

2. AMENDMENT/MODIFICATION NO. 0002	3. EFFECTIVE DATE 11 AUG 2004	4. REQUISITION/PURCHASE REQ. NO. N/A	5. PROJECT NO. <i>(If applicable)</i>
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6. ISSUED BY USACE SACRAMENTO DISTRICT ATTN: CONTRACTING DIVISION 1325 J STREET SACRAMENTO, CALIFORNIA 95814-2922	7. ADMINISTERED BY <i>(If other than Item 6)</i> SEE ITEM 6
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8. NAME AND ADDRESS OF CONTRACTOR <i>(No., street, county, State and ZIP Code)</i>	(✓)	9A. AMENDMENT OF SOLICITATION NO. W91238-04-B-0009
	X	9B. DATED <i>(SEE ITEM 11)</i> 29 JUL 2004
		10A. MODIFICATION OF CONTRACTS/ORDER NO. N/A
		10B. DATED <i>(SEE ITEM 13)</i> N/A

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers is extended, is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:
 (a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(✓)	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: <i>(Specify authority)</i> THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES <i>(such as changes in paying office, appropriation date, etc.)</i> SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER <i>(Specify type of modification and authority)</i>

E. IMPORTANT: Contractor is not, is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*
 EMERGENCY GENERATOR BUILDING/ELEVATOR UPGRADE - AMERICAN RIVER WATERSHED PROJECT (FOLSOM DAM MODIFICATION)
 FOLSOM, CALIFORNIA

2 ENCLS: 1) 16405, 16410, 16453 & (DELETE 13452 IN IT'S ENTIRETY). 2) DRAWING SHEETS E-1, E-10 AND E-12.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER <i>(Type or print)</i>	16A. NAME AND TITLE OF CONTRACTING OFFICER <i>(Type or print)</i>
15B. CONTRACTOR/OFFEROR _____ <i>(Signature of person authorized to sign)</i>	15C. DATE SIGNED
16B. UNITED STATES OF AMERICA BY _____ <i>(Signature of Contracting Officer)</i>	16C. DATE SIGNED

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SECTION 16405

480-VOLT REAR-CONNECTED DRAWOUT GENERATOR SWITCHBOARD
10/03

PART 1 GENERAL

1.1 SECTION INCLUDES

1.1.1 Switchboard

This section includes requirements for Low-Voltage Rear-Connected Drawout Switchboards, to be utilized as a component of NFPA 110 Level 1 Emergency Power Systems, including everything needed to operate as a safe and reliable alternate electrical power source.

1.2 ASSOCIATED EQUIPMENT

- (1) Section 13452, POWER MONITORING SYSTEM
- (2) Section 16262, DIESEL-GENERATOR SETS, WITH DIGITAL CONTROLS AND AUXILIARIES
- (3) Section 16410, AUTOMATIC TRANSFER SWITCHES
- (4) Section 16430, LOW VOLTAGE DRAWOUT SWITCHBOARD CIRCUIT BREAKERS
- (5) Section 16453, NEUTRAL GROUNDING RESISTORS

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.50	(1989; R 2000) Switchgear Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM B 187	(1997) Copper Bar, Bus Bar, Rod and Shapes
ASTM B 187M	(1997) Copper Bar, Bus Bar, Rod and Shapes (Metric)
ASTM A 653/A 653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	(2000) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D 149	(1997; Rev. A) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D 1535	(1997) Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C12.16	(1991) Electricity Metering Solid-State Electricity Meters
IEEE C37.13	(1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.20.1	(1993) Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
IEEE C37.20.2	(1993; C37.20.2b) Metal-Clad and Station-Type Cubicle Switchgear
IEEE C37.20.3	(1993) Metal-Enclosed Interrupter Switchgear
IEEE C37.90	(1989; R 1994) Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.12.01	(1989) Dry-Type Distribution and Power Transformers Including those with Solid Cast and/or Resin-Encapsulated Windings
IEEE C57.12.91	(1995) Test Code for Dry-Type Distribution and Power Transformers
IEEE C57.13	(1993) Instrument Transformers

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001:2000	(2000) Quality management systems -- Requirements
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA AB 3	(1996) Molded Case Circuit Breakers and Their Application
NEMA C80.3	(1994) Electrical Metallic Tubing - Zinc Coated (EMT)
NEMA FB 1	(1993) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
NEMA ICS 2	(2000) Industrial Control and Systems: Controllers, Contactors, and Overload Relays
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA LI 1	(1998) Industrial Laminating Thermosetting Products
NEMA PB 2	(1995) Dead-front Distribution Switchboards
NEMA PB 2.1	(1996) Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less
NEMA SG 3	(1995) Low-Voltage Power Circuit Breakers
NEMA SG 5	(1995) Power Switchgear Assemblies
NEMA TR 1	(1993) Transformers, Regulators, and Reactors
NEMA WC 7	(1991; Rev 1) Crosslinked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(1999) Electrical Power Distribution Equipment and Systems
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
NFPA 110	(1999) Emergency and Standby Power Systems

UNDERWRITERS LABORATORIES (UL)

UL 467	(1993; R 1999, Bul. 2000) Grounding and Bonding Equipment
UL 489	(2002) Molded Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 891	(1998, Bul. 1999) Dead-Front Switchboards
UL 1066	(1997) Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.4 SUBMITTALS

Submittals with a "G" designation require Government review and approval. "ED" means by the Engineering Division and "RE" means the by the Resident Engineer's office. Submittals having an "FIO" designation shall be submitted for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES and Section 01780A CLOSEOUT SUBMITTALS:

SD-02 Shop Drawings

Switchboard Drawings; G ED

SD-03 Product Data

Equipment Description; G ED

Equipment descriptions and references to equipment, material, articles or patented processes by trade name, make, and/or catalog number.

Switchboard; G ED

- a. Bulletins, including manufacturer's information for each component, device and accessory provided with the equipment
- b. Installation instructions
- c. Manufacturer's instruction manuals, including procedures for cleaning unit and replacing components

SD-06 Test Reports

Design Tests; FIO

Production Tests; FIO

Test Schedule; G ED

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G ED

Drawings shall be folded, with the title block visible, and placed in plastic pockets with reinforced holes. One full size reproducible of each drawing shall accompany the manual. The manual shall

include: step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems; the manufacturer's name, model number, and a description of equipment in the system. The instructions shall include procedures for interface and interaction with related systems to include. Each booklet shall include a CD containing the manual.

Maintenance Procedures; FIO

Special Accessories and Tools; FIO

Spare Parts; FIO

SD-11 Closeout Submittals

Acceptance Checks and Tests; G ED

Request for Settings; G ED

Assembled Manuals; G ED

- a. Drawing required by paragraph, "SD-02 Shop Drawings."
- b. Catalog data required by the paragraph entitled, "SD-03 Product Data."
- c. Test reports required by paragraph, "SD-06 Test Reports."
- e. Certificates required by paragraph, "SD-07 Certificates."
- c. Operation and maintenance information required by paragraph, "SD-10 Operation and Maintenance Data."
- d. A complete list of spare parts, material and supplies needed for continued operation, including supply source and current prices. List shall be in two parts: elements recommended by the manufacturer for scheduled replacement and the remaining elements.

Onsite Training; G ED

A letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video tape to be provided, and the kind and quality of the tape to be left with the Contracting Officer at the end of the instructional period.

1.5 QUALITY ASSURANCE

1.5.1 Equipment Description

The switchboards shall be Square D/Schneider Electric QED-6, using Square D MASTERPACT and POWERPACT circuit breakers and switches, or approved equal.

1.5.2 Standard of Quality

Equipment descriptions and references to equipment, material, articles or patented processes by trade name, make, and/or catalog number, shall be

regarded as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may, at its option, use any equipment, material, article, or process that has been evaluated by the Engineer and, in the judgment of the Contracting Officer, is equal to that named in this specification, unless otherwise specifically provided.

1.5.3 Manufacturer's Experience

The manufacturer of the equipment listed in Paragraph "Equipment Description" shall have at least 30 years of documented experience manufacturing that equipment.

1.5.4 Compatibility

To assure compatibility the manufacturer shall be the same as that of the associated equipment in Paragraph PRODUCT COORDINATION, excluding the manufacturer of the diesel-generator set. Alternately the switchboards may be constructed by the diesel-generator set manufacturer, provided the circuit breakers, switches, and associated equipment and systems meet the compatibility requirements.

1.5.5 ISO Certification

The manufacturer shall be certified to ISO 9001:2000 and shall have third party certification verifying quality assurance in design/development, production, installation, and service.

1.6 GENERAL REQUIREMENTS

1.6.1 Switchboard Function

The switchboard will be used to distribute power to 480-volt power distribution centers and other loads. The switchboard shall include electrically-operated drawout power circuit breakers, insulated case switches, and molded case circuit breakers as indicated. Breakers and switches shall have microprocessor-based power metering tripping units and/or power metering circuit monitors for metering, data acquisition and control, utilizing MODBUS data communications. The generator switches shall be capable of remote control from the generator master controller specified in Section 16262, DIESEL-GENERATOR SET, WITH DIGITAL CONTROLS AND AUXILIARIES.

1.6.2 Switchboard Prewiring

The switchboard shall be prewired to terminals for connection to the generator master controller specified in Section 16262 DIESEL-GENERATOR SET, WITH DIGITAL CONTROLS AND AUXILIARIES.

1.6.3 Power Monitoring and Control System

The switchboard shall be prewired to port(s) for connection to an Ethernet local area network based system ~~as specified in 13452, POWER MONITORING AND CONTROL SYSTEM~~, and shall include the necessary communications modules. Circuit breaker and switch programmable functions shall be remotely accessible via the communications port(s), through which the system shall send and receive information for setup and process tracking, status, data logging, troubleshooting, and ground fault conditions.

1.6.3.1 Protocol

MODBUS, MODBUS+, or MODBUS/IP

1.6.3.2 Communications Ports

For MODBUS: RS-485, configurable for either 2-wire or 4-wire communication.
For MODBUS/IP: UTP RJ-45.

1.6.4 Nameplate

Customer nameplates shall be provided as indicated. In addition, each item of equipment mounted on the switchgear which does not have a suitable designation included as an integral part of the device shall be provided with an engraved nameplate or other suitable means of identification. Nameplates shall be made of laminated sheet plastic or of anodized aluminum approximately 1/8 inch thick, engraved to provide white letters on a black background. Equipment of the withdrawal type shall be provided with nameplates mounted on the removable equipment in locations visible when the equipment is in place. The nameplates shall be fastened to the panels in proper positions with black finished roundhead screws. Glued nameplates are not acceptable. A nameplate showing manufacturer's name and equipment ratings shall be mounted to the front of the enclosure and shall comply with nameplate requirements of NEMA ICS 2.

1.6.5 Seismic Requirements

Seismic requirements shall be in accordance with Section 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.6.6 Items Included

Any items not specifically mentioned herein, but which are obviously necessary for proper operation, are implied in this specification.

1.7 MAINTENANCE

1.7.1 Maintenance Procedures

Maintenance information shall include procedures for each routine maintenance item, procedures for troubleshooting, a copy of the posted instructions, a component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components specified for nameplates, and copies of the final relay and protective device settings.

1.7.2 Special Accessories and Tools

A complete set of accessories and special tools unique to equipment provided and required for erecting, handling, dismantling, testing and maintaining the apparatus shall be furnished by the Contractor. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. Hand tools shall be supplied complete with a suitable tool box. Special tools shall include the following.

- a. Provide a lifter bar for each type breaker and switch.
- b. Provide a rail-mounted manually cranked traveling type lifter on the top of the switchboard for lifting the breakers into and out of

their compartments.

- c. Provide a floor crane with rollers for moving the breakers.

1.7.3 Spare Parts

A complete list of spare parts for each piece of equipment and a complete list of all material and supplies needed for continued operation shall be provided. Lists shall include supply source and current prices. Each list shall be separated into two parts, those elements recommended by the manufacturer to be replaced after 3 years of service, and the remaining elements. Spare parts, materials, etcetera, shall be furnished as specified below. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished.

- a. 2 - bus bar steel bolts and spring washers
- b. 1 - Complete set of main contacts for each style breaker, where replaceable
- c. 1 - Complete arc chamber for each style breaker, where replaceable.
- d. 1 - Spring-charging motor or mechanism for each style breaker having one.

PART 2 PRODUCTS

2.1 SWITCHBOARD

NEMA PB 2 and UL 891. Switchboards shall be UL listed and labeled for their intended use.

2.1.1 Ratings

- a. Voltage: 480-Volt, three-phase, 3-wire with resistance ground.
- b. Operating Frequency: 60-Hertz.
- d. Generator Buses Ampacity: 800-Amperes, continuous.
- d. Main Bus Ampacity: 1200-Amperes, continuous.
- e. Short Circuit Rating: 65-kA, RMS symmetrical.
- f. Momentary Rating: 42-kA, RMS Asymmetrical.

2.1.2 Construction

Switchboards shall consist of vertical sections bolted together to form a rigid assembly and shall be front and rear aligned. Front-to-back, each vertical section shall consist of three compartments: a front compartment, a bus compartment, and a rear cable compartment. The front compartments shall be divided into vertical compartments for circuit breakers, switches, or auxiliary instruments. For control and communications wiring, each shall have horizontal and vertical wire ways. Each front compartment shall have control wiring knockouts top and bottom, and a top wiring compartment that shall extend the full width of the switchboards. Front compartments shall have hinged and latched doors. Switchboard side panels shall be removable.

Circuit breakers and switches shall be through-the-door front accessible. The rear compartments shall have removable hinged doors, with latches, and top and bottom conduit cutouts with removable steel plates. All vertical sections shall have bottom plates and rodent barriers. Switchboards shall have vertical insulating barriers between the front section, the main bus section, and the cable compartment with full front to rear vertical insulating barriers between adjacent sections. Each circuit breaker and switch shall be individually mounted in a barriered compartment with full steel barriers at the top, bottom and sides. Shutters shall be provided to cover live parts when a circuit breaker or switch is removed. Where indicated, "space" shall mean provision for future addition of circuit breakers. Switchboards shall be completely factory engineered and assembled, including switches, circuit breakers, protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

2.1.2.1 Enclosure

The switchboard enclosures shall be a NEMA ICS 6 Type 1 with gasketing around doors and between sections. Wiring holes between circuit breaker compartments shall be grommets. All ventilation openings shall be filtered. Base channels shall be no less than 1.5 inches high. Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of galvanized steel. Base shall include any part of enclosure that is within 1.5 inches of the mounting surface. Enclosure, including bases, shall be painted medium grey ANSI No. 49, using an electro-deposition process on structural parts.

2.1.2.2 Compartments

Circuit breakers, switches, and auxiliary equipment shall be completely enclosed in metal compartments, with access provided through hinged steel doors. Access to instrument and relay wiring, instrument transformers and fuses, shall also be through hinged doors. All hinged doors shall have bent angle or channel edges, invisible hinges and suitable latches or fastenings. Access to bus compartments shall be through removable bolted panels, cover plates or hinged doors.

2.1.2.3 Bus Bars

Bus bars shall be silver-plated copper. Bus joints shall be made with a minimum of two Grade-5 hardened steel bolts with conical-type spring washers. Distribution bussing shall be rated at the full ampacity of the main throughout the switchboards. Bus ratings shall be based on a standard temperature rise of 140-F (65-C) above a maximum ambient air temperature of 104-F (40-C). All runbacks from compartments to the cable compartment shall be insulated. Cable termination compression lugs and cable supports shall be provided in the cable compartments. A silver-plated copper ground bus shall be secured to the bottom rear of each cable compartment in each vertical section, and shall extend the entire length of the switchboards. Phase bus bars shall be insulated with an epoxy finish coating powder providing a minimum breakdown voltage of 16,000 volts per ASTM D 149.

2.1.2.4 Combination Sections

Combination vertical sections shall consist of individually mounted drawout power and electronic trip circuit breakers, switches, and/or auxiliary equipment as indicated. Section widths shall be 22, 30, or 36-inches wide depending on the size of the equipment being installed, and shall be

arranged as indicated. Section depth shall not exceed 60 inches. Circuit breaker and switch compartments shall have cradles with interference interlocks to assure that the breaker is correctly matched for the compartment. Closing and opening push buttons, racking handle, and racking mechanism shall be accessible through the front door cutout, allowing switch or circuit breaker operation and disconnection without opening the door.

2.1.2.5 Auxiliary Sections and Compartments

Auxiliary sections and/or compartments shall be provided for indicated grounding resistors (refer to Section 16453, NEUTRAL GROUNDING RESISTORS), instruments, metering equipment, control equipment, transformers, and current transformers. Compartments shall be arranged as indicated.

2.1.3 Heaters

Provide 120-volt heaters in each switchboard section. Heaters shall be of sufficient capacity to control moisture condensation in the section, shall be 250 watts minimum, and shall be controlled by a thermostat and humidistat located in the section. Thermostat shall be industrial type, high limit, to maintain sections within the range of 60 to 90 degrees F. Humidistat shall have a range of 30 to 60 percent relative humidity. Supply voltage for the heaters shall be obtained from an external source. Energize electric heaters in switchboard assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source. Provide temporary, reliable external power source if commercial power at rated voltage is not available on site.

2.1.4 Terminal Blocks

Provide 600-Volt molded or fabricated type barriered terminal blocks for external wiring between components and for internal wiring between removable assemblies. Terminals for current transformers shall be short-circuiting type. Terminal block identification shall be identical in similar units. External wiring shall be color coded consistently for similar terminal boards.

2.1.5 Wiring

Circuit breaker and switch secondary wiring shall be front accessible and available in cage clamp or ring terminal connections. Secondary wiring shall not be accessible when switchgear door is closed. All secondary control and communications connections shall be made from the front of the switchboard line-up. External wiring shall be color coded consistently for similar terminal boards. Control wiring shall be AWG #14 SIS. Current transformer wiring shall be AWG #10 SIS. Communications wiring shall be AWG #22 shielded.

2.1.6 Markings

Wiring shall be consistent with the wiring diagrams. Wire numbers shall be marked on each end of the wire using machine-lettered, slip-on, shrinkable type wire markers, type TM 600/TM 650 system as manufactured by Kroy LLC or approved equal. Internal control panel components may be identified with metallized adhesive labels. Text may utilize an abbreviated legend provided the legend is identified on the wiring diagram. Control components shall be permanently identified. Each wire marker shall indicate the device or

equipment, including specific terminal number to which the remote end of the wire is attached.

2.1.7 Switchboard Drawings

Complete drawings, including, but are not limited to the following shall be provided:

- a. Bill of materials
- b. Outline dimensions, weights, specified ratings and materials, front elevation, section views, and footprint
- c. Markings and NEMA nameplate data
- d. Three-line diagrams and elementary diagrams and wiring diagrams, indicating prewired and field wired interconnections.

2.2 LOW-VOLTAGE POWER CIRCUIT BREAKERS

Refer to Section 16430 LOW VOLTAGE DRAWOUT SWITCHBOARD CIRCUIT BREAKERS

2.3 ELECTRONIC TRIP UNITS

Refer to Section 16430 LOW VOLTAGE DRAWOUT SWITCHBOARD CIRCUIT BREAKERS

2.4 MOLDED CASE ELECTRONIC TRIP CIRCUIT BREAKERS

Refer to Section 16430 LOW VOLTAGE DRAWOUT SWITCHBOARD CIRCUIT BREAKERS

2.5 INSULATED CASE SWITCHES

Refer to Section 16430 LOW VOLTAGE DRAWOUT SWITCHBOARD CIRCUIT BREAKERS

2.6 GROUNDING

2.6.1 Neutral Grounding Resistor

The 480-Volt system shall be high resistance grounded; the neutral conductors from the generators shall be connected to the ground bus through the grounding resistor specified in Section 16453 NEUTRAL GROUNDING RESISTORS. The Neutral Grounding Resistor shall be located in an auxiliary cabinet in the switchboard, and shall be fully connected and tested at the factory.

2.6.2 Ground Bus

The switchgear assembly shall include a full-length copper bar interior ground bus to which the housing, framework, cable supports, bus supports, and non-current carrying metallic parts of all equipment and conduits shall be grounded insofar as practicable. The ground bus shall have a continuous current-carrying capacity not less than 25 percent of the continuous rating of the power bus.

2.6.3 Drawout Unit Grounding

If the operating mechanism of drawout units is not permanently grounded, ground contacts shall be provided to automatically connect the movable element to the ground buses. These connections shall make before the main

disconnecting devices upon insertion, and break after the main disconnecting devices upon withdrawal.

2.7 FACTORY INSPECTION AND TESTS

The factory inspections and complete operational tests for function and performance shall be made on each switchboard. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy. The accuracy shall be directly traceable to the National Institute of Standards and Technology. Inspections shall be completed and all necessary repairs made, prior to testing. Submit Test Schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.7.1 Design Tests

NEMA PB 2 and UL 891. Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

- a. Short-circuit current test
- b. Enclosure tests
- c. Dielectric test

2.7.2 Production Tests

NEMA PB 2 and UL 891. Production tests shall be performed on the actual equipment to ensure that the design performance is maintained in production. Furnish reports which include results of production tests performed.

- a. 60-hertz dielectric tests
- b. Mechanical operation tests
- c. Electrical operation and control wiring tests

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with manufacturer's instructions and as indicated on project drawings, the approved shop drawings, and as specified herein. Installation shall conform to IEEE C2, and NFPA 70.

3.1.1 Shipping Splits

The line-up may be divided into shipping splits capable of being lifted overhead by a forklift. Each shipping split shall be provided with removable lifting straps. Removable base channels shall be provided with prying slots for ease of final positioning at the job site.

3.1.2 Acceptance and Storage

Visually inspect to confirm that all items and accessories are in accordance with specifications and drawings. Inspect for shipping damage before accepting equipment on site. Store and protect products according to manufacturer's instructions.

3.1.3 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A 780, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.1.4 Paint Repair

Touch-up all chips and scratches with manufacturer-supplied paint.

3.1.5 Housekeeping Slab

Mount switchboards on concrete "housekeeping" slab. The slab shall be at least 4 inches thick, with the top of the concrete slab approximately 4 inches above finished floor. Edges above floor shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 2 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03307 CONCRETE FOR MINOR STRUCTURES.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounds shall have a resistance not exceeding 5 ohms.

3.2.1 Equipment Grounding

Ground equipment as indicated. When work in addition to that indicated or specified is necessary to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.2 Connections

Make joints in grounding conductors by exothermic weld or compression connector.

3.2.3 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 FIELD QUALITY CONTROL

Contractor shall submit Request for Settings of breakers to the Contracting Officer after approval of switchboards and at least 30 days in advance of their requirement.

3.3.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior

to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All Acceptance Checks and Tests will be signed and dated by the Contractor.

3.3.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.3.3 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS, and referenced ANSI standards.

3.3.3.1 Switchboard Assemblies

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical, electrical, and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.
- (4) Verify appropriate anchorage, required area clearances, and correct alignment.
- (5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
- (6) Verify that circuit breaker and switch sizes and types correspond to approved shop drawings.
- (7) Verify that current transformer ratios correspond to approved shop drawings.
- (8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- (10) Clean switchboard.
- (11) Inspect insulators for evidence of physical damage or contaminated surfaces.

- (12) Verify correct barrier and shutter installation and operation.
- (13) Exercise all active components.
- (14) Inspect all mechanical indicating devices for correct operation.
- (15) Verify that vents are clear.
- (16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.
- (17) Inspect control power transformers.

b. Electrical Tests

- (1) Perform insulation-resistance tests on each bus section.
- (2) Perform overpotential tests.
- (3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.
- (4) Perform control wiring performance test.
- (5) Perform primary current injection tests on the entire current circuit in each section of assembly.
- (6) Perform phasing check to ensure correct bus phasing.
- (7) Verify operation of switchboard heaters.

3.3.3.2 Power Circuit Breakers

Test in accordance with the Test Procedures in ANSI C37.50.

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.
- (4) Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.
- (5) Verify that all maintenance devices are available for servicing and operating the breaker.
- (6) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- (7) Perform all mechanical operator and contact alignment tests

on both the breaker and its operating mechanism.

(8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(9) Verify cell fit and element alignment.

(10) Verify racking mechanism.

b. Electrical Tests

(1) Perform contact-resistance tests on each breaker.

(2) Perform insulation-resistance tests.

(3) Adjust Breaker(s) for final settings in accordance with Government provided settings.

(4) Determine long-time minimum pickup current by primary current injection.

(5) Determine long-time delay by primary current injection.

(6) Determine short-time pickup and delay by primary current injection.

(8) Determine instantaneous pickup value by primary current injection.

(9) Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to ensure operation of shunt trip devices; Check the operation of electrically-operated breakers in their cubicle.

(10) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

(11) Verify operation of charging mechanism.

3.3.3.3 Metering and Instrumentation

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's

published data.

(3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.3.3.4 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

3.3.4 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Each item to shall be demonstrated to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days' advance notice of the dates and times for checks, settings, and tests.

3.4 MANUFACTURER'S FIELD SERVICE

3.4.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer as indicated in Onsite Training. The training period shall consist of a total of 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the Operation and Maintenance Manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training session shall be submitted.

3.4.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the Acceptance Checks and Tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3.5 ACCEPTANCE

3.8 ACCEPTANCE

Final acceptance will not be given until the contractor has successfully completed all tests and after all defects in installation material or operation have been corrected and the Assembled Manuals have been received and approved.

-- End of Section --

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SECTION 16410

AUTOMATIC TRANSFER SWITCHES

10/03

PART 1 GENERAL

1.1 SECTION INCLUDES

This section includes requirements for Automatic Transfer Switches, with and without By-pass Isolation Switches, to be utilized as a component of NFPA 110 Level 1 Emergency Power Systems, including everything needed to operate as a safe and reliable alternate electrical power source.

1.2 ASSOCIATED EQUIPMENT

- (1) Section 13452, POWER MONITORING AND CONTROL SYSTEM
- (2) Section 16262, DIESEL-GENERATOR SETS, WITH DIGITAL CONTROLS AND AUXILIARIES
- (3) Section 16405, 480-VOLT REAR-CONNECTED DRAWOUT GENERATOR SWITCHBOARD
- (4) Section 16453, NEUTRAL GROUNDING RESISTORS

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.13 (1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures

IEEE C37.90.1 (1989; R 1994) IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

IEEE C62.41 (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

IEEE Std 602 (1996) Recommended Practices for Electric Systems in Health Care Facilities

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001:2000 (2000) Quality management systems -- Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (1993) Industrial Controls and Systems

NEMA ICS 2 (2000) Industrial Control and Systems: Controllers, Contactors, and Overload Relays

NEMA ICS 4 (1993) Industrial Control and Systems Terminal Blocks

NEMA ICS 6 (1993) Industrial Control and Systems Enclosures

NEMA ICS 10 (1993) Industrial Control and Systems: AC Transfer Switch Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 110 (1999) Emergency and Standby Power Systems

UNDERWRITERS LABORATORIES (UL)

UL 1008 (1996; Rev Sep 1997) Transfer Switch Equipment

UL 1066 (1997) Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.4 SUBMITTALS

Submittals with a "G" designation require Government review and approval. "ED" means by the Engineering Division and "RE" means the by the Resident Engineer's office. Submittals having an "FIO" designation shall be submitted for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES and Section 01780A CLOSEOUT SUBMITTALS:

SD-02 Shop Drawings

Automatic Transfer Switch; G ED

Schematic, external connection, one-line schematic and wiring diagram of each ATS assembly. Interface equipment connection diagram showing conduit and wiring between ATS and related equipment. Device, nameplate, and item numbers shown in list of equipment and material shall appear on drawings wherever that item appears. Diagrams shall show interlocking provisions and cautionary notes, if any. Operating instructions shall be shown either on one-line diagram or separately. Unless otherwise approved, one-line and elementary or schematic diagrams shall appear on same drawing.

Installation; FIO

Dimensioned plans, sections and elevations showing minimum clearances, weights, and conduit entry provisions for each ATS.

SD-03 Product Data

Equipment Description; G ED

Equipment descriptions and references to equipment, material, articles or patented processes by trade name, make, and/or catalog number.

SD-06 Test Reports

Tests; G ED

A description of proposed field test procedures, including proposed date and steps describing each test, its duration and expected results, not less than 4 weeks prior to test date.

Certified factory and field test reports, within 14 days following completion of tests. Reports shall be certified and dated and shall demonstrate that tests were successfully completed prior to shipment of equipment.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G ED

The operation and maintenance manuals shall consist of a resubmission of all technical data with as-built corrections and revisions and with addenda/appendices as necessary to identify any special characteristics or operations not covered in the manufacturer's standard documentation. The Contractor shall submit 4 copies of the operation and maintenance manuals within 30 days following successful completion of the Performance Verification Tests.

Instructions; FIO

Operating manual outlining step-by-step procedures for system startup, operation, and shutdown. Manual shall include manufacturer's name, model number, service manual, parts list, and brief description of equipment and basic operating features. Manufacturer's spare parts data shall be included with supply source and current cost of recommended spare parts. Maintenance manual listing routine maintenance, possible breakdowns, repairs, and troubleshooting guide. Manual shall include simplified wiring and control diagrams for system as installed.

SD-11 Closeout Submittals

Onsite Training; G ED

A letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video tape to be provided, and the kind and quality of the tape to

be left with the Contracting Officer at the end of the instructional period.

1.5 QUALITY ASSURANCE

1.5.1 Equipment Description

The Automatic Transfer Switches, with and without By-pass Isolation Switches shall be Square D/Schneider Electric PowerLogic, or approved equal.

1.5.2 Standard of Quality

Equipment descriptions and references to equipment, material, articles or patented processes by trade name, make, and/or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may, at its option, use any equipment, material, article, or process that has been evaluated by the Engineer and, in the judgment of the Contracting Officer, is equal to that named in this specification, unless otherwise specifically provided.

1.5.3 Manufacturer's Experience

The manufacturer of the equipment listed in Paragraph "Equipment Description" shall have at least 10 years of documented experience manufacturing that equipment.

1.5.4 Compatibility

To assure compatibility the manufacturer shall be the same as that of the associated equipment in Paragraph PRODUCT COORDINATION, excluding the manufacturer of the diesel-generator set.

1.5.5 ISO Certification

The manufacturer shall be certified to ISO 9001:2000 and shall have third party certification verifying quality assurance in design/development, production, installation, and service.

1.6 GENERAL REQUIREMENTS

1.6.1 Location

The Automatic Transfer Switch shall be located in an auxiliary cabinet of the Generator Switchboard. Refer to 16405, 480-VOLT REAR-CONNECTED DRAWOUT GENERATOR SWITCHBOARD

1.6.2 Power Monitoring and Control System

Each Automatic Transfer Switch shall include a communications module ~~compatible with the system described in Section 13452 POWER MONITORING AND CONTROL SYSTEM.~~ The equipment's programmable functions shall be remotely accessible via the communications port, through which the system shall send and receive information for setup and process tracking, status, data logging, troubleshooting, and ground fault conditions.

1.6.2.1 Protocol

MODBUS, MODBUS+, or MODBUS/IP

1.6.2.2 Communications Port

For MODBUS: RS-485, configurable for 2-wire or 4-wire communication. For MODBUS/IP: UTP RJ-45.

1.6.2.3 Protective and Programmable Functions

Setup parameters shall include

1. Password
2. Type of electric system (phase, wire, wye/delta)
3. Source to be monitored (normal, emergency, load, other)
4. Potential transformer ratios
5. Current transformer ratios
6. Communication parameters (protocol, baud rate, address, etc)
7. Clear energy parameters
8. Power demand "window" size
9. Setpoint output relay parameters

Input/output Registers shall include

1. Voltages lines A-B, B-C and C-A
2. Voltages average line to line
3. Currents for phases A, B, and C
4. Current average
5. Current unbalance
6. Power for phases A, B, and C
7. Power total
8. Power demand instantaneous
9. Power factor for phases A, B, and C
10. Power factor total
11. Volt-Amperes for phases A, B, and C
12. Volt-Amperes total
13. Frequency phase A
14. kWh normal source import, export and net
15. kVARh normal source import, export and net
16. kWh emergency source import, export and net
17. kVARh emergency source import, export and net
18. 8 programmable general purpose digital inputs
19. 4 programmable general purpose digital outputs
20. Switch positions, main and auxiliary
21. Software information
22. Device information
23. System type
24. Source mode
25. PT ratio
26. CT ratio
27. Communications port protocol, baud rate and device address
28. RS485 port protocol, baud rate and device address
29. Demand window size (minutes)
30. Reset demand registers
31. Clear energy registers
32. Setpoint configuration settings

1.6.3 Nameplate

Customer nameplates shall be provided, including each item of equipment that does not have a suitable designation included as an integral part of

the device. Nameplates shall be made of laminated sheet plastic or of anodized aluminum approximately 1/8 inch thick, engraved to provide white letters on a black background, and fastened in proper positions with black finished roundhead screws. Glued nameplates are not acceptable. A nameplate showing manufacturer's name and equipment ratings shall comply with the nameplate requirements of NEMA ICS 2.

1.6.4 Seismic Requirements

Seismic requirements shall be in accordance with Section 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.6.5 Items Included

Any items not specifically mentioned herein, but which are obviously necessary for proper operation, are implied in this specification.

1.7 Application Description

This ATS will deliver power to 480\208-120 volt stepdown transformer and circuit breaker load center. It transfers between normal power supply from Folsom Dam Power House to the emergency supply from the emergency electrical system switchgear.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH (ATS)

ATS shall be electrically operated and mechanically held in both operating positions. ATS shall be suitable for use in emergency systems described in NFPA 70. ATS shall be UL listed. ATS shall be manufactured and tested in accordance with applicable requirements of IEEE C37.90.1, IEEE C37.13, IEEE C62.41, IEEE Std 602, NEMA ICS 1, NEMA ICS 2, NEMA ICS 10, UL 1008 and UL 1066. ATS shall conform to NFPA 110. To facilitate maintenance, manufacturer's instruction manual shall provide typical maximum contact voltage drop readings under specified conditions for use during periodic maintenance. Manufacturer shall provide instructions for determination of contact integrity. ATS shall be rated for continuous duty at specified continuous current rating. ATS shall be fully compatible and approved for use with BP/IS specified. BP/IS shall be considered part of ATS system. ATS shall have following characteristics:

- a. Voltage: 480 Volts ac.
- b. Number of Phases: Three.
- c. Number of Wires: Four.
- d. Frequency: 60 Herz.
- e. Poles: Three open transition switched poles and ~~open transition switched~~ solid neutral/ground.
- f. ATS WCR: Rated to withstand short-circuit current of 42,000 kA, RMS symmetrical.
- g. Nonwelding Contacts: Rated for nonwelding of contacts when used with upstream feeder overcurrent devices shown and with available fault current specified.

- h. Main Contacts: Contacts shall have silver alloy composition.
- i. Continuous phase or main current rating for the contacts shall not be less than 150 amperes.
- j. Overload Rating of the switch must withstand the motor inrush currents and shall be at least 6 times the rated full load.

2.1.1.1 Override Time Delay

Time delay to override monitored source deviation shall be adjustable from 0.5 to 6 seconds and factory set at 3 second. ATS shall monitor phase conductors to detect and respond to sustained voltage drop of 25 percent of nominal between any two normal source conductors and initiate transfer action to emergency source and start engine driven generator after set time period. Pickup voltage shall be adjustable from 70 to 100 percent of nominal and factory set at 90 percent. Dropout voltage shall be adjustable from 75 to 98 percent of pickup value and factory set at 85 percent of nominal.

2.1.1.2 Transfer Time Delay

Time delay before transfer to emergency power source shall be adjustable from 0 to 5 minutes and factory set at 3 seconds. Time Delay Device shall monitor frequency and voltage of emergency power source and transfer when frequency and voltage are stabilized. Pickup voltage shall be adjustable from 85 to 100 percent of nominal and factory set at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal and factory set at 100 percent.

2.1.1.3 Return Time Delay

Time delay before return transfer to normal power source shall be adjustable from 0 to 30 minutes and factory set at 5 minutes. Time delay shall be automatically defeated upon loss or sustained undervoltage of emergency power source, provided that normal supply has been restored.

2.1.1.4 Engine Shutdown Time Delay

Time delay shall be adjustable from 0 to 30 minutes and shall be factory set at 10 minutes.

2.1.1.5 Exerciser

The ATS is to be capable of being exercised remotely as defined in Section 16262 DIESEL-GENERATOR SET, WITH DIGITAL CONTROLS AND AUXILIARIES.

2.1.1.6 Auxiliary Contacts

Two normally open and two normally closed auxiliary contacts rated at 10 or amperes at 120 volts shall operate when ATS is connected to normal power source, and two normally open and two normally closed contacts shall operate when ATS is connected to emergency source.

2.1.1.7 Supplemental Features

ATS shall be furnished with the following:

- a. Engine start contact.
- b. Emergency source monitor.
- c. Test switch to simulate normal power outage.
- d. Voltage sensing. Pickup voltage adjustable from 85 to 100 percent of nominal; dropout adjustable from 75 to 98 percent of pickup.
- e. Time delay bypass switch to override return time delay to normal.
- f. Manual return-to-normal switch.
- g. Means shall be provided in the ATS to insure that motor/transformer load inrush currents do not exceed normal starting currents. This shall be accomplished with either in-phase monitoring, time-delay transition, or load voltage decay sensing methods. If manufacturer supplies an in-phase monitoring system, the manufacturer shall indicate under what conditions a transfer cannot be accomplished. If the manufacturer supplies a time-delay transition system, the manufacturer shall supply recommendations for establishing time delay. If load voltage decay sensing is supplied, the load voltage setting shall be user programmable.

2.1.8 Operator

Manual operator conforming to UL 1008 shall be provided, and shall incorporate features to prevent operation by unauthorized personnel. ATS shall be designed for safe manual operation under full load conditions. If manual operation is accomplished by opening the door, then a dead-front shall be supplied for operator safety.

2.1.9 Override Switch

Override switch shall bypass automatic transfer controls so ATS will transfer and remain connected to emergency power source, regardless of condition of normal source. If emergency source fails and normal source is available, ATS shall automatically retransfer to normal source. Provide one (1) nameplate near normal position which reads as "Auto Retransfers To Normal"; and two nameplates near emergency position- 1st nameplate to read as "Maintains Emergency Position" and 2nd nameplate to read as "Return this switch to normal position when leaving this building unattended".

2.1.10 Green Indicating Light

A green indicating light shall supervise normal power source and shall have a nameplate engraved as NORMAL.

2.1.11 Red Indicating Light

A red indicating light shall supervise emergency power source and shall have a nameplate engraved EMERGENCY.

2.1.12 Manual Operation

Instructions and equipment shall be provided for safe manual nonelectric transfer in the event the transfer switch malfunctions.

2.2 BY-PASS/ISOLATION SWITCH (BP/IS)

2.2.1 Design

Bypass/isolation switch (BP/IS) shall permit load by-pass to either normal or emergency power source and complete isolation of associated ATS, independent of ATS operating position. BP/IS and associated ATS shall be products of same manufacturer and shall be completely interconnected and tested at factory and at project site as specified. BP/IS shall be manufactured, listed, and tested in accordance with paragraph AUTOMATIC TRANSFER SWITCH (ATS) and shall have electrical ratings that exceed or equal comparable ratings specified for ATS. Operating handles shall be externally operated and arranged so that one person can perform the bypass and isolation functions through the operation of a maximum of two handles within 5 seconds. The ATS shall have provisions for locking in the isolation position. Handle for manual operation shall be permanently attached to operating mechanism. BP/IS operation shall be accomplished without disconnecting switch load terminal conductors. Isolation handle positions shall be marked with engraved plates or other approved means to indicate position or operating condition of associated ATS, as follows:

- a. Indication shall be provided to show that ATS section is providing power to the load.
- b. Indication shall be provided of ATS isolation. The ATS controls shall remain functional with the ATS isolated or in bypass mode to permit monitoring of the normal power source and automatic starting of the generator in the event of a loss of the normal power source. In the isolated mode, the bypass section shall be capable of functioning as a manual transfer switch to transfer the load to either power source. The ATS shall be capable of undergoing functional operation testing without service interruption. The ATS may also be completely removed from the enclosure, if required for maintenance or repair, while the bypass section continues to power the load.

2.2.2 Switch Construction

Bypass/isolation switch shall be constructed for convenient removal of parts from front of switch enclosure without removal of other parts or disconnection of external power conductors. Contacts shall be as specified for associated ATS, including provisions for inspection of contacts without disassembly of BP/IS or removal of entire contact enclosure. To facilitate maintenance, manufacturer shall provide instructions for determination of contact integrity. BP/IS and associated ATS shall be interconnected with suitably sized copper bus bars silver-plated at each connection point, and braced to withstand magnetic and thermal forces created at WCR specified for associated ATS.

2.3 ENCLOSURE

ATS and accessories shall be installed in wall-mounted or free-standing, floor-mounted, NEMA ICS 6, Type NEMA 12, smooth sheet metal enclosure constructed in accordance with applicable requirements of UL 1066 and/or UL 1008. Door shall have suitable hinges, locking handle latch, and gasketed jamb. Thermostatically controlled heater shall be provided within enclosure to prevent condensation over temperature range stipulated in paragraph SERVICE CONDITIONS. Metal gauge shall be not less than No. 14. Enclosure shall be equipped with at least two approved grounding lugs for grounding

enclosure to facility ground system using No. 4 AWG copper conductors. Factory wiring within enclosure and field wiring terminating within enclosure shall comply with NFPA 70. If wiring is not color coded, wire shall be permanently tagged or marked near terminal at each end with wire number shown on approved detail drawing. Wire markers shall be of the machine-lettered, slip-on shrinkable type, using the type TM600/TM680 system as manufactured by Kroy LLC, or approved equal. Terminal block shall conform to NEMA ICS 4. Terminals shall be arranged for entrance of external conductors from top and/or bottom and bottom of enclosure as shown. Main switch terminals, including neutral terminal if used, shall be pressure type suitable for termination of external copper conductors shown.

2.3.1 Construction

Enclosure shall be constructed for ease of removal and replacement of ATS components and control devices from front without disconnection of external power conductors or removal or disassembly of major components. Enclosure of ATS with BP/IS shall be constructed to protect personnel from energized BP/IS components during ATS maintenance.

2.3.2 Cleaning and Painting

Both the inside and outside surfaces of an enclosure, including means for fastening, shall be protected against corrosion by enameling, galvanizing, plating, powder coating, or other equivalent means. Protection is not required for metal parts that are inherently resistant to corrosion, bearings, sliding surfaces of hinges, or other parts where such protection is impractical. Finish shall be manufacturer's standard material, process, and color and shall be free from runs, sags, peeling, or other defects. An enclosure marked Type NEMA 12 shall be acceptable if there is no visible rust at the conclusion of a salt spray (fog) test using the test method in ASTM B 117, employing a 5 percent by weight, salt solution for 24 hours. Type 4X enclosures are acceptable following performance of the above test with an exposure time of 200 hours.

2.4 TESTING

2.4.1 Factory Testing

A prototype of specified ATS shall be factory tested in accordance with UL 1008. In addition, factory tests shall be performed on each ATS as follows:

- a. Insulation resistance test to ensure integrity and continuity of entire system.
- b. Main switch contact resistance test.
- c. Visual inspection to verify that each ATS is as specified.
- d. Mechanical test to verify that ATS sections are free of mechanical hindrances.
- e. Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.

2.4.2 Factory Test Reports

Manufacturer shall provide three certified copies of factory test reports.

PART 3 EXECUTION

3.1 INSTALLATION

ATS shall be installed as shown and in accordance with approved manufacturer's instructions.

3.2 INSTRUCTIONS

Manufacturer's approved operating instructions shall be permanently secured to cabinet where operator can see them. One-line and elementary or schematic diagram shall be permanently secured to inside of front enclosure door.

3.3 SITE TESTING

Following completion of ATS installation and after making proper adjustments and settings, site tests shall be performed in accordance with manufacturer's written instructions to demonstrate that each ATS functions satisfactorily and as specified. Contractor shall advise Contracting Officer not less than 5 working days prior to scheduled date for site testing, and shall provide certified field test reports within 2 calendar weeks following successful completion of site tests. Test reports shall describe adjustments and settings made and site tests performed. Minimum operational tests shall include the following:

- a. Insulation resistance shall be tested, both phase-to-phase and phase-to-ground.
- b. Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.
- c. Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.
- d. Low phase-to-ground voltage shall be simulated for each phase of normal source.
- e. Operation and settings shall be verified for specified ATS features, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.
- f. Manual and automatic ATS and BP/IS functions shall be verified.

3.4 MANUFACTURER'S FIELD SERVICE

3.4.1 Commissioning

The resistor shall be placed in service under the supervision of a manufacturer's representative.

3.4.2 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer as indicated in Onsite Training. The

training period shall consist of a total of 1 hour of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, and servicing the equipment, and finding ground faults using the Portable Ground Detector, as well as all major elements of the Operation and Maintenance Manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training session shall be submitted.

3.5 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation material or operation have been corrected.

-- End of Section --

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SECTION 16453

NEUTRAL GROUNDING RESISTORS

10/03

PART 1 GENERAL

1.1 SECTION INCLUDES

1.1.1 Grounding Resistor

This section includes requirements for Neutral Grounding Resistors, to be utilized as a component of NFPA 110 Level 1 Emergency Power Systems, including everything needed to operate as a safe and reliable alternate electrical power source.

1.2 ASSOCIATED EQUIPMENT

- (1) Section 13452, POWER MONITORING SYSTEM
- (2) Section 16262, DIESEL-GENERATOR SETS, WITH DIGITAL CONTROLS AND AUXILIARIES
- (3) Section 16405, 480-VOLT REAR-CONNECTED DRAWOUT GENERATOR SWITCHBOARD
- (4) Section 16410, AUTOMATIC TRANSFER SWITCHES

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- | | |
|----------|--|
| IEEE 32 | (1972; 1990) Standard Requirements, Terminology, and Test Procedures for Neutral Grounding Devices |
| IEEE 142 | (1991) Recommended Practices for Grounding of Industrial and Commercial Power Systems. |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

- | | |
|---------------|---|
| ISO 9001:2000 | (2000) Quality management systems -- Requirements |
|---------------|---|

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- | | |
|------------|--|
| NEMA ICS 2 | (2000) Industrial Control and Systems: Controllers, Contactors, and Overload |
|------------|--|

Relays

NEMA ICS 6 (1993) Industrial Control and Systems Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 110 (1999) Emergency and Standby Power Systems

UNDERWRITERS LABORATORIES (UL)

UL 467 (1993; R 1999, Bul. 2000) Grounding and Bonding Equipment

UL 508 (1999) Industrial Control Equipment

1.4 SUBMITTALS

Submittals with a "G" designation require Government review and approval. "ED" means by the Engineering Division and "RE" means the by the Resident Engineer's office. Submittals having an "FIO" designation shall be submitted for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES and Section 01780A CLOSEOUT SUBMITTALS:

SD-02 Shop Drawings

Resistor Drawings; G ED

Operator's Panel; G ED

SD-03 Product Data

Equipment Description; G ED

Equipment descriptions and references to equipment, material, articles or patented processes by trade name, make, and/or catalog number.

SD-06 Test Reports

Factory Test; FIO

Capacitive Charging Current Test; G ED

Acceptance Checks and Tests; FIO

- a. A copy of all measurements taken.
- b. The dates of testing.
- c. The equipment and values to be verified.
- d. The condition specified for the test.
- e. The test results, signed and dated.
- f. A description of all adjustments made.

- g. Final position of controls, and device settings.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; FIO

Maintenance Procedures; FIO

Spare Parts; FIO

SD-11 Closeout Submittals

Assembled manuals; G ED

- a. Drawing required by paragraph, "SD-02 Shop Drawings."
- b. Catalog data required by the paragraph entitled, "SD-03 Product Data."
- c. Test reports required by paragraph, "SD-06 Test Reports."
- e. Certificates required by paragraph, "SD-07 Certificates."
- c. Operation and maintenance information required by paragraph, "SD-10 Operation and Maintenance Data."
- d. A complete list of spare parts, material and supplies needed for continued operation, including supply source and current prices. List shall be in two parts: elements recommended by the manufacturer for scheduled replacement and the remaining elements.

Onsite Training; G ED

A letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video tape to be provided, and the kind and quality of the tape to be left with the Contracting Officer at the end of the instructional period.

1.5 QUALITY ASSURANCE

1.5.1 Equipment Description

Neutral grounding resistor for high resistance grounding system, as manufactured by Square D/Schneider Electric, Post Glover PulserPlus, or approved equal.

1.5.2 Standard of Quality

Equipment descriptions and references to equipment, material, articles or patented processes by trade name, make, and/or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may, at its option, use any equipment, material, article, or process that has been evaluated by the Engineer and, in the judgment of the Contracting Officer, is equal to that named in this specification, unless otherwise specifically provided.

1.5.3 Manufacturer's Experience

The manufacturer of the equipment listed in Paragraph "Equipment Description" shall have at least 10 years of documented experience manufacturing that equipment.

1.5.4 Compatibility

To assure compatibility the manufacturer shall be the same as that of the associated equipment in Paragraph PRODUCT COORDINATION, excluding the manufacturer of the diesel-generator set.

1.5.5 ISO Certification

The manufacturer shall be certified to ISO 9001:2000 and shall have third party certification verifying quality assurance in design/development, production, installation, and service.

1.6 GENERAL REQUIREMENTS

1.6.1 Location

The Neutral Grounding Resistor shall be located in an auxiliary cabinet of the Generator Switchboard. Refer to 16405, 480-VOLT REAR-CONNECTED DRAWOUT GENERATOR SWITCHBOARD

1.6.2 Power Monitoring and Control System

The Neutral Grounding Resistor shall include a communications module—~~compatible with the system described in Section 13452 POWER MONITORING AND CONTROL SYSTEM.~~ The equipment's programmable functions shall be remotely accessible via the communications port, through which the system shall send and receive information for setup and process tracking, status, data logging, troubleshooting, and ground fault conditions.

1.6.2.1 Protocol

MODBUS, MODBUS+, or MODBUS/IP

1.6.2.2 Communications Port

For MODBUS: RS-485, configurable for either 2-wire or 4-wire communication.
For MODBUS/IP: UTP RJ-45.

1.6.2.3 Metering and Protective Functions

Digital OUT:

1. System status - Normal
2. System status - Ground fault detected
3. System status - Pulser on/off
4. Automatic reset on/off
5. Neutral-to-ground voltage display on/off (optional)
6. Neutral amperage display on/off (optional)

Digital IN:

1. Automatic reset on/off

Analog OUT (values shall be scaled to application):

1. Neutral-ground voltage trip setpoint
2. Neutral amperage trip setpoint
3. Alarm delay time

Analog IN (values shall be scaled to application):

1. Neutral-ground voltage trip setpoint
2. Neutral amperage trip setpoint
3. Alarm delay time

1.6.3 Nameplate

Customer nameplates shall be provided as indicated. In addition, each item of equipment mounted on the switchgear which does not have a suitable designation included as an integral part of the device shall be provided with an engraved nameplate or other suitable means of identification. Nameplates shall be made of laminated sheet plastic or of anodized aluminum approximately 1/8 inch thick, engraved to provide white letters on a black background. Equipment of the withdrawal type shall be provided with nameplates mounted on the removable equipment in locations visible when the equipment is in place. The nameplates shall be fastened to the panels in proper positions with black finished roundhead screws. Glued nameplates are not acceptable. A nameplate showing manufacturer's name and equipment ratings shall be mounted to the front of the enclosure and shall comply with nameplate requirements of NEMA ICS 2.

1.6.4 Seismic Requirements

Seismic requirements shall be in accordance with Section 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.6.5 Items Included

Any items not specifically mentioned herein, but which are obviously necessary for proper operation, are implied in this specification.

1.7 MAINTENANCE

1.7.1 Maintenance Procedures

Maintenance information shall include procedures for each routine maintenance item, procedures for troubleshooting, a copy of the posted instructions, a component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components specified for nameplates, and copies of the final relay and protective device settings.

1.7.2 Spare Parts

A complete list of spare parts for each piece of equipment and a complete list of all material and supplies needed for continued operation shall be provided. Lists shall include supply source and current prices. Each list shall be separated into two parts, those elements recommended by the manufacturer to be replaced after 3 years of service, and the remaining elements. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished.

PART 2 PRODUCTS

2.1 MATERIAL AND EQUIPMENT

UL 508 and IEEE 32. Neutral grounding resistors shall be UL listed and labeled for their intended use.

2.1.1 General

The high resistance neutral grounding equipment shall limit ground fault current to a set value and enable the system to continue operation with a single line-to-ground fault present, coincidentally reducing transient overvoltages during arcing type faults. Fault current shall be limited to slightly more than the system's natural capacitive charging current. It shall detect and give immediate warning when a ground fault occurs, and provide a means of locating the fault by producing a tracer signal of current pulses that is easily distinguishable from background noise.

2.1.2 Grounding Resistor

2.1.2.1 Resistor Ratings

- a. Line-to-Line Voltage: 480-Volts, 60-Hertz.
- b. Connection: Wye-connected neutral.
- b. Current Level: 1 to 10-Amperes
- c. Time Rating: Continuous
- d. Temperature Rise: 385-Celsius (727-Fahrenheit)

2.1.2.2 Resistor Elements

The neutral grounding resistor shall have high-grade chromium stainless steel or nichrome elements. The terminals shall be highly corrosion resistant, double insulated, durable, and have extremely high and stable electrical resistivity. The resistor shall be mounted on standoff insulators rated more than the line-to-neutral voltage.

2.1.2.3 Resistor Taps

The resistor shall have taps to permit adjustment of the magnitude of the fault current.

2.1.3 Control System

2.1.3.1 Controls

Controls shall be solid-state, microprocessor based. Control voltage shall be 120-Volts. Control wiring shall be 14-AWG minimum and rated at 600-Volts. Controls shall be located in the floor-mounted control and resistor enclosure, and shall include the following:

- a. Electronic power controller module, interfacing with operator's panel.
- b. Fault locating pulsing contactor.

- c. Alarm relaying contacts for local and remote annunciation.
- d. Line disconnect switch.
- e. Door-interlocked control power disconnect switch.
- f. System test pushbutton.
- g. Operator's panel.
- h. Communications port.

2.1.3.2 Operator's Panel

The operators panel shall be NEMA ICS 6 NEMA 4.

- a. Alphanumeric display: The alphanumeric display shall display neutral-ground voltage, neutral amperage and programming functions.
- b. Selector display pushbutton.
- c. Audible fault alarm.
- d. Alarm silencing pushbutton.
- e. Fault locating pushbutton switch.
- f. Fault locating pulse timer, 40 pulses per minute.
- g. Indicating lights for system status: normal (green), ground fault detected (red), and pulser on (yellow).
- h. Reset pushbutton
- i. Programming pushbuttons

2.1.3.3 Programmable Functions

The following shall be manually programmable using both the programming pushbuttons and the communications port.

- a. Neutral-ground voltage trip setpoint.
- b. Neutral amperage trip setpoint.
- c. Alarm delay time.
- d. Current transformer ratio, including an off position.
- e. Automatic reset on or off.
- f. Neutral-to-ground voltage display on or off.
- g. Neutral amperage display on or off.

2.1.4 Operation and Control

During normal operating conditions, with no ground fault on the system and a non-appreciable capacitance-charging current flowing through the

resistor, the system shall indicate "normal" status. When a ground fault occurs, the resistor shall limit the ground current to a low value. The voltage across the resistor shall be sensed with a variable time delay. After time out, the system shall indicate "ground fault detected" status. The fault indicator shall latch on and remain lighted until the ground fault is removed and the system reset. Alarm relaying contacts shall operate in the same mode.

2.1.4.1 Fault Location

With the fault locating switch pushed, the control circuit shall cause the pulse timer to cyclically energize and de-energize the pulse contactor and short out a portion of the grounding resistor to produce a traceable signal. The signal shall be adjustable in both magnitude and duration. After the fault is cleared, the system shall be placed in normal operational mode by pressing the "reset" pushbutton.

2.1.4.2 System Test

Pushing the "test" pushbutton shall test the alarm circuits, but not the grounding resistor.

2.1.5 Current Transformer

The ammeter current transformer and shorting contactor shall be mounted in the resistor enclosure.

2.1.6 Space Heater

100-Watt, 120-Volt anti-condensation heater and thermostat.

2.1.7 Grounding Bus

The grounding bus shall be copper.

2.1.8 Control and Resistor Enclosure

The controls, operator panel and resistor shall be in a free-standing, floor-mounted, NEMA ICS 6 NEMA 12 enclosure. Maximum size shall be 30-inches wide, 30-inches deep, and 90-inches high. The enclosure shall be finished and painted, with outside surfaces given not less than 2 coats of quick air drying lacquer or synthetic enamel, ANSI gray No. 49 or 61 in color, semi-gloss finish. Accessories and interior surfaces shall be finished in accordance with manufacturer's standard practices. The enclosure shall be equipped with removable lifting angles and/or plates for crane hooks or slings, and/or removable base channels for positioning with rollers.

2.1.9 Markings

Wiring shall be consistent with the wiring diagrams. Wire numbers shall be marked on each end of the wire using machine-lettered, slip-on, shrinkable type wire markers, type TM 600/TM 650 system as manufactured by Kroy LLC or approved equal. Internal control panel components may be identified with metallized adhesive labels. Text may utilize an abbreviated legend provided the legend is identified on the wiring diagram. Control components shall be permanently identified.

2.1.10 Resistor Drawings

Complete drawings, including, but are not limited to the following shall be provided:

- a. Bill of materials
- b. Outline dimensions, weights, specified ratings and materials, front elevation, section views, and footprint
- c. Markings and NEMA nameplate data
- d. Three-line diagrams and elementary diagrams and wiring diagrams, indicating prewired and field wired interconnections.

2.1.11 Operating Instructions

Provide operating instructions at the control operators.

2.2 Portable Ground Detector

Portable clamp-on ground detector and carrying case. The detector will be a "split core" type ammeter, with a multiple range switch, a short-circuiting switch, and greater than 6" diameter jaws. The detector handle shall be insulated for use on a 5-kiloVolt class system.

2.3 FACTORY INSPECTION AND TESTING

2.3.1 Factory Test

The factory inspections and complete operational tests for function and performance shall be made. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy. The accuracy shall be directly traceable to the National Institute of Standards and Technology. Inspections shall be completed and all necessary repairs made, prior to testing.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Acceptance and Storage

Visually inspect to confirm that all items and accessories are in accordance with specifications and drawings. Inspect for shipping damage before accepting equipment on site. Store and protect products according to manufacturer's instructions. Provide power to the anti-condensation heater during storage.

3.1.2 Grounding

Ground the unit prior to making any system power connections. Size ground conductors in accordance with NFPA 70.

3.1.3 Connection

Connect line and control connections according to the manufacturer's instructions and as indicated. Verify that connections are properly made.

3.2 TESTING AND INSPECTION

3.2.1 Capacitive Charging Current Test

Determine the system capacitive charging current according to the manufacturer's testing instructions. The emergency electrical system's connected loads shall be energized during the determination to maximize the system's capacitance to ground and accurately assess the magnitude of the zero-phase-sequence charging current. The test shall be supervised by a manufacturer's representative.

3.2.2 Resistor Tap Adjustments

Adjust the resistor taps, in accordance with the manufacturer's instructions, so ground current with one ground fault is slightly greater than the system capacitive charging current under maximum load, as determined by Paragraph "Capacitive Charging Current Test".

3.2.3 Performance of Acceptance Checks and Tests

Perform visual and mechanical inspections and electrical tests in accordance with the manufacturer's recommendations.

3.3 MANUFACTURER'S FIELD SERVICE

3.3.1 Commissioning

The resistor shall be placed in service under the supervision of a manufacturer's representative.

3.3.2 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer as indicated in Onsite Training. The training period shall consist of a total of 1 hour of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, and servicing the equipment, and finding ground faults using the Portable Ground Detector, as well as all major elements of the Operation and Maintenance Manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training session shall be submitted.

3.4 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation material or operation have been corrected and the Assembled Manuals have been received and approved..

-- End of Section --