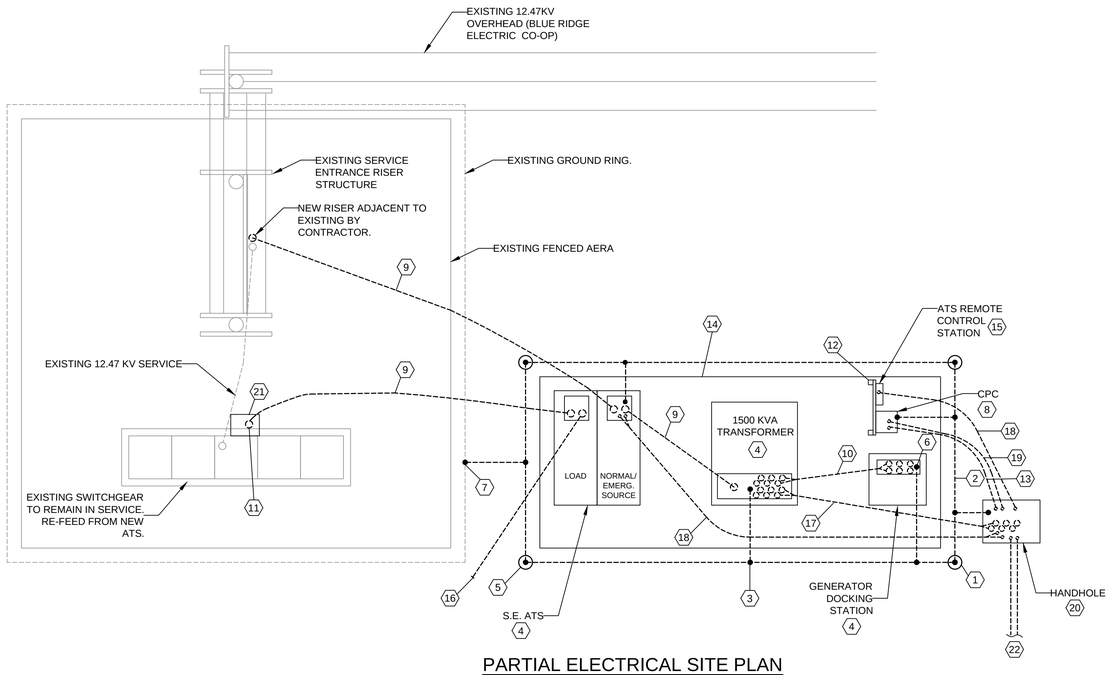
ADDENDUM 1

Request for Bids
OJRSA Project #2026-09
WRF Generator Transfer Switch Equipment Installation
February 17, 2026

Question 1 (general): Is there a construction cost estimate or budget associated with the project?
Answer 1: No. This RFB is considered a request for documents of and incidental to proposed contractual arrangements and therefore exempt from disclosure pursuant to the South Carolina Freedom of Information Act. Once the bids are opened, the project approved for contractual negotiations by the OJRSA Board of Commissioners, and the contract is executed, then the information will be available at www.ojrsa.org/opportunities.

Question 2 (general): The specifications were not included in the RFB. Can you post these as an addendum?
Answer 2: The plans and specifications were inadvertently not included in Attachment C of the RFB. See the following page of Addendum 1 for the plans, equipment, materials, and specifications for this project.



PARTIAL ELECTRICAL SITE PLAN

SCALE: 1" = 5'

SITE PLAN NOTES

1. 3/4" X 10' COPPERCLAD DRIVEN GROUND ROD. (TYPICAL)
2. #4/0 BARE COPPER NO LESS THAN 30" DEEP.
3. EXOTHERMIC WELD. (TYPICAL)
4. SEE SPECIFICATIONS AND ONE-LINE DIAGRAM.
5. GROUND ROD TEST WELL PER DETAIL.
6. BOND EQUIPMENT TO GROUND RING. (TYPICAL)
7. LOCATE AND BOND TO EXISTING GROUND RING.
8. SEE SCHEDULE.
9. 15KV WIRING. SEE ONE-LINE DIAGRAM.
10. 480V WIRING. SEE ONE-LINE DIAGRAM..
11. STUB UP BEHIND GEAR AND NIPPLE THROUGH TO EXISTING GEAR.
12. EQUIPMENT RACK PER SPECIFICATIONS.
13. 480V FEEDER FROM OFFICE COMPLEX.
14. REINFORCED EQUIPMENT PAD.
15. SEE RISER DIAGRAM.
16. 4" EMPTY CONDUIT. STUB OUT AND CAP.
17. 6-4" EMPTY CONDUITS.
18. 2" EMPTY CONDUIT.
19. 2-1" EMPTY CONDUITS.
20. SEE DETAIL AND SPECIFICATIONS.
21. NEMA 4X, CODE GAUGE, CODE SIZE SCREW COVER PULL BOX.
22. 480V AND EMPTY CONDUIT TO OFFICE COMPLEX. ENCASE PER DETAIL. CONTRACTOR IS RESPONSIBLE FOR MEASURING DISTANCE FROM PANEL AC 480/277 TO CPC PRIOR TO SUBMITTING BID.

GENERAL ELECTRICAL NOTES

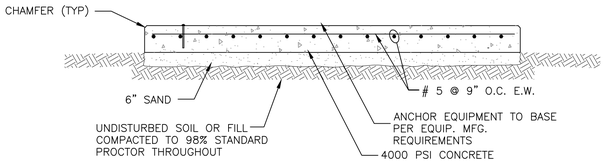
1. CONTRACTOR WILL BE HELD RESPONSIBLE FOR HAVING VISITED THE SITE AND BEING FAMILIARIZED WITH THE EXISTING CONDITIONS PRIOR TO SUBMITTING BID.
2. CONSULT APPROVED MANUFACTURER'S WIRING AND CONNECTION DIAGRAMS AND SHOP DRAWINGS IN DETAIL FOR EXACT CONNECTION REQUIREMENTS TO EQUIPMENT PROVIDED BY OTHER TRADES.
3. CONTRACTOR'S RECORD DRAWINGS SHALL SHOW EXACT LOCATIONS OF UNDERGROUND CONDUITS AND DUCT BANKS.
4. ALL EXPOSED CONDUIT SHALL BE INSTALLED USING SPECIFIED CLAMPS PROVIDING MINIMUM OF 1/2" SPACE BETWEEN CONDUIT AND MOUNTING SURFACE.
5. ALL WIRING PULLS SHALL BE WITHIN CABLE MANUFACTURER'S RECOMMENDED CABLE PULL TENSIONS. VERIFY WITH MANUFACTURER AND FIELD RECORD TENSIONS FOR SUBMITTAL TO ENGINEER.
6. ANY COATED MATERIAL THAT HAS FINISH DAMAGED, BROKEN OR CUT DURING INSTALLATION SHALL BE CLEANED AND COATED WITH A REPAIR KIT.
7. ALL SUPPORT FRAMING HARDWARE, BOLTS, ANCHORS, ETC. SHALL BE PROVIDED IN ACCORDANCE WITH SPECIFICATIONS.
8. UNLESS OTHERWISE NOTED PULL AND JUNCTION BOXES SHALL BE PER SPECIFICATIONS AND SIZED PER CODE AND/OR AS CONDITIONS DICTATE.
9. MINIMUM RACEWAY SIZE SHALL BE 3/4".
10. LEAVE SUFFICIENT SLACK IN ALL WIRING AND CABLES TO REACH FINAL TERMINATION POINTS. VERIFY FROM APPROVED EQUIPMENT DRAWINGS AND WIRING DIAGRAMS.
11. ANY POWER INTERRUPTION SHALL BE SCHEDULED WITH OWNER IN WRITING 72 HOURS PRIOR TO SHUTDOWN. SHUTDOWNS MAY BE LIMITED TO OFF-PEAK HOURS (LATE NIGHT).
12. ROUTING OF RACEWAYS IS ONLY A SUGGESTION BUT SHOULD BE FOLLOWED AS CLOSELY AS POSSIBLE. HOWEVER, ALTERNATE ROUTING WILL BE CONSIDERED WHERE BROUGHT TO THE ATTENTION OF THE ENGINEER AND SHOWN TO BE MORE FEASIBLE. WHERE EXACT ROUTING IS NOT INDICATED, RACEWAYS SHALL BE ROUTED CONCEALED IN SLAB OR STRUCTURE IN THE MOST PRUDENT MANNER.
13. EXISTING CONDUITS MAY BE RE-USED WHERE CLEANED BY PULLING THROUGH A SWAB FOLLOWED BY A MANDREL 85% OF THE CONDUIT INSIDE DIAMETER.

SPECIFIC SEQUENCING NOTES

1. INSTALL ALL CONDUIT TO EXISTING FENCED AREA, EQUIPMENT PAD, EQUIPMENT AND GROUND RING.
2. COORDINATE OUTAGE WITH OWNER AND BREC TO INSTALL CONDUIT WITHIN FENCED AREA AND UNDER EXISTING EQUIPMENT PAD.
3. RESTORE POWER.
4. COORDINATE OUTAGE WITH OWNER AND BREC TO INSTALL WIRING IN CONDUIT.
5. RESTORE POWER.
6. SCHEDULE AND CONDUCT CABLE TESTING AND TERMINATE CABLES OUTSIDE OF FENCED AREA.
7. COORDINATE OUTAGE WITH OWNER AND BREC TO TERMINATE CABLES AT EXISTING SWITCHGEAR AND AT SERVICE ENTRANCE RISER STRUCTURE.

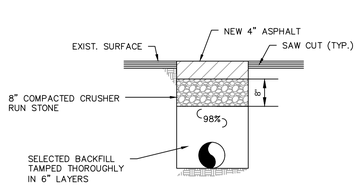
GENERAL SEQUENCING NOTES

1. ALL OUTAGES SHALL BE SCHEDULED WITH OWNER 72 HOURS IN ADVANCE AND SHALL NOT EXCEED 8 HOURS. DURING THE OUTAGE POWER SHALL BE ABLE TO BE RESTORED WITHIN 30 MINUTES AT THE OWNER'S REQUEST.
2. OUTAGES SHALL BE SCHEDULED DURING NON-PEAK HOURS AND TO AVOID CERTAIN WEATHER EVENTS AS DIRECTED BY OWNER.
3. A SPECIFIC PLAN OF ACTION SHALL BE SUBMITTED FOR EACH OUTAGE.



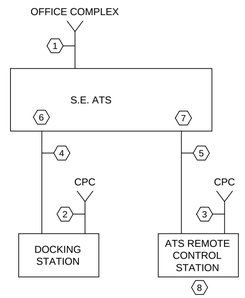
EQUIPMENT PAD SECTION

NOT TO SCALE



DRIVEWAY ASPHALT REPLACEMENT DETAIL

NOT TO SCALE

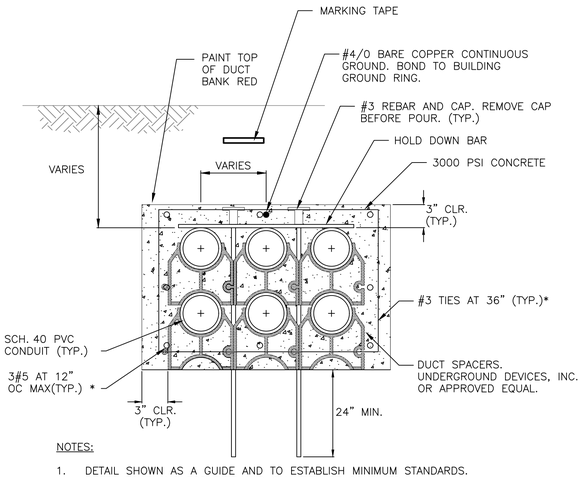


ATS

RISER DIAGRAM

ATS RISER DIAGRAM NOTES

1. 1 1/2" CONDUIT ROUTED INTO OFFICE COMPLEX FOR FUTURE USE BY OWNER. STUB INTO BUILDING AND CAP.
2. 2#12, 2#10, 1#10G.-1" CONDUIT FOR MTS RECEPTACLES.
3. 2#12, 1#12G.-3/4"C.
4. 4#14, 1#14G.-1"C. (GENERATOR START SIGNAL).
5. 12#14, 1#14G.-1"C.
6. CONNECT TO "ENGINE START" TERMINALS.
7. CONNECT TO "REMOTE TRANSFER TO EMERGENCY" TERMINALS AND DRY CONTACT TERMINALS "EMERGENCY CB OPEN", "EMERGENCY CB CLOSED", "NORMAL CB OPEN" AND NORMAL CB CLOSED" DRY CONTACTS.
8. CONTRACTOR TO PROVIDE NEMA 4X CONTROL STATION WITH THE FOLLOWING FEATURES: "CONTROL POWER ON-OFF" AND "TRANSFER TO EMERGENCY ON-OFF" SELECTOR SWITCHES, GREEN "EMERGENCY CB OPEN" (GREEN), "EMERGENCY CB CLOSED" (RED), "NORMAL CB OPEN" (GREEN) AND "NORMAL CB CLOSED" (RED) PILOT LIGHTS. ALL PILOT DEVICES TO BE 30.5MM, NEMA 4X AND PILOT LIGHTS TO BE PUSH TO TEST. PROVIDE TERMINALS, MICARTA NAMEPLATES AND SUBMITTAL DRAWINGS.



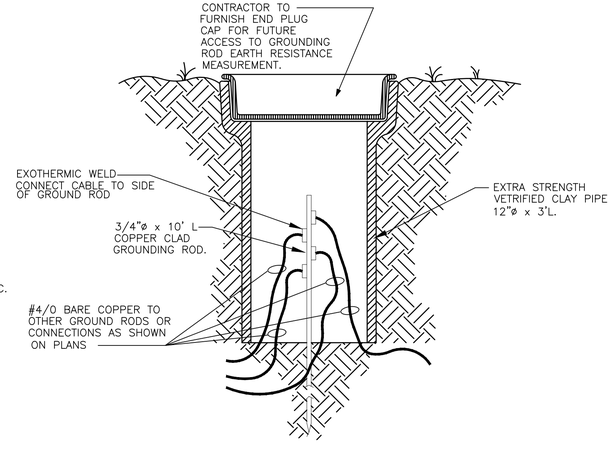
NOTES:

1. DETAIL SHOWN AS A GUIDE AND TO ESTABLISH MINIMUM STANDARDS. REFER TO PLANS FOR SIZE AND QUANTITY OF CONDUITS.
2. INSTALL DUCT SPACERS, REBAR AND HOLD DOWN BAR EVERY 5'-0".

* REINFORCEMENT REQUIRED AT ROAD CROSSINGS ONLY

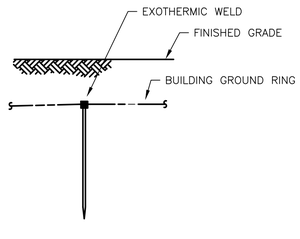
TYPICAL DUCT BANK SECTION

NOT TO SCALE



GROUNDING ROD TEST WELL

NOT TO SCALE



DRIVEN GROUND ROD

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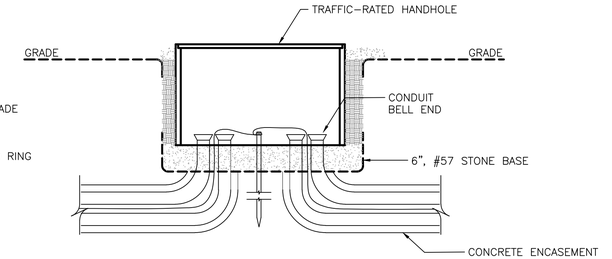


NOTES: PROVIDE QUAZITE PULL BOXES OF STYLE "PC" WITH A TOP SIZE OF 30"x48" AT A DEPTH AS REQUIRED TO MAINTAIN SPECIFIED CONDUIT COVER DEPTH AND SLOPE. INCLUDE STANDARD LOGO LABELED "ELECTRICAL"

HANDHOLE DETAIL

NOT TO SCALE

REVISIONS

NO.	DESCRIPTION	DATE	BY

APPROVALS

PROJECT ENG:	ATH
DESIGNED BY:	ATH
DRAWN BY:	MWW
CHECKED BY:	ATH
APPROVED:	ATH

SOUTH CAROLINA PROFESSIONAL ENGINEER — HOWARD ENGINEERING & CONSULTING, LLC — CERTIFICATE OF AUTHORIZATION No. 001308

SOUTH CAROLINA PROFESSIONAL ENGINEER — REGISTERED — No. 16565 — ANDREW T. HOWARD — 1-5-25

HOWARD ENGINEERING
ELECTRICAL-MECHANICAL-CONTROLS
MARIETTA, SOUTH CAROLINA
(864) 836-0440

SHEET TITLE:
ELECTRICAL SITE PLAN, NOTES AND DETAILS

PROJECT:
OJRSA
CONEROSS WWTP
PORTABLE GENERATOR CONNECTION

DATE: DECEMBER 2025

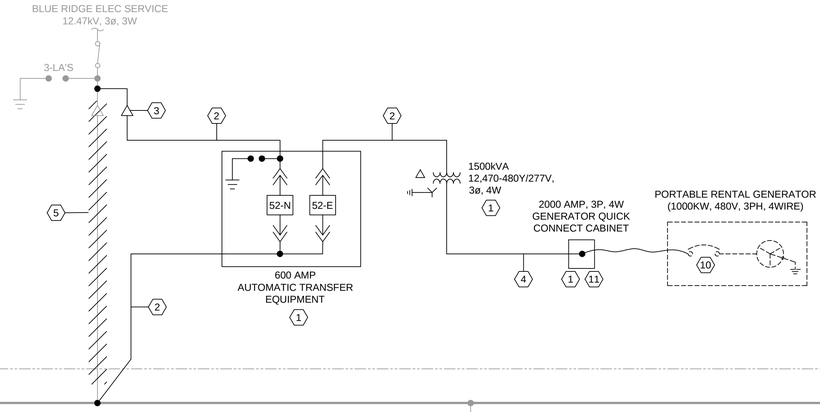
HEI PROJECT NO. A25087

SCALE: AS SHOWN

SHEET NO. 1 OF 2

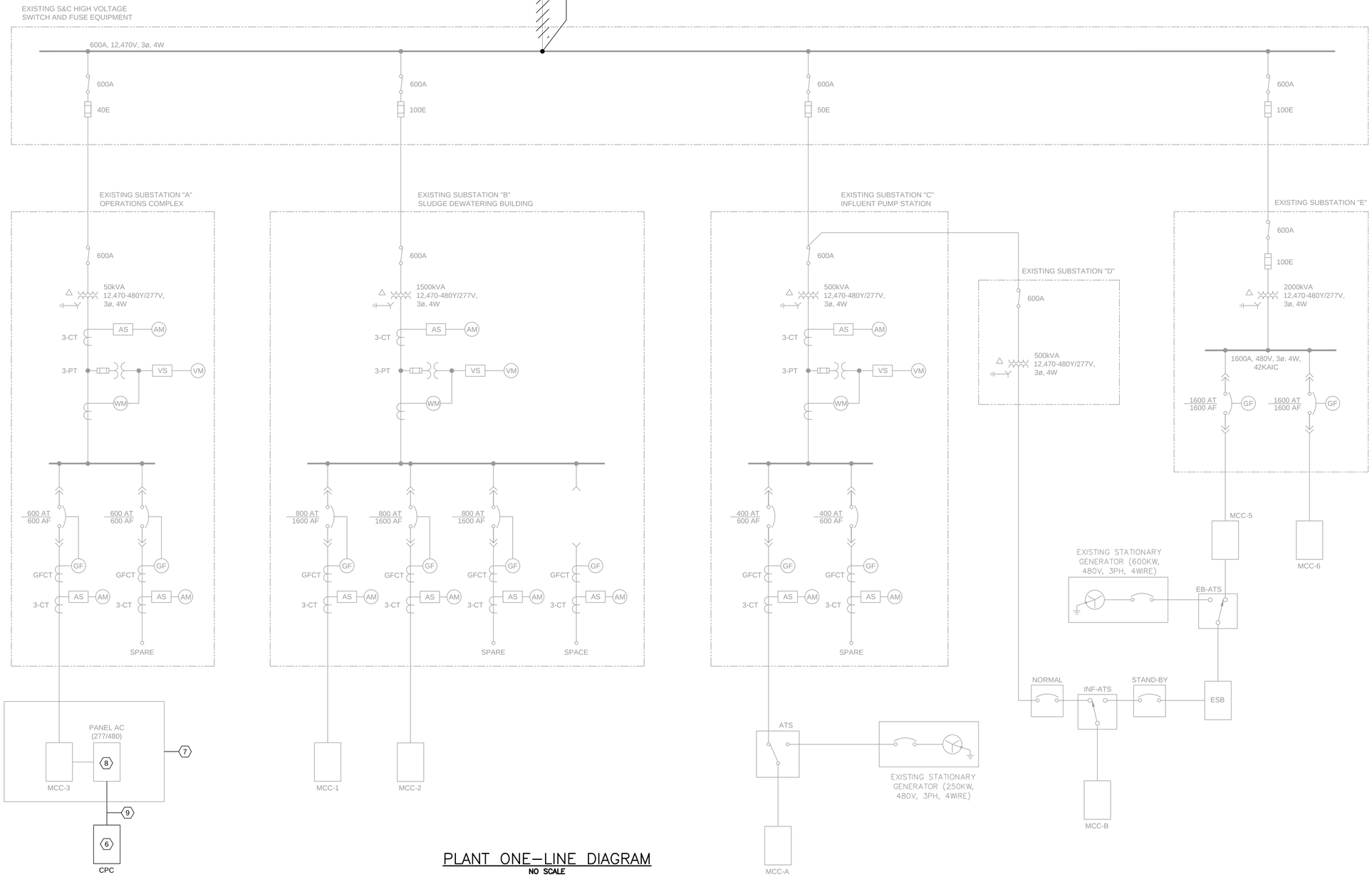
CPC SCHEDULE

PHASE		COMBINATION POWER CENTER "CPC"	BUS: COPPER					15 KVA, 1Ø TRANSFORMER	PHASE	
"L1"	"L2"	480V. PRI-40/2 BREAKER	RATING: N3R, STAINLESS					LOCATION: EQUIPMENT RACK	"L1"	"L2"
V.A.	V.A.	120/240V. SEC.-30/2 BREAKER	STEEL						V.A.	V.A.
		LOAD	P	BKR	CKT #		BKR	P LOAD		
4500		BLOCK HEATER RECEPTACLE	2	30	1	2	20	1 ATS REMOTE CONTROL STATION	200	
	4500				3	4	20	1 SPARE		
1200		BATTERY CHARGER RECEPTACLE	1	20	5	6	20	1 SPARE		
		SPARE	1	20	7	8	20	1 SPARE		
		SPARE	1	20	9	10	20	1 SPARE		
5700		TOTAL "L1"	5900					TOTAL "L1"	200	
	4500	TOTAL "L2"	4500					TOTAL "L2"		0
		TOTAL LOAD =	10400							



ONE LINE DIAGRAM NOTES:

1. SEE SPECIFICATIONS.
2. 3/#4/0 (15KV), 1/#2G.-4"C.
3. AERIAL TERMINATION KIT WITH STRESS CONE.
4. 4/#400KCM, 1/#250G, IN SIX (6) 4" CONDUITS.
5. DISCONNECT AND REMOVE EXISTING WIRING AND EXPOSED CONDUIT AT COMPLETION OF WORK.
6. SEE SCHEDULE. LOCATE ON EQUIPMENT RACK.
7. EQUIPMENT LOCATED IN OPERATIONS COMPLEX MECHANICAL ROOM #2. CONTRACTOR IS RESPONSIBLE FOR MEASURING DISTANCE FROM PANEL AC 480/277 TO CPC PRIOR TO SUBMITTING BID.
8. EXISTING TYPE NF SQUARE D PANELBOARD. INSTALL 40 AMP, 2P 480V BREAKER IN EXISTING SPACE TO FEED NEW CPC, UPDATE DIRECTORY.
9. 2/#4, 1/#10G.- 1 1/2"C.
10. GENERATOR OUTPUT BREAKER MUST BE SET AT NO MORE THAN 2000 AMPS TO PROTECT CABLES AND TRANSFORMER.
11. CONTRACTOR TO PROVIDE SIGNAGE "GENERATOR OUTPUT BREAKER MUST BE SET AT NO MORE THAN 2000 AMPS TO PROTECT CABLES AND TRANSFORMER."



PLANT ONE-LINE DIAGRAM

NO SCALE

REVISIONS

NO.	DESCRIPTION	DATE	BY

APPROVALS

PROJECT ENG:	DESIGNED BY:	DRAWN BY:	CHECKED BY:	APPROVED:
ATH	ATH	MWW	ATH	ATH

SOUTH CAROLINA CERTIFICATE OF AUTHORIZATION
HOWARD ENGINEERING
PROFESSIONAL ENGINEERING
No. 021088

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER
No. 16565
ANDREW T. HOWARD
1-5-25

HOWARD ENGINEERING
ELECTRICAL—MECHANICAL—CONTROLS
MARIETTA, SOUTH CAROLINA
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SHEET TITLE:
ELECTRICAL
ONE-LINE DIAGRAM

PROJECT:
OJRSA
CONEROSS WWTP
PORTABLE GENERATOR
CONNECTION

DATE: DECEMBER 2025
HEI PROJECT NO. A25087
SCALE: AS SHOWN

SHEET NO. 2 OF 2

SECTION 26 36 23.21

MEDIUM VOLTAGE

SERVICE ENTRANCE RATED AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 Scope

A. Furnish and install service entrance rated automatic transfer switch (ATS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of medium voltage (15 kV) freestanding metal-clad switchgear with vacuum circuit breakers and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.

1.02 Codes and Standards

The automatic transfer switches and controls shall conform to the requirements of:

A. UL 1008A – Standard for Medium Voltage Transfer Switches, 1st Edition, for transfer switches rated greater than 750 volts up to 46 kV.

B. ANSI/IEEE C37.20.2 – Standard for Metal-Clad Switchgear.

C. ANSI/IEEE C37.04 – Standard Rating Structure for AC High-Voltage Circuit Breakers.

D. ANSI/IEEE C37.06 – Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings an Related Required Capabilities for Voltages Above 1000V.

E. ANSI/IEEE C37.11 – Standard Requirements for electrical control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis or a total current basis.

F. ANSI/IEEE C37.09 – Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

G. ANSI Z55.1 – Gray Finishes for Industrial Apparatus and Equipment.

H. ANSI/IEEE C57.13 – Standard Requirements for Instrument Transformers.

I. NEMA SG4 – Alternating Current High Voltage Circuit Breakers.

J. NEMA SG5 – Power Switchgear Assemblies.

K. IEEE C37.100.1 – Standard of Common Requirements for High Voltage Power Switchgear Rated Above 1000 V.

L. NFPA 99 - Essential Electrical Systems for Health Care Facilities.

M. NFPA 110 - Emergency and Standby Power Systems.

N. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

O. NEMA Standard ICS10 (formerly ICS2-447) – AC Automatic Transfer Switches.

P. UL 508 Industrial Control Equipment.

1.03 Acceptable Manufacturers

A. Automatic transfer switches shall be ASCO 7000 Series. Any alternate shall be submitted for approval to the consulting engineer at least 10 days prior to bid. Alternate bids must list any deviations from this specification.

B. The metal-clad switchgear and circuit breaker shall be manufactured by Square D, Siemens or an approved equal.

1.04 Warranty

ASCO product is warranted to be free of defects in material and workmanship for a period of eighteen (18) months from date of shipment from ASCO provided that the product has been stored in a suitable environment prior to installation. The product shipment date will be determined only from the ASCO bill of lading. If any part or portion of the ASCO product fails to conform to the Warranty within the Warranty period, ASCO, at its option, will furnish new or factory remanufactured products for repair or replacement of that portion or part.

1.05 Extra Materials/Accessories

A. Submit one racking handle per Medium Voltage ATS line-up. Charging handle to be furnished on each breaker mechanism.

B. Provide one circuit breaker lifting device.

C. Following are Recommended Spare Parts for Medium Voltage ATS up to 15 kV.

ASCO Part No.	Qty.	Description
15.5CAVH1E	3	Bussman, Fuse Type CAV 1 Amp, 15.5KV
942095	3	ABB, Control Relay, 2NO/2NC, 48-130V, 50/60Hz Coil, 600VAC, 10A Cont., 7200VA Make, 720VA Break, ABB Type NF22E-12
483763	1	ASCO Harness GRP1/5 Y-Adapter
601800-002	1	ASCO Group 5 Control Panel

601799	1	ASCO, Dual Operator Control (DOC)
203987-010	3	Bussman, Fuse Type KTK 1 Amp, 600V
203987-015	3	Bussman, Fuse Type KTK 6 Amp, 600V
985449	1	Chint, Circuit Breaker, 2P, 10A, 125VDC
255102	3	Deltrol Controls, Relay DPDT 24VDC Coil
658-403-1	3	Electro Switch Green LED's for Circuit Breaker Control Switch
658-402-1	3	Electro Switch Red LED's for Circuit Breaker Control Switch
658-401-1	3	Electro Switch Yellow LED's for Circuit Breaker Control Switch
707016-007-A	3	IDEC, PL Green LED, 16mm, 24VAC/VDC Pilot Light
707016-006-A	3	IDEC, PL Red LED, 16mm, 24VAC/VDC Pilot Light
PK61SP	2	Square D Spray Paint, ANSI 61
410120VAC	1	Timemark Corp., Capacitor Trip Device, Auto Charge, 120VAC 60Hz Input, 380VDC Min. Output

PART 2 PRODUCTS

2.01 Metal-Clad Switchgear Assembly

A. The metal-clad switchgear shall consist of a Type 3R Outdoor Non-Walk-In enclosure containing circuit breakers and the necessary accessory components all factory assembled (except for necessary shipping splits) and operationally checked. The assembly shall be a self-supporting and floor mounted on a level concrete pad. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.

B. System Voltage: 12.47 kV nominal, three-phase solidly grounded, 60 Hz.

C. Maximum Design Voltage: 15.0 kV.

D. Impulse Withstand (Basic Impulse Level): 95 kV.

E. Power Frequency Withstand: 36 kV, 1 minute test.

F. Main Bus Ampacity: 1200 amps, continuous.

G. Momentary Current Ratings: Equal to the circuit breaker close and latch rating, 40 kAIC @ 15 kV.

2.02 Components

A. Stationary Structure

1. The switchgear shall comprise a minimum of two (for 1200A) sections including one breaker compartment and one auxiliary compartment with

potential assemblies for Normal and Emergency sources assembled to form a rigid self-supporting completely enclosed structures providing steel barriers between sections.

2. The first section (right) is divided by metal barriers into the following compartments: (a.) Normal and Emergency circuit breakers, main bus and cable.

3. The second section (left) is divided by metal barriers into the following compartments: (a.) Two sets of potential transformer assembly, load bus and cable.

B. Circuit Breaker Compartment

1. Each circuit breaker compartment shall be designed to house a horizontal drawout metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts are to be silver-plated copper and mounted within glass polyester support bushings. The movable contacts and springs shall be mounted on the circuit breaker element for ease of inspection/maintenance.

2. Entrance to the stationary primary disconnecting contacts shall be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment. Extend a ground bus into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Guide rails for positioning the circuit breaker and all other necessary hardware are to be an integral part of the circuit breaker compartment. Blocking devices shall interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating.

C. Ground Bus

1. A ¼ inch x 2 inch copper ground bus shall extend through the entire length of the transfer switch.

D. Main Bus Compartment

1. The main bus is to be rated 1200 amps and be fully insulated for its entire length with an epoxy coating by the fluidized bed process. The conductors are to be silver-plated copper and be of a bolted design. Access to this compartment is gained from the front or rear of the structure by removing a steel barrier. Provide standard provisions for future extension, as applicable.

E. Doors and Panels

1. Relays, control switches, etc., shall be mounted on a formed front-hinged panel for each circuit breaker compartment. Front doors shall include features to facilitate quick and complete removal or reinstallation of entire front door assembly. Door hinges shall have removable pins. Where

allowable, all control circuits (except, for example, current transformers and grounding) shall be wired via plugs/receptacles prior to termination.

F. Circuit Breakers

1. The circuit breakers shall be rated 12470 nominal volts, 15000 maximum volts, 60 Hz, with a continuous current rating of 1200 amps.
2. Furnish vacuum circuit breakers with one vacuum interrupter per phase. Breakers of same type and rating shall be completely interchangeable. The circuit breaker shall be operated by means of a stored energy mechanism which is normally charged by a universal motor but can also be charged by the manual handle supplied on each breaker for manual emergency closing or testing. The closing speed of the moving contacts is to be independent of both the control voltage and the operator. Provide a full front shield on the breaker. Secondary control circuits shall be connected automatically with a self- aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position. Provision shall be made for secondary control plug to be manually connected in test position. A minimum of 4 auxiliary contacts (2a 2b), shall be provided for external use. 6 additional cell-mounted auxiliary contacts MOC type for external use shall be provided. The racking mechanism to move the breaker between positions shall be operable with the front door closed and position indication shall be visible with door closed.

3. An interlocking system shall be provided to prevent racking a closed circuit breaker to or from any position. An additional interlock shall automatically discharge the stored-energy operating mechanism springs upon removal of the breaker out of the compartment.

4. The circuit breaker control voltage shall be: 250 volts DC, 120 volts ac - one capacitor trip unit provided for each circuit breaker with ac control power.

G. Instrument Transformers

1. Voltage transformers are drawout mounted with primary current-limiting fuses and shall have ratio as indicated. The transformers shall have mechanical rating equal to the momentary rating of the circuit breakers and shall have metering accuracy per ANSI Standards.

2. Current transformers: Each breaker compartment shall have provision for mounting of optional current transformers per phase (ANSI standard relay accuracy). The current transformer assembly shall be insulated for the full voltage rating of the switchgear. The current transformers wiring shall be Type SIS #16 AWG minimum. Shorting terminal blocks shall be provided; ring tongue connectors shall be used.

H. Control Wiring

1. The switchgear shall be wired with Type SIS #14 AWG minimum. The control wiring shall be UL listed and have VW-1 flame retardant rating. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

2.03 Fabrication

A. Construction: Each equipment bay shall be a separately constructed cubicle assembled to form a rigid freestanding unit with sufficient bracing to minimize distortion. Minimum sheet metal thickness shall be 11 gauge steel on all exterior surfaces. Adjacent bays shall be securely bolted together to form an integrated rigid structure. The rear covers shall be removable to assist installation and maintenance of bus and cables.

B. The metal-clad switchgear shall be fully assembled, inspected and tested at the factory prior to shipment. Large line-ups shall be split to permit normal shipping and handling as well as for ease of rejoining at the job site.

2.04 Factory Finishing

A. All steel parts, shall be cleaned and a [zinc-phosphate (outdoor equipment)] [iron phosphate (indoor equipment)] pre-treatment applied prior to paint application.

B. Paint color shall be ANSI-61 [light grey]; TGIC polyester powder applied electro statically through air. Following paint application, parts shall be baked to produce a hard durable finish. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.

C. Adequacy of paint finish to inhibit the buildup of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2-1987. Salt spray withstand tests in accordance with ASTM #D-1654 and #B-117 shall be periodically performed on a sample to confirm conformance with the corrosion resistance standard of at least 2500 hours minimum (outdoor equipment).

2.05 Microprocessor Controller

A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

B. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator’s

manuals.

C. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

D. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

EN 55011	Emission standard - Group 1, Class A
EN 50082-2	Generic immunity standard, from which:
EN 61000-4-2	Electrostatic discharge (ESD) immunity
ENV 50140	Radiated Electro-Magnetic field immunity
EN 61000-4-3	Radiated RF Electromagnetic Field Immunity
EN 61000-4-4	Electrical fast transient (EFT) immunity
EN 61000-4-5	Surge transient immunity
EN 61000-4-6	Conducted Radio-Frequency field immunity
EN 61000-4-11	Voltage Dips, Interruption and Variations Immunity

2.06 Enclosure

A. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement.

PART 3 OPERATIONS

3.01 Controller Display and Keypad

A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration
   (Open transition, Closed transition, or Delayed transition)

To appropriately trained operators, all instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

3.02 Voltage, Frequency and Phase Rotation Sensing

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Undervoltage	N&E,3ϕ	70 to 98%	85 to 100%
Overvoltage	N&E,3ϕ	102 to 115%	2% below trip

Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

B. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

D. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

E. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

3.03 Automatic and User Supervised Non-Automatic Control

A. Open, Closed, and Delayed Transition Switching Solutions provide complete automatic control of the transfer switch. Because ASCO 7000 Series Transfer Switches are constructed as Metal-Clad Switchgear, they also include full function Non-Automatic Control to permit safe, electrically interlocked user supervised operation.

B. A Transfer Switch Automatic-Manual selector switch allows the user to place the transfer switch in a fully manual mode of operation. The Normal and Emergency Source Circuit Breakers may then be operated using the circuit breaker control switches on the front of each circuit breaker compartment. This provides electrically interlocked operation to ensure that both circuit breakers cannot be closed simultaneously. Additionally, the Normal or Emergency Source Circuit Breakers may be tripped open by the circuit breaker control switches at any time during Automatic or Manual operation.

C. Included Components:

1. “Transfer Switch Auto-Man” Utility Quality Selector Switch.

2. “Breaker Control” Utility Quality Switch. One each for Normal & Emergency Circuit Breaker.
   a. Trip, Close, and Pull to Lock
   b. Closed LED – Red
   c. Open LED – Green
   d. Tripped LED – Amber (When Optional Protective Relaying is provided)

3. Controls Not In Auto LED (Indicates Automatic Operating Mode Disabled).

3.04 Time Delays

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 10 hours. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.
4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. All transfer conditions or only when both sources are available.

F. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

G. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

3.05 Additional Features

A. A three position momentary-type test switch shall be provided for the *test / automatic / reset* modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

D. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

E. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability

of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

F. Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

G. Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

4. Enable or disable the routine.
5. Enable or disable transfer of the load during routine.
6. Set the start time:
   - Time of day
   - Day of week
   - Week of month (1st, 2nd, 3rd, 4th, alternate or every)
7. Set the duration of the run.

At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

H. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency.

I. System Status - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,
Normal Failed Load
on Normal
TD Normal to Emerg 2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

J. Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

K. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer

switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

L. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non- volatile memory:

1. Event Logging
   a. Data and time and reason for transfer normal to emergency.
   b. Data and time and reason for transfer emergency to normal.
   c. Data and time and reason for engine start.
   d. Data and time engine stopped.
   e. Data and time emergency source available.
   f. Data and time emergency source not available.

2. Statistical Data
   a. Total number of transfers.
   b. Total number of transfers due to source failure.
   c. Total number of days controller is energized.
   d. Total number of hours both normal and emergency sources are available.

O. Communications Module - A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. The serial communication interface shall be equal to ASCO Accessory 72A.

PART 4 ADDITIONAL REQUIREMENTS

4.01 Tests and Certification

A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

C. The ATS manufacturer shall be certified to ISO 9001:2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001:2008.

D. The equipment shall be factory tested to simulate a complete and integrated system. The circuit breakers supplied shall be installed in their actual positions and electrically and mechanically tested. A narrative of the system operation shall be provided and shall be utilized when testing the equipment.

Copies of the test reports shall be provided.

E. Upon request at order placement, the manufacturer shall provide upon completion of the order a certificate of seismic qualifications.

F. Circuit breaker test reports shall not be provided.

G. Customer inspection of equipment and witnessing of factory tests shall not be provided.

H. All tests shall comply with applicable ANSI standards.

1. Dielectric Test: ANSI C37.20 Para. 5.3.1, latest revision.

2. Mechanical Test: ANSI C37.20 Para. 5.3.2, latest revision.

3. Grounding of Instrument Transformer Case Test: ANSI C37.20 Para. 5.3.3, latest revision.

4. Electrical Operation & Control Wiring Test: ANSI C37.20 Para. 5.3.3, latest revision.

5. Polarity Test: ANSI C37.20 Para. 5.3.4.3, latest revision.

6. Sequence Test: ANSI C37.20 Para. 5.3.4.4, latest revision.

4.02 Service Representation

A. A representative of the ATS manufacturer shall be perform startup and testing services.

B. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

C. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

PART 5 OPTIONAL FEATURES

5.01 Retransfer to normal selector.

5.02 Provides 2 sets of Form C contacts rated at 6A for each of the following status signals: normal source acceptability, emergency source acceptability, pre/post transfer signal.

5.03 On Emergency: SEL751A with Device 86 (lockout relays) and CT's (Ethernet)

5.04 Bundle Package - SQD PM8000 (Acc.148L1), Backup Power Source (Acc. 1PS1), Comm. Module (Acc. 72EE2).

5.05 Provide CTs and protective relays as required for metering and control scheme.

5.06 Surge protection on the normal source.

SECTION 26 00 00

ELECTRICAL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work included: Provide a complete electrical system as indicated on the Drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to:

1. Medium voltage main service and feeders.
2. Medium voltage automatic transfer switch. (See section 26 36 23.21)
3. Pad mounted transformer.
4. 2000 amp generator docking station.
5. 480V feeder system, in conduit.
6. Combination Power Center for power and lighting.
7. Branch circuit wiring, in conduit, for receptacles.
8. ATS remote control station.
9. Other items and services required to complete the systems whether particularly mentioned or not.

1.2 ABBREVIATIONS

A	Ampere (Amps)	MCA	Minimum Circuit Amps
AFF	Above Finished Floor	MCC	Motor Control Center
AFG	Above Finished Grade	MCM	1000 Circular Mils (KCMIL)
AHJ	Local Authority Having Jurisdiction	MOCP	Maximum Over-current Protection
AIC	Amps Interrupting Current	N	Neutral
AFCI	Arc-Fault Circuit Interrupter	NEC	2011 National Electrical Code
ANSI	The American National Standards Institute	NEMA	National Electrical Manufacturers Association
BF	Ballast Factor	NFPA	National Fire Protection Association
Bkr.	Breaker	NIC	Not in Contract
C	Conduit	OSHA	Occupational Safety and Health Act
Ckt.	Circuit	PF	Power Factor
CRI	Color Rendering Index	PLC	Programmable Logic Controller
CU	Copper Conductor	PVC	Polyvinyl Chloride Conduit
DETD	Dual Element Time Delay Fuse	RGSC	Rigid Galvanized Steel Conduit
Disc.	Disconnect	RMS	Root Mean Square
Dn	Down	RTU	Remote Terminal Unit
EMT	Electrical Metallic Tubing	SCADA	Supervisory Control and Data Acquisition
FLA	Full Load Amps	SCCR	Short-Circuit Current Rating
FPM	Fuse per Manufacturer Requirements	SPD	Surge Suppression Device
FS	Federal Specifications	Sym	Symmetrical

FWE	Furnished with equipment		
G or Gnd.	Ground	THD	Total Harmonic Distortion
GFCI	Ground-Fault Circuit Interrupter	TSP	Twisted Shielded Pair
GFP	Ground-Fault Protection	TST	Twisted Shielded Triplet
HD	Heavy Duty	TVSS	Transient Voltage Surge Suppressor
HP	Horsepower	UL	Underwriters Laboratories Inc.
IBC	International Building Code	UON	Unless Otherwise Noted
IEEE	The Institute of Electrical and Electronics Engineers	V	Volts
IMC	Intermediate Metallic Conduit	W	Watts
KVA	Kilovolt-Amps	WFC	Watertight Flexible Conduit
KW	Kilo Watt	WG	Wire Guard
KA	Kilo Amps	XFMR	Transformer
LCCF	Lamp Current Crest Factor		

1.3 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section. These shall include, but not be limited to, an electrical supervisor who is a licensed master electrician, a field foreman with a minimum journeyman electrician's license and adequate electricians and helpers.

B. Without additional cost to the Owner, provide such other labor and materials required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.

1.4 SUBMITTALS

A. Comply with pertinent provisions of other Sections of these Specifications.

B. Product data: Within 30 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:

1. Materials list of items proposed to be provided under this Section.
2. Manufacturer's specifications, other data and shop drawings needed to prove compliance with the specified requirements. Provide the following approval drawings:

a. MV Automatic Transfer Switch.
b. Pad Mounted Transformer.
c. Handholes.
d. Generator Quick Connect Cabinet.
e. Combination Power Center.
f. ATS Remote Control Station.
g. Wiring devices and cover plates.
h. Conduit and fittings.
i. Conductors (low and medium voltage).
j. Connectors.

k. Special systems.

3. Manufacturer's recommended installation procedures which, when approved by the Engineer, will become the basis for accepting or rejecting actual installation procedures used on the Work.

C. Layouts:

1. In addition to manufacturer's equipment shop drawings, submit electrical installation working drawings containing the following:
   a. Concealed and buried conduit layouts, shown on floor plans drawn at not less than 1/4" = 1-ft-0-in scale. The layouts shall include locations of ATS, transformer, quick connect, concealed conduit in the work area.
   b. Concrete pad containing concealed conduits shall not be poured until conduit layouts are approved.

D. Manual: Upon completion of this portion of the Work and as a condition of its acceptance, provide operation and maintenance manuals in accordance with the other Sections of these Specifications. Include within each manual:

1. Copy of the approved Record Documents for this portion of the Work.
2. Copies of all circuit directories.
3. Copies of all warranties and guaranties.

1.5 PRODUCT HANDLING

A. Comply with pertinent provisions of other Sections of these Specifications.

1.6 WARRANTY

A. Provide standard one (1) year warranty on all labor and materials.

B. Provide a two (2) year warranty on ATS.

C. Comply with other Sections of these Specifications.

1.7 RULES AND PERMITS

A. The entire installation shall be in accordance with the latest edition of the NEC, OSHA, and all local codes.

B. Apply and pay for all permits and inspections required by local or state laws.

C. Furnish the Owner with certificate of inspection and final approval from all authorities having jurisdiction.

1.8 DRAWINGS

A. The drawings and specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. The drawings are diagrammatic and are to be followed as closely as the construction will permit.

B. The drawings show the general location of outlets, conduits and circuit arrangement. Because of the small scale of the drawings, it is not possible to indicate all of the detail involved. The Contractor shall carefully investigate the structural and finish conditions affecting all his Work and shall arrange such work accordingly, furnishing such fittings, junction boxes and accessories as may be required to meet such conditions.

1.9 ELECTRICAL SERVICE

A. From the utility company, establish requirements for connections, etc., and make provisions for them; providing and installing all lugs, connectors, grounding, etc., required for a complete installation.

1. Coordinate work with both the electric utility company and the Owner, and schedule the installation of the service in accordance with the construction schedule such that there will be no delays in equipment startup and placing the facilities in operation.

1.10 ELECTRICAL OUTAGE

A. Coordinate all outages with the Owner, 72 hours prior. Schedule all outages such that they will not interfere with normal plant operation and that there will be no delays in equipment startup and placing the facilities in operation. See additional requirements on the Drawings.

PART 2 – PRODUCTS

2.1 GENERAL

B. Provide only materials that are new, of the type and quality specified. Where Underwriters' Laboratories, Inc. have established standards for such materials, provide only materials bearing the UL label. Materials called for are to be considered as standard that, however, implies no right on the part of the Contractor to substitute other materials and methods without written authority from the Engineer.

C. Temporary power:

1. Provide temporary power as described in other Sections of these Specifications,
2. Provide temporary power at various stages of construction to keep the pump station operational.

D. Where any material or operation is specified by reference to published specifications or standards or the specifications or standards of any other organization; the referenced specification or standard shall be as much a part of this Section as if quoted in full herein.

2.2 RACEWAYS

A. Applicable Standards:

1. ANSI C80.1: Rigid Steel Conduits, Zinc-Coated.
2. ANSI C80.3: Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5: Rigid Aluminum Conduits.
4. ANSI C80.6: Intermediate Metallic Conduits.
5. ANSI/NEMA FB1: Fittings and Supports for Conduit and Cable Assemblies.
6. UL 6: Rigid Steel Conduit – Zinc Coated.
7. UL 651-2002: Schedule 40 PVC and schedule 80 Rigid PVC Conduit.
8. UL 514B: Flexible conduit fittings.

9. NEMA RN 1: Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
10. NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
11. ASTM F512: Polyvinyl Chloride (PVC) Conduit.
12. ASTM D870: Standard Practice for Testing Water Resistance of Coatings Using Water Immersion.
13. ASTM D1151: Standard Practice for Effect of Moisture and Temperature on Adhesive Bonds.
14. FS WW-C 581E: Federal Specification for Rigid Galvanized Steel Conduit.
15. FS-WW-C-563A: Federal Specification for Electrical Metallic Tubing.
16. FS-WW-C-540C: Federal Specification for Rigid Aluminum Conduit.
17. FS WW-C 566: Federal Specification for Flexible Metal Conduit.

B. Acceptable Manufacturers:

1. Wheatland.
2. Allied Tube.
3. Patrot Industries
4. Perma-Cote; Division of Robroy.
5. Ocal.
6. Plasti-Bond
7. Carlon.
8. Cantex

C. Provide conduit and fittings conforming to the above standards.

D. Provide compression type fittings and conduit bodies with matching material for electrical metallic tubing conduit.

E. Rigid aluminum conduit:

1. Provide threaded type fittings and form 8 conduit bodies with material to match conduit. Provide PVC coated fittings for PVC coated aluminum conduit installations.
2. Provide rigid aluminum conduit with external 40-mil PVC coating and internal, 2-mil urethane surface.
3. Provide seal fittings for rigid aluminum conduit where indicated on the plans equal to Crouse-Hinds series EYSX. Provide PVC coated seal fittings for PVC coated rigid aluminum conduit installations.
4. Provide sealing compound and fiber by Crouse-Hinds or approved equal:
   a. Sealing Compound: Chico A.
   b. Sealing Fiber: Chico X.
5. Provide USA manufactured base materials for PVC coated fittings, hangers, straps, etc.

6. Provide thread type fittings and conduit bodies with matching material.
7. Provide PVC coated standard electric conduit couplings
   a. Do not use pipe couplings or sleeves.
8. Provide PVC coated aluminum fittings.
9. Do not imbed aluminum conduit concrete containing chlorides, unwashed beach sand, sea water, or coral bearing aggregates without PVC coating or heat shrink.
10. Use strap wrenches for tightening aluminum conduit.
    a. Do not use Pipe wrenches, channel locks, chain wrenches, pliers, etc.
11. Clean and coat all threads on aluminum conduit and fittings with “No-Oxide” compound before using.

12. Completely cover Aluminum conduit installed in concrete or below grade with two(2) coats of bitumastic paint or PVC coating.
13. Terminate aluminum conduit entering manholes and below grade pullboxes with grounding type bushings and connected to a 3/4" x 10" copperclad rod with a #6 bare copper wire.
14. All risers from underground, concrete pads, floors, etc.
    a. Provide heat shrink tubing (Raychem or equal) from a point 12 inches below bottom of slab or grade to a point not less than 6 inches above grade or surface of slab.

F. Provide PVC coated aluminum flexible conduit for flexible installations.

G. Conduit/Cable supports – properties:

1. Provide 316 stainless steel supports for all exposed metallic conduit as manufactured by Unistrut or approved equal.
2. Provide fiberglass supports for all exposed non-metallic conduit/cable as manufactured by Aickinstrut or approved equal.
3. Provide stainless steel strain relief and cable grips/supports for power cables. Tie each support of to the hanger support.

H. All conduits to conform to the following specifications:

1. Installations under concrete slab: Schedule 40 PVC
2. Exposed outdoor locations: Rigid aluminum conduit.
3. Exposed Interior locations: Rigid aluminum conduit.
4. Installations in concrete-encased duct banks: Schedule 40 PVC.
5. Installations underground exposed to earth: Rigid aluminum conduit with PVC coating.

2.3 CONDUCTORS

A. Applicable standards:

1. NEMA WC 3: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
2. NEMA WC 5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
3. UL 44 – 2002: Rubber-Insulated Wires and Cables.
4. UL 83 – 1999: Thermoplastic-Insulated Wires and Cables.
5. UL 854 – 2002: Service Entrance Cables.

B. Conductors Acceptable Manufacturers:

1. Okonite.
2. Pirelli.
3. Southwire.
4. Superior Essex.
5. Belden.

C. Connectors Acceptable Manufacturers:

1. ILSCO
2. Polaris

D. Conductor types:

1. Low voltage conductors (0 to 600V):

a. For secondary service entrance, feeders, underground, under floor, in damp or wet locations, and to any process associated equipment provide copper, 600V, 90ºC, Type XHHW.
b. For all other low voltage conductors, provide copper, 600V, 75ºC, Type THWN.
c. Provide stranded conductors for sizes #12 and larger.
d. Provide same type of equipment grounding conductors as specified above.
e. Provide all branch circuit wiring installed within ballast compartment of light fixtures rated 90ºC, Type THHN.
f. Analog Control/Communications (2/C SH or 3/C SH) – Provide tinned copper, polyethylene insulated, twisted pair or triplet, aluminum-polyester, overall shield with 20-gauge drain.
g. Provide analog signal conductors sized as shown on drawings with minimum size of 18-gauge.
h. For all discrete signal conductors, provide copper stranded, 600V, Type THWN with a minimum size of #14, unless otherwise noted.
i. For all control conductors installed in underground conduits provide cable listed as suitable for direct burial.

2. Splices, Connections and Terminations (0 to 600V):

a. For #8 AWG, use solderless pressure connectors with insulating covers for copper wire splices and taps. Use insulated spring wire connectors with plastic caps for #10 AWG and smaller.
b. Use insulated, mechanical connectors for copper wire splices and taps, #6AWG and larger. Tape connectors with electrical tape to prevent moisture infiltration.
c. Where connections are located in manholes or handholes use insulated submersible type.

3. Medium voltage conductors (601V to 15kV):

a. Provide single conductor 15kV, 100%, compact round copper conductor with copper tape shield, insulated with ethylene-propylene rubber insulation, and an encapsulated linear low-density polyethylene jacket.
b. Provide with insulation system rated for 105ºC for normal operation, 140ºC for emergency operation and 250ºC for short circuit conditions.
c. Provide power cable with a performance record demonstrating a minimum of thirty-years successful operating experience in utility and industrial power cable applications.
d. Provide cable that is annealed, uncoated copper and compact stranded.
e. Provide discharge free design insulation system consisting of an extruded semi-conducting, thermosetting, ethylene-propylene rubber, 220 mils insulation, 105ºC, and an extruded semi-conducting thermosetting ethylene-propylene rubber insulation shield.
f. Provide cable with conductor and insulation shields with a volume resistivity not in excess of 100 ohmmeters at 90ºC when tested.
g. Provide cable with insulation compounded in the cable manufacturer’s facility.
h. Use cable with ethylene content of elastomer in the insulation that does not exceed 72% by weight or the insulation compound contains any polyethylene.

i. Provide a metallic shield consisting of 5-mil bare copper tape, helically applied directly over the insulation shield.
j. Provide overall jacket with black linear low-density polyethylene with 3 red stripes spaced 120º apart. Provide 80 mils thickness over the tape shield.
k. Mark the cable in strict accordance with ICEA S-94-649 and AEIC CS8, and containing the power cable identifier (Lightning Bolt).
l. Make primary system terminations on live-front equipment with one-piece molded slip on terminals and stress relief cones of voltage and sizes required. Provide cones manufactured by Elastimold, Kerney, 3M, GandS or equal.
m. Make primary system terminations on dead-front equipment with separable elbow connectors of voltage and ampacity as shown on drawings. Provide elbows manufactured by Elastimold, Kerney, 3M, GandS or equal.

2.4 GROUNDING AND BONDING

A. Applicable standards:

1. UL 467-1998: Grounding and Bonding Equipment.
2. NFPA 70: National Electrical Code.
3. ANSI/IEEE 32: Requirements, Terms and Test Procedures for Neutral Grounding Devices.
4. IEEE 80: Guide for Safety in Substation Grounding.
5. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
6. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Associates).

B. Grounding electrodes (Rod type):

1. Acceptable Manufacturers:
   a. LTV Copperweld.
   b. Line Material.
2. Material: Copper-clad steel.
3. Diameter: 3/4”.
4. Length: 10’-0”
5. Type: Sectional.

C. Mechanical connectors:

1. Acceptable Manufacturers:
   a. Burndy.
   b. Robbins.
   c. Harger.
2. Material: Bronze.

D. Exothermically-welded connections:

1. Acceptable Manufacturers:
   a. Cadweld.

E. Grounding Electrode Conductor:

1. Material: Bare, soft-drawn, stranded, tinned copper.
2. Minimum size: Meet NFPA 70 requirements.

F. Bonding Material:

1. Material: Bare, soft-drawn, stranded, copper.
2. Minimum size: Meet NFPA 70 requirements.

G. Regulatory requirements:

1. Products: Listed and classified by UL as suitable for the purpose specified and indicated.

H. Ground Access Wells:

1. Provide 12”x12”x12” polymer concrete ground access or clay pipe access wells where indicated on plans.
2. Provide engraved cover with “ground” indicator.
3. Rated for a minimum of 20,000 lbs.
4. Provide Harger GAW series or approved equal.

2.5 OUTLET BOXES

A. Applicable standards:

1. ANSI/NEMA OS 1: Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports.
2. ANSI/NEMA OS 2: Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
3. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
4. NEMA FB 1: Type FD, Cast Ferroalloy Boxes.
5. UL 508: UL Standard for Safety Industrial Control Equipment.

B. B. Types and properties:

1. Outlet boxes:
   a. Cast aluminum Device boxes (NEMA FB1; deep type, gasketed cover, threaded hubs).

C. Pull and junction boxes:

1. Sheet metal boxes:
   a. Indoor location installations:
      1) Provide the type specified in ANSI/NEMA OS1, 316 stainless steel unless stated otherwise on drawings.
      2) Provide hinged-type enclosure for enclosures larger than 12 inches in any dimension.
   b. Indoor location installations: Provide hinged-type enclosure for enclosures larger than 12 inches in any dimension.
   c. Outdoor location installations:
      1) NEMA 4X 316 stainless steel.

2. Cast aluminum boxes:
   a. Outdoor and wet location installations: Conform to NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain tight, aluminum box cover with ground flange, neoprene gasket, and stainless steel cover screws as manufactured by Cooper Crouse-Hinds.
3. Non-metallic boxes:
   a. In Ground location installations: Conform to UL 508, NEMA type as shown on drawings, pre-cast polymer concrete, with removable,

heavy-duty bolted cover, and stainless steel cover screws as manufactured by Strongwell.

D. Box locations:

1. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
   a. Electrical box locations shown on Contract Drawings are approximate unless dimensioned.
   b. Verify the location of all boxes and outlets prior to rough in.
   c. Locate the boxes to allow access.
   d. Locate and install boxes such that headroom is maintained and a neat appearance is presented.

2.6 HANDHOLES

A. Applicable standards:

1. ANSI/SCTE 77: Specification for Underground Enclosure Integrity.
2. ASTM C1028: Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
3. ASTM C478-03a" Standard Specification for Pre-cast Reinforced Concrete Manhole Sections.
4. ASTM A615: Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
5. ASTM C857-07: Practice of Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
6. ASTM 858-07: Specifications for Underground Precast Concrete Utility Structures .

B. Handholes:

1. Provide handholes a minimum size of 48" x 30" x 24" and larger sizes as required by per NEC.
2. Provide H2 traffic rated enclosures with knockouts as indicated on plans and cover tested to a minimum of 32,000 psi. Provide cover engraved with "Electric".
3. Provide enclosures with divider, pulling eyes, cable racks and extension sleeves as applicable.
4. Provide enclosures equal to Quazite PG series with HA type cover.

2.7 WIRING DEVICES

A. Applicable standards:

1. FS W-C-596: Electrical Power Connector, Plug, Receptacle, and Cable Outlet.
2. FS W-S-896: Switch, Toggle.
3. NEMA WD 1: General Purpose Wiring Devices.
4. NEMA WD 2: Semiconductor Dimmers for Incandescent Lamps.
5. NEMA WD 5: Specific Purpose Wiring Devices.
6. UL 943: Standard for Ground Fault Circuit Interrupters.

B. Acceptable Manufacturers:

1. Hubbell.

2. Pass and Seymour.
3. ABB.
4. TayMac.
5. Lutron.
6. Leviton.

C. Wall Switches:

1. Provide wall switches for lighting circuits and motor loads under 1/2 HP conforming to NEMA WD; FS W-S-896; AC-general use snap switch with toggle handle, rated 20 amperes and 120-277VAC.
2. Provide switch with gray handle.
3. For exterior applications, provide cast box and weatherproof actuating lever toggle switch cover.

D. Receptacles:

1. Provide convenience and straight-blade receptacles conforming to NEMA WD 1, locking blade receptacles conforming to NEMA WD 5, and convenience receptacle configuration conforming to NEMA WD 1; Type 5-20, gray plastic face.
2. Provide specific-use receptacle configuration conforming to NEMA WD 1 type as indicated on the drawings, and with a brown plastic face.
3. Provide GFCI duplex convenience receptacles with integral ground fault current interrupters and gray plastic face.

E. Wall Plates:

1. Provide type 304 stainless steel oversized (jumbo) interior wall plates.
2. Provide continuous-use rated exterior device cover. Provide cover constructed entirely of UV stabilized high impact polycarbonate material with gasket, stainless steel mounting screws and UL listed for wet location continuous-use. Provide cover equal to TayMac Specification Grade series.
3. Design plates to fit the device or devices on which they are used.

2.8 COMBINATION POWER CENTERS

A. Applicable standards:

1. Eaton
2. Schneider Electric
3. ABB

C. The combination power center consists of an encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.

1. Transformer Rating: KVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown on the Drawings.
2. Branch Circuits: Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.
3. Enclosure: Weatherproof, NEMA 3R, stainless steel.

2.9 PAD MOUNTED OIL IMMERSED TRANSFORMER

A. Applicable standards:

1. NFPA 70: National Electrical Code.
2. ANSI C57.12.34: Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors, High Voltage, 34,500 Gnd Y/19,920 Volts and Below; 2500 KVA and Smaller, Requirements
3. ANSI C57.12.70: Terminals Markings and Connections for Distribution and Power Transformers
4. ANSI C119.2
5. ANSI/IEEE C57.12.00: Distribution, Power, and Regulating Transformers, General Requirements for Liquid-Immersed
6. ANSI/IEEE C57.12.80: Terminology for Power and Distribution Transformers
7. ANSI/IEEE C57.12.90: Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
8. DOE 10 CFR Part 431 – Energy Conservation Program for Commercial Equipment: Distribution transformers Energy Conservation Standards; Final Rule.

B. Acceptable manufacturers:

1. Eaton
2. Schneider Electric
3. Cooper Industries
4. ABB

C. Provide pad-mounted, oil-immersed, exterior mounted transformers of size as indicated on the plans.

D. Pad-mounted, compartmental-type transformer shall consist of a transformer tank and two cable terminating compartments, one each for high and low voltage.

E. Transformer tank and compartments shall be assembled as an integral unit for mounting on a pad.

F. Construct with no exposed screws, bolts, or other fastening devices that are externally removable.

G. Provide with no openings through which foreign objects such as sticks, rods, or wires might contact live parts.

H. Provide means for padlocking compartment door(s).

I. Construction shall limit entry of water (except flood water) into compartment so as not to impair transformer operation.

J. Construction:

1. Transformer ratings shall be as indicated on drawings with the following:
   a. Three-phase
   b. Oil-immersed, self-cooled
   c. 60 Hz
   d. 65degree C Rise
   e. Primary winding: Delta
   f. Secondary winding: Wye

g. Tap changer control shall be for de-energized operation only. It shall be externally operable with a wrench and require at least two operator actions to change taps.
h. Primary taps: Two, 2 1/2 percent above and two, 2 1/2 percent below
i. 60 KV BIL

2. Full-height, air-filled incoming and outgoing terminal compartments with hinged doors and separated by a steel barrier shall be located side-by-side. Incoming compartment shall be on the left, outgoing compartment on the right.
3. High-voltage compartment shall be accessible only after door to low-voltage compartment has been opened.
4. Compartment hood shall be removable for pulling cables and making connections. Compartment door sills shall be removable to permit rolling or skidding unit into place over conduit studs in foundation.
5. Compartments hinged doors shall be equipped to latch in open position. High-voltage compartment door shall have a fastening device that is accessible only through low-voltage compartment.
6. Door hinge assemblies shall be made of corrosion-resistant material. 3/8 inch (minimum) diameter stainless-steel hinge pins shall be used.
7. Both compartment doors shall be able to be locked with a single padlock having a maximum 1/2-inch diameter shackle.
8. Provide lifting provisions in accordance with ANSI Standards, as well as jacking and rolling provisions.
9. Instruction nameplate shall be located in low-voltage portion of compartment and shall be readable with cables in place. Where the nameplate is mounted on a removable part, manufacturer's name and transformer serial number shall be permanently affixed to a non-removable part.
10. Transformer tank shall be sealed-tank construction with a welded main cover.
11. A bolted tamper-resistant handhole shall be provided in tank cover for access to internal connections.
12. Provisions for tank grounding shall be supplied in both high- and low-voltage compartments. These provisions shall consist of:
    a. For 500 KVA and below, 1/2-13 UNC tapped hole 7/16-inch deep
    b. For 750 KVA and above: 2, 1/2-13 UNC tapped holes 1/2-inch deep.
13. Low voltage bushings shall be tinned, spade-type with 9/16-inch holes spaced on 1-3/4-inch centers in accordance with latest revisions of applicable ANSI standards. Provide with a minimum of 8 holes or bus extension as necessary.
14. For wye-wye connected units, high- and low-voltage neutrals shall be connected internally and brought out through a bushing in secondary compartment.
15. Incoming primary section shall be equipped with 200 ampere dead break bushing wells, 200 ampere dead break switch modules and elbows.
16. Unit shall contain manually operated sectionalizing switches of configuration as shown on the drawings for a looped primary cable system.
17. The switch shall be either two (2) two-position switches or a four-position switch. The switch must be capable of switching 200 amperes to permit sectionalizing of the system.
18. Overcurrent Protection
    a. Oil-immersed, current-limiting and expulsion fuses internally mounted, oil-immersed coordinated to provide full-range protection with expulsion fuses clearing low-current faults and current-limiting fuses clearing high-current faults up to 50,000 amperes.

b. The fuseholders shall be located in the primary compartment and shall be hot stick operable for external replacement of the fuses.

19. The dielectric coolant shall be listed less-flammable fluid meeting the requirements of National Electrical Code Section 450-23 and the requirements of the National Electrical Safety Code (IEEE C2-2002), Section 15. The dielectric coolant shall be non-toxic, non-bio-accumulating and be readily and completely biodegradable per EPA OPPTS 835.3100

2.10 GENERATOR DOCKING STATION

A. Enclosures:

1. Surface mount, NEMA 3R rain-tight, aluminum enclosure with rake system for cable entry at the bottom.
2. Cable entry area at the bottom of the enclosure shall be covered by a hinged trap door.
   a. It shall be possible to close and lock the front door to the enclosure with the trap door open, and power cables connected through the bottom of the enclosure. The enclosure shall maintain NEMA 3R integrity with power cables connected.
3. Front Cover:
   a. Hinged.
   b. Gasketed.
   c. Pad-lockable latch.
4. Finishes:
   a. Paint after fabrication. Powder coated Hammer Gray.

B. Phase, Neutral, and Ground Buses:

1. Material: Silver-plated, Tin-plated or Hard-drawn copper, specified upon order.
2. Equipment Ground Bus: bonded to box.
3. Isolated Ground Bus: insulated from box.
4. Ground Bus: 25%, 50% or 100% of phase size.
5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
6. Round edges on bus.

D. Inputs connectors shall be Camlok style mounted on 45° angle plate or on gland plate.

E. Output connectors shall be broad range set-screw type, located behind an aluminum barrier.

F. Lockable rake system with reinforced support struts to reduce cable theft.

G. Voltage & Phase shall be as shown on project one line drawing. Camloks provided for incoming generator power shall be color coded as appropriate for the specified voltage.

H. Amperage rating shall be as shown on project one line drawing.

I. Provide 20 amp and 30 amp receptacles for battery charger and block heater.

2.11 CONCRETE SUPPORT FOUNDATIONS

A. Install each freestanding unit of electrical equipment on a 4" thick, 3000 PSI wire mesh reinforced concrete pad or curb with 36" clear on front side and 12" clear on all remaining sides, unless otherwise noted on drawings. Provide ¾" chamfer all sides. See structural specifications for additional requirements.

2.12 MISCELLANEOUS MATERIALS

A. Provide support framing, channel and associated accessories of aluminum conforming to the Drawings and to other Sections of these specifications, except in areas containing chemicals, whereby fiberglass reinforced plastic only shall be utilized.

B. Where not detailed on the drawings, provide and install equipment racks for panels as shown on the drawings and as described in the specifications, with the following as a minimum:

1. Provide cross members consisting of a minimum of two (2) horizontal pieces of 4" x 1-1/2" channel. Provide additional channel to accommodate equipment.
2. Support the channel "cross bars" vertically by C-channels, 6" x 2" x 8'.
3. Mount vertical channels a maximum of 36" apart, center-to-center, quantity as required to accommodate equipment.
4. All aluminum in contact with the earth or concrete shall be painted with 2 coats of bitumastic paint.

B. Provide a foundation buried 36" underground and secured with 3000 PSI concrete pad, sized as shown on plans with a minimum of 36" clear walking space in front of control panels and 12" on sides and rear of panel.

1. Provide ¾" chamfer on all concrete edges.

C. Provide 316 stainless steel (bolts, nuts, washers, U-bolts, anchors, threaded rods, etc.) attachment hardware.

2.12 LABELING

A. Mark all 480-volt equipment with red laminated plastic nameplates having one-half inch (1/2") engraved lettering, reading "DANGER 480-VOLTS". Attach plate to equipment with stainless steel screws.

B. Mark conductors within panelboards with self-sticking label bearing the number corresponding to the circuit number on the drawings. Connect these conductors to corresponding breaker in panel. Mark circuit numbers in outlet boxes only where color-coding is repeated by having two or more conductors of the same color.

C. Mark equipment, switchboards, panelboards, cabinets, transformers, control devices, starters, switches, etc.

D. Labels shall be created by means of black pheonolic material having engraved Micarta letters with white core having ¼" engraved lettering.

E. Provide designations as indicated on the drawings to include:

1. Name of the equipment or equipment that is being served,
2. Power source and circuit of origin along with room location
3. Voltage and number of phases.

F. Attach plates to equipment with weatherproof, UV resistant adhesive transfer tape 3M VHB or equal

G. Mark all junction boxes with the voltages contained internal to it. If multiple power sources are internal to the junction boxes, it shall be labelled “Contains Multiple Power Sources”

H. Panelboards shall contain typed and laminated panel schedules indicating circuit numbers and loads.

I. All receptacles and light switches shall be marked with UV resistant weatherproof adhesive printed label indicating the branch circuit from which the device is fed.

J. Mark conduit at each end with orange UV resistant vinyl label printed with black letters with designation shown on the drawings. In addition, include a second line of text at the source end of the conduit “TO: XXXXX” where XXXX is the text from the TO column on the cable schedule. At the load end include the text “FROM: XXXX” where XXXX is the text from the FROM column on the cable schedule.

PART 3 – EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Coordination:

1. Coordinate as necessary with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
2. Coordinate the installation of electrical items with the schedule for work of other trades to prevent unnecessary delays in the total Work.
3. Where lighting fixtures and other electrical items are shown in conflict with locations of structural members and mechanical or other equipment, provide required supports and wiring to clear the encroachment.

B. Data indicated on the Drawings and in these Specifications are as exact as could be secured, but their absolute accuracy is not warranted. The exact locations, distances, levels, and other conditions will be governed by actual construction and the Drawings and Specifications should be used only for guidance in such regard.

C. Where outlets are not specifically located on the Drawings, locate as determined in the field by the Engineer. Where outlets are installed without such specific direction, relocate as directed by the Engineer and at no additional cost to the Owner.

D. Verify all measurements at the building. No extra compensation will be allowed because of differences between work shown on the Drawings and actual measurements at the site of construction.

E. Branch circuit wiring and arrangement of home runs have been designed for maximum economy consistent with adequate sizing for voltage drops and other

considerations. Install the wiring with circuits arranged exactly as shown on the Drawings, except as otherwise approved in advance by the Engineer.

3.3 TRENCHING AND BACKFILLING

A. Perform trenching and backfilling associated with the work of this Section in strict accordance with the provisions of other Sections of these Specifications. Conduits shall be buried below NEC required minimums.

3.4 CONDUCTORS

A. Install no conductor smaller than #12 AWG unless otherwise indicated.

B. Provide copper conductors.

C. Provide conductors as shown on the plans or as specified herein.

D. Provide continuous wiring from outlet to outlet, identified by color and marked with size, grade and manufacturer.

E. Provide continuous wiring without joints, through pull boxes.

F. Provide minimum of #10 AWG conductors on branch circuits, which exceed 100' at 120 volts and 200' at 277 volts from panel to load center.

G. Terminate #14 AWG stranded conductors where indicated for control, using insulated compression-type spade lugs.

H. Terminate #12 AWG stranded conductors using insulated compression-type spade lugs.

I. Install an equal number of conductors for each phase of a circuit in the same raceway or cable.

J. The conductor lengths for parallel circuits must be made equal.

K. Neatly train and lace all wiring inside boxes, equipment, and panel boards.

L. Provide phase, neutral, and ground conductors as required to accommodate metering installed. Any additional conductors required for meter to function properly shall be installed at the Contractor's expense.

M. Megger testing of medium voltage cable per UL 1072.

3.5 COLOR CODE AND MARKERS

A. Provide color-coding for #12 and #10 conductors as follows:

	277/480-Volt	**120/208(240)-Volt**
Phase "A"	Brown	Black
Phase "B"	Orange	Red
Phase "C"	Yellow	Blue
Neutral	White with Tracer	White
Ground	Green	Green

B. Mark all conductors #8 and larger and all feeders with plastic tape to match the above color-coding.

3.6 SPLICES, CONNECTIONS, AND TERMINATIONS IN 600V. CONDUCTORS

A. Provide final connections and/or terminations for all wiring indicated on the electrical drawings and in this division of the specifications. Equipment supplied under other divisions of the specifications that require electrical connections under this division shall be provided with Engineer approved wiring and termination diagrams.

B. Splice only in accessible junction boxes.

C. Thoroughly clean wires before installing lugs and connectors.

D. Terminate spare conductors with electrical tape.

3.7 RACEWAYS AND FITTINGS

A. When PVC coated conduit systems are utilized, the raceway manufacturer prior to installation shall certify the Contractor. Submit certification to the Engineer in writing.

B. When PVC coated conduit systems are utilized, provide inspection and certification of the complete raceway installation in writing by an authorized representative of the PVC coated materials supplier.

1. During the construction process, at regular intervals, and prior to any raceway being covered, the representative shall inspect the system until it is confirmed that it meets the manufacturer's intended requirements.
2. Remove and reinstall any portion of the conduit installation that does not meet the intended installation methods at no additional cost to the Owner.

C. Provide certification to ensure that all PVC overlapping connections, conduit threading, thread coating, sealing, etc., has been performed in accordance with manufacturer's recommended procedures.

D. Apply thread compound to all field-cut threads prior to installation.

E. In general, follow the raceway installation layout shown on the plans, however, this layout is diagrammatic only, and where changes are necessary due to structural conditions, other apparatus or other causes, make such changes without any additional cost to the Owner.

F. Cut all conduits square using a saw or pipe cutter and de-burr cut ends.

G. Install the conduit to the shoulder of fittings and couplings and fastened securely.

H. Use conduit hubs, or sealing locknuts, for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.

I. No more than the equivalent of three 90-degree bends may be installed between boxes.

J. Use conduit bodies to make sharp changes in direction, as around beams.

K. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2” size.

L. Avoid Moisture traps where possible; where moisture traps are unavoidable, there must be a junction box with drain fitting provided at the conduit low point. Use suitable conduit caps to protect installed conduit against entrance of dirt, concrete, plaster, mortar, and moisture.

M. Size all conduits for conductor type installed with ¾” being the minimum size conduit allowed.

N. Arrange conduit to maintain headroom and present a neat appearance.

O. Route any exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

P. Provide at all times a minimum of 6” clearance between conduit and piping and a 12” clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

Q. Arrange all conduit supports to prevent distortion of alignment by conductor pulling operations.

R. Fasten conduits above finished ceilings using straps, lay-in adjustable hangers, clevis hangers or bolted split stamped hangers.

1. Do not fasten conduit with wire or perforated pipe straps. All wire that was used for temporary conduit support during construction must be removed before conductors are pulled.
2. All conduits must be supported at a maximum distance of 5’ on centers.

S. Group conduits in parallel runs where practical using a conduit rack.

T. Make all underground conduit joints watertight by applying manufacturer’s recommended thread compound. Thread compound must be conductive and be compatible with conduit and conductor-jacket material.

U. Provide suitable pull string or #12 AWG insulated conductor in empty conduit, except sleeves and nipples.

V. Maintain minimum 12” clearance between all conduits containing signal circuits and conduits containing power circuits.

W. Install expansion-deflection joints where conduit crosses building expansion or seismic joints.

X. Where conduit penetrates fire-rated walls and floors, the opening around the conduit must be sealed with UL listed foamed silicone elastomer compound.

Y. Install exposed raceways either parallel or perpendicular to building walls.

Z. Install raceways exposed on walls or free standing perpendicular to the floor.

AA. Install exposed raceways on channel so as to provide a minimum spacing of 1/2” between raceway and the surface to which it is mounted.

BB. Bends:

1. Where emerging from walls, ceilings, floor or concrete slabs, all conduit bends shall be made entirely within the structure (i.e.: the conduit shall emerge perpendicular to the surface and the bend shall be covered).
2. Make all 90-degree conduit turns with factory-bent, rigid galvanized steel, long radius elbows.
3. Utilize rigid galvanized steel, long radius elbows on all 90 degree conduit bends of 2" and larger.

CC. Install no metal conduit in contact with the earth or concrete slab unless protected with PVC coating.

DD. Provide necessary sleeves and chases where conduits pass through floors and walls, and provide other necessary openings and spaces, arranging for in proper time to prevent unnecessary cutting in connection with the Work.

EE. Perform cutting and patching in accordance with the provisions for the original Work.

FF. Sealing Conduit:

1. Install watertight conduit hubs on all conduits terminating in the top or sides of NEMA 3R, 4 or 4X enclosures.
2. Use a sealing locknut having an integral gasket on conduits terminating in the bottom of NEMA 3R, 4 or 4X enclosures.
3. Seal all conduits terminating in NEMA 3R, 4 or 4X enclosures with duct seal.
4. Seal watertight all conduits terminating in NEMA 6 or watertight rated enclosures.
5. Install sealing compound and fiber, per manufacturer's recommendation, in hazardous location conduit sealing fittings. Tighten plugs per manufacturer's recommended torque.

GG. Make motor lead connections and connections to other electrical equipment subject to vibration, or where indicated with flexible liquidtight weatherproof type steel core conduit with wrapping and cover, factory assembled.

HH. Conduit installations in hazardous locations as defined by Article 500 of the NEC must conform to the special requirements of Articles 501, 502, and 503 of the NEC.

II. Chapter 9 of the NEC shall apply unless larger raceways are specified.

JJ. Ensure all threads are fully installed into fittings, boxes, enclosures and equipment per NEC and UL listing requirements to provide mechanical integrity, grounding and sealing. Provide fittings and adapters to ensure full length of conduit or conduit fitting threads are installed per code and listing requirements.

KK. Liquidtight flexible metal conduit shall be supported and securely fastened within 12 inches of each box, cabinet, conduit body or other conduit body termination and shall be supported and secured at intervals not to exceed 4-1/2 feet. Flexible metal conduit shall not exceed 6 feet in length except for luminaire connections as allowed per the NEC.

LL. Provide plastic threaded type bushings for all conduits terminated in enclosures.

3.8 CONDUIT SUPPORTS

A. Seal all ends of non-metallic conduit support with manufacturer’s recommended sealer.

B. Provide UL listed vinyl end caps for all ends of strut-type metallic conduit supports.

C. Provide all miscellaneous materials and supports as required by the NEC and these specifications to provide support for conduits, raceways, boxes, fittings and equipment.

3.9 GROUNDING AND BONDING

A. Ground and bond the electrical system and motors in accordance with Article 250 of the NEC.

B. Install electric bond around panels, cabinets, pull boxes, enclosures, etc., to incoming and outgoing sub-feed raceways by use of grounding type bushings.

C. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

D. Provide grounding electrode conductor(s) and connect as shown on drawings.

E. Bond together metal siding not attached to grounded structure; bond to ground.

F. Provide separate, insulated, green equipment grounding conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

G. Provide grounding type bushings for conduits 1" or larger and bond to ground bar or lug of enclosure.

H. Bond neutral and ground at service entrance only.

I. Provide exothermic-type weld grounding connections that are buried or otherwise normally inaccessible, and excepting specifically those connections for which access is required for periodic testing.

J. Make each grounding connection strictly in accordance with the manufacturer’s written instructions. Failure to follow manufacturer's written instructions shall result in immediate rejection.

K. Welds which have "puffed up" or which show convex surfaces, indicating improper cleaning, are not acceptable. Provide grounding connection devices compatible with the conductor(s) and/or rods being joined.

L. Maximum acceptable resistance to earth ground is 5 Ohms. Provide testing of the service entrance system ground and verify the resistance to earth ground is within the specified requirements. If the existing service entrance ground does not meet the specified requirements, install additional rod electrodes as required to achieve specified resistance to ground and notify Engineer.

M. Interface with lightning protection system where applicable.

3.10 OUTLET BOXES

A. Install boxes exposed on walls.

B. Provide knockout closures for unused openings.

C. Support boxes independently of the conduits.

D. Use multiple gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

E. Install outlets to locate luminaires as shown on plans.

F. Align wall mounted outlet boxes for switches, thermostats, and similar devices.

G. Provide cast outlet boxes in locations (exposed to the weather) and indoor locations.

H. Size all boxes in strict accordance with Article No. 370 of the NEC, except that no box will be less than the minimum specified.

I. Check the location of all outlets to see that the outlets will clear any new or existing wall fixture, shelving, work tables, sinks, bulletin boards, etc. and the outlet will fit the area intended.

J. Set floor boxes level and flush with finish flooring material. Use cast iron floor boxes for installations in slab on grade.

K. Locate pull and junction boxes above accessible ceilings or in unfinished areas. Support pull and junction boxes independently of conduit.

L. Install underground boxes as shown on drawings with top of box approximately 2” above finished grade. Install bottom of box over 12” of gravel to allow for adequate drainage.

3.11 CONVENIENCE OUTLETS AND SWITCHES

A. Install wall switches at 48” above the floor level and 6” from edge of door jam on strike side, unless otherwise noted on Drawings.

B. Install wall switches with the OFF position down.

C. Install convenience receptacles at 18” above the floor level or 6” above counter or backsplash.

D. Install convenience receptacles with the grounding pole on top.

E. Install all specific-use receptacles at heights shown on Contract Drawings.

F. Install PVC coated plates on switch, receptacle, and blank outlets for surface mounted outlets.

3.12 POWER EQUIPMENT

A. Provide power and control wiring for motor starters and safety switches as shown on the Drawings.

B. Connections to miscellaneous building equipment:

1. Wire to, and connect to, all items of building equipment not specifically described but to which electrical power is required.

2. Coordinate as necessary with other trades and suppliers to verify types, numbers, and locations of equipment.

3.13 MOUNTING OF ELECTRICAL EQUIPMENT

A. Install all equipment per the manufacturer's recommendations and the contract drawings.

B. Install surface-mounted panelboards plumb, in conformance with NEMA PB 1.1.

C. Install disconnect switches with centerline at 48" above finished floor, grade, etc. unless otherwise noted.

D. Secure switchboard assemblies to foundation or floor channels.

E. Secure disconnect switches to channel frames with spring-type fasteners and hardware intended for this specific use where wall mounted, unless otherwise indicated.

F. Mount floor and wall mounted equipment utilizing Type 316 stainless steel anchors and fasteners of the size and number recommended by the manufacturer.

G. Provide necessary hardware to secure the assembly in place.

H. Provide 316 stainless steel fasteners for all other installation types.

I. Inspect switchboards and panel boards for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

J. Install and check all equipment in accordance with the manufacturer's recommendations.

K. Ensure that equipment mounting pad locations are level to within 0.125 inches per three foot of distance in any direction. Notify Engineer immediately if any discrepancies are found in the field.

L. Ensure that all equipment bus bars are torqued to the manufacturer's recommendations.

M. Assemble all equipment shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.

N. Provide filler plates for unused spaces in panelboards and switchboards.

O. Provide typed circuit directory with protective plastic sleeve secured to inside of panel door for each branch circuit panelboard.

P. Provide Micarta type labels located adjacent to each breaker operator, delineating equipment served for each circuit breaker in all switchboards.

Q. Measure steady state load currents at each switchboard and panelboard feeder. Should the voltage difference measured at the equipment between any two phases exceed 20 percent, rearrange circuits to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

R. Measure and recording Megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four wire systems only).

3.14 TESTING AND INSPECTION

A. Provide personnel and equipment, make required tests, and secure required approvals from the Engineer and governmental agencies having jurisdiction.

B. Provide written notice to the Engineer adequately in advance of each of the following stages of construction:

1. In the underground condition prior to placing concrete floor slab, when all associated electrical work is in place.
2. When all rough-in is complete, but not covered.
3. At completion of the work of this Section.

C. When material and/or workmanship are found to not comply with the specified requirements, replace items within three days after receipt of notice at no additional cost to the Owner.

D. Provide a qualified field serviceman, representing the manufacturer of each piece of major electrical equipment, to make proper and complete adjustments of all adjustable devices, load switches, etc. after final installation and completion of all field wiring. Verify and approve all connections prior to any initial or test operation of equipment. Submit confirmation in writing by the manufacturer's authorized representative of said services to the Engineer.

E. Contractor shall engage a qualified testing firm to Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test. Test continuity of each circuit.

3.15 CLEANING AND PAINTING

A. Collect and remove from the premises all debris, scraps and other waste material after completion of work.

B. Tamp and level all trench work.

C. Remove excess dirt and debris, when and as directed by the Engineer.

D. Thoroughly clean all electrical equipment, lighting fixtures, exposed conduit, enclosures and boxes of all foreign materials

E. Clean any exposed threaded area of raceway of cutting oil and paint with an approved joint compound to improve resistance to oxidation.

3.16 PROJECT COMPLETION

A. Test all 600-Volt service entrance and feeder wiring using an instrument, which applies a voltage of approximately 500 volts DC to provide a direct reading of resistance.

B. Perform test on ground system utilizing Fall-Of-Potential method. Meg grounding systems to measure ground resistance, and provide not more than 5 ohms resistance, adding ground rods as necessary to achieve that level.

C. Conduct all tests in presence of Engineer or his representative. Identify and properly record all readings. Submit readings to Engineer for acceptance.

D. Measure voltages as directed by the Engineer and report to him these values.

E. Provide entire system free from all shorts and grounds.

F. Fully comply with local and national codes for equipment bonding and grounding.

G. Test system in the presence of the Engineer and operate to his complete satisfaction in accordance with true intent of plans and specifications. Defray cost of all adjustments necessary to bring system up to standards set forth by Contract Documents at no additional cost.

H. Thoroughly indoctrinate the Owner's operation and maintenance personnel in the contents of the operations and maintenance manual.

I. On the first day the facility is in operation, for at least eight (8) hours at a time directed by the Engineer, provide a qualified foreman and crew to perform such electrical work as may be required by the Engineer.

3.17 FIELD SETTINGS

A. Perform field adjustments of the protective devices, as required, to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device evaluation study, and protective device coordination study.

B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the Owner.

END OF SECTION