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SUGGESTED SPECIFICATION

for

Medium Voltage Generator and Distribution Control Switchgear

Division 26

Standby Power Generator Systems

PART 1 GENERAL

1.1 Scope

A. Medium voltage (through 15 kV) freestanding or close-coupled metal-clad switchgear with vacuum circuit breakers.

B. It is the intent of this specification to provide a complete control and power distribution system for the operation of _____ generator units, rated ____ kW at 0.8 PF, _____ volts, 3 phase, 3 wire, 60 Hertz. All components, testing, and services specified or required for a complete operable system shall be included. The switchgear shall consist of _____ generator section(s), one master control section and _____ distribution sections.

1.2 Related Sections

A. Section 26___: *(spec writer to determine applicable section)*
B. Section 26___: Critical Power Management System *(optional)*

1.3 Application Codes and Standards

A. ANSI/IEEE C37.20.2 - Standard for Metal-Clad Switchgear.
B. ANSI/IEEE C37.04 and .06 - Standard ratings and preferred ratings for Indoor AC Medium-Voltage Circuit Breakers used in Metal-Clad Switchgear.
C. 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.
D. ANSI/IEEE C37.09 - Standard Design and Production Testing.
E. ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment.
F. ANSI/IEEE C57.13 - Requirements for Instrument Transformers.
G. NEMA SG4 - Alternating Current High Voltage Circuit Breakers.

H. NEMA SG5 - Power Switchgear Assemblies.

1.4 Manufacturer's Qualifications

Automatic Transfer Switches, Bypass Switches, Paralleling Switchgear, Switchboards, Station Batteries (if required), Monitoring and Control, and Critical Power Management shall be supplied by a single manufacturer.

The equipment described, as a minimum, shall meet all of the requirements specified in this section. The equipment shall be the product of a manufacturer who has produced paralleling switchgear for a period of no less than 20 years. The manufacturer must provide integral electrical and mechanical design. Comprehensive documentation detailing electrical and mechanical designs shall be available upon request. The manufacturer must be certified under ISO 9001.

1.5 Order Management

Management of orders shall be assigned to personnel employed and trained specifically and exclusively for project management; the use of field service representatives, design engineers or sales representatives for order management purposes shall not be acceptable. Each order shall be managed by both a factory-based project manager and a factory-direct field-based project manager.

1.6 Documentation

A. Submittals for approval shall include the following:

1. Elevation drawings with shipping splits identified and estimated weights.
2. Outline drawings showing conduit entry areas and anchoring information.
3. Single line diagram.
4. Sequence of operation.
5. Complete bill of material listing items by manufacturer's name, part number and description.
6. Complete nameplate and status annunciator panel schedule.
7. Technical literature for major components.

B. Operation and maintenance manuals shall contain:

1. Complete Set of Drawings
2. Detailed Interconnect Spreadsheet
3. Complete Bill of Material
4. Instruction Manuals for Major Components

5. Sequence of Operation
6. Warranty Statement

O&M manuals will be provided in electronic format via a secure link.

1.7 Design Requirements

A. The metal-clad switchgear shall consist of an enclosure containing circuit breakers, components and wiring, all factory assembled (except for necessary shipping splits) and operationally checked as an integrated switchgear and controls assembly. The assembly shall be self-supporting and floor mounted on a level surface. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.
B. System Voltage: ____ kV nominal, three-phase [grounded**][ungrounded], 60 Hz.
C. Maximum Design Voltage: [4.76] [15.0] kV.
D. Impulse Withstand (Basic Impulse Level): [60] [95] kV.
E. Power Frequency Withstand: [19] [36] kV, 1 minute test.
F. Main Bus Ampacity: [1200] [2000] [3000] amps, continuous.
G. Momentary Current Ratings: Equal to the circuit breaker close and latch rating.
H. Circuit Breaker Interrupt Rating: [25|40|50] KAIC
I. Surge Arrestors shall be [*distribution* | *intermediate* | *station*] class and provided as shown on contract drawings

** *Specifier to insert description of a specific type of impedance grounding.*

1.8 Warranty and Service

A**.** Manufacturer shall warrant the equipment for eighteen months from date of shipment subject to terms and conditions of manufacturer's current warranty publication.

B**.** Manufacturer shall have an established network of factory-direct service technicians capable of servicing the equipment.

C**.** Manufacturer's field service representatives shall be on call and available for immediate dispatch 24 hours a day, 365 days a year. All field service personnel shall be factory trained, by the manufacturer, and certified in the maintenance and repair of the specified equipment. Manufacturer must employ a minimum of 2 field service technicians within a 150 mile radius of the installation site. Field service representatives shall have access to common replacement components locally and the service organization shall have a detailed counter-to-counter process for providing emergency spares 24 hours a day 7 days a week.

D**.** Post-warranty service contracts shall be made available to the owner by the manufacturer to provide scheduled maintenance and/or emergency repair of

the equipment.

1.9 General Requirements

A. Switchgear Enclosure

1. Structure. The enclosure shall be free-standing and floor supported, with front and rear access. An adequate number of anchor bolt holes shall be designed to place the base in direct contact with the foundation when bolted. The flatness of the floor surface upon which the equipment is installed shall deviate no more than 0.125 inches per 10 feet in any direction. All doors shall be formed of 11 gauge steel.

   All steel parts, except galvanized (if used), shall be cleaned and a zinc-phosphate (outdoor equipment) or iron phosphate (indoor equipment) pre-treatment applied prior to paint application.

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

   Adequacy of paint finish to inhibit the buildup of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2-1987. Salt spray withstand tests in accordance with ASTM #D-1654 and #B-117 shall be performed on a periodic basis to provide conformance with the corrosion resistance standard of at least 2500 hours minimum (outdoor equipment) or 600 hours minimum (indoor equipment).

2. Bus. The main bus is to be rated [1200] [2000] [3000] amps and be fully insulated for its entire length with an epoxy coating. The conductors shall be [*silver-plated* | *tin-plated*] copper and be of a bolted design. Access to this compartment is gained from the front or rear of the structure by removing a steel barrier. Provide standard provisions for future extension, as applicable. Lugs shall be provided per cable schedule and shall be compression type.

3. Wiring. AC voltage sensing wiring shall be SIS #14 AWG. CT wiring shall be SIS #12 AWG. All DC control wiring shall be a minimum of #18 SIS AWG. Current transformer circuit termination's shall be ring tongue type and include shorting terminal

blocks.

Control wires shall be numbered every eight (8) inches or less and visible next to the terminals. Also, the wiring shall be permanently marked with wire termination designations. These designations shall include the device and connection point where the wire is terminated. All control wire markings shall be printed directly on the wire insulation and be permanent. Low level signal circuits shall be separated and provided with shielded wire to minimize electromagnetic interference. Shielded wire shall be grounded at one point. Ethernet cabling shall be unshielded category 5 or higher.

Wiring between each section shall not be spliced, and shall be free of abrasions and tool marks. Connections between cubicles shall use labeled connection plugs. Wires shall be placed in wire duct or harnessed, and shall be supported to prevent sagging or breakage from weight or vibration. Inter-cubicle wiring harnesses shall be contained in overhead steel wire troughs. Communication cables and current transformer circuits shall be hard wired.

All wiring to hinged doors, except communication and current transformer circuits, shall be run through door terminal blocks or connection plugs. Terminal blocks shall be provided for all external connections and placed in an accessible area not exposed to hazardous bus or cables, if possible. Current transformer circuits shall be connected through shorting terminal blocks.

4. Nameplates. Engraved laminated plastic nameplates, having black letters on white background, shall identify major components, vertical sections, and circuit breakers. Nameplates shall be attached with self-tapping screws.

B. Components

1. Metering Instrumentation. Analog metering instrumentation consisting of industrial switchboard type meters, 4-1/2" square, 1% accuracy. Current and potential transformer ratios shall be selected and coordinated for nominal and rated values for ammeters, voltmeters and kW meters.

2. Instrument Switches. Instrument switches shall be of the rotary type. Each switch shall be supplied with a titled escutcheon plate, suitably marked for each position. The switches shall have positive means of maintaining contact, which shall be silver to silver with a

wiping action.

3. Current Transformers. Current transformers shall be furnished with VA burden and relay class ratings suitable to supply the metering and protective devices without affecting accuracy.

4. Potential Transformers. Two (2) open-delta connected draw-out potential transformers shall be provided in turns ratio and VA burden rating to be compatible with the controls and voltage sensing as applied. Transformers shall have integrally mounted primary and secondary fuses.

5. Alarm and Status Indication. Visual and audible alarm and status indication lights, including spares, shall be furnished as indicated by customer. Visual alarms shall be reset only after the fault condition has been corrected. The audible alarm shall include a silencing circuit which after activation shall permit audible annunciation of subsequent failures. Lamp test shall be an integral feature of this indicator. Each illuminated indicator tile shall be 24 mm x 24 mm.

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

7. Protective Relays. Door mounted protective relays shall be utility grade with semi-flush mounting. They shall have standard built-in test features and targets.

C. Electromagnetic Control Relays

All electromagnetic control relays shall be suitable and adequately rated for their intended service in the control system. All relays for control circuit duty shall be plug-in type with retaining clips and transparent plastic covers. Relays shall be clearly marked for control voltage. When possible, all relays shall have light-emitting diodes to indicate that the coil is energized. Separate lockout relays shall be provided.

D. Circuit Breakers

All circuit breakers shall be type VR, and PCS controls shall monitor the trip coil status and control voltage (close/trip). PCS controls shall prevent closing circuit breakers when the trip voltage is not available.

1.10 Acceptable Manufacturer

The equipment described shall be manufactured by ASCO Power Technologies. Any alternates to this bid shall only be considered if a complete written description of the proposed system along with any variances to the specification, are received ten (10) days prior to bid due date. Any variances not specifically enumerated prior to bidding shall be considered non-responsive. Alternate manufacturers must be approved in writing by the Engineer as an addendum. Costs incurred to modify the building and/or interfacing equipment which are affected as a result of an alternate, shall be the responsibility of the contractor.

PART 2 SECTIONS

2.1 Generator Power and Control Section

A. Each generator section shall contain over-current protection, controls, relays and auxiliary devices associated with its respective engine generator set. It shall include the following:

For each generator set, a medium voltage Square D type VR vacuum circuit breaker shall be furnished to provide paralleling functions. Circuit breakers shall be rated _____ nominal volts, [4760] [15000] maximum volts, 60 Hz, with a continuous current rating of 1200 amps and a maximum symmetrical interrupting rating of [*4760V system at: 40kA | 50kA | 63kA*] [*15000V system at: 25kA | 40kA | 50kA | 63kA*]. Furnish circuit breakers with one vacuum interrupter per phase. Breakers of same type and rating shall be completely interchangeable. The circuit breaker shall be operated by means of a stored energy mechanism which is normally charged by a universal motor but can also be charged by the manual handle supplied on each breaker for manual emergency closing or testing. The closing speed of the moving contacts is to be independent of both the control voltage and the operator. Provide a full front shield on the breaker. A minimum of 6 auxiliary contacts and 5 MOC and 5 TOC type contacts, shall be provided for external use. The racking mechanism to move the breaker between positions shall be operable with the front door closed and position indication shall be visible with door closed.

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

The circuit breaker control voltage shall be: [*48 | 125*] volts DC. Close and

trip control power shall be independently monitored. Breaker closure shall be inhibited if trip power is unavailable.

A Circuit Breaker Trip Switch shall be provided with open/closed/tripped indicating LEDs.

B. Generator Control System

Paralleling controls for each generator shall include a programmable logic controller and a Woodward DSLC-2 digital synchronizer and load controller designed for use on three-phase AC generators and mounted in the switchgear. The controls shall combine a synchronizer (with voltage matching capability), load sensor, load control, dead bus closing system interlock, VAR, power factor and process control. The load sharing network and VAR sharing network shall be redundant and completely integrated in the switchgear with network status monitoring and diagnostics available via switchgear operator terminal screens. Applications shall allow up to 32 generators to be paralleled and controlled.

The controls shall sense true RMS power and provide soft loading and unloading functions on the main bus.

DC-to-DC converter(s) shall be in each generator control section to provide a constant 24VDC power. The generator section DC-to-DC converter shall supplement the DC-to-DC converter in the master control section. Control power shall be sourced from generator set batteries and sustain adequate control voltage during an engine crank. The converters shall provide power for up to 75% rated load if the source voltage drops to 12 volts. Source voltage shall not exceed 32 volts.

Generator controls shall include the following functions, components, devices, and indicators.

1. Generator Voltage Monitoring and Frequency Monitoring

   Generator set controller shall monitor voltage and frequency to insure the generator is not connected to the bus until frequency is at least 59 Hertz and 90% rated voltage.

2. Automatic Synchronizer

   The synchronizer shall include a differential voltage detector, differential frequency detector and differential phase detector. Analog voltage bias signal shall be provided for voltage matching and an analog speed bias signal shall be provided for frequency matching and phase angle control. Synchronizer shall issue a breaker close signal when frequency, phase and voltage conditions are met.

   The differential voltage detector shall compare the voltage of the

oncoming generator to the paralleling bus. If the voltage is not within the factory set difference of plus or minus 5% (adjustable from 0 to plus or minus 10%), the voltage detector shall inhibit the circuit breaker from closing. When the oncoming generator voltage is within the preset acceptable limit, the inhibit shall be removed.

The differential frequency detector shall compare the frequency of the oncoming engine generator set to the paralleling bus. If the frequency is not within the preset acceptable difference of plus or minus 0.5 Hz (adjustable from 0 to plus or minus 0.5 Hz), the frequency detector shall inhibit the circuit breaker from closing. When the oncoming engine generator frequency is within the acceptable limit, the inhibit shall be removed.

The differential phase detector shall compare the phase angle of the oncoming engine generator set to the paralleling bus. If the phase angle is not within the preset acceptable difference of plus or minus 0.05 Hz (adjustable from plus/minus 0.02 to 0.25 Hz), the phase detector shall inhibit the circuit breaker from closing. When the oncoming engine generator phase angle is within the acceptable limit, the inhibit shall be removed.

3. Multiple Circuit Interlock

Generator controls shall provide for first-up, first-on operation of the generator set. This device shall positively prevent more than one set from being simultaneously connected to a dead bus. Upon initiation of the connection of the first set to the bus, this circuit shall shift the control of the remaining sets to automatic or manual synchronizing at the operator's discretion.

C. Programmable Logic Controller

1. The automatic engine starting control shall be provided via a dedicated programmable logic controller and shall automatically start, protect, and monitor each engine generator set. The controller shall be provided with power supply, CPU and required I/O modules. Engine start control shall additionally be hard wired so that the engine can be automatically or manually started if the controller is not available. Systems without hard wired backup are not acceptable. The programmable logic controller shall be dedicated for control exclusively of the engine and generator set and shall be independent of the Master PLC. Distributed I/O systems which rely on a master controller shall not be acceptable.

Programmable Controller shall be Modicon type M340.

2. Engine Start/Stop Operation

The automatic engine control logic shall initiate operation of the engine upon receipt of a signal from a contact that closes for engine run, and opens for engine stop.

3. Five Position Engine Control Selector Switch

Lockout/Reset - When placed in this position, the engine shall not be capable of starting and/or running from the ASCO PCS controls. If the engine was shut down due to the operation of a protective device, the shut down 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 shut down, the circuit breaker shall be opened and the and the generator locked out.

Off/Cooldown - When placed in this position, the generator shall be soft unloaded from the bus (when possible) and the engine start signal shall be removed after a defined cool-down period.

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

Test Off-Line - When placed in this position, the engine shall start and run as if a start signal were received except the circuit breaker shall not be closed and it shall not be connected to the bus. If a start signal is received, normal automatic functions shall resume. When returned to the Automatic position, the engine shall shut down.

Test On-Line - When placed in this position, the engine shall start, run, and connect to the bus. When returned to the Automatic position the circuit breaker shall open, provided no automatic start signal is present, and the engine shall run for its cool-down period before shutting down.

4. Four Position Synchronizing Mode Selector Switch

Permissive - In this position the governor controls are deactivated. However, the synchronizer shall operate as a passive synch check relay and signal the closing of the generator breaker when both

sources are in phase.

Check - In this position the synchronizer is fully operational except it cannot close the generator breaker. The phase-lock feature holds the generator output in synchronism with the bus.

Off - In this position the synchronizer is turned off to allow for manual paralleling at the Master Cubicle.

Run - In this position the synchronizer is in the fully operational, automatic mode.

5. Engine Cooldown Time Delay

The cooldown time delay shall be adjustable from 1 to 10 minutes (factory set at 5 minutes) and automatically bypassed for malfunction and manual shutdown of the engine generator set.

6. Failure to Synchronize Time Delay Relay

The failure to synchronize time delay shall be fixed at 60 seconds. It shall provide audible and visual indication, but it shall not terminate synchronizing attempts nor shut down the engine.

D. Circuit Breaker - Protective Relaying and Monitoring

A Schneider Electric Easergy P3G32 or equivalent Generator management relay shall be provided to provide complete protection and monitoring functions.

Protection functions shall include:

- Instantaneous overcurrent when offline (50)
- High-set overcurrent (50)
- Instantaneous and definite time overcurrent for ground (50/51GN)
- Stator thermal modeling and RTD (49)
- Negative sequence overcurrent (46)
- Phase differential (87G) with a dedicated set of CT's
- Over and undervoltage (59/27)
- Reverse power for anti-motoring (32)
- Voltage restrained phase overcurrent (51V)
- Voltage phase reversal (47)
- Loss of field (40 & 40Q)
- Over and under frequency (81)

Monitoring and metering functions shall include:

- RMS current, negative sequence current, voltage, three phase power, and temperature (via 12 RTDs)

Current and Voltage Test blocks shall be provided to facilitate testing of the relay. A separate Lockout Relay (Device 86) shall be provided for each protective relay. In conjunction with the generator differential (87G) protection above, which includes dedicated CT's in the switchgear as noted, another set of matching CT's shall be shipped loose with the switchgear to install on the generator for connection to the protective relay.

E. Alarm and Status Indication

FUNCTION	COLOR
LAMP TEST (PUSHBUTTON)	
PARALLEL CB OPEN	GREEN
PARALLEL CB CLOSED	RED
PARALLEL CB LOCKOUT	RED
PARALLEL CB FAIL TO CLOSE	RED
FAILURE TO SYNC	RED
GEN OUTPUT CB OPEN	GREEN
GEN OUTPUT CB CLOSED	RED
PARALLEL CB NOT CONNECTED	RED
PARALLEL CB FAIL TO OPEN	RED
OVER CRANK SHUTDOWN	RED
OVER SPEED SHUTDOWN	RED
REVERSE POWER SHUTDOWN	RED
LOW OIL PRESSURE SHUTDOWN	RED
HIGH WATER TEMP SHUTDOWN	RED
AUTO START	GREEN
ECS RESET REQUIRED	RED
ENGINE CONTROL NOT IN AUTO	RED
LOW OIL PRESSURE ALARM	AMBER
HIGH WATER TEMP ALARM	AMBER
ENGINE RUNNING	GREEN
PLC STOPPED	RED
CONTROL VOLTAGE FAILURE	RED
CONTROLS NOT IN AUTO	RED
LOCAL/REMOTE EMERGENCY STOP	RED
LOW WATER LEVEL ALARM	AMBER
LOW WATER TEMP ALARM	AMBER
POWERQUEST OVERRIDE	AMBER
DAY TANK LOW FUEL	AMBER
DAY TANK HIGH FUEL	AMBER
DAY TANK RUPTURE BASIN	AMBER
BATTERY CHARGER FAILURE	RED
HIGH BATTERY VOLTAGE	AMBER
LOW BATTERY VOLTAGE	AMBER
(Protective Relay) COMMON ALARM	AMBER
(Protective Relay) COMMON SHUTDOWN	RED
DC TRIP/CLOSE VOLTAGE FAILURE	RED
GEN COMMON SHUTDOWN	RED
GEN COMMON ALARM	AMBER
DC CONVERTER FAILURE	RED

DSLC-2 SELF TEST FAILED	RED

F. Generator Analog Metering / Instrumentation.

1. Ammeter 0 - _____ Ampere scale.
2. Voltmeter 0 - _____ Volt scale.
3. Kilowatt meter 0 - _____ Kilowatt scale.
4. Frequency meter ___ - ___ Hertz scale.
5. 4 Position Ammeter/Voltmeter selector switch means shall be included.

G. Generator Control Station

FUNCTION	SELECTIONS
GENERATOR CONTROL SWITCH	LOCKOUT/RESET OFF/COOLDOWN AUTOMATIC TEST OFFLINE TEST ONLINE
SYNCHRONIZING MODE SWITCH	PERMISSIVE CHECK OFF/COOLDOWN RUN
EMERGENCY STOP PUSHBUTTON	-
ALARM RESET PUSHBUTTON	-
VOLTAGE CONTROL SWITCH	LOWER OFF RAISE
SPEED CONTROL	LOWER OFF RAISE

2.2 Master Control Section

The master control section shall contain redundant programmable logic controllers capable of storing necessary control sequence algorithms, variable operation set-points, time delays and alarming levels. Distributed I/O stations shall include modular input and output cards for discrete and analog signals necessary to provide the integrated system operations specified below. Master PLCs shall be Modicon M580.

A. Priority Load Control

Discrete output modules shall be provided to control the necessary priority load blocks. The number of load blocks shall equal the number of engine

generator sets, and shall be sized such that the connectable load of each block is not greater than the kilowatt rating of the generator set connected. As the generators are connected to the bus, the controller shall signal for the connection of the load blocks in an ascending sequential priority with the highest priority load requiring emergency power being connected first. Priority failure pass-along logic shall initiate the connection of low priority loads to the first generator on-line if start signals have not been received from high priority transfer switches or other devices.

Load shedding shall be done on a last-on, first-off basis. The generator bus shall have a solid-state frequency monitor, with integral time delay to initiate load shedding upon a reduction of bus frequency to 58 Hz or less, for a period of three seconds or more. Upon sensing a bus underfrequency, the system shall automatically shed the lowest priority load connected at the time of occurrence. This shed circuit shall override any manual load-add operation, and shall lock out the manual load-add circuitry. It shall provide visual and audible alarm annunciation of bus underfrequency load shed.

Provide a means to reset bus underfrequency signal.

Provide a "load shed bypass/reset" push-button, for manual supervised operation over the load-shed, load-add control logic. One push-button shall be provided for each priority block except first priority. Logic shall be provided in the event that a bus overload occurs resulting in a reduction in bus frequency; the bypassed priority load shall be shed automatically through override logic control.

System loads shall not shed unless a bus overload or a bus under frequency occurs; this feature is referred to as "load-latch".

B. Power Management Applications

Master controls applications shall include Load Bus Optimization and Generator Load Demand. Applications shall dynamically adjust to bus conditions.

Load Bus Optimization shall control up to 128 individually prioritized and separately controlled distribution loads via power transfer switches and/or electrically operated circuit breakers. Loads shall be added or removed from the bus according to the available headroom on the bus.

Generator Load Demand shall control up to 32 individually prioritized and separately controlled engine-generator sets. Engine-generator sets shall be added or removed from the bus according to dynamic measurements of

power consumption and engine-generator efficiency set-points.

C. Manual Paralleling Controls

A Synchroscope selector switch shall be provided to select any generator for manual paralleling operation. The positioning of the selector switch shall simultaneously connect the synch-check relay, Synchroscope, and "manual paralleling" push-button to the selected generator.

Two voltmeters and two frequency meters shall respectively indicate oncoming source and the main bus.

A solid-state sync check relay shall be furnished for manual paralleling, to sense and compare the phase angle difference between the oncoming generator and the bus. This relay shall lockout the manual paralleling push-button until the oncoming generator is within 15 degrees of synchronism.

Operation shall be arranged so the operator shall depress and hold the manual paralleling push-button. When the relative phase angle reduces to 15 degrees and going towards zero degrees, the sync check relay's output contact shall initiate the closing of the respective oncoming generator breaker.

All manual paralleling interface controls and metering shall be grouped in a central location on the front of the master control section. This shall allow for multiple generators paralleling from one location within the switchgear. Manual paralleling controls and sync check relay shall be hardwired and shall not rely on touch screens or programmable controllers to perform manual paralleling functions.

D. DC Control Power Selector – Best Battery System

Control power for the system logic shall be derived from the engine starting batteries and/or an optional station battery system. The control logic shall be powered through a suitable means that shall permit continuity of power until the last battery is no longer available. The controls shall be powered from any battery or combination of batteries and prevent feedback to a failing battery. The transition of control logic power from any battery combination to any other battery combination shall be accomplished without disruption in the power flow.

A single DC-to-DC converter shall provide a constant 24VDC power to the master and generator controllers during starting and cranking of all engine generator sets "simultaneously".

Additionally, the best battery system shall provide power to each generator

paralleling circuit breaker trip coil if the generator battery power is lost to its cubicle.

Station batteries shall be converted to 24VDC to provide backup to DC controls.

E. System Test Switch

Provide a system no-load test switch to initiate a complete automatic system operation by simulating the closure of the remote engine start signal. This switch shall be mounted inside the master section to limit access to authorized personnel only.

F. Alarm and Status Indication

FUNCTION	COLOR
LAMP TEST (PUSHBUTTON)	
GEN # RUNNING	GREEN
GEN # ONLINE	RED
GEN # LOCKED OUT	RED
PRI # LOAD SHED ACTIVE	AMBER
PRI # LOAD SHED BYPASSED	AMBER
SYSTEM TEST	AMBER
EMERGENCY MODE	AMBER
I/O COMM FAILURE	RED
SYSTEM PLC DIAGNOSTIC FAULT	AMBER
LOAD DEMAND MODE ACTIVE	AMBER
LOAD DEMAND START TD ACTIVE	AMBER
LOAD DEMAND STOP TD ACTIVE	AMBER
BUS UNDER FREQUENCY	RED
BUS OVER FREQUENCY	RED
BUS UNDER VOLTAGE	RED
BUS OVER VOLTAGE	RED
BUS OPTIMIZATION MODE ACTIVE	AMBER
NEXT LOAD EXCEEDS HEADROOM	AMBER
BUS LOADED TO CAPACITY	AMBER
BUS OVERLOAD	RED
STATION BATTERY CHARGER FAILURE	AMBER
MAIN TANK LOW FUEL	AMBER
ATS CONTROL FUSE BLOWN	RED
PLC 1 STOPPED	RED

PLC 2 STOPPED	RED
CONTROL VOLTAGE FAILURE	RED
DC CONVERTER FAILURE	RED

G. Main Audible Alarm

Provide a main audible alarm. The alarm horn shall be the DC vibration type, subsequent malfunctions to resound the alarm if the horn had been previously silenced.

H. Paralleling Bus Analog Metering / Instrumentation

1. Ammeters 0 - ____ A scale
2. (2) Voltmeters 0 - ____ V scale
3. Kilowatt Meter 0 - ____ kW scale
4. (2) Frequency Meters ___ - ___ Hz scale
5. Synchroscope and Synchroscope Plant Selector Switch with positions for each generator.
6. 4 Position Ammeter/Voltmeter selector switches for bus metering shall be included.

I. Main Bus Monitoring

Main bus monitoring shall include a discrete Bus Under/Overvoltage Relay, a discrete Bus Under/Over-Frequency Relay and a Main Bus Power Watt Transducer.

J. Master Control Station

FUNCTION	**COLOR**
BUS ALARM RESET PUSHBUTTON	-
ALARM SILENCE PUSHBUTTON	RED
MANUAL PARALLEL PUSHBUTTON	GREEN
PRIORITY # LOAD SHED PUSHBUTTON	-

K. Master Controller

The master controller shall be programmed by ASCO and shall meet or exceed the following specifications:

1. Modicon M580 with CPU, power supply, I/O, and communications.

2. The controller shall have the capability to interface to an I/O rack; I/O network shall be a managed ring configuration.

L. Master PLC Redundancy

This system shall consist of identical and synchronized redundant programmable logic controllers and common I/O systems between the controllers. Normally, the primary controller shall be the active one that controls the system I/O while secondary controller(s) shall be on standby, ready to take control of the system I/O. Any single failure to the active controller shall cause automatic switch over to the standby controller. As both controllers shall be synchronized, there shall be a transfer from one controller to the other without interruption. The I/O shall be held in their current state during the transfer.

If the active controller fails and control transfers to the standby controller, the failed controller can be turned off and repaired without affecting the rest of the system.

Status indicators shall indicate which controller is active and if a controller is in run or stop mode.

M. Redundant I/O
*[**optional**: spec writer to remove this section if not required]*

I/O shall be redundant and connected to the PLC's through a managed Ethernet ring communication network. Loss of a single I/O module shall be annunciated but have no impact on the performance of the system. The loss of dual IO modules or the communication network shall be annunciated and the system shall revert to manual mode.

2.3 Operator Interface Terminals

The monitoring and control interface shall be ASCO PowerQuest 7000 SCADA.

Metering and monitoring network devices and design standards shall include IEC 62443-3, NERC CIP and IEEE 1613, providing a secure network with security management. Encrypted connections and configuration files shall provide data confidentiality with connection verification required for access. Simple general purpose security for industrial applications shall include IEC 62443-4-2 Level 1 and Level 2 for medium and high security options. The controls network shall remain isolated.

The monitoring and control interface shall include programmable 24-inch color touch screen units and shall interface with Controllers, Synchronizer/Load Controllers (PCS 7000 DSLC-2), Power Meters, and Transfer Switches. The automatic operation of the system shall not be impeded by the unavailability, disconnection or failure of any single

or all color touch screens.

The default screen shall consist of a one-line overview of the system that includes:

- Dynamically updated and color-coded (according to status) one-line representing power flow and sources, and emergency power system elements such as engine-generator sets, circuit breakers included in scope of delivery (including breaker position and alarms), switchgear assemblies, and transfer switches (including transfer switch position, source availability, and bypass position if available).
- Communication status of PLCs
- Generators and transfer switches shall, when selected, link to a separate screen showing detailed status and alarm information ("drill down screens")
- Main menu buttons, buttons linking to user guides, and buttons that link to other screens
- ATS summary/configuration screen shall be accessible via menu button
- Common alarm status including number of active alarms, number of unacknowledged alarms, and a flashing warning indicator if there are active alarms
- The current KW value of all main and tie breakers
- Color legend, abbreviation legend, and customer logo

Drill down screens shall include:

- A dynamically updated mimic of the Master Status Panel.
- A mimic of the Master Status Panel, dynamically updated, and representing the current color-coded status of each signal.
- Generator status panels shall mimic the actual switchgear panels including dynamically updated color indications and signal nomenclature.
- Generator control stations shall mimic the actual switchgear control stations with fully functional engine control switch and synchronizing mode switch.
- Metering screens shall include a photographic image icon of the actual meters and dynamically updated parameters that are available from the meter (voltages, currents, power measurements) and configuration parameters (PT connection, PT ratio, CT ratio).
- Synchronizer/Load Share controller screens shall include a photographic image icon of the actual controller and dynamically updated parameters that are available from the controller such as metering status (voltages, currents, power measurements) and synchronization status (frequencies, voltages, synchroscope).

- Transfer Switch drill down screens shall include details of selected transfer switches, if available, including present status and position, source availability, transfer/retransfer controls (password protected), bypass status, pickup/dropout settings, time delay settings, and metering data.

The monitoring and control interface screens shall also include:

- A load management screen which shall dynamically indicate the current load demand status and provide operator controls to change settings (password protected). Each generator shall be represented and include "pick up" and "drop out" information and parameters (user-defined time delays, current timer status, and actual power) to manage loading of all engine-generator sets.
- A bus optimization screen which shall dynamically indicate application status (enabled/disabled), most recent step load added, next available step load information, headroom, and priority load shed controls.
- A generator priority screen for load demand.
- A load priority screen for assigning unique priorities and tag names to each transfer switch and/or electrically operated circuit breaker for distribution loads. Parameters for each load shall include current power status and step add time delay. Transfer switches shall include (when available) engine start signal, load shed signal, and HOA (Hand-Off-Auto) mode.
- An alarm summary screen with a current listing of all active alarms up to 500 entries and option for operator to acknowledge alarms (password protected)
- An alarm history screen with up to 500 entries and a button linking to folder containing archive of 3 months or longer
- A communication status screen with network connections color-coded and dynamically updated
- Historical trending of up to 10 parameters (phase currents; average current; average line-to-line voltage; total apparent, real, and reactive power; frequency; power factor) for 3 months or longer. Buttons shall be provided to zoom in and out as well as recall historical data and fast forward up to the current time. Plots shall display up to 8 curves concurrently.

Security features shall include definition of at least three distinct security levels (monitor, control, manage) and a unique user name and password for each individual. Each individual account shall also be assigned to a security level thereby defining the scope of their access and control. Logging into or out of the system shall be an event entered into the alarm history. Each operator-triggered alarm shall be logged as an alarm history entry with the operator identity included. If an individual is logged in to the system with no activity for 30 minutes, the individual shall be automatically logged out.

On loss of screen communication, the operator must be able to take control at any time; systems that utilize "instant auto" features shall be excluded.

Screens shall be turned off (power standby mode) after 30 minutes of inactivity to protect the LCD monitor; a single touch of the screen shall turn the screen back on.

2.4 Remote Annunciation Panel

[optional; spec writer to remove this section if not required]

[The remote annunciation panel shall consist of a 24-inch or 42-inch color operator interface and audible alarm horn, or a 21.5-inch color operator interface. Connectivity to the main PCS assembly shall be via network communication.]

[Optional: A UPS shall provide standby power for the annunciation panel (customer to supply power for the UPS).]

2.5 Distribution Sections

Distribution sections shall be provided with number and size of distribution circuit breakers as shown on the project drawings.

Provide circuit breaker control switches for all circuit breakers. Control switches shall have built in indicating lights to indicate breaker status (open, closed, tripped). Manually opening the circuit breaker with the breaker control switch shall inhibit automatic operation and shall be annunciated on the one-line screen.

A. One High Feeder Breaker Sections shall be provided as shown the project drawings and shall contain the following components:

1	[*1200A* | *2000A*] square D type VR vacuum circuit breaker with Auxiliary Contacts, MOC and TOC Switches (charge, close and trip voltage as specified in section **2.1 A**)
3	Current transformers for metering and relays, ratio as shown on drawings
1	Circuit Breaker Control Switch with open/closed/tripped LEDs
1	Schneider Electric Easergy P3F30 or equivalent Feeder Protective Relay with overcurrent protection and test blocks
1	Device 86, lockout relay

B. One High Feeder Breaker & Main Bus PT Section

1	[*1200A* | *2000A*] Square D type VR vacuum circuit breaker with Auxiliary Contacts, MOC and TOC Switches (charge, close and trip

voltage as specified in section **2.1 A**)

3 Current transformers for metering and relays, ratio as shown on drawings
1 Circuit Breaker Control Switch with open/closed/tripped LEDs
1 Schneider Electric Easergy P3F30 or equivalent Feeder Protective Relay with overcurrent protection and test blocks
1 Device 86, lockout relay
2 Main Bus Potential Transformers, ratio as required

C. Two High Feeder Breaker Sections shall be provided as shown the project drawings and shall contain the following components:

2 Square D type VR vacuum circuit breakers [*(2) 1200 A | (1) 1200A + (1) 2000A*], each with Auxiliary Contacts, MOC and TOC Switches (charge, close and trip voltage as specified in section **2.1 A**)
6 Current transformers for metering and relays, ratio as shown on drawings
2 Circuit Breaker Control Switches with open/closed/tripped LEDs
2 Schneider Electric Easergy P3F30 or equivalent Feeder Protective Relays with overcurrent protection and test blocks
2 Device 86, lockout relays

PART 3 DESCRIPTION OF OPERATION

The equipment shall conform to the operational specifications described in the document "ASCO PCS 7000 Series Description of Operation". A graphical representation of the sequence of operation shall be provided with the submittal.

PART 4 PCS SIMULATOR

{note: the simulator is optional, spec writer to determine if needed}

To verify operating sequence and facilitate on-site training by developing and evaluating operator expertise, the scope of delivery shall include a PCS Simulator comprising:

4.1 Operator Station

The Operator Station shall be a monitor and control station that contains the actual operator screens from the PCS system.

4.2 Master PLC

The Master PLC shall be a fully-functioning PLC that includes and executes the actual sequences of operation from the PCS system.

4.3 Configuration Station

The Configuration Station shall include application software simulating devices and system components including breakers, synchronizers, switchgear control stations, transfer switches, utility feeds and generators. The Configuration Station shall also provide ways to set up scenarios including device and component failures and system events in order to test operator knowledge, capabilities and responsiveness.

PART 5 ACCESSORIES AND FACTORY WITNESS TEST

5.1 Circuit Breaker Accessories

A. A portable circuit breaker lifting device shall be provided.
B. A circuit breaker test cabinet shall be provided.
C. A circuit breaker racking handle shall be provided.

5.2 Witness Test *[optional]*

An inspection and witness test of the switchgear prior to shipment shall be scheduled in advance with the factory.

5.3 PCS Technology Package

*[**optional**; spec writer to remove this section if not required]*

A. Supply an 150PCS-S technology package (**OPTIONAL: Specify 150PCS-R instead for redundant data storage and control power**) integral to the 7000 Series Power Control System (PCS herein) to provide a single Ethernet TCP/IP communications interface to building monitoring systems, configurable email / text alerts and time synchronization for event logs of connected PCS devices.
B. The technology package shall consist of a gateway device that is able to aggregate and share power control systems and integral power devices, transfer switches, circuit breakers, surge protection devices, power meters and protective relays. Aggregated data shall be shared in industry standard open ethernet-based protocols including Modbus, BACnet, SNMP and OPC.
C. Automatically generate accreditation and regulatory compliance reports to comply with required regulatory emergency power testing standards including NFPA 110, CALEA, NFPA 99, DVL GL, The Joint Commission EC 7.40 and CMS. The report shall include engine-generator, transfer switches and load bank loading.
D. Automated Utility Outage reports shall be self-triggered and automatically generate a power outage report.

E. Increased cybersecurity by (1) encrypting generator and transfer control and monitored signals between PCS and ATS using AES 128-bit encryption, (2) Utilize the IT digital certificate to encrypt all HTTPS data, and (3) support Active Directory (LDAP) for user authentication management, and (4) offering 4-levels of user privileges including administration, supervisor, control and monitoring.

F. Aggregated analog trend, alarm log and sequence of events data shall be downloadable in an Excel file format.

G. The technology package shall be compatible with facility wide EcoStruxure-ASCO Critical Power Management Systems & Power Expert Modules.

H. The gateway device shall automatically synchronize the time clocks of power control system devices including transfer switches, power quality meters, circuit breakers, protective relays, active surge monitors and generators.

I. Alarms and alert notifications shall be user-configurable and instantly sent individually or combined into a single periodic email alert.

J. Provide a central repository to upload and view facility drawings, equipment user manuals, and other reference material.

K. Automated performance reports include energy-usage, alarm, control activity, settings and event log reports. Reports generation can be automated and scheduled once a week or month and emailed to users.

PART 6 INSTALLATION ASSISTANCE

The manufacturer of the generator control switchgear shall provide the services of a factory-employed and factory-trained technician to provide installation assistance.

6.1 It shall be the responsibility of the installing contractor to verify that the following items have been completed per applicable codes and standards, and are ready to perform as specified before the arrival of the factory technician.

A. Inspect for obvious shipping damage.

B. The switchgear is properly installed, anchored and grounded.

C. Shipping splits have been reinstalled with the splits bolted together, interconnect wiring installed, and bus splice plates installed.

D. Terminate all power cables.

E. Install customer control wiring to external equipment including engines, batteries, building management systems, associated motor control, etc.

F. The engine generator set is installed and ready to run.

G. Associated motor controls, plumbing, building utilities are complete and operational.

6.2 It shall be the responsibility of the Field Service Technician to perform the following:

A. Verify contractor connections and control power availability.
B. With the engine generator supplier's technical representative controlling the engines, verify that the switchgear and control equipment are fully operational, and perform per the sequence of operation specified. Test equipment and services as required for the engine generator sets shall be provided by the engine generator set supplier.
C. With the engine generator supplier's technical representative controlling the engines, demonstrate all functions of the control system, both automatic and manual, to the satisfaction of the owner or representative.
D. Provide plant operators with instruction on the plant operating procedures and major component maintenance after acceptance by the owner’s representative.