



SUGGESTED SPECIFICATION

**AUTOMATIC
GENERATOR CONTROL
SYNCHRONIZING SWITCHGEAR**

SYSTEM 2000

**GENERATOR STANDBY SYSTEMS
600V (Maximum)**

Specification No.ES007-SYS2000

ES007 DRAFT 98/01/05

1. SCOPE

Specification writer's notes:

1. This suggested specification is intended for typical standby generator auto synchronizing control systems consisting of the following main characteristics:
 - generator standby operation during utility power fail conditions
 - diesel engine driven generator sets
 - multiple section switchgear with main generator circuit breakers
 - maximum voltage rating of 660Vac, 50/60Hz
 - maximum amperage rating of 5000Aac

For systems of different rating, equipment types or operation modes, contact Thomson Technology Inc. for alternate sample specifications as available.

2. Included in this suggested specification are sections identified as "**Alternates**". These sections provide the specifying engineer many design options which allow for system customizing and possible cost saving opportunities. In general, "**Alternates**" typically provide more cost effective design solutions however the specifying engineer should use discretion based on specific application requirements.

Note:

The following information is provided by Thomson Technology Inc. as a guide only for use by specifying engineers in designing a generator standby synchronizing system. All system designs and installations must be done in accordance with all applicable electrical regulation codes and practices as required. Please contact Thomson Technology Inc. for any additional information.

1.1. AUTOMATIC GENERATOR CONTROL SYNCHRONIZING SWITCHGEAR

- 1.1.1. This Specification covers the supply of a complete operational automatic generator control synchronizing switchgear system to operate standby power engine generator sets. The system shall be designed to control a maximum of ___ engine generator sets, each rated at ___KW, ___Amps, ___Volts, ___Phase, ___Hz, 0.8 power factor. The automatic synchronizing switchgear shall consist of generator main circuit breakers, engine generator control and metering sections; and a master control section for common synchronizing and control equipment.

2. GENERAL REQUIREMENTS

- 3.1.5. Finish: All steel parts shall be cleaned, sealed and painted with one coat rust resistant primer and two coats of ASA #61 grey enamel or polyester powder coat finish inside and out. Interior sub-panels shall be similarly painted gloss white.
- 3.1.6. Dimensions: Overall height, maximum 91 5/8" (2330mm) (including base channels). Individual cubicle width, maximum 36"(915mm). Total structure width shall be ____ inches/(millimeters) (maximum) Overall structure depth shall not exceed ____ inches/(millimeters).
- 3.1.7. Each generator cubicle shall have an upper hinged front door for mounting of instruments, switches, indicators, and to provide access to the low voltage control compartment. This compartment shall be completely isolated from the circuit breaker and bus compartments. Doors shall be secured with matching key lockable three point latch handles.
- 3.1.8. A lower front hinged door shall provide access to the generator circuit breaker compartment. This compartment shall be completely isolated from the bus and low voltage control compartments. Doors shall be secured with two screws.
- 3.1.9. The master control cubicle shall have a full-length front door for mounting of meters, switches, indicators, and shall provide access to the low voltage control compartment. This compartment shall be completely isolated from the circuit breaker and bus compartments. The door shall be secured with matching key lockable three point latch handles.

Specification writer's note: For applications with minimal master control requirements (refer to section 4.3) use "Alternate".

"Alternate"

The master control section shall be located within generator # ____ cubicle. The controls and meters shall be mounted above the generator controls and metering.

- 3.1.10. The rear section shall contain, when required, bussing and provisions for customer incoming and outgoing line and load cables. Access shall be by removable rear covers.

Specification writer's note: For Front Access applications use "Alternate" as required.

"Alternate"

The rear section shall contain bussing and provisions for customer incoming and outgoing line and load cables. The switchboard shall be designed for front access only for installation and servicing. Cover plates shall be provided for all access points to busbars, load lugs and instrument transformer primary control wiring.

3.1.11.Low voltage control and circuit breaker compartments in each cubicle shall be completely isolated from adjacent cubicle(s).

3.1.12.Shipping splits: The switchgear cubicles shall be manufactured with provisions to ship the equipment in separate pieces. The switchgear drawings shall clearly indicate which switchgear sections will be split, including their dimensions. Terminal blocks for all interposing control wiring (between shipping split sections) shall be provided. All bus bar jumper plates and associated hardware shall be provided. Lifting eyes shall be provided for all cubicles.

Specification writer's note: For applications which do not require shipping splits use "Alternate" as required.

"Alternate"

The switchgear shall be shipped in one complete assembly with lifting eyes suitably placed.

3.1.13.Busbars: The bus system shall be tin plated round-edge high conductivity copper and be sized for 100% continuous load rating of the complete system, in accordance with NEMA, CSA and UL guidelines. The short circuit rating of the completed bus assembly shall be not less than the short circuit capacity specified.

Specification writer's note: For Aluminum Bus bar applications use "Alternate" as required.

"Alternate"

The bus system shall be tin plated round-edge aluminum and be sized for 100% continuous load rating of the complete system in accordance with NEMA, CSA , and UL guidelines. The short circuit rating of the completed bus assembly shall be not less than the short circuit capacity specified.

3.1.14. Maximum continuous current rating of the common load bus shall be minimum _____Aac, _____Vac, _____ Phase, _____Hz, _____Wire with full capacity neutral load bus. Connections from generator circuit breakers to the common load bus shall be by bus bars sized for continuous duty at maximum generator full load output current or maximum attainable circuit breaker trip rating, whichever is greater.

Specification writer's note: For 3 wire systems delete requirement for neutral load bus.

3.1.15. Load Bus Extensions: The switchgear common load bus shall be designed for future extension beyond either side of the enclosure. The load bus shall have pre-drilled holes to accept interconnection plates as required. Switchgear drawings shall clearly indicate specific dimensions of all load bus sizes and connection holes. The ampacity of the common load bus shall be sized for the total maximum load current of the system when all future switchgear sections are added.

Specification writer's note: For applications which do not require future bus extensions, delete the above requirement.

3.1.16. Ground Bus: Full length copper ground bus bonded to the frame conforming with NEMA, CSA and UL guidelines.

3.1.17. Cable Connections: Provision shall be made to terminate all incoming and outgoing power cables and grounding conductors. Connections shall be via screw type cable lugs.

Specification writer's note: Alternate or special connection requirements shall be detailed by the specifier.

3.1.18. The switchboard shall be constructed to accommodate top (Alternate: bottom) entry of incoming generator power cables and top (Alternate: bottom) exit of outgoing load cables. Cable type will be _____.

Specification writer's note: Specifiers to provide details of incoming and outgoing power cabling.

3.1.19. Current transformers shall be located appropriately to accommodate power cable routing.

3.1.20. Control Wiring: Control wiring shall be #18-#14 AWG(0.75-2.5mm²) SIS switchboard wire with number coded heat shrink wire markers

at all terminations. All control wiring shall be neatly bundled or contained within wireways.

3.1.21.Cubicle Numbering: Each switchgear cubicle shall be numbered for ease of identification. Cubicle numbering shall be from left to right (1-n). Generator unit numbering shall also be from left to right (i.e. Gen 1, Gen 2,)

3.1.22.All metering and control switches mounted on the switchgear doors shall be located at a height suitable for system operators to easily view and/or change switch position. The maximum height for any control switch shall be 72" (1829mm).

3.1.23.All materials and parts used in the switchgear shall be new, of current manufacture, of best industrial grade, and free from defects and imperfections.

4. FUNCTIONAL REQUIREMENTS

4.1. AUTOMATIC SYSTEM OPERATION

Specification writer's note: The following automatic sequence of operation is typical only and is dependent upon specific options and types of equipment utilized.

4.1.1. Under normal operation with utility power available, all generator sets will be stopped with their main breakers open. Engine generator control switches shall be set for automatic starting and synchronizing operation.

4.1.2. All engines shall automatically start when a remote start contact closes to signal a utility power fail condition. Engine start contacts shall be supplied from utility supply voltage sensing relays as supplied with the system automatic transfer switch(es).

4.1.3. The first generator set to achieve 90% voltage and speed shall automatically close its generator breaker to the load bus. The system shall have provisions to prevent multiple generators from being connected to the emergency bus without being synchronized if they should reach frequency and voltage simultaneously.

4.1.4. Once the first generator set has successfully connected to the load bus, a load permit signal shall be given to the highest priority loads via contact closure to system automatic transfer switches or other distribution breakers, to energize all critical loads.

- 4.1.5. The remaining generator(s) shall automatically synchronize and parallel to the first generator set. The control system shall provide a fail to sync alarm should the remaining generator(s) fail to automatically synchronize to the bus after an adjustable time delay.
- 4.1.6. Once each generator set has successfully connected to the emergency bus, a load permit signal shall be given to the lower priority loads via contact closure. Kilowatt and KVAR load shall be automatically shared amongst all generator sets once they are operating in parallel.
- 4.1.7. Should a generator set fail on load, an automatic load shed circuit shall be activated. The lowest priority loads shall be automatically disconnected from the system to prevent overloading of the remaining generator sets. Loads will be typically disconnected via automatic transfer switches transferring to the neutral position or via tripping open distribution breakers. Upon restoration of the failed generator set, the load shall be re-added to the bus, once the load shed signal has been manually reset.
- 4.1.8. Upon a signal from the transfer switches that utility power has been restored and that the transfer switches have re-transferred the load to the utility supply, the generator circuit breakers shall be opened simultaneously, and the engines shall remain operating at no load for their cooldown periods then shall automatically stop.

4.2. ENGINE GENERATOR CONTROLS

Engine generator controls shall be located in dedicated switchgear control cubicles. The following controls shall be provided for each engine generator set:

Specification writer's note: For applications utilizing engine generator controls which are locally mounted at the generator set, use "Alternate" as required.

"Alternate"

Engine generator controls shall be supplied by the engine generator set manufacture and shall be located on the generator set. The switchgear supplier shall be responsible for ensuring the coordination between all wiring and control interface between the synchronizing switchgear and local unit mounted control panels.

4.2.1. ENGINE GENERATOR CONTROLLER

- 4.2.1.1. The engine generator controller shall be microprocessor based and shall contain the following basic features;

automatic and manual start/stop control modes, monitoring and control of essential engine generator set parameters and automatic shutdown and/or alarm status of specified protection fault circuits. The automatic operation mode shall have provisions for accepting an automatic starting/stopping signal from a remote device. Alarm and shutdown fault circuits provided shall meet CSA 282 building code standards and NFPA 110 level 1 regulatory standards. The following alarm and shutdown fault circuits shall be provided (but not be limited to):

Low Oil Pressure	Shutdown
High engine Temperature	Shutdown
Battery Charger Input Fail ¹	Alarm
Low Fuel Level	Alarm
Overcrank	Shutdown
Overspeed	Shutdown
Loss of speed	Shutdown
Low battery voltage	Alarm
High battery voltage	Alarm
Weak battery	Alarm
Low oil pressure	Alarm

¹For CSA 282 applications, substitute "Low Coolant Level Shutdown" fault.

High engine temperature	Alarm
Low engine temperature	Alarm
Reverse power	Shutdown
Undervoltage	Shutdown
Overvoltage	Shutdown
Underfrequency	Shutdown
Overfrequency	Shutdown
Breaker Tripped	Shutdown
Fail to Sync	Alarm
Emergency Stop	Shutdown
Switch not in auto	Alarm
Spare	Shutdown
Spare	Shutdown

4.2.1.2. Individual contacts shall be provided for each alarm/shutdown fault circuit. Contacts shall be user configurable for open or close upon initiation of the fault. Fault contacts shall be factory configured for "close on fail". Contacts shall be rated 0.5Aac 120Vac, 1.0Adc 30Vdc resistive, maximum.

4.2.1.3. The engine generator controller software program shall

include a 3 level security password system for access to all programming functions. Specific password levels shall be provided for "read only", "read/write" and "master". All programming set points for voltage, frequency and time delays shall be software programmable from the front panel mounted keypad, and all parameters shall be displayed in alpha numeric format.

4.2.1.4. The engine generator controller shall include an operator interface liquid crystal display (LCD) screen which is door mounted. The following parameters shall be displayable:

- Generator AC digital metering (3 phase V, A, F)
- Timer countdown display
- Operating status /switch position
- Alarm/Shutdown fault display
- Engine Hourmeter
- Engine Oil Pressure (PSI or KPA)
- Engine Coolant Temperature (Degrees C or F)
- Engine RPM (Tachometer)
- Battery Voltage

4.2.1.5. Generator AC digital metering shall be integral to the engine generator controller and shall have an accuracy of +/-1%. The digital metering shall be fully programmable from the front panel display. Programming for voltage and current PT/CT ratios and software calibration shall be provided for all input ranges. The following generator output AC parameters shall be monitored and displayed:

- AC Voltage -3 phase (line to line and average)
- AC Current -3 phase (individual phases and average)
- AC frequency (resolution to 0.1 Hz)

4.2.1.6. Digital display of Engine parameters shall be provided by the engine generator controller. Engine oil pressure and engine temperature shall be monitored and shall be displayed in metric or imperial engineering units. Oil pressure and temperature senders shall be supplied for mounting on the engine generator set.

4.2.1.7. Long life LED type pilot lights shall be provided on the engine generator controller to indicate general operating conditions as follows:

- Common Alarm (Flashing-Amber)
- Common Shutdown (Flashing-Red)
- System Ready (Green)

- Speed Signal Present (Green)

4.2.1.8. The engine generator controller shall contain the following protective functions utilizing analog input signals:

4.2.1.8.1. (27/59) Three phase under/over voltage protection shall be provided for the engine generator. The under/over voltage protection function shall be programmable as follows:

- under voltage pick-up 70-100% of nominal, factory set at 90%.
- under voltage dropout 70-100% of nominal, factory set at 80%.
- under voltage delay 0 - 10 seconds, factory set at 3 seconds.
- over voltage pick-up 100-130% of nominal, factory set at 110%.
- over voltage dropout 100-130% of nominal, factory set at 108%.
- over voltage delay 0 - 10 seconds, factory set at 2 seconds.

4.2.1.8.2. (81 O/U) Over/under frequency protection shall be provided for the engine generator. The over/under frequency protection function shall be programmable as follows:

- under frequency setpoint 70-100% of nominal, factory set at 90%.
- under frequency delay 0 - 10 seconds, factory set at 5 seconds.
- over frequency setpoint 100-130% of nominal, factory set at 110%.
- over frequency delay 0 - 10 seconds, factory set at 2 seconds.

4.2.1.8.3. (51) Three phase over current alarm protection shall be provided for the engine generator. The over current protection function shall be programmable as follows:

- over current setpoint 100-150% of nominal, factory set at 110%.
- over current delay 0 - 10 seconds, factory set at 5 seconds.

4.2.1.8.4. Low/High battery voltage protection shall be

provided for the control system. The protection function shall be programmable as follows:

- Low battery voltage set point 50-100% of nominal, factory set at 12.8Vdc (12Vdc systems) or 25.6Vdc (24Vdc systems).
- Low battery voltage delay 0-300 seconds, factory set at 120 seconds.
- High battery voltage set point 100-130% of nominal, factory set at 15.2Vdc (12Vdc systems); 30.4Vdc (24Vdc systems).
- High battery voltage delay 0-300 seconds, factory set at 10 seconds.

4.2.1.8.5. Weak battery sensing shall be provided to detect a low capacity engine starting battery system. This function shall be programmable as follows:

- Weak battery set point 50-100% of nominal, factory set at 8.0Vdc (12Vdc systems) 18.0Vdc (24Vdc systems).
- Weak battery transient delay 0-300 seconds, factory set at 3 seconds.

4.2.1.9. Diagnostic LED's shall be provided on the rear of engine generator control module to allow simple visual indication of operating status or mode. Individual LED's shall be provided for the following functions:

- Watchdog (CPU running)
- Remote start signal activated
- Crank output energized
- Run output energized
- Common fail alarm activated

4.2.1.10. The engine generator controller shall have an audible alarm feature to signal shutdown and alarm conditions.

4.2.1.11. The engine generator controller shall include the following operator control functions:

- Operation Mode (Auto/Off/Manual/LoadTest)
- Programming (Enter/Exit/Value Increment/Decrement)
- Lamp Test
- Fault Reset
- Alarm Horn Silence
- Emergency Stop

4.2.1.12. LOAD TEST control feature shall be provided by the

engine generator controller to remotely signal an automatic transfer switch for load testing purposes. The load test function shall be automatically bypassed should the engine generator set fail.

4.2.1.13. The engine generator controller shall provide cycle cranking control logic with programmable number of crank attempts (Adj. 1-99, factory set at 3 attempts) crank period time (Adj 0-99 sec, factory set at 15 sec) and rest period time (Adj 0-99 sec, factory set at 10 sec).

4.2.1.14. Engine control logic shall include the following sensing and protection circuits:

- Loss of speed signal sensing shutdown
- Starter re-engage sensing control (to re-engage starter motor upon initial failure to engage).
- Run output fail safe selection (to prevent engine starting if speed signal is not present).

4.2.1.15. Programmable output function contacts shall be provided by the engine generator controller. Contacts shall be type Form C, rated 10A, 240Vac, 30Vdc resistive, maximum.

The following programmable output control functions shall be available for specific system applications:

- energize to stop
- cycle lube
- system ready
- air flap
- preheat
- ATS test
- switch not in auto
- overcurrent
- engine run
- oil bypass delay expired
- common fail
- common alarm
- common shutdown

4.2.1.16. A time delay on engine start shall be provided to delay the engine start signal. The time delay shall be programmable 0 - 60 seconds, factory set at 2 seconds

4.2.1.17. A time delay for engine cooldown shall be provided which delays engine stopping. The time delay shall be programmable 0 - 30 minutes, factory set at 5 minutes.

4.2.1.18. The engine generator controller shall provide a lamp test function to test all LED lights and the LCD display.

4.2.1.19. The engine generator controller shall have the ability for remote communication of all status points (alarms,

shutdowns, switch position) and all measured analog values. Remote control and configuration of all switch functions and setups shall be supported. Communication shall be via _____.

Specification writer's note: If remote communication will be utilized, include full details as appropriate. Note that the provision of remote communication capability within the controller, even if not initially used, will allow for future connection to remote equipment.

4.2.2. AC METERING

4.2.2.1. Analog metering shall be provided to monitor the output of each engine generator. Metering shall be 4 ½", 250 degree movement with 1% accuracy and scaled to suit the specific application. The following meter types shall be provided:

- AC Voltmeter c/w phase selector switch (line to line)
- AC Ammeter c/w phase selector switch
- Frequency Meter
- Kilowatt Meter
- Power Factor Meter

Specification writer's note: For lower accuracy metering applications, specify 3½", 100 degree meters with 2% accuracy.

4.2.2.2. Potential and current metering transformers shall be provided of adequate burden and thermal ratings to meet the specified metering accuracy. Potential transformers shall be provided with primary side fusing of adequate rating.

4.2.3. GENERATOR PROTECTIVE DEVICES

4.2.3.1. The following industrial grade protective devices shall be provided (as minimum) for each engine generator:

- Reverse Power Relay (Device 32)-three phase
- Sync check Relay (Device 25)
- Under/Overvoltage relay ¹ (Device 27/59)-3 phase
- Under/Overfrequency relay ¹ (Device 81 O/U)
- Timed/Inst. Overcurrent relay ² (Device 50/51)

¹ Protective functions may be integral to the engine generator controller.

² 50/51 protective device may be integral to generator main breaker.

Specification writer's note: If Ground Fault protection is required, the type of ground fault relay and connection is dependent upon system neutral grounding method and may require coordination with other system equipment.

Specification writer's note: The specifying engineer may require utility grade protective relays or multifunction relays for certain applications and should specify accordingly.

Specification writer's note: Optional generator protective relaying functions may be required to suit certain applications. Select the following optional protection functions as required:

- Loss of Excitation Relay (Device 40)
- Differential Overcurrent Relay (Device 87)

4.2.4. SYNCHRONIZING/PARALLELING CONTROLS

4.2.4.1. Automatic Synchronizer: A speed matching synchronizer compatible with the engine's electronic governor shall be provided. It shall monitor the voltage, frequency and phase angle of the incoming generator to the load bus, and provide automatic breaker closure signal when in synchronism. The automatic synchronizer shall have adjustable gain and stability for optimal synchronizing speed. One automatic synchronizer shall be provided per each engine generator.

Specification writer's note: One common automatic synchronizer may be utilized to provide a sequential synchronizing logic system. Cost savings may be achieved, however response time of synchronizing generators and reduction of system redundancy should be considered.

4.2.4.2. Synchronizing Mode Switch: A two position selector switch shall be provided to select automatic or manual mode of synchronizing. In the automatic mode the automatic synchronizer(s) shall be activated. In the manual position the automatic synchronizer(s) shall be disabled and the manual sync controls are enabled.

4.2.4.3. KW Load Sharing Module: An isochronous load sharing module which is compatible with the engine's electronic governor shall be provided for each engine generator. It

shall provide automatic KW load sharing between loaded engine generators when operating in parallel.

Specification writer's note: The electronic governor is generally included in the generator set specification, however, it may be mounted in the switchgear. Some models of electronic governors are equipped with integral KW load sharing feature.

4.2.4.4. Cross Current Compensation Reactive Load Sharing: The generators' automatic voltage regulators shall be capable of reactive load sharing utilizing a non-droop type cross current compensation connection amongst generators. Systems using reactive droop compensation shall not be acceptable. Note: Automatic voltage regulators and associated current transformer wiring may be located directly inside the generator set terminal connection box.

Specification writer's note: The automatic voltage regulator is generally included in the generator set specification. It may be physically located in the generator junction box (c/w cross current CT) or in the switchboard. Some type of voltage regulators are equipped with integral cross current compensation.

4.2.4.5. Reactive Load Sharing Bypass: A method to prevent undesirable voltage droop when only one generator set is on load shall be provided.

4.2.4.6. Voltage Adjust Rheostat: A door mounted ten turn voltage adjust rheostat shall be provided to manually adjust generator output voltage level (plus/minus 5%) for manual synchronizing purposes. The rheostat shall be provided with a locking type vernier adjust knob. The rheostat's ohmic value shall be compatible with the automatic voltage regulator utilized.

4.2.4.7. Speed Adjust Rheostat: A door mounted ten turn speed adjust rheostat shall be provided to manually adjust engine speed (plus/minus 5%) for manual synchronizing purposes. The rheostat shall be provided with a locking type vernier adjust knob. The rheostat's ohmic value shall be compatible with the electronic engine governor utilized.

4.2.5. GENERATOR OUTPUT CIRCUIT BREAKERS AND CONTROL

Specification writer's note: For desired main generator circuit

breaker type, select one of the appropriate “Alternate” breaker types as follows:

“Alternate 1”- stored energy air circuit breaker, drawout type

“Alternate 2”- stored energy air circuit breaker, fix mounted type

“Alternate 3”- molded case breaker with electrical operator (not recommended for consideration except on smaller generator sets).

“Alternate 1” Generator Breaker: A main generator power circuit breaker shall be provided for each generator with the following ratings and features: _____amp frame, _____amp trip, 3 pole, stored energy type, electrically operated, drawout, with electronic overcurrent trip relay. The overcurrent relay shall have fully adjustable LSI trip functions with trip target indicator. Breaker accessories shall include at least two normally open / two normally closed 10A/240Vac auxiliary contacts, 120Vac close coil, 120Vac undervoltage release coil and 24Vdc shunt trip. The breaker shall have a manual spring charging mechanism and “test” operating position. The breaker shall have a short circuit interrupting, rating which is equal to or greater than the switchboard’s interrupting rating as specified. The breaker shall have cell switches to operate when the breaker is withdrawn, as required to integrate with the control logic.

“Alternate 2” Generator Breaker: A main generator power circuit breaker shall be provided for each generator with the following ratings and features: _____amp frame, _____amp trip, 3 pole, stored energy type, electrically operated, fixed mounted, with electronic overcurrent trip relay. The overcurrent relay shall have fully adjustable LSI trip functions with trip target indicator. Breaker accessories shall include at least two normally open/ two normally closed 10A/240Vac auxiliary contacts, 120Vac close coil, 120Vac undervoltage release coil and 24Vdc shunt trip. The breaker shall have a manual spring charging mechanism. The breaker shall have a short circuit interrupting rating which is equal to or greater than the switchboard’s interrupting rating as specified.

“Alternate 3” Generator Breaker: A main generator circuit breaker shall be provided for each generator with the following ratings and features: _____amp frame, _____amp trip, 3 pole, molded case, motor operated with spring charged closing mechanism for high speed closing as required for synchronizing, fixed mounted, with electronic overcurrent trip relay. The overcurrent trip relay shall have fully adjustable LSI trip functions with trip target indicator. Breaker accessories shall include at least two normally open / two normally closed 10A/240Vac auxiliary contacts, 120Vac motor operator and 120Vac undervoltage release coil. The breaker shall

have provisions for manual operation. The breaker shall have a short circuit interrupting rating which is equal to or greater than the switchboards maximum interrupting rating as specified.

Specification writer's note: If Ground fault protection is required, it may be added to the specific breaker trip unit however the type of ground fault relay, connection and zone of protection is dependent upon system neutral grounding method and may require coordination with other system equipment.

4.2.5.1. The breaker overcurrent trip relay shall be an electronic type utilizing current transformers integral with the circuit breaker. Trip functions shall be LSI (Long time, Short time & Instantaneous). The trip functions shall be adjustable to provide protection for the alternator under all conditions of overcurrent, and shall be capable of allowing continuous full load operation.

Specification writer's note: The "long time" overcurrent trip function should be calibrated for generator rated full load amps. If the generator set (alternator plus engine) is rated to carry 110%, it is generally not possible to guarantee protection of the alternator if the long time trip setting is calibrated to allow operation at 110% or rated KVA continuously (this would require an oversized alternator). It is usually adequate to set the long time trip to match the 100% amp rating, and rely upon the inherent time delay of the trip function to allow for short term overloads.

4.2.5.2. Breaker Mode Switch: A three position Auto/Off/Manual breaker mode switch shall be provided. In the Manual mode, the breaker may only be closed through the permissive logic of a sync check relay or dead bus relay and use of the trip/close switch. The Automatic mode shall provide automatic breaker closure via synchronizing control logic. In the OFF position the breaker shall not close, however the tripping functions shall be operative.

4.2.5.3. Breaker Trip/Close Switch: A 3 position spring return to center trip / close switch shall be provided. The breaker may be manually closed provided the breaker mode is selected for manual and the permissive closing logic is satisfied. The breaker may be tripped open at any time.

4.2.5.4. Breaker Pilot Lights: Breaker position indication pilot lights shall be provided for each generator breaker. Pilot lights shall be long life LED type (green for breaker open, red for

breaker closed).

4.2.6. REMOTE ALARM/STATUS CONTACTS

The following alarm and status contacts shall be provided for remote equipment use. All contacts shall be type Form C, rated 10A @ 120/240Vac or 30Vdc resistive maximum, and shall be wired to suitably sized terminal blocks for customer use:

- Engine Running Alarm Quantity 2
- Engine Generator Common Fail Alarm Quantity 2
- Generator Breaker Position (open/closed) Quantity 2

4.3. MASTER CONTROL

The master control section shall contain all common control equipment for the system including manual synchronizing controls, load shedding/ permit circuitry and dead bus closing circuitry.

4.3.1. Synchroscope: A common 4.5” synchroscope shall be provided for the system to monitor the phase relationship between the incoming generator and load bus.

4.3.2. Manual Synchronizing Selector: A manual synchronizing selector switch shall be provided for the system. The switch shall include positions for “off” and a position for each generator. When the selector switch is in the off position the synchroscope is de-energized. When a specific generator position is selected, the synchroscope shall be connected to the voltage of the incoming generator and to the load bus.

4.3.3. Common System Control Logic: Common system control logic shall be provided to perform the following:

- Dead Bus Auto Breaker closure sequencing logic
- Engine Starting/Stopping signals
- Load Dumping/Load Permit control logic

4.3.4. DC Control power for all common control circuits shall be provided from all engine starting battery supplies through adequately sized feedback/isolating diode networks. All control circuits shall be designed to correctly operate during typical low DC voltage dip conditions when engine starting occurs.

Specification writer’s note: The specifying engineer shall select the following optional control features as required for the application:

- 4.3.5. Engine Generator Starting/Stopping on Load Demand: The control system shall be provided with necessary equipment and control logic to automatically start and stop the engine generator sets based upon load demand of the system or operator manual selection.

Specification writer's note: The specifying engineer must detail the specific logic sequence required.

- 4.3.6. Priority Load sequencing of Automatic Transfer Switch or Load Breakers: The control system shall be provided with necessary equipment and control logic to automatically shed and add loads based upon system load demand as required.

Specification writer's note: The specifying engineer must detail the specific loading sequences and number of steps required for the specific application. If automatic transfer switches are utilized for load sequencing, they may require modification to incorporate remote control for load shed and load permit operation (only transfer switches which can achieve a "neutral" position may be used).

- 4.3.7. Bus Underfrequency Load Shedding: The control system shall provide a load bus frequency sensor and two latching output contacts to signal a bus underfrequency load shed condition. Contacts are provided for customer connection to remote load shedding feeder breakers as required. Contacts shall be latching, form C type and rated for 10A @ 120/240Vac, 30Vdc resistive duty. Control circuitry shall include an alarm indication light with reset pushbutton. A control switch shall be provided to override the load shedding operation if required.

- 4.3.8. Load Shedding upon Generator Failure: The control system shall provide a load shed signal which is activated upon failure of any generator on load. Contacts shall be provided for customer connection to remote load shedding feeder breakers as required. Contacts shall be latching, form C type and rated for 10A @ 120/240Vac, 30Vdc resistive duty. Control circuitry shall include an alarm indication light with reset pushbutton. A control switch shall be provided to override the load shedding operation if required.

Specification writer's note: For applications requiring additional more complex control logic, add "Alternate" as required.

"Alternate" - A programmable logic controller (PLC) shall be provided to perform all common automatic system logic. The

control system shall provide manual backup control logic to manually operate any automatic function. Failure of PLC shall not prevent any engine generator from being manually started and synchronized to the load bus. The PLC shall be provided with necessary input/output/power supply cards to perform all logic. Input and output cards shall include approximately 20% spare circuits, each wired to terminal blocks.

Specification writer's note: For applications requiring integral automatic transfer switches or other distribution equipment, contact Thomson Technology Inc. for additional sample specifications as available.

Acceptable system will be a **Thomson Technology Inc. System 2000** series automatic generator control synchronizing switchgear system.