SECTION 26 13 13
GENERATOR PARALLELING CONTROLS
(NON-UTILITY PARALLELING)

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of medium voltage indoor switchgear control components for paralleling Standby Electrical System generators. The generator paralleling components shall be integral to the switchgear shall be furnished by a single supplier with sole responsibility for the form and function of the switchgear, generator paralleling controls and generator controls, as well as all field work.

B. For generator paralleling switchgear power components, including enclosures, bussing, and circuit breakers, see related specification sections.

C. New generator paralleling system shall be Programmable Logic Controller based and shall interface with power distribution, new and existing, as described in the specifications and on the drawings to provide manual or automatic (selectable) campus wide standby power system. System shall be capable of expanding from one genset to three gensets.

E. Existing Main Service Switchgear.

1. Two independent utility services terminate on two separate main circuit breakers, “MA” and “MB”. A tie circuit breaker connects the output of the two mains. Each breaker is controlled by Schweitzer SEL-351S Protection and Breaker Control Relays. Control communication is via “Mirrored Bits®”. The main-tie-main breaker controls are configured to provide automatic transfer in case of loss of one of the utility sources.
2. The Standby Generator Control system provided herein shall coordinate fully and interface with the existing service main-tie-main control system and new generator circuit breaker configurations as specified herein, as shown on the drawings, and as necessary to provide a fully functional breaker control system with all necessary safeties, permissives, communications, and alarms.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible fault currents.

C. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Coordination study of overcurrent protection devices.

D. Section 26 13 00, MEDIUM-VOLTAGE SWITCHGEAR: For medium-voltage enclosures, bussing, and circuit breakers for generator paralleling switchgear.

E. Section 26 32 13, ENGINE-GENERATORS: Requirements for power generation.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Manufacturer’s Qualifications:

1. The equipment shall be the product of a manufacturer who has produced this type of equipment for at least 15 years. The manufacturer must be certified under ISO 9001.
2. Manufacturer shall have a local service organization, with 24x7 emergency response by factory trained and certified technicians. Local technicians must be fully able to troubleshoot, program and service the entire system without requiring a 3rd Party or factory support person.

C. Master Control shall bear a UL 891 label.

1.4 FACTORY TESTS

A. Generator paralleling controls shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. Refer to related specification sections for tests. Tests shall be conducted as per UL and ANSI standards. Factory tests shall be certified.

B. Furnish four copies of certified manufacturer's factory test reports to the COTR prior to shipment of the generator paralleling switchgear to ensure that the switchgear has been successfully tested as specified.

C. The Government shall have the option to witness the factory tests. The Government shall pay for all expenses of the Government Representative's trips to witness the testing. Notify the COTR not fewer than 30 days prior to making tests at the factory. Factory tests shall be performed and reported even if no on-site government representation.

D. All switchboard equipment shall be given complete operational tests to ascertain that all design functions are satisfactorily performed. Testing shall include:
   1. Actuation of all alarm indication devices.
   2. All control circuits, automatic operations and interlocks shall be tested under simulated operating conditions.
   3. All of the above shall be tested according to design specifications for correct and positive operations.

1.5 SUBMITTALS

A. Supplier shall submit for review and approval detailed control system design to demonstrate detailed functionality in conformance with the intent of the drawings and specifications. Supplier shall submit simplified logic that illustrate modes of control, sequence of operation and breaker interlocks.

B. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

C. Shop Drawings:
   1. Per the requirements of Section 26 13 00, MEDIUM-VOLTAGE SWITCHGEAR.
   2. Include sequences of operation and interconnecting controls diagrams, showing connections to generators, circuit breakers, existing Schweitzer service breaker controls and remote annunciators and controls.

D. Manuals:
   1. When submitting the shop drawings, submit companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
      a. The terminals of wiring diagrams shall be identified to facilitate installation, maintenance, and operation.
      b. Wiring diagrams shall indicate internal wiring for each piece of equipment and the interconnection between the pieces of equipment.
      c. Provide a clear and concise description of operation, including detailed information required to properly operate the equipment.
      d. Approvals shall be based on complete submissions of manuals together with shop drawings.

2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manuals to the COTR.
   a. The manuals shall be updated to include any information necessitated by shop drawing approval.
   b. Complete "As Installed" wiring and schematic diagrams shall be included, showing all pieces of equipment and their interconnecting wiring.
   c. Show all terminal identification.
   d. Include information for testing, repair, trouble-shooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.
   e. Provide a replacement and spare parts list. Include a list of tools and instruments for testing and maintenance purposes.
   f. Furnish manuals in loose-leaf binder or manufacturer's standard binder.
   g. Provide CD of final software and system programming installed.

E. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
   1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
   2. Certification by the contractor that the materials have been properly installed, connected, and tested.
   3. Certification from the manufacturer that the generator paralleling controls will withstand any seismic forces and that the unit will be fully operational after the seismic event at the project site.
   4. Certification that supplier shall provide updated software during warranty period.

1.6 APPLICABLE PUBLICATIONS

A. The Generator Power Control System and all related components shall be designed, manufactured and tested in accordance with the latest edition of the following applicable standards:
   1. American National Standards Institute, Inc. (ANSI)
      C37.20.2 Switchgear Assemblies
      C57.13 Standard Requirements for Instrument Transformers
   2. National Fire Protection Association (NFPA)
      NFPA - 70 National Electrical Code
      NFPA - 110 Standard for Emergency and Standby Power Systems

3. Underwriters Laboratories, Inc. (UL)
   UL 1670 UL Circuit Breakers and Metal-Clad Switchgear Over 600 Volts
4. National Electrical Manufacturers Association (NEMA)
   NEMA SG-5 Power Switchgear Assemblies
5. International Standards Organization (ISO)
   ISO 9001:2000
6. IEEE 1547 Interconnection Standard
7. ANSI/IEEE C37.11 – Requirements for electrical control for AC High-Voltage Circuit Breakers rated on a symmetrical current basis or a total current basis.
8. ANSI/IEEE C37.09 – Standard Design and Production Testing.
9. UL891 – Switchboards and controls. Control equipment provided in switchboard enclosures shall be listed and labeled under this standard UL
10. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity.
11. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
12. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE SWITCHGEAR

Refer to Section 26 13 00, MEDIUM VOLTAGE SWITCHGEAR.

2.2 ENGINE GENERATOR CONTROL, MONITORING AND PROTECTION SYSTEM

A. Layout: All equipment shall be arranged in a logical manner to facilitate ease of operation and maintenance of the equipment. In general, components shall include a single Master Control and Operator Interface Panel located at the medium voltage switchgear, a Digital Paralleling Control System panel in each generator breaker cubicle, and individual Generator Monitor and Control devices per specification Section 26 32 13, ENGINE GENERATORS located at each generator as shown on the block diagram included at the end of this section.

B. Wiring: Switchgear control wiring shall be 600 volt, 90 degrees C switchboard type SIS, minimum size No. 14. Use solderless compression type connectors for terminating all wires to devices requiring lugs. Devices designed for lugless connections will not use lugs at those

connection points. For wiring from supervisory and annunciator devices to terminal blocks, UL recognized wire smaller than 14 AWG may be used. Control wires shall be permanently numbered on both ends with the number visible. The low-level signal circuits shall be provided with shielded wire to minimize electromagnetic cross talk and interference. Provisions shall be made for wires to pass between vertical sections. Wireways or holes between sections shall be provided. Any opening that control wiring will pass through that might abrade wire will have a grommet.

Wiring shall not be spliced and shall be free of abrasions and tool marks. Wires shall be neatly bundled and shall be supported to prevent sagging or breakage from weight or vibration. Wiring bundles shall be contained in covered metal or plastic gutters.

All wiring to hinged doors shall be run through door plugs. Terminal blocks shall be provided for all external connections and they shall be readily accessible in an area not exposed to primary bus or cables.

C. **Local Engine Generator Monitor and Control:**

1. Each Engine Generator shall have its own local dedicated processor and controls at the generator performing functions (refer to Section 26 31 13, ENGINE GENERATORS), without depending upon Master Controller, or any other Generator Controllers. Failure of the Master Controller shall not prevent the Engine Generator Control from starting and connecting the Engine Generator to the bus.

D. **Digital Paralleling Control System:** Each medium voltage generator ouptut breaker compartment in the switchgear shall contain a dedicated Digital Paralleling Control System to control that particular generator and communicate with the control/monitoring panel located at the generator as well as the Master Control. It shall perform functions such as start/stop, synchronizing, load sharing, grid VAP/PF sharing, without depending upon the Master Controller or the local generator controllers. Failure of the Master Controller shall not prevent the Digital Paralleling Control System from starting and connecting the engine generator to the bus.

1. Five Position Engine Control Selector Switch

a. Lockout/Reset - In this position, the engine shall not be capable of starting and/or running. If the engine was shutdown due to the operation of a protective device, the shutdown malfunction shall

be reset when the switch is moved to this position. If the engine is running when the switch is moved to this position, it shall immediately shutdown.

b. Off/Cool-down - In this position, the engine shall shutdown after a cool-down period.

c. Automatic - In this position, the engine control shall be in readiness for fully automatic operation upon receipt of a start signal.

d. Test Off-Line - When placed in this position, the engine shall start and run as if a start signal were received except it shall not be connected to the bus unless a start signal is received. When returned to the Automatic position, the engine shall shutdown.

e. Test On-Line - When placed in this position, the engine shall start, run, synchronize and connect to the bus as if a start signal were received. When returned to the Automatic position the circuit breaker shall open and the engine shall run for its cool-down period before shutting down.

2. Generator Running Green Lamp (On for Running, Flashing for Cool-down).
3. Controls Not In Auto Red Lamp (Flashing).
4. Provide analog meters and status panels that allows the operator to view status. Status tiles shall be provided for all Engine Generator Alarms, including the following at a minimum:
   a. Not in Auto.....(Red)
   b. Generator Circuit Breaker Ground Fault Alarm...(Amber)
   c. Pre-High Coolant Temperature.....(Amber)
   d. Pre-low Oil Pressure.....(Amber)
   e. Low Coolant Temperature.....(Amber)
   f. Low Battery Voltage.....(Amber)
   g. Low Fuel Pressure Level Alarm.....(Amber)
   h. Battery Charger Malfunction.....(Amber)
   i. Engine Overcrank.....(Red)
   j. Engine Overspeed.....(Red)
   k. Engine Low Oil Shutdown.....(Red)
   l. Engine High Coolant Temp Shutdown.....(Red)

m. Engine Low Coolant Level Shutdown.....(Red)
n. Generator Circuit Breaker Tripped.....(Red)
o. Generator Reverse Power.....(Red)
p. Generator Under Voltage.....(Red)
q. Generator Over Voltage.....(Red)
r. Generator Under Frequency.....(Red)
s. Generator Over Frequency.....(Red)
t. Generator Loss of Excitation.....(Red)
u. Generator Phase Reversal.....(Red)

2.2 MASTER CONTROL

A. The Master Control shall have a color touch screen Operator Interface Panel (OIP) located in the switchgear that allows the operator to view status and allows adjusting system variables (via a 2-step process to prevent accidental adjustments). The Master Control and Monitoring Panel shall be an integrated controller and shall combine the Screen Interface, Networking and I/O into a single compact unit utilizing single programming software for all graphics and logic. Program shall be expandable from control of one genset to three gensets without requiring hardware change out or major software upgrade.

B. The LCD graphic display shall be mounted in the master control cubicle. The system graphic display shall include as a minimum the following features:

Display Size: 40 inches
Active Screen Area: 700 square inches
Resolution: 1280 x 768
Viewing Angle: 170°
Contrast Ratio: 350:1

1. The system graphic display shall indicate the entire one-line of the system including the paralleling switchgear, the main-tie-main utility service switchgear, and the fused distribution switchgear “1A” and “1B”. As a minimum the following shall be displayed.
   a. Each Generator (simultaneously)
      1) Generator output CB open and close
      2) Generator output available
      3) Generator KW value
   b. Distribution and synchronizing gear
      1) Distribution CB open and close
   c. Main-tie-main utility service switchgear
      1) Breakers open/closed

2) Auto throw-over control in “auto” or “manual” mode
3) Amps, volts, KW

d. Distribution switchgear “1A” and “1B”
1) Switchgear open/closed
2) Feeder amps, volts, KW

e. Generator bus values
1) Amperes
2) Volts
3) KW
4) Frequency

C. The Master Control and Monitoring Panel shall provide the following features and characteristics:

1. The color screen OIP shall have at a minimum a resolution of 800 x 600, TFT, supporting 32768 different colors. System shall be a true controller with its own operating system, and the reliability of an industrial Programmable Logic Controller. The control logic shall be ladder.
2. The Master Control and Monitoring Panel shall have Portable memory in the form of a Compact FLASH card or USB that is readily available in most electronic stores. The Master Control and Monitoring Panel shall have the capability of reading, and updating the program from the Portable Memory
3. The Master Control and Monitoring Panel shall have the capability of storing and capturing any of the displayed screens onto Portable Memory, in the form of JPEG or BMP files. The Master Control and Monitoring Panel shall also have the capability of reading any of these screen captures directly from the Portable Memory.
4. The Unit shall be powered with a 120Vdc control voltage using switchgear station batteries These battery systems shall be connected through a Best Battery System to prevent “brownout” situations during the engine crank cycle.
5. The Unit shall operate at an ambient temperatures range from 0 to 104 degree F, with humidity 5 to 95% Non-condensing.
6. The Unit shall be UL labeled and CE approved, including any ancillary AC power monitoring devices.

D. The Master Control and Monitoring Panel shall have the following screens which can be displayed individually or simultaneously on split display:
   1. Main Menu Screen - to provide system status and access to One-Line diagrams, Manual Paralleling, Individual Generator Set and Individual Generator & Bus Metering, Alarm Status, Event Log data, System Control and Certified Service Tech Screens.
   2. One-Line Diagram Screen – to display system paralleling configuration. Shall depict system configuration in a single line format and system status.
      a. All switchgear Circuit Breaker Positions, generator sets, Open/Closed, including main service and distribution switchgear.
      b. Real time power values of generator sets, service switchgear and distribution switchgear: Voltage, A, kW, pF, kVar and Frequency.
   3. Manual Paralleling Control Screen – to provide manual paralleling control capability over individual generator sets.
      a. Synchroscope Graphical (real time 360-degree analog movement) with digital display.
      b. Manual Raise / Lower voltage and frequency.
      c. Automatic voltage and frequency set points of generator.
      d. Real time power values of generator / generator bus.
      e. Generator Circuit Breaker Position.
      f. Ability to select generator set to be paralleled.
      g. Manual closing of generator Circuit Breaker.
   4. Single Three-Phase Metering Screen: graphical analog (270 electrical degree) metering representation with digital display. Shall display the following minimum metering data for selected generator set or selected switchgear bus.
      a. True RMS three-phase Voltage, A, kW, kVA, kVar, pF & Frequency
      b. Engine battery Voltage display
   5. System Setup Control Screen: Control on/off.
      a. Engine priority, with Load Demand time delays (password protected).
      b. Adjustable Load Demand pick-up and drop-out kW levels (password protected). Control on/off.

c. Scrolling system status: Normal mode, exercise mode, standby mode, Gen(s) on-line, Gen(s) failure, Gen _ available, Gen _ synchronizer active, Gen _ Var Sharing active, Gen Load Sharing active.

6. Engine Generator Alarms and Shutdowns Screen:
   a. Exercise Mode.....(Green)
   b. Standby Mode.....(Red)
   c. Generator Circuit Breaker Ground Fault Alarm...(Amber)
   d. Pre-High Coolant Temperature.....(Amber)
   e. Pre-low Oil Pressure.....(Amber)
   f. Low Coolant Temperature.....(Amber)
   g. Low Battery Voltage.....(Amber)
   h. Low Fuel Pressure Alarm.....(Amber)
   i. Battery Charger Malfunction.....(Amber)
   j. Engine Overcrank.....(Red)
   k. Engine Overspeed.....(Red)
   l. Engine Low Oil Shutdown.....(Red)
   m. Engine High Coolant Temp Shutdown.....(Red)
   n. Engine Low Coolant Level Shutdown.....(Red)
   o. Generator Circuit Breaker Tripped.....(Red)
   p. Generator Reverse Power.....(Red)
   q. Generator Under Voltage.....(Red)
   r. Generator Over Voltage.....(Red)
   s. Generator Under Frequency.....(Red)
   t. Generator Over Frequency.....(Red)
   u. Generator Loss of Excitation.....(Red)
   v. Generator Phase Reversal.....(Red)
   w. Alarm reset button
   x. Emergency Stop Button

   NOTE: Information provided via serial communication by local engine control panel for items “d” through “n” above.

7. Engine Generator Protection and Setup Screen.
   a. Device 40Q Settings with enable feature.
   b. Device 81 O/U Settings with enable feature.
   c. Device 27/59 three phase with enable feature.
   d. Device 15/25V Auto and manual synchronizing with voltage matching settings for both.

e. Device 32 reverse power.

f. Current and potential transformer ratio setup.

8. Bus Protection and Setup Screen.
   a. Device 81 O/U Settings with enable feature.
   b. Device 27/59 three phase with enable feature.
   c. Current and potential transformer ratio setup.
9. Engine Generator Control and Setup Screen:
   a. Engine cool down timer setting.
   b. Cycle Crank attempts.
   c. Cranking time delay.
   d. Crank reset timer setting.
   e. Failure to synch timer setting.
   f. Number of actual crank attempts.
   g. Actual cool down timer left.
   h. Synch Mode Switch OFF, Auto, Check, Permissive.
   i. Cycle Crank logic enabled / disabled.
10. kW Trending Screen- to display kW trending of generator sets, main breakers MA and MB, generator breakers GA and GB, and fused disconnect switches 1A1, 1A3, 1A4, 1B1, 1B3 and 1B4. The kW trend screen shall have the capability to enable or disable auto store. The Auto store feature when enabled will automatically store the trend screen onto compact flash card every five minutes.
    a. Generator ‘X’ Trending.
    b. Generator Bus Total Trending.
    c. Main breaker MA.
    d. Main breaker MB.
    e. Output breaker GA.
    f. Output breaker GB.
    g. Fused switches 1A1, 1A3, 1A4, 1B1, 1B3 and 1B4.
11. Multiple Parameter Service Trending Screen: Capable of trending up to 16 different parameters on one screen, comparing all generators/loads/utilities, kW, kVar, voltage, THD, current and frequency. Trending screen shall have the capability to enable or disable auto store. Auto store feature when enabled will automatically store the trending screen onto compact flash every five minutes. The operator shall also have the ability to manual store any screen captures onto the compact flash card.

12. Event data Log Screen: Provides viewing of events logged with time and date. Operator can acknowledge and clear alarms, up to 2049 different events.
    a. Alarm History Log of the last 64 events.
    b. Alarm Summary (Active Alarms and Unacknowledged)
    c. Active Alarm Indicator
13. Full Range of Service Screens: Without the aid of a Laptop computer, a certified service technician shall have the capability of setting up all the paralleling parameters including proportional gains, ranges, and sensitivities of all parallel functions. The operator shall be able to view all controlling outputs to the voltage regulator and speed controller, including all power parameters of all engines on one screen.

E. Door Mounted Control Station with the following system controls:
1. Audible Alarm Horn.
2. Horn Silence Push-button.

2.3 PARALLELING OPERATION

A. General: Generators shall operate in parallel with one another, but shall not parallel with utility. Safeties shall be provided to prevent paralleling with utility power intentionally or inadvertently. Refer to drawings for general sequence of operation.
1. System shall provide soft-load transition when generators are brought on line to share load or taken off line.
2. Operator shall select mode of operation:
    a. Normal: All breakers are aligned for normal utility power.
    b. Exercise: Utility power available--system manually and automatically manipulated to allow gensets to pick up partial campus load per sequence of operation shown on the drawings.
    c. Standby (Utility Outage): Utility power not available--system manually and automatically manipulated to allow gensets to pick up all campus load per sequence of operation shown on the drawings.

B. Standby (Utility Outage) Mode: Provide manual or automatic control selector.
1. Automatic: Upon initiation of the automatic sequence, all engine-generators shall start. The first engine-generator to achieve 100% of nominal voltage and frequency shall be connected to the dead

generator bus. As the remaining engine-generators start, their respective synchronizers shall initiate control of voltage and frequency of the oncoming set with the bus. Upon synchronizing with the bus, the oncoming set shall be paralleled on the bus. Loads will be manually added to generator bus.

2. Manual: Manual mode shall operate similarly to automatic mode except that generator start, generator breaker control and load breaker control shall be operator controlled.
3. Automatic load demand sensing (provide manual or automatic control selector) shall be furnished to ensure that sufficient generating capacity is connected to the bus to carry the load. The load demand sensing shall also ensure that not more than the required capacity plus a limited reserve is connected to the bus at any time. The system in conjunction with the load demand shall ensure maximum efficiency in the utilization of engine-generator sets to ensure maximum fuel economy.
4. Automatic load demand sensing shall ensure that the on-line reserve capacity does not fall to less than 10% or exceed more than 110% of a single engine-generator. Upon sensing if the connected load exceeds the present limit for an established period of time, the next engine-generator will be started and paralleled. If upon sensing, the connected load is determined to be less than the preset limit for an established period of time, the last engine-generator to be paralleled will be disconnected and shut down. Alarm first to allow operator to take corrective action if necessary rather than risk interrupting power to the hospital. Its controls will be automatically reset so that the engine-generator will be ready for next operation. In “manual” mode all decisions and operations shall be by operator.
5. While one engine-generator is connected to the bus, and if the connected load exceeds the capacity of the bus, resulting in a decrease in system frequency to 58 Hz or less, an alarm shall activate. Similarly, with increased loading, the remaining engine-generator shall be signaled to start and be paralleled to the engine-generator already connected to the bus. Upon restoration of the normal source of power supply, as defined at the utility service breakers, the generator load will be transferred from generators

back to utility sources, generator outputs reduced to zero and generator output breakers opened per the sequence defined on the drawings. Subsequently, the engine-generator shall be run for an adjustable period of time up to 15 minutes maximum for cool down, and then shut down. All controls associated with operation of the engine-generator shall automatically reset for the next automatic operation.

C. Manual Mode: The engine-generators and system circuit breakers shall be manually operable.

D. Exercising Mode: Incorporate controls so as to allow automatic and manual testing of each engine-generator. The system shall include control equipment which will operate the standby power system in exercise mode in the following way:

1. Upon initiation of an automatic sequence for exercising operation, all engine-generators shall be started. The first engine-generator to achieve 100% of utility voltage and frequency shall be connected to the bus. As the remaining engine-generators start and achieve 100% of bus voltage and frequency, their individual automatic synchronizers shall initiate control of voltage and frequency to bring the oncoming engine-generators into synchronism with the bus. Upon achieving synchronism, the oncoming engine-generators shall be paralleled.
2. Operator initiates “Exercise Operations” and control system automatically executes sequence shown on drawings within constraints of interlocks and permissives.
3. Upon termination of the exercising operation, the generator outputs shall be reduced to zero, their output breakers opened, loads shall be retransferred to the normal power source. The engines run for a cool down period, and shut down.

E. Monitoring shall be based on true RMS three-phase, on all generators sensing methods. Monitoring based on averaging or calculating a potential phase from the other two phases is not acceptable.

2.4 COMMUNICATIONS REQUIREMENTS

A. The digital Master Control system shall be interconnected to allow monitoring of any unit by a single connection to a Local Area Network via Ethernet. All information including engine points and parameters, and other third party devices shall be communicated with effectively.

B. The Master Control shall have the capability of communicating directly with different engine generator set control panels and Schweitzer relays.

C. The Master Control shall communicate with local Johnson Controls Metasys network to allow existing Johnson Control system to monitor all system parameters via Johnson Control controlled software.

D. Provide communication cards and point list for JCI interface.

2.5 SECURITY

A. Security Code Required For Access - The Master Control shall have built-in security to protect against configuration changes and alarm purges by unauthorized personnel. There are two levels of access to the configuration menus. They are listed below. Each successive level has access to all of the levels above. A four-digit security code is required for access to the configuration menus.

B. Levels of Access:

1. Monitor with limited control (no security code) - Access to all Status Screens, view Alarm / Event Log Display, and ability to commit (clear) an Audible Alarm, provide some limited control.
2. Operator /Administrator (Level one) - Access to system set-points.
3. Technician (Level two) - Allows access to all set points including Engine generating paralleling digital calibration

2.6 MISCELLANEOUS COMPONENTS - REQUIREMENTS

A. Control Fuses - Control fuses shall be mounted in locations where they are readily accessible. Pullout type fuses shall be provided for all primary circuits and shall be of the current limiting type.

B. DC Control Power

Control power for the system logic shall be derived from the switchgear control batteries. Control power for the operation of the circuit breakers shall be derived solely from the switchgear battery. The switchgear manufacturer shall provide a DC load requirement calculation to the station battery provider. The control logic shall be powered through a suitable means which shall permit continuity of power until the last battery is no longer available.

C. Grounding of the system shall be accomplished via neutral grounding resistors, sized by generator manufacturer.

2.7 SEQUENCE OF OPERATION – SEE DRAWINGS

PART 3 - EXECUTION

3.1 FACTORY TESTING AND QUALITY ASSURANCE INSPECTION

A. A factory witness test shall be provided for a minimum of (1) Consulting Engineering, (1) Electrical Contractor and Owner representatives. Cost of transportation to and from the system manufacturing facility along with required associated lodging shall be included in the sale price of the system. Provide test procedure 2 weeks prior to testing.

B. 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. A certified factory test report shall be furnished to verify system testing.

1. The switchgear shall be subjected to the factory testing and quality control inspections to insure reliable operation. These tests and inspections shall include, but not necessarily be limited to, the following:
2. Perform a Megger test with a 1000V Megger. The minimum acceptable Megger reading shall be 100 MOhms on the switchgear, with all fuses, switches, circuit breakers, and contactors in the open position.
3. Insulation tests of all equipment and wiring, buses, etc., in accordance with manufacturer's standard practice.
4. Circuit continuity and wiring.
5. Mechanical equipment adjustment and operation of all moveable equipment and devices.
6. Equipment arrangements, types, and ratings for conformance with approved drawings.
7. Bus bar phase arrangement and bracing.
8. Integrity of all electrical connections.
9. Conformity with the nameplate and circuit identification indicated on the drawings and the approved manufacturer's drawings.
10. Demonstration of switchgear functions.

C. All switchboard equipment shall be given complete operational tests to ascertain that all design functions are satisfactorily performed. Testing shall include:

1. Actuation of all alarm indication devices.

2. All control circuits, automatic operations and interlocks shall be tested under simulated operating conditions.
3. All of the above shall be tested according to design specifications for correct and positive operations.

3.2 INSTALLATION - the installing contractor shall perform all receiving, unloading, storage and installation of the equipment per all local applicable codes.

A. Installation Instructions:
1. One copy shall be furnished of the installation, operation and maintenance instructions for all equipment and devices provided under this Contract for use during the installation and commissioning into service of the emergency power system.

B. After installation by the installing contractor, the engine-generator set and switchgear manufacturers shall provide the services of competent locally based service technicians/project managers to instruct the Installing Contractor, and to coordinate the commissioning of the equipment. They shall assist in placing the equipment into operation and provide instruction, as required, to the person or persons who are delegated to operate the equipment. This service shall include a minimum as follows:
1. Pre-installation coordination meeting to coordinate the installation and interconnection of the switchgear with the engine-generator equipment.
2. Initial checkout of the installation of the equipment to allow energizing of the switchgear.
3. Post-installation start-up and testing prior to system turnover and for the initial instruction period for operating personnel. This shall include all service required to checkout the emergency power system and demonstrate its complete operation, for final acceptance by the Owner.

C. The switchgear manufacturer shall maintain a proficient factory service organization that is available for service and on call 24 hours a day, 7 days a week.

D. It shall be the responsibility of the installing contractor to verify that the following items have been completed and are ready to perform as specified before the arrival of the start-up technician.
1. Inspect for obvious shipping damage.
2. The switchgear is installed, anchored down and grounded.

3. Shipping splits have been reinstalled with the splits bolted together, interconnect wiring installed and bus splice plates installed.
4. Terminate all power cables.
5. Install customer control wiring to external equipment including engines, batteries, ATS, associated motor controls, etc.
6. The engine-generator set is installed and ready to run. (Batteries charged, etc.).
7. Associated motor controls, plumbing, building utilities are complete and operational.

E. The start-up technician shall perform the following items:
1. Provide start-up procedure for Owner review.
2. Verify Contractor connections, control power availability, visually inspect any relay settings.
3. With the engine generator supplier's technical representative controlling the engine, verify that the switchgear and control equipment are fully operational and perform per the sequence of operation specified. Equipment or services shall be provided by the engine generator set supplier.
4. With the engine generator supplier's technical representative controlling the engine, demonstrate all functions of the control system, both automatic and manual, to the satisfaction of the approving engineer.
5. Provide documentation in the form of function checklists and recorded data for each section to the approving engineer.
6. Provide plant operators with instruction on the plant operating procedures and major component operation after acceptance by the approving engineer.

3.3 WARRANTY AND SERVICE

A. Switchgear manufacturer warrants the equipment to be free from defects in material and workmanship for eighteen months from date of shipment.
B. Switchgear manufacturer shall have an established network of factory owned and operated service centers within the continental US capable of servicing the specified equipment.

C. The manufacturer's personnel shall be on call 24 hours a day, 7 days a week. Personnel shall be factory trained and certified in the maintenance and repair of the specified equipment. These personnel must be located within a 4 hour drive of the project site. Any manufacturer without a local service organization capable of complete service, maintenance, troubleshooting and repair is not acceptable.

D. After-warranty service contracts shall be available to the owner by the manufacturer to provide periodic maintenance and/or repair of the specified equipment.

E. Supplier to provide all available software updates during warranty period.

3.4 OPERATION AND MAINTENANCE MATERIALS

A. Operation Instructions and Maintenance Manuals:

1. After completion of work and start-up of the equipment at the project site, deliver to the Owner's Representative, (3) copies of operation instructions, maintenance manuals and drawings presenting full details for care and maintenance of each item of equipment provided under this Contract.
2. Each manual shall contain the operating and maintenance information and parts lists for all equipment provided under this Contract. When necessary, provide supplemental drawings to show system operation and servicing and maintenance points. For all electrical components, provide wiring and connection diagrams. Manuals shall include instructions required to accomplish specified operation and functions. Data shall be neat, clean, legible copies.
3. Switchgear drawings and wiring diagrams shall be included and up to date at the completion of start-up and system acceptance by the Owner. Drawings and wiring diagrams shall include any field modifications or changes to reflect actual as installed conditions.
4. In general the manual shall include, but not necessarily be limited to, the following:
   a. Switchgear Elevation drawings & One Line diagrams
   b. AC & DC Schematic and Physical Component Layout Drawings
   c. Remote Interface drawing
   d. Bill of Material
   e. Circuit Breaker Operation Manuals
   f. Description of System Operation

g. Recommended Spare Parts List - showing all consumables anticipated to be required during routine maintenance and testing.

Manuals shall be in the form of three-ring binders and compact discs (CD’s) adequately labeled with the project name and location and the contents indexed. Three (3) sets of manuals and three (3) sets of compact discs (CD’s) shall be provided to the Owner's Representative.

3.5 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the paralleling switchgear is in good operating condition and properly performing the intended function.

3.6 INSTRUCTION

Furnish the services of a factory-certified instructor for three 4-hour periods to instruct personnel in the operation and maintenance of the switchgear and related equipment on the date requested by the COTR.

3.7 ACCEPTABLE MANUFACTURERS

A. ASCO SYNCHROPOWER®
B. Caterpillar, Engine Division
C. GE Zenith Controls
D. Onan Corporation; Cummins Inc., Industrial Business Group
E. Russelectric
F. Schweitzer Engineering Laboratories, Inc.
G. Other VA approved equal

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