minimum, 9 in rung spacing, 6 in loading depth, with covers where exposed to falling objects or to sunlight on instrument cable
Unions	Explosionproof, ground-joint type
Supports	Hot-dip galvanized strut with 316 stainless steel or galvanized hardware, at the NEC 344.30 spacing and not more than 10 ft

2.03 CABLE

A. Cable shall meet Table 2-2. All cable shall pass the IEEE 1202 (FT4) flame test. Voltage drop shall not exceed 3 % on branch circuits and 5 % in total from the service to the farthest load, as calculated in ELE-CAL-001.

Table 2-2: Cable Requirements

Service	Cable
Power, 480 V and 208Y/120 V, classified areas	MC-HL, copper, XHHW-2 conductors, with listed MC-HL fittings; or TC-ER-HL in tray or conduit
Power in unclassified areas and in conduit	THHN/THWN-2 or XHHW-2 copper, 600 V; ampacity at the 75 °C rating

Service	Cable
Control, 120 VAC and 24 VDC	Multiconductor TC-ER-HL, 14 AWG minimum, 600 V
Analog instrument	Individually shielded twisted pairs, 16 AWG minimum (18 AWG in multipair cable with EOR approval), overall shield, ITC-ER or PLTC-ER; TC-ER-HL where run in Division 1 without conduit
Safety PLC signal cable	A dedicated cable for each of PT-133A, PT-133B and PT-133C, each in a separate conduit, separated from the others and from basic process control cable for at least the last 20 ft at the field end; the SDV-102 solenoid circuit in its own conduit
Communication	Shielded outdoor-rated Category 6, or single-mode fiber in inner duct, per ELE-LST-001
Fire and gas detection	Cable type specified by the fire and gas vendor to NFPA 72, red jacket or red tags
Equipment grounding conductor	Insulated green copper in each power conduit, sized to NEC Table 250.122

- B. The three safety PLC transmitter cables shall be kept apart because a common-cause failure of their wiring would defeat the 2-out-of-3 voting of the overpressure shutdown function.

2.04 GROUNDING MATERIALS

- A. Ground rods shall be copper-clad steel, 3/4 in x 10 ft, to UL 467, with at least 10 mil of copper.
- B. Ground conductors shall be bare soft-drawn stranded copper: 4/0 AWG for the grid and main ties, 2/0 AWG for equipment taps and 2 AWG minimum for structure and fence bonds, unless ELE-CAL-005 shows larger.
- C. Connections below grade shall be exothermic welds or listed irreversible compression connectors qualified to IEEE 837. Connections above grade shall be listed bolted lugs, two-hole on equipment pads.
- D. Ground test wells shall be 10 in diameter polymer boxes with traffic lids, at each grid corner and at the main ground bus tie in B-102.
- E. No exothermic weld shall be made to pressure-containing pipe. Piping shall be bonded by clamp or by a lug on a non-pressure attachment. The only pipe-attached thermite welds on the station are the cathodic protection cable connections of SPC-SPC-015.

2.05 LIGHTING AND DEVICES

- A. Area light fixtures shall be LED, listed for Class I, Division 2 (Division 1 where located in Division 1), IP66 minimum, 4,000 to 5,000 K, controlled by photocell with a hand-off-auto switch in B-102. Illuminance shall meet ELE-CAL-007, and not less than 1 fc average on walkways and 5 fc at the meter skid, the B-101 entry, the V-101 and PR-101 closures, the H-101 burner front and the T-101 loadout.
- B. Receptacles in classified areas shall be listed interlocked explosionproof receptacles and plugs with ground-fault protection to NEC 210.8.

- C. B-101 and B-102 shall have emergency egress lighting with a 90 minute battery.

PART 3 EXECUTION

3.01 GENERAL

- A. No work shall be done on or near energized conductors except as NFPA 70E permits, under an energized electrical work permit signed by the Owner. Lockout and tagout shall follow the Owner's program and CON-RPT-003.
- B. Exothermic welding inside the fence after any section contains gas shall require a hot work permit.
- C. Excavation for duct bank or ground grid shall follow an OKIE811 locate and the Owner's excavation permit. Excavation within 24 in of a marked facility and within 10 ft of the (receiving pipeline operator) trunkline shall be by hand or vacuum. No excavation shall be made inside the right-of-way without an encroachment agreement and the receiving pipeline operator's inspector present (HOLD H-04).

3.02 AREA CLASSIFICATION CONTROL

- A. Before installing any device, the Contractor shall mark the Division 1 and Division 2 boundaries of ELE-DWG-002 on the construction drawings and in the field around V-101, the PR-101 closure, SK-110, FG-101, VS-101, T-101, the blowdown valve outlets, the H-101 fuel train and B-101.
- B. The compliance matrix (13-03) shall be approved before installation, and each installed device shall carry a laboratory marking, visible after installation, that matches the matrix.
- C. Device temperature codes shall be below the autoignition temperature of the design gas, and not less than T3 (200 °C). Heat tracing and luminaire surface temperatures shall be checked against the temperature code.

3.03 CONDUIT INSTALLATION

- A. Threaded joints shall be made up wrench tight with at least five full threads engaged. Field-cut threads shall be standard NPT taper cut with a die, cleaned and coated with zinc-rich compound. Running threads are prohibited. Thread lubricant shall be conductive and listed for explosionproof joints; tape shall not be used on explosionproof joints.
- B. Field cuts and threads on PVC-coated conduit shall be recoated with the manufacturer's touch-up compound and covered by the overlap sleeve. Pipe wrenches shall not be used on coated surfaces.
- C. Conduit shall be supported within 3 ft of each box, fitting or termination and at intervals not exceeding 10 ft, and shall not be supported from process piping, insulation or handrails. Conduit on the SK-110 canopy shall be supported from canopy steel.
- D. A drain or drain-breather fitting shall be installed at every low point where water can collect, with the conduit sloped at least 1/8 in per ft toward it where practical.



- E. Underground duct shall have at least 24 in of cover in the yard and 36 in under roads (or concrete encasement at 24 in), with warning tape 12 in above the duct. Duct shall clear buried process piping by 12 in at crossings and 36 in when parallel, and shall not share a trench with gas lines. Separation from cathodic protection cable shall follow SPC-SPC-015.
- F. Stub-ups shall be PVC-coated RGS elbows and risers extending at least 6 in above finished grade or slab, plugged until the cable is pulled.
- G. Conduit entering B-101 and B-102 shall be sealed at the building wall to NEC 501.15 and weather sealed under SPC-SPC-016. Conduit passing from a Division 1 location into B-102 shall have a seal within 10 ft of the boundary, with no fitting between the seal and the boundary other than those NEC 501.15(A)(4) permits.

3.04 SEALS

- A. Seals shall be installed within 18 in of each enclosure in Division 1 containing arcing or high-temperature devices, at each Division 1 boundary, where a conduit leaves a Division 2 location, at each building entry, and at each process-connected instrument as NEC 501.17 requires (a single-seal device listed to ANSI/ISA 12.27.01, or a secondary seal with a vent or drain).
- B. The seal pour procedure shall include at least the following:
 - 1. Conductors pulled and terminated, then separated in the seal hub so that compound surrounds each conductor. Cable jacket and shield removed within the seal unless the cable is a listed gas and vapor-tight continuous-sheath cable terminated in a listed fitting.
 - 2. Fiber dam packed to the manufacturer's depth, with no strands in the pour zone.
 - 3. Compound mixed at the manufacturer's ratio and poured only within the manufacturer's temperature range (typically 35 to 100 °F).
 - 4. Pour depth at least the trade size of the conduit and not less than 5/8 in (NEC 501.15(C)(3)).
 - 5. Cure for the manufacturer's time (typically 72 hours) before energizing.
 - 6. Each seal tagged with its number, date, crew and inspector, and recorded on QF-13-01.
- C. Conductor fill in a seal shall not exceed 25 % of the cross-sectional area of the same trade size of RGS (NEC 501.15(C)(6)) unless the seal is listed for more.
- D. The Owner's inspector shall witness the first pour of each crew and 20 % of later pours. Every seal shall be inspected before the fitting is closed.

3.05 CABLE INSTALLATION

- A. Cable shall be pulled only after the raceway is complete, reamed, swabbed and dry, with a lubricant compatible with the jacket, within the manufacturer's pulling tension and sidewall pressure. Minimum bend radius shall be 12 times the outside diameter for MC-HL and shielded cable and 8 times for unshielded cable. Cut ends shall be sealed at once, and reels stored chocked, off the ground and covered.

- B. Cable in tray shall be laid, not pulled over rungs, and tied at 6 ft intervals horizontally and 18 in vertically with UV-resistant nylon or 316 stainless steel ties.
- C. Power circuits above 120 V, 120 VAC control, 24 VDC control and analog signals, and any intrinsically safe circuits shall be in separate raceways or separated by a barrier in tray. Power and signal trays shall be at least 12 in apart.
- D. Splices shall not be made in underground raceways or pull points, and elsewhere only with Owner approval in listed enclosures.
- E. MC-HL and TC-ER-HL shall be terminated with listed hazardous-location glands of the correct bushing size, with the sheath bonded at the gland.
- F. Analog cable shields shall be grounded at one end only, at the B-102 instrument ground bus, and insulated at the field end.
- G. Conductor colors shall be brown, orange and yellow with gray neutral at 480 V; black, red and blue with white neutral at 208Y/120 V; green or bare for ground; and the Owner's standard for 24 VDC (to be confirmed with the Owner's systems integrator). Stranded conductors on terminal blocks shall have compression lugs or insulated ferrules, torqued with a calibrated tool and torque-striped.

3.06 GROUNDING AND BONDING

- A. The ground grid shall be installed per
 ELE-CAL-005 and
 ELE-DWG-004, with 4/0 AWG bare copper at least 18 in below finished grade (below the 12 in frost depth) and rods at the grid corners and intersections shown.
- B. The following shall be bonded to the grid: B-101; B-102 (grounding electrode system to NEC 250.50); the XF-101 pad; the G-101 frame and neutral to NEC 250.30 as the ATS configuration on
 ELE-DWG-001 requires; all equipment skids and structural steel; the SK-110 canopy; cable tray every 50 ft and at each end; fences at each corner post, each gate post, every 50 ft and where overhead lines cross; gates, with flexible braided jumpers across hinges; H-101; T-101 at two points 180° apart; and VS-101.
- C. Grounding and bonding conductors shall not short IJ-101 or IJ-102. Where
 CP-CAL-001 requires decouplers between the grounding system and cathodically protected piping, they shall be installed exactly as shown and tested under
 SPC-SPC-015.
- D. Flange jumpers are not required across metallic-bolted ASME B16.5 joints. Where the design shows them, they shall be 2 AWG flexible copper with two-hole lugs on bolt studs.
- E. Station ground resistance shall be measured by the fall-of-potential method (IEEE 81) before connection to the utility neutral or to any other grounding system.
- F. The T-101 loadout shall have a listed static grounding reel bonded to the grid, and a ground verification system where
 ELE-CAL-005 requires it.

3.07 LIGHTNING PROTECTION

- A. Lightning protection shall be installed to NFPA 780 and ELE-CAL-006: strike termination devices on B-101 and B-102 with down conductors and ground terminations bonded to the grid. The H-101 stack, VS-101 and T-101 are self-protecting where their metal is at least 3/16 in thick, as NFPA 780 requires for structures containing flammable vapors, and shall each be bonded to the grid at two points.
- B. Surge protective devices shall be installed at the service entrance and on the load side of the ATS, and on remote terminal unit power supplies and on signal and communication circuits leaving the buildings, per ELE-CAL-006.
- C. Down conductors shall have a minimum bend radius of 8 in, with no bend of less than 90° included angle.

3.08 LABELING

- A. Every enclosure, junction box, panel, disconnect, receptacle, fixture and field device shall carry an engraved phenolic or 316 stainless steel tag (3/4 in text on equipment, 1/4 in on devices) matching ELE-LST-001 and INS-LST-001.
- B. Each cable shall be tagged at both ends and at every pull point; each conductor shall carry a printed heat-shrink sleeve with its wire number at both ends; each conduit shall be tagged at both ends; each seal shall carry its pour tag. Panel directories shall be typed.
- C. Arc flash labels to NFPA 70E and ANSI Z535.4 shall be fixed to every panelboard, ATS, UPS, disconnect and motor control device likely to be examined, adjusted or serviced while energized, showing nominal voltage, arc flash boundary, incident energy at working distance or PPE category, and the study date. The data shall come from ELE-CAL-001; the EOR shall confirm who performs the arc flash study.
- D. Signs reading "Hazardous location, no ignition sources without hot work permit" shall be posted at the Division 1 and Division 2 boundaries on access routes.

3.09 UPS, ATS, GENERATOR AND E-161 INTEGRATION

- A. The Owner-furnished 24 VDC battery and charger system shall be installed and terminated per the vendor, with battery racks restrained and ventilation to NEC Article 480 and the vendor (valve-regulated lead-acid batteries are expected).
- B. UPS-101 (1.5 kVA, 120 VAC, on-line) and its external battery shall be installed per ELE-CAL-003, with the maintenance bypass fed from panel LP-101. LCV-104 and the other loads on the UPS panel schedule (ELE-LST-002) shall be fed from UPS-101, so that the V-101 liquid dump keeps working through a power outage.
- C. Before the first transfer, the Contractor shall confirm that utility and G-101 phase rotation match. ATS time delays shall be set per ELE-DWG-001 (typically engine start 3 s, transfer 5 s after stable voltage and frequency, retransfer 5 min, cooldown 5 min; confirm with vendor data, HOLD H-15).

D. G-101 electrical work covers the starting battery charger, block heater circuit, and remote annunciation to the remote terminal unit (XS-209). The G-101 fuel connection is covered by other sections.

E. The generator restart sequence of ELE-CAL-002 shall be set and function tested: step 1 at ATS closure (UPS and chargers, lighting, analyzer heaters, heat tracing, burner management system, exhaust fan EF-101A); step 2, E-161 through the HCP-161 restart delay at 30 s; step 3, UH-101 and the AC-102A heat strip at 60 s. Relay settings and measured times shall be recorded on QF-13-05. The steps are staggered so that the 60 kW generator does not see the full block load at once.

F. E-161 (5 kW, 480 V three-phase, explosionproof, listed for the location on ELE-DWG-002) is mounted on the FG-101 skid on line 2"-F-1050 upstream of PCV-161. Its supply shall have a listed seal within 18 in of the enclosure, the heater and controller shall be bonded, and the over-temperature cutout and the 105 °F setpoint of TIC-161A shall be verified with the instrument technician. Element insulation resistance at 500 VDC shall meet the vendor minimum (typically 10 megohm, HOLD H-15).

3.10 TESTING

A. The Contractor shall perform the tests in Table 3-1.

Table 3-1: Electrical Tests

Test	Method	Extent
Visual and mechanical inspection	NETA ATS Section 7 inspections; listing marks checked against the compliance matrix	100 %
Conduit thread engagement	Visual count before make-up	10 % of joints per crew per day
Seals	Pour tag, depth, dam and cure	100 % visual; 20 % of pours witnessed
Continuity	Point to point on every conductor	100 %
Insulation resistance	DC megohmmeter per Table 3-2	All power and control conductors; instrument cable only with electronics disconnected
Ground resistance	Fall-of-potential to IEEE 81, current probe at least 5 times the grid diagonal away, 62 % potential probe with readings at 52 % and 72 % agreeing within 5 %	Station grid and each building electrode system
Bond resistance	Low-resistance ohmmeter between each bonded item and the grid	100 % of bonds
Torque	Calibrated torque wrench	100 % of power terminations, 10 % of control

Test	Method	Extent
Phase rotation	Rotation meter at the service, both ATS sources and each motor feeder	100 %
Functional test	Every circuit, light, receptacle (ground-fault trip) and motor (rotation, overload setting)	100 %
NETA ATS acceptance tests	Panelboards, molded-case breakers above 100 A, dry-type transformers, ATS, UPS, generator connection, surge arresters, grounding	Each item
UPS autonomy	Discharge of the 24 VDC system and of UPS-101 at actual connected load, utility and G-101 off, for at least 30 min, with runtime projected from the vendor discharge curve; a full 8 hour test at the Owner's option	Once each
ATS transfer	Utility breaker opened with load on; transfer and retransfer times measured	Three consecutive successful transfers

B. Insulation resistance shall be tested at the voltages in Table 3-2 for 1 min, corrected to 20 °C. Readings below the minimum, or differing by more than 50 % between phases of the same cable, shall be rejected. Surge devices, electronics and instruments shall be disconnected before testing, and temperature and humidity recorded on QF-13-02.

Table 3-2: Insulation Resistance Test Values

Circuit or cable	Test voltage, VDC	Minimum resistance, megohm
600 V power and control cable on 480 V and 208Y/120 V	1,000	100
600 V cable on 24 VDC control	500	100
300 V instrument cable, electronics disconnected	500	50
Motors to 600 V (valve actuators, fans)	500	5 (IEEE 43, random-wound below 1 kV)
Panelboard bus, 480 V	1,000	100

Note 1: Values follow ANSI/NETA ATS-2021 Table 100.1. Utility primary cable is tested by the cooperative.

3.11 ACCEPTANCE

A. The electrical installation is accepted when every criterion in Table 3-3 is met.

Table 3-3: Acceptance Criteria

Parameter	Criterion	Method
Hazardous location equipment	Every device in Division 1 or 2 marked for Class I, Group D or better, T3 or better, matching the approved matrix	Visual, matrix check
Thread engagement	At least five full threads on every explosionproof joint (NEC 500.8(E))	Visual count

Parameter	Criterion	Method
Explosionproof covers	All bolts installed and tight; flame paths clean, unpainted and without gaps	Visual, feeler gauge per manufacturer
Seal depth	At least the conduit trade size and not less than 5/8 in; fully cured	Pour tag, visual
Station ground grid	5 ohm or less; if higher, rods or counterpoise added as the EOR directs until met	Fall-of-potential
Building grounding electrode	25 ohm or less per rod, or a supplemental electrode (NEC 250.53), bonded to the grid	Fall-of-potential or clamp-on
Bond resistance	0.1 ohm or less to the grid; 0.01 ohm or less across bolted bus joints	Low-resistance ohmmeter
Insulation resistance	Per Table 3-2	Megohmmeter
Voltage at the service and ATS output	Within ± 5 % of nominal; phase unbalance under 2 % (ANSI C84.1)	True-RMS meter
Phase rotation	A-B-C at utility, generator and each motor; valve actuator direction confirmed	Rotation meter, bump test
ATS transfer	Transfer and retransfer within the set times ± 10 %, no nuisance trips, three consecutive successes	Timed test
UPS autonomy	8 hours or more at actual connected load for the 24 VDC system and for UPS-101, by projection from the 30 min test or by full test; end voltage above the vendor minimum	Discharge test
Generator restart sequence	Steps at 0, 30 s and 60 s within ± 5 s; no G-101 trip and no voltage dip beyond the ELE-CAL-002 values	Functional test with the utility opened
E-161	Listed for the location; seal within 18 in; over-temperature cutout works; 105 °F setpoint	Inspection, functional test
Ground-fault receptacles	Trip at 4 to 6 mA (UL 943)	Tester
Lighting	Measured average illuminance meets ELE-CAL-007	Light meter at night
Labels	100 % of equipment, cables, conductors and conduits; arc flash labels on all required equipment	Walkdown
As-builts	Underground duct and grid surveyed to ± 0.2 ft horizontally and vertically	Survey

3.12 FIELD QUALITY CONTROL

- A. Test and inspection records shall use forms QF-13-01 (seal pour and inspection log), QF-13-02 (insulation resistance and continuity), QF-13-03 (buried electrical inspection), QF-13-04 (ground resistance), QF-13-05 (ATS, generator and restart sequence), QF-13-06 (UPS autonomy) and QF-13-07 (hazardous area walkdown).
- B. The hold and witness points in Table 3-4 apply. Party codes: C Contractor, O Owner, E EOR, W receiving pipeline operator; H hold, W witness, R review, S surveillance, P perform.

Table 3-4: Hold and Witness Points

ID	Activity	C	O	E	W	Record
HP-13-01	Hazardous location compliance matrix and product data approved before installation in classified areas	P	R	H	-	Submittals 13-02, 13-03
WP-13-01	Underground conduit and ground grid before backfill (depth, separation, connections)	P	W	S	-	QF-13-03
WP-13-02	First seal pour of each crew, then 20 % of pours	P	W	-	-	QF-13-01
HP-13-02	All seals inspected before circuits through classified areas are energized	P	H	S	-	QF-13-01
HP-13-03	Station grid ground resistance accepted before utility service connection	P	H	R	-	QF-13-04, submittal 13-08
WP-13-03	Insulation resistance and continuity tests of feeders	P	W	-	-	QF-13-02
HP-13-04	NETA ATS reports accepted before each panelboard, UPS and ATS is energized	P	H	R	-	Submittal 13-10
WP-13-04	ATS transfer test and G-101 load test	P	W	S	-	QF-13-05
WP-13-05	Autonomy tests of the 24 VDC battery system and UPS-101; generator restart sequence	P	W	R	-	QF-13-06
HP-13-05	Final classified-area walkdown (every device, seal, cover bolt, breather, drain and label) before gas is introduced	P	H	H	-	QF-13-07

END OF SECTION