Model: C2000 N6C
Frequency: 60 Hz
Fuel Type: Low BTU
Emissions Performance NOx: 0.5 g/hp-h
LT Water Inlet Temperature: 50°C (122°F)
HT Water Outlet Temp: 92°C (198°F)

Generator set data sheet
2000 kW continuous

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Power Generation

Measured Sound Performance Data Sheet:	MSP - 1039
Prototype Test Summary Data:	PTS - 269
Remote Radiator Cooling Outline:	0500-5093

Fuel Consumption (ISO3046/1)	See Note	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Fuel Consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	5398 (18.44)	4918 (16.8)	4216 (14.4)	3083 (10.53)
Mechanical Efficiency ISO3046/1, percent	2,4,7	39.1%	38.6%	37.6%	34.7%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	37.1%	36.6%	35.6%	32.4%

Engine	
Engine Manufacturer	Cummins
Engine Model	QSV91G
Configuration	V18
Displacement, L (cu.in)	91.6 (5591)
Aspiration	Turbocharged (1)
Gross Engine Power Output, kWm (hp)	2108 (2826)
BMEP, bar (psi)	18.5 (268)
Bore, mm (in)	180 (7.09)
Stroke, mm (in)	200 (7.87)
Rated Speed, rpm	1514
Piston Speed, m/s (ft/min)	10 (1968
Compression Ratio	12.5
Lube Oil Capacity, L (qt)	550 (581)
Overspeed Limit, rpm	1800
Regenerative Power, kW	N/A
Full Load Lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.4 (0.3)
Fuel	
Gas supply pressure to engine inlet, bar (psi)	.15-.20 (2.2-2.9)
Minimum Methane Index	76
Starting System(s)	
Electric starter voltage, volts	24
Minimum battery capacity @ 40 deg.C (104 deg.F), AH	780
Air Starter Pressure, barg (psig)	10.3 (150)
Air Starter Flow Nm^3/s (scfm)	0.37 (780)
Genset Dimensions (see note 1)	
Genset Length, m (ft)	7.12 (23.4)
Genset Width, m (ft)	2.16 (7.1)
Genset Height, m (ft)	2.78 (9.1)
Genset Weight (wet), kg (lbs)	20705 (45,644)

	See Notes	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Energy Data					
Continuous Shaft Power, kWm (bhp)	2,10	2108 (2826)	1900 (2546)	1586 (2126)	1071 (1436)
Continuous Generator Electrical Output kWe	6,10	2000	1800	1500	1000
Heat Dissipated in Lube Oil Cooler, kW (MMBTU/h)	5	271 (0.92)	252 (0.86)	237 (0.81)	204 (0.70)
Heat Dissipated in Block, kW (MMBTU/h)	5	595 (2.03)	519 (1.77)	479 (1.63)	425 (1.45)
Total Heat Rejected in LT Circuit, kW (MMBTU/h)	5	175 (0.60)	161 (0.55)	134 (0.46)	104 (0.35)
Total Heat Rejected in HT Circuit, kW (MMBTU/h)	5	1263 (4.31)	1101 (3.76)	939 (3.20)	704 (2.40)
Unburnt, kW (MMBTU/h)	13	149 (0.51)	132 (0.45)	112 (0.38)	76 (0.26)
Heat Radiated to Ambient, kW (MMBTU/h)	13	389 (1.33)	356 (1.21)	305 (1.04)	231 (0.79)
Available Exhaust heat to 105C, kW (MMBTU/h)	5	1505 (5.13)	1449 (4.94)	1273 (4.34)	1011 (3.45)
Intake Air Flow					
Intake Air Flow Mass, kg/s (lb/hr)	4	3.39 (26848)	3.02 (23909)	2.54 (20145)	1.75 (13894)
Intake Air Flow Volume, m3/s @ 0°C (scfm)	4	2.62 (5854)	2.33 (5213)	1.97 (4393)	1.36 (3030)
Maximum Air Cleaner Restriction, mmHG (in H_2O)		22.07 (11.8)	22.07 (11.8)	22.07 (11.8)	22
Exhaust Air Flow					
Exhaust Gas Flow Mass, kg/s (lb/hr)	4	3.51 (27771)	3.12 (24742)	2.63 (20859)	1.82 (14407)
Exhaust Gas Flow Volume, m3/s (cfm)	4	7.18 (15212)	6.48 (13727)	5.60 (11856)	4.08 (8638)
Exhaust Temperature After Turbine, °C (°F)	2	451 (843)	460 (860)	478 (892)	519 (966)
Max Exhaust System Back Pressure, mmHG (in H_2O)	6,14	37.3 (20.0)	37.3 (20.0)	37.3 (20.0)	37.3 (20.0)
Min Exhaust System Back Pressure, mmHG (in H_2O)	6,14	18.7 (10.0)			
HT Cooling Circuit					
HT Circuit Engine Coolant Volume, l (gal)		424 (112)	424 (112)	424 (112)	424 (112)
HT Coolant Flow @ Max Ext Restriction, m^3/h (gal/min)		70 (308)	70 (308)	70 (308)	70 (308)
Maximum HT Engine Coolant Inlet Temp, °C (°F)	8	75 (167)	75 (167)	75 (167)	75 (167)
HT Coolant Outlet Temp, °C (°F)	8	92 (198)	92 (198)	92 (198)	92 (198)
Max Pressure Drop in External HT Circuit, bar (psig)		1.5 (22)	1.5 (22)	1.5 (22)	1.5 (22)
HT Circuit Maximum Pressure, bar (psig)		6.0 (87)	6.0 (87)	6.0 (87)	6.0 (87)
Minimum Static Head, bar (psig)		0.5 (7)	0.5 (7)	0.5 (7)	0.5 (7)
LT Cooling Circuit					
LT Circuit Engine Coolant Volume, l (gal)		295 (78)	295 (78)	295 (78)	295 (78)
LT Coolant Flow @ Max Ext Restriction, m^3/h (gal/min)		50.00 (220)	50.00 (220)	50.00 (220)	50.00 (220)
Maximum LT Engine Coolant Inlet Temp, °C (°F)	9	50 (122)	50 (122)	50 (122)	50 (122)
LT Coolant Outlet Temp, ɵC (°F) Reference Only	9	52.4 (126)	52.2 (126)	51.9 (125)	51.5 (125)
Max Pressure Drop in External LT Circuit, bar (psig)		1.5 (22)	1.5 (22)	1.5 (22)	1.5 (22)
LT Circuit Maximum Pressure, bar (psig)		6.0 (87)	6.0 (87)	6.0 (87)	6.0 (87)
Minimum Static Head, bar (psig)		0.5 (7)	0.5 (7)	0.5 (7)	0.5 (7)
Emissions					
NO_x Emissions wet, ppm	5	77	77	77	74
NO_x Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	5	243 (0.50)	242 (0.50)	239 (0.50)	225 (0.50)
THC Emissions wet, ppm	13	2000	2000	2000	2000
THC Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	2857 (6.23)	2857 (6.23)	2857 (6.23)	2857 (6.23)
CH_4 Emissions wet, ppm	13	1825	1827	1828	1825
CH_4 Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	2029 (4.46)	2023 (4.45)	2004 (4.49)	1948 (4.65)
NMHC Emissions wet, ppm	13	175	173	172	175
NMHC Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	109 (0.23)	108 (0.23)	108 (0.23)	109 (0.23)
CO Emissions (dry), ppm	13	580	572	558	515
CO Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	1002 (2.20)	984 (2.17)	951 (2.13)	850 (2.03)
O2 Emissions (dry), percent	13	7.3	7.3	7.3	7.3
Particulates PM10, g/hp-h	13	<0.03	<0.03	<0.03	<0.03

 Preliminary - Specifications May Change Without Notice

Genset De-rating

Altitude and Temperature Derate Multiplication Factor

Barometer		Altitude		Table A *								
In Hg	mbar	Feet	Meters	Derate Multiplier with Grid Parallel Operation								
20.7	701	9843	3000									
21.4	723	9022	2750									
22.1	747	8202	2500	0.75	0.75							
22.8	771	7382	2250	0.80	0.80							
23.5	795	6562	2000	0.85	0.85	0.75						
24.3	820	5741	1750	0.90	0.90	0.80						
25.0	846	4921	1500	0.95	0.95	0.85	0.75					
25.8	872	4101	1250	1.00	1.00	0.90	0.80					
26.6	899	3281	1000	1.00	1.00	0.95	0.85	0.75				
27.4	926	2461	750	1.00	1.00	1.00	0.90	0.80				
28.3	954	1640	500	1.00	1.00	1.00	0.95	0.85				
29.1	983	820	250	1.00	1.00	1.00	1.00	0.90				
29.5	995	492	150	1.00	1.00	1.00	1.00	0.95	0.75			
30.0	1012	0	0	1.00	1.00	1.00	1.00	1.00	0.80			
			℃	20	25	30	35	40	45	50	55	60
			℉	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

* Based on SAE standard ambient pressure vs. altitude. Assumes LT return temperature is 10C above air filter inlet.

Temperature & Altitude Derate

1. Determine derate multiplier vs. temperature and altitude in Table A or B depending upon your operating condition.
2. Assumes the LT return temperature is 10 deg C above the air filter inlet with a maximum LT temperature of 50 deg C.
3. If the LT temperature exceeds 50 deg C, consult factory for recommendations.
4. Altitude is based upon SAE standard ambient pressure vs. altitude. For low barometric conditions add 150m (500 ft) to site altitude.

Barometer		Altitude		Table B *								
In Hg	mbar	Feet	Meters	Derate Multiplier Off Grid (Island or Load Share)								
20.7	701	9843	3000									
21.4	723	9022	2750									
22.1	747	8202	2500	0.75	0.75							
22.8	771	7382	2250	0.80	0.80							
23.5	795	6562	2000	0.85	0.85	0.75						
24.3	820	5741	1750	0.90	0.90	0.80						
25.0	846	4921	1500	0.95	0.95	0.85	0.75					
25.8	872	4101	1250	1.00	1.00	0.90	0.80					
26.6	899	3281	1000	1.00	1.00	0.95	0.85	0.75				
27.4	926	2461	750	1.00	1.00	1.00	0.90	0.80				
28.3	954	1640	500	1.00	1.00	1.00	0.95	0.85				
29.1	983	820	250	1.00	1.00	1.00	1.00	0.90				
29.5	995	492	150	1.00	1.00	1.00	1.00	0.95	0.75			
30.0	1012	0	0	1.00	1.00	1.00	1.00	1.00	0.80			
			℃	20	25	30	35	40	45	50	55	60
			℉	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

* Based on SAE standard ambient pressure vs. altitude. Assumes LT return temperature is 10C above air filter inlet.

Methane Number Capability

Load (Percent of Rated)			
100%	90%	75%	50%
76	n/A	n/a	n/a

Heat Rejection Factor (altitude and ambient) for HT and LT Circuits

Barometer		Altitude		Table C								
In Hg	mbar	Feet	Meters	Multiplier for HT & LT Heat Rejection vs Alt & Temp.								
20.7	701	9843	3000	1.11	1.13	1.14	1.15	1.17	1.18	1.19	1.20	1.22
21.4	723	9022	2750	1.10	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.21
22.1	747	8202	2500	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.18	1.20
22.8	771	7382	2250	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18
23.5	795	6562	2000	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.17
24.3	820	5741	1750	1.06	1.07	1.08	1.10	1.11	1.12	1.14	1.15	1.16
25.0	846	4921	1500	1.05	1.06	1.07	1.09	1.10	1.11	1.12	1.14	1.15
25.8	872	4101	1250	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14
26.6	899	3281	1000	1.02	1.04	1.05	1.06	1.08	1.09	1.10	1.12	1.13
27.4	926	2461	750	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.12
28.3	954	1640	500	1.00	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.11
29.1	983	820	250	0.99	1.00	1.02	1.03	1.04	1.06	1.07	1.08	1.10
29.5	995	492	150	0.99	1.00	1.01	1.03	1.04	1.05	1.06	1.08	1.09
30.0	1012	0	0	0.98	0.99	1.01	1.02	1.03	1.05	1.06	1.07	1.08
			℃	20	25	30	35	40	45	50	55	60
			℉	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

LT & HT Circuit Heat Rejection Calculation

1. Determine derate multiplier vs. temperature derate per above.
2. Using the multiplier from #1 above as the percent load factor determine the Heat rejection from the previous page.
3. From Table C find the HT and LT circuit multiplier.
4. Multiply the result of step 2 by the result of step 3 to obtain the heat rejection at your altitude and temperature.

Alternator Data

Voltage Range	Connection Configuration	Temp Rise Degrees C	Duty[11] Cycle	Single Phase Factor	Maximum Surge kVA[12]	Alternator Data Sheet	Feature Code
380	Wye, 3 Phase	105	C	N/A	7960	515	B597-2
416-480	Wye, 3 Phase	80	C	N/A	9700	517	B587-2
416-480	Wye, 3 Phase	105	C	N/A	8400	516	B654-2
416-480	Wye, 3 Phase	125	C	N/A	7200	515	B627-2
480	Wye, 3 Phase	80	C	N/A	8400	516	B653-2
480	Wye, 3 Phase	105	C	N/A	7200	515	B583-2
600	Wye, 3 Phase	80	C	N/A	8250	516	B589-2
600	Wye, 3 Phase	105	C	N/A	7200	515	B582-2
4160	Wye, 3 Phase	80	C	N/A	6300	518	B590-2
12470-13800	Wye, 3 Phase	80	C	N/A	8000	523	B591-2
12470-13800	Wye, 3 Phase	105	C	N/A	6800	522	B484-2
13200-13800	Wye, 3 Phase	105	C	N/A	5000	521	B657-2
13800	Wye, 3 Phase	80	C	N/A	6800	522	B565-2

Continuous Rating Definition

Applicable for supplying power continuously to a constant load up to the full output rating for unlimited hours. No sustained overload capability is available for this rating. Consult authorized distributor for rating. (Equivalent to Continuous Power in accordance with ISO8528, ISO3046, AS2789, DIN6271, and BS5514). This rating is not applicable to all generator set models.

Notes

1) Weights and set dimesions represent a generator set with its standard features only. See outline drawing for other configurations.
2) At ISO3046 reference conditions, altitude 1013 mbar (30in Hg), air inlet temperature 25°C (77°F)
3) Nominal performance ± 2 1/2%.
4) According to ISO 3046/I with fuel consumption tolerance of +5% / -0%
5) Production variation/tolerance ±20%.
6) At electrical output of 1.0 Power Factor.
7) Based on gas with LHV of 16Mj/Nm3 (400BTU/SCF)
8) Outlet temperature controlled by thermostat. Inlet temperature for reference only.
9) Inlet temperature controlled by thermostat, outlet temperature for reference only.
10) With engine driven coolant pump.
11) Standby (S), Prime (P), Continuous (C)
12) Maximum rated starting kVA that results in minimum of 90% of rated sustained voltage during starting.
13) Tolerance +/- 15%
14) Exhaust system back pressure is a rated load and will decrease at lower loads.

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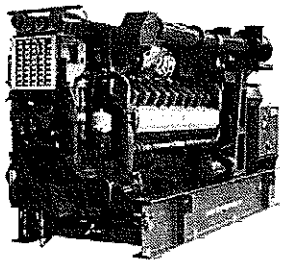
Power Generation

Natural gas generator set QSV91 series engine

OPTION E



> Specification sheet
1250 kW - 2000 kW

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Power Generation

Description

This Cummins Power Generation gas generator set is a fully integrated power generation system utilizing state of the art technology that results in optimum performance and efficient use of fuel for continuous duty, CHP, peaking and low BTU applications.

This generator set is designed in facilities certified to ISO 9001 and manufactured in facilities certified to ISO 9001 or ISO 9002.

The Prototype Test Support (PTS) program verifies the performance integrity of the generator set design.

Features

Exhaust emissions – Lean burn technology provides exhaust emissions levels as low as 250 mg/Nm^3 (0.5 g/hp-hr) NO_x.

Cummins® heavy-duty engine – Rugged 4-cycle lean burn gas combustion engine utilizing full authority electronic engine management and monitoring.

Permanent magnet generator (PMG) – Offers enhanced motor starting and fault clearing short circuit capability.

Alternator – Several alternator sizes offer selectable voltage and temperature rise with low reactance 2/3 pitch windings; low waveform distortion with non-linear loads, fault clearing short-circuit capability, class F or H insulation (see Alternator Data Sheet for details), bearing and stator RTDs and anti-condensation heater. Mechanically strengthened for use on utility paralleling with unreliable grid.

Control system – The PowerCommand 3.3 generator set control is standard equipment and provides total genset system integration including full paralleling capability in grid or load share mode, precise frequency and voltage regulation, alarm and status message display, AmpSentry™ protection, output metering, auto-shutdown at fault detection and a user interface panel installed onto the genset. Optional remote operator panels are also available.

Cooling system – The generator set is equipped with the capability of interfacing with a remote radiator or heat exchanger.

Warranty and service – Backed by a comprehensive warranty and worldwide distributor network that can provide all levels of service from replacements parts to performance guarantee programs.

50 Hz				60 Hz			
New Model	**Old Model**	**kW (kVA)**	**Configuration**	**New Model**	**Old Model**	**kW (kVA)**	**Configuration**
				C1250 N6C	**GQNA**	1250 (1250)	6 pole direct drive
C1540 N5C	**GQNA**	1540 (1540)	4 pole direct drive	**C1540 N6C**	**None**	1540 (1540)	4 pole alternator through gearbox
C1750 N5C	**GQNB**	1750 (1750)	4 pole direct drive	**C1750 N6C**	**GQPB**	1750 (1750)	4 pole alternator through gearbox
C2000 N5C	**GQNC**	2000 (2500)	4 pole direct drive	**C2000 N6C**	**GQPC**	2000 (2500)	4 pole alternator through gearbox

*Genset is capable of operating between 0.8 lagging and 1.0 power factor. All fuel consumption and heat balance data is at 1.0 power factor.

S-1463g (11/08)

Model: C2000 N6C
Frequency: 60 Hz
Fuel Type: Low BTU
Emissions Performance NOx: 0.5 g/hp-h
LT Water Inlet Temperature: 50°C (122°F)
HT Water Outlet Temp: 103°C (217°F)

Generator set data sheet
2000 kW continuous

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Power Generation

Measured Sound Performance Data Sheet:	MSP - 1039
Prototype Test Summary Data:	PTS - 269
Remote Radiator Cooling Outline:	0500-5093

Fuel Consumption (ISO3046/1)	See Note	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Fuel Consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	5398 (18.44)	4918 (16.8)	4216 (14.4)	3083 (10.53)
Mechanical Efficiency ISO3046/1, percent	2,4,7	39.1%	38.6%	37.6%	34.7%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	37.1%	36.6%	35.6%	32.4%

Engine	
Engine Manufacturer	Cummins
Engine Model	QSV91G
Configuration	V18
Displacement, L (cu.in)	91.6 (5591)
Aspiration	Turbocharged (1)
Gross Engine Power Output, kWm (hp)	2108 (2826)
BMEP, bar (psi)	18.5 (268)
Bore, mm (in)	180 (7.09)
Stroke, mm (in)	200 (7.87)
Rated Speed, rpm	1514
Piston Speed, m/s (ft/min)	10 (1968
Compression Ratio	12.5
Lube Oil Capacity, L (qt)	550 (581)
Overspeed Limit, rpm	1800
Regenerative Power, kW	N/A
Full Load Lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.4 (0.3)

Fuel	
Gas supply pressure to engine inlet, bar (psi)	.15-.20 (2.2-2.9)
Minimum Methane Index	76

Starting System(s)	
Electric starter voltage, volts	24
Minimum battery capacity @ 40 deg.C (104 deg.F), AH	780
Air Starter Pressure, barg (psig)	10.3 (150)
Air Starter Flow Nm^3/s (scfm)	0.37 (780)

Genset Dimensions (see note 1)	
Genset Length, m (ft)	7.12 (23.4)
Genset Width, m (ft)	2.16 (7.1)
Genset Height, m (ft)	2.78 (9.1)
Genset Weight (wet), kg (lbs)	20705 (45,644)

	See Notes	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Energy Data					
Continuous Shaft Power, kWm (bhp)	2,10	2108 (2826)	1900 (2546)	1586 (2126)	1071 (1436)
Continuous Generator Electrical Output kWe	6,10	2000	1800	1500	1000
Heat Dissipated in Lube Oil Cooler, kW (MMBTU/h)	5	271 (0.92)	252 (0.86)	237 (0.81)	204 (0.70)
Heat Dissipated in Block, kW (MMBTU/h)	5	595 (2.03)	519 (1.77)	479 (1.63)	425 (1.45)
Total Heat Rejected in LT Circuit, kW (MMBTU/h)	5	175 (0.60)	161 (0.55)	134 (0.46)	104 (0.35)
Total Heat Rejected in HT Circuit, kW (MMBTU/h)	5	1263 (4.31)	1101 (3.76)	939 (3.20)	704 (2.40)
Unburnt, kW (MMBTU/h)	13	149 (0.51)	132 (0.45)	112 (0.38)	76 (0.26)
Heat Radiated to Ambient, kW (MMBTU/h)	13	389 (1.33)	356 (1.21)	305 (1.04)	231 (0.79)
Available Exhaust heat to 105C, kW (MMBTU/h)	5	1505 (5.13)	1449 (4.94)	1273 (4.34)	1011 (3.45)
Intake Air Flow					
Intake Air Flow Mass, kg/s (lb/hr)	4	3.39 (26848)	3.02 (23909)	2.54 (20145)	1.75 (13894)
Intake Air Flow Volume, m3/s @ 0°C (scfm)	4	2.62 (5854)	2.33 (5213)	1.97 (4393)	1.36 (3030)
Maximum Air Cleaner Restriction, mmHG (in H_2O)		22.07 (11.8)	22.07 (11.8)	22.07 (11.8)	22
Exhaust Air Flow					
Exhaust Gas Flow Mass, kg/s (lb/hr)	4	3.51 (27771)	3.12 (24742)	2.63 (20859)	1.82 (14407)
Exhaust Gas Flow Volume, m3/s (cfm)	4	7.18 (15212)	6.48 (13727)	5.60 (11856)	4.08 (8638)
Exhaust Temperature After Turbine, °C (°F)	2	451 (843)	460 (860)	478 (892)	519 (966)
Max Exhaust System Back Pressure, mmHG (in H_2O)	6,14	37.3 (20.0)	37.3 (20.0)	37.3 (20.0)	37.3 (20.0)
Min Exhaust System Back Pressure, mmHG (in H_2O)	6,14	18.7 (10.0)			
HT Cooling Circuit					
HT Circuit Engine Coolant Volume, l (gal)		424 (112)	424 (112)	424 (112)	424 (112)
HT Coolant Flow @ Max Ext Restriction, m^3/h (gal/min)		70 (308)	70 (308)	70 (308)	70 (308)
Maximum HT Engine Coolant Inlet Temp, °C (°F)	8	75 (167)	75 (167)	75 (167)	75 (167)
HT Coolant Outlet Temp, °C (°F)	8	92 (198)	92 (198)	92 (198)	92 (198)
Max Pressure Drop in External HT Circuit, bar (psig)		1.5 (22)	1.5 (22)	1.5 (22)	1.5 (22)
HT Circuit Maximum Pressure, bar (psig)		6.0 (87)	6.0 (87)	6.0 (87)	6.0 (87)
Minimum Static Head, bar (psig)		0.5 (7)	0.5 (7)	0.5 (7)	0.5 (7)
LT Cooling Circuit					
LT Circuit Engine Coolant Volume, l (gal)		295 (78)	295 (78)	295 (78)	295 (78)
LT Coolant Flow @ Max Ext Restriction, m^3/h (gal/min)		50.00 (220)	50.00 (220)	50.00 (220)	50.00 (220)
Maximum LT Engine Coolant Inlet Temp, °C (°F)	9	50 (122)	50 (122)	50 (122)	50 (122)
LT Coolant Outlet Temp, eC (°F) Reference Only	9	52.4 (126)	52.2 (126)	51.9 (125)	51.5 (125)
Max Pressure Drop in External LT Circuit, bar (psig)		1.5 (22)	1.5 (22)	1.5 (22)	1.5 (22)
LT Circuit Maximum Pressure, bar (psig)		6.0 (87)	6.0 (87)	6.0 (87)	6.0 (87)
Minimum Static Head, bar (psig)		0.5 (7)	0.5 (7)	0.5 (7)	0.5 (7)
Emissions					
NO_x Emissions wet, ppm	5	77	77	77	74
NO_x Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	5	243 (0.50)	242 (0.50)	239 (0.50)	225 (0.50)
THC Emissions wet, ppm	13	2000	2000	2000	2000
THC Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	2857 (6.23)	2857 (6.23)	2857 (6.23)	2857 (6.23)
CH_4 Emissions wet, ppm	13	1825	1827	1828	1825
CH_4 Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	2029 (4.46)	2023 (4.45)	2004 (4.49)	1948 (4.65)
NMHC Emissions wet, ppm	13	175	173	172	175
NMHC Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	109 (0.23)	108 (0.23)	108 (0.23)	109 (0.23)
CO Emissions (dry), ppm	13	580	572	558	515
CO Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	1002 (2.20)	984 (2.17)	951 (2.13)	850 (2.03)
O2 Emissions (dry), percent	13	7.3	7.3	7.3	7.3
Particulates PM10, g/hp-h	13	<0.03	<0.03	<0.03	<0.03

 Preliminary - Specifications May Change Without Notice

Genset De-rating

Altitude and Temperature Derate Multiplication Factor

Barometer		Altitude		Table A *								
In Hg	mbar	Feet	Meters	Derate Multiplier with Grid Parallel Operation								
20.7	701	9843	3000									
21.4	723	9022	2750									
22.1	747	8202	2500	0.75	0.75							
22.8	771	7382	2250	0.80	0.80							
23.5	795	6562	2000	0.85	0.85	0.75						
24.3	820	5741	1750	0.90	0.90	0.80						
25.0	846	4921	1500	0.95	0.95	0.85	0.75					
25.8	872	4101	1250	1.00	1.00	0.90	0.80					
26.6	899	3281	1000	1.00	1.00	0.95	0.85	0.75				
27.4	926	2461	750	1.00	1.00	1.00	0.90	0.80				
28.3	954	1640	500	1.00	1.00	1.00	0.95	0.85				
29.1	983	820	250	1.00	1.00	1.00	1.00	0.90				
29.5	995	492	150	1.00	1.00	1.00	1.00	0.95	0.75			
30.0	1012	0	0	1.00	1.00	1.00	1.00	1.00	0.80			
			°C	20	25	30	35	40	45	50	55	60
			°F	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

* Based on SAE standard ambient pressure vs. altitude. Assumes LT return temperature is 10C above air filter inlet.

Temperature & Altitude Derate

1. Determine derate multiplier vs. temperature and altitude in Table A or B depending upon your operating condition.
2. Assumes the LT return temperature is 10 deg C above the air filter inlet with a maximum LT temperature of 50 deg C.
3. If the LT temperature exceeds 50 deg C, consult factory for recommendations.
4. Altitude is based upon SAE standard ambient pressure vs. altitude. For low barometric conditions add 150m (500 ft) to site altitude.

Barometer		Altitude		Table B *								
In Hg	mbar	Feet	Meters	Derate Multiplier Off Grid (Island or Load Share)								
20.7	701	9843	3000									
21.4	723	9022	2750									
22.1	747	8202	2500	0.75	0.75							
22.8	771	7382	2250	0.80	0.80							
23.5	795	6562	2000	0.85	0.85	0.75						
24.3	820	5741	1750	0.90	0.90	0.80						
25.0	846	4921	1500	0.95	0.95	0.85	0.75					
25.8	872	4101	1250	1.00	1.00	0.90	0.80					
26.6	899	3281	1000	1.00	1.00	0.95	0.85	0.75				
27.4	926	2461	750	1.00	1.00	1.00	0.90	0.80				
28.3	954	1640	500	1.00	1.00	1.00	0.95	0.85				
29.1	983	820	250	1.00	1.00	1.00	1.00	0.90				
29.5	995	492	150	1.00	1.00	1.00	1.00	0.95	0.75			
30.0	1012	0	0	1.00	1.00	1.00	1.00	1.00	0.80			
			°C	20	25	30	35	40	45	50	55	60
			°F	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

* Based on SAE standard ambient pressure vs. altitude. Assumes LT return temperature is 10C above air filter inlet.

Methane Number Capability

Load (Percent of Rated)			
100%	90%	75%	50%
76	n/A	n/a	n/a

Heat Rejection Factor (altitude and ambient) for HT and LT Circuits

Barometer		Altitude		Table C								
In Hg	mbar	Feet	Meters	Multiplier for HT & LT Heat Rejection vs Alt & Temp.								
20.7	701	9843	3000	1.11	1.13	1.14	1.15	1.17	1.18	1.19	1.20	1.22
21.4	723	9022	2750	1.10	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.21
22.1	747	8202	2500	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.18	1.20
22.8	771	7382	2250	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18
23.5	795	6562	2000	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.17
24.3	820	5741	1750	1.06	1.07	1.08	1.10	1.11	1.12	1.14	1.15	1.16
25.0	846	4921	1500	1.05	1.06	1.07	1.09	1.10	1.11	1.12	1.14	1.15
25.8	872	4101	1250	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14
26.6	899	3281	1000	1.02	1.04	1.05	1.06	1.08	1.09	1.10	1.12	1.13
27.4	926	2461	750	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.12
28.3	954	1640	500	1.00	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.11
29.1	983	820	250	0.99	1.00	1.02	1.03	1.04	1.06	1.07	1.08	1.10
29.5	995	492	150	0.99	1.00	1.01	1.03	1.04	1.05	1.06	1.08	1.09
30.0	1012	0	0	0.98	0.99	1.01	1.02	1.03	1.05	1.06	1.07	1.08
			°C	20	25	30	35	40	45	50	55	60
			°F	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

LT & HT Circuit Heat Rejection Calculation

1. Determine derate multiplier vs. temperature derate per above.
2. Using the multiplier from #1 above as the percent load factor determine the Heat rejection from the previous page.
3. From Table C find the HT and LT circuit multiplier.
4. Multiply the result of step 2 by the result of step 3 to obtain the heat rejection at your altitude and temperature.

Alternator Data

Voltage Range	Connection Configuration	Temp Rise Degrees C	Duty[11] Cycle	Single Phase Factor	Maximum Surge kVA[12]	Alternator Data Sheet	Feature Code
380	Wye, 3 Phase	105	C	N/A	7960	515	B597-2
416-480	Wye, 3 Phase	80	C	N/A	9700	517	B587-2
416-480	Wye, 3 Phase	105	C	N/A	8400	516	B654-2
416-480	Wye, 3 Phase	125	C	N/A	7200	515	B627-2
480	Wye, 3 Phase	80	C	N/A	8400	516	B653-2
480	Wye, 3 Phase	105	C	N/A	7200	515	B583-2
600	Wye, 3 Phase	80	C	N/A	8250	516	B589-2
600	Wye, 3 Phase	105	C	N/A	7200	515	B582-2
4160	Wye, 3 Phase	80	C	N/A	6300	518	B590-2
12470-13800	Wye, 3 Phase	80	C	N/A	8000	523	B591-2
12470-13800	Wye, 3 Phase	105	C	N/A	6800	522	B484-2
13200-13800	Wye, 3 Phase	105	C	N/A	5000	521	B657-2
13800	Wye, 3 Phase	80	C	N/A	6800	522	B565-2

Continuous Rating Definition

Applicable for supplying power continuously to a constant load up to the full output rating for unlimited hours. No sustained overload capability is available for this rating. Consult authorized distributor for rating. (Equivalent to Continuous Power in accordance with ISO8528, ISO3046, AS2789, DIN6271, and BS5514). This rating is not applicable to all generator set models.

Notes

1) Weights and set dimesions represent a generator set with its standard features only. See outline drawing for other configurations.
2) At ISO3046 reference conditions, altitude 1013 mbar (30in Hg), air inlet temperature 25°C (77°F)
3) Nominal performance ± 2 1/2%.
4) According to ISO 3046/I with fuel consumption tolerance of +5% / -0%
5) Production variation/tolerance ±20%.
6) At electrical output of 1.0 Power Factor.
7) Based on gas with LHV of 16Mj/Nm3 (400BTU/SCF)
8) Outlet temperature controlled by thermostat. Inlet temperature for reference only.
9) Inlet temperature controlled by thermostat, outlet temperature for reference only.
10) With engine driven coolant pump.
11) Standby (S), Prime (P), Continuous (C)
12) Maximum rated starting kVA that results in minimum of 90% of rated sustained voltage during starting.
13) Tolerance +/- 15%
14) Exhaust system back pressure is a rated load and will decrease at lower loads.

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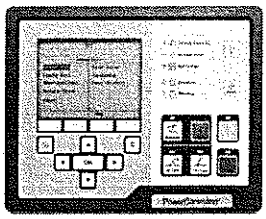
Power Generation

PowerCommand® 3.3 control system



PowerCommand control system is a microprocessor-based genset monitoring, metering and control system designed to meet the demands of today's engine driven gensets. The integration of all control functions into a single control system provides enhanced reliability and performance, compared to conventional genset control systems. These control systems have been designed and tested to meet the harsh environment in which gensets are typically applied. Major features include:

- AmpSentry™ protection providing a full range of alternator protection functions matched to the alternator provided.
- Extended Paralleling (Peak Shave/Base Load) regulates the genset real and reactive power output while paralleled to the utility. Power can be regulated at either the genset or utility bus monitoring point.
- Digital frequency synchronization and voltage matching.
- Isochronous Load Share
- Droop KW and KVAR Control
- Real time clock for fault and event time stamping.
- Real time clock for start/stop to initiate a test with or without load, or a Base Load or Peak Shave session.
- Digital voltage regulation. Three phase full wave FET type regulator.
- Genset/Engine monitoring and protection.
- Utility/AC Bus metering and protection
- Modbus® interface for interconnecting to customer equipment.

Operator/display panel

- Auto/Manual/Run/Stop mode selectors
- Alpha-numeric display with pushbutton access for viewing engine and alternator data and providing setup, controls and adjustment
- Circuit breaker position indication and manual control
- 320 x 240 pixels graphic LED backlight LCD.
- Multiple language support

Engine Protection

- Engine vitals - oil temperature and pressure, coolant temperature and levels
- Derate
- Configurable alarm and status inputs
- Emergency stop
- Low and high battery voltage warning
- Weak battery warning
- Dead battery shutdown
- Fail to start (overcrank) shutdown
- Fail to crank shutdown
- Cranking lockout

Engine Data

- Oil temperature and pressure
- Coolant temperature and pressure, HT and LT
- Intake manifold pressure and temperature
- Exhaust temperature and pressure
- Engine electronics temperature and DC voltage
- Gas inlet and downstream pressures, mass flow rate, and control valve position
- Spark advance and knock level/count, per cylinder
- Lube oil status, priming status
- Oil and engine heater status
- Start system status
- Compressor and compressor bypass status
- Auxiliary power supply status

AmpSentry™ alternator protection

- Overcurrent and short circuit shutdown
- Single and three phase fault current regulation
- Over and under voltage shutdown
- Over and under frequency shutdown
- Overload warning and load shed alarm output
- Reverse power and Var shutdown
- Excitation fault

Alternator data

- AC voltage, line-to-line and line-to-neutral
- Three phase AC current
- Frequency
- Total and individual phase power factor, kW and KVA
- Alternator heater status
- Winding and bearing temperatures

Other data

- Genset hardware data
- Data logs – operational data
- Fault history – up to 32 events
- Start attempts, starts, running hours, kW hours
- Engine data – operational data, monitored status functions, auxiliary system inputs, etc.
- Service adjustments - operational, customer configurable set up, calibration, etc.

Paralleling data, functions and protection

- Genset and Utility/AC Bus Source AC Metering
- First Start Sensor™ System
- Active Digital phase lock loop synchronizer
- Sync check
- Isochronous kW and kVAR load share controls
- kW import/export and kVAR/PF control for extended utility (mains) paralleling
- Multiple Genset Load Demand control
- Power Transfer Control
- Breaker Control and status monitoring/warning
- Inputs for remote kW and kVAR control

For further detail on PowerCommand™ 3.3 see document S-1570

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S-1463g (11/08)

Power Generation

Scope of Supply

Cummins QSV 91 C2000

Rating: 2000 kW Continuous

Voltage: 12.47kV, 3 Phase, 60 Hz

Generator: PMG Type Excitation, 2/3 Pitch

Engine: Cummins QSV 91

One (1) new Cummins Model C2000N6C rated at 2000 kW for Continuous Duty at 12.47kV, 3 phase, 60 hertz for operation ondigester gas with low emission setting of .5 gr/bhp-hr of NOx in accordance with specification sheets D-3469, S-1463. The generator set includes our standard accessories plus the following items:

1.1 General

1.1.1 Description

The generator sets proposed are designed for continuous (COP) operation as defined in ISO 8528.

1.2 Engine

1.2.1 Description

The engine is an 18V configuration. Cylinder bore is 180 mm, stroke 200 mm, giving a displacement of 91 liters. The standard engine includes a pre-lubrication engine oil pump, oil filtration, and air inlet filters suitable for normal operating conditions.

1.2.2 Chassis

The coupled engine and alternator assembly are mounted on a welded, structural steel chassis. This provides the assembly with a stable and torsion resistant platform.

1.2.3 Flexible Coupling

The engine torque is transmitted to the alternator by a flexible coupling, which reduces vibration and provides torque damping characteristics.

1.2.4 Anti Vibration Mounts (AVM's)

The generator set is supplied with appropriately sized anti vibration mounts (AVM's).

1.2.5 Engine Protection

The engine is continuously monitored by means of the Cummins Engine Sensors Equipment (CENSE) module which is an environmentally hardened digital controller mounted on the generator set. It is connected to dedicated engine sensors and senders via engine looms. CENSE is as fully detailed later in this specification.

1.2.6 Engine Starter

The generator set is supplied with a single 24 Volt Electric starter motor as standard. This engages onto the engine flywheel starter ring when the starter solenoid receives a start signal from the Generator Control Panel. Starting Power is supplied by four SAE#8D lead-acid batteries. A 30A battery charger is included to maintain battery readiness.

1.2.7 Gas Train

The Gas Train is an inline gas inlet manifold which incorporates a manual shutoff valve, a dual solenoid emergency shutdown valve, filter and pressure regulator. The flange sizes of the inlet and outlet flanges are 80mm. Adaptor flanges are available for ANSI Flange types. Requires inlet pressure 4.0 – 5.0 psi (G)

1.2.8 Filtration

The engine is fitted as standard with the following filtration:

- duplex type, replaceable element, lubricating oil filters.
- centrifugal oil filter
- gas filter (supplied loose for incorporation in the gas train.
- replaceable aspiration air filters.

1.2.9 Lubricating Oil Sump Automatic Filling / Level Switch

This system allows the generator set to have continuous availability. The system keeps the optimum engine oil level by means of a float mechanism and a flexible connection (1.6 ft of inlet hose which has a 1" BSP straight female hose adapter fitting) which is connected to an engine lubricating oil make up tank. A site glass is included on the gauge for the operator to visually check. Electrical switch contacts are provided which will initiate a low level warning indication displayed on the GCP. The engine lubricating oil make up tank has a volume of 30 gallons.

1.2.10 Engine Pre-heating

The stationary engine temperature is maintained above 100°F for fast start and load acceptance. This is achieved by the provision of thermostatically controlled water heaters (2 heaters of 6 kW each connected to the engine block. In addition to the heating elements a water circulation pump (.3 kW) is included to circulate the cooling water through the block. This allows for an even heat transfer through the engine block. The heating elements and pumps are controlled from the GCP.

1.2.11 Flexible Connections

All connections to the engine that are required are supplied with flexible connections. These connections are: coolant water circuits, crankcase breather filter drains, lubricating oil sump drain, gas inlet, cooling system venting, etc..

1.2.12 Crankcase Breather

A crankcase breather filter is mounted on the engine. The crankcase breather vent is piped to this filter. The outlet of the filter must be routed to discharge to atmosphere by others.

1.2.13 Exhaust Bellows

The exhaust bellows provide a flexible connection to the exhaust system which allows for some generator set movement / vibration. Shipped loose for field installation by others.

1.3 Alternator

1.3.1 Description

The four pole 105°C temperature rise alternator is of the brushless, rotating field design. Insulation and temperature rise is class 'H'. The Cummins Generation Technologies™ alternators use a permanent magnet generator (PMG) excitation system which provides power excitation for the exciter field via the automatic voltage regulator (AVR). The automatic voltage regulator (AVR) and power factor control (PFC) are controlled through the Power Command Supervisor™ based GCP.

1.3.2 Alternator Protection

The alternator has an IP22 enclosure and includes:

- bearing resistive temperature devices (RTDs), one per bearing
- winding resistive temperature devices (RTDs), two per phase
- anti-condensation heater, thermostatically controlled

The GCP also houses AmpSentry™ which guards the electrical integrity of the alternator and the power system from the effects of over current, short circuit, over / under voltage, under frequency and overload. Current is regulated to 300 % for both single phase and 3 phase faults for the duration of the condition to allow for the selective clearing of downstream devices.

2.0 Generator Control System

2.1.1 General Description

The generator control system consists of three main components:

- Generator control panel (GCP2)
- a.c. auxiliary enclosure
- Generator set interconnection box (GIB)

2.1.2 Generator Control Panel (GCP)

This is the generator control panel and is as fully detailed later in this specification.

2.1.3 AC Auxiliary Enclosure

This is a separate enclosure mounted on the generator set chassis. It interfaces with the GCP and houses the equipment which controls / monitors and protects the generator set a.c. systems which are not located in the GCP.

2.1.4 Generator Set Interconnection Box

This enclosure is mounted on the generator set base frame. It interfaces with the GCP and is the termination box for all engine controls, etc. which are not located in the a.c. auxiliary enclosure.

2.2 CENSE Module (Cummins Engine Sensor Equipment)

2.2.1 General

The Cummins Engine Sensor Equipment (CENSE) Module is an environmentally hardened digital controller which is mounted directly on the generator set. CENSE continuously monitors the generator set, sensing fault conditions and condition monitoring and, although it does not control the generator set, it can initiate an automatic shutdown by sending a common fault signal to the PowerCommand™ Supervisor (PCS). The module has built in test equipment, constantly performing self checks and the built in Lithium battery maintains fault data in the event of control battery power failure. CENSE monitors functions using generator set mounted sensors and senders connected via a wiring loom.

2.2.2 Features

2.2.2.1 Monitoring Functions

Lubricating Oil System:	oil filter inlet & outlet pressure, oil temperature
Air Induction System:	intake restriction pressure, compressor inlet temperature, charge air pressure and temperature
Cooling System:	low coolant level, HT & LT water pressure, LT water temperature before engine, HT water temperature after engine
Exhaust System:	exhaust gas temperature after turbo (each cylinder is monitored giving high average cylinder temperature), individual cylinder temperature, sensor / insulation compensation fault. Low exhaust temperature is also monitored on each cylinder: aiding diagnosis of engine misfire.
Engine Speed:	over speed / speed monitoring
Single Cylinder Diagnostics:	high / low power faults, high exhaust temperature fault

The following information Is accessible to CPG service personnel only

Fault Snapshots:	1 second data up to 4 minutes before fault, 1 second data up to 30 seconds after fault. 18 snapshots of this size can be saved.
Trend Data:	records every 15 minutes Trends for over 1350 hours at this rate.
Maintenance Monitor:	oil & filter, coolant & filter, fuel filter

2.2.2.2 Diagnostics

An RS232 link is incorporated in the wiring loom to link into the CENSE module. The service engineer can connect a personal computer operating in a Windows environment with dedicated software to obtain data on the following:

- View data in real time mode.
- Analyze faults & relevant engine data.
- Guides user on diagnostic directions with built in graphics, drawings and diagrams.

2.2.3 CENSE Sensors & Connections

2.2.3.1 Engine Sensors

High & low coolant temperature and pressure
Intake manifold temperature and pressure
Front intake restriction
Post filter oil pressure
Front turbocharger inlet temperature
Oil temperature
Rear turbocharger inlet temperature
Rear intake air restriction
Engine speed
Fuel pressure
Engine exhausts left & right bank individual temperature sensors

2.2.3.2 Connectors

2 x 40 pin Deutsch
4 pin Deutsch
23 pin Deutsch
31 pin Deutsch
RS422 Data Link

2.3 Genset Control Panel Incorporating PCS™

2.3.1 GCP System Configuration 3.3

The generator set control panel (GCP) is designed to be specifically integrated with QSV/QSK60G – 91G range of CPG engines.

Standard components used to provide the system control comprise:

- Control batteries and charger
- PC based HMI (touchscreen)
- PLC based auxiliary control
- PLC based CENSE interface
- Power Command Supervisor™
- Auxiliary a.c. enclosure
- Engine interface enclosure

The system is intended for use in single or multi-set isolated bus or single set base load utility paralleling applications while providing both isolated bus paralleling control (set to set synchronizing, isochronous kW and Kvar load sharing) and base load utility paralleling (synchronizing to utility, base load kW control, VAR/PF control). It provides compatibility with master controllers for multi set utility paralleling applications requiring supervisory system control, i.e. load demand, multi-level load shed/add etc, whilst enabling data control and monitoring via an optional (Modbus) communications interface.

2.3.2 Control Panel - Environmental Hardening

The control system touchscreen, PCS and other door mounted equipment are provided with sealed front faces to minimize the effects of dust and moisture on the equipment.

Operating range of the complete GCP is:

Operating Temperature:	0 to $+122^0$ F
Storage Temperature:	14 to 140 °F
Humidity:	95%
Rating:	IP54

2.3.3 Construction

The control system is genset mounted. Each wire, device and functional component is identified by silk-screen or similar permanent identification.

Circuit breakers are installed to allow more effective overload and short circuit protection to be provided. Terminals for field connection are provided with removable plugs for ease of installation.

The internal components of the GCP require a 24V d.c. power supply. This is derived from the battery and charger system located within the GCP. The power supply to the GCP requires a permanent single phase AC supply (determined by the site application) via the fused supply from the AC generator set mounted auxiliary enclosure or the container power distribution board.

2.3.4 PC Based HMI (Touchscreen)

A micro-processor based graphic interface (touchscreen) package is provided to allow operator monitoring and control. Data from the generator set is displayed to the operator in layered menus so that it is easy to understand and allows operators to easily learn the functionality and diagnostic facilities of the unit

The screen is mounted on a console on the front of the GCP with gaskets between the touchscreen and the enclosure for environmental protection. The HMI is interconnected to the PLC via serial communications utilizing **Modbus protocol**.

2.3.4.2 System Screens

The main screen is designed to enable the operator to determine the current generator set status. It further allows access to the data embedded in the layered screens. Data includes:

- voltage per phase
- current per phase
- kW
- mW/hr
- frequency
- power factor
- oil pressure
- speed
- engine hours.

Touchscreen activities allow access to the following data via other screens:

- engine data
- alternator data
- a.c. auxiliaries mimic
- alarm activities
- GCP user level configuration
- related plant data

The main screen is designed to include an alarm capability so that the operator is immediately advised of all alarm and shutdown conditions.

2.3.5 PowerCommand Supervisor™

This unit is a microprocessor based genset monitoring, metering and control system. It is integrated into the GCP and incorporates the following key features:

- voltage regulator
- synchronizer (frequency, phase & volts)
- Iso-Bus kW and Kvar load sharing
- utility paralleling kW load control
- utility paralleling PF control
- AmpSentry™ alternator protection
- overload
- over current [51]
- short circuit [50]
- high AC Volts [59]
- low AC Volts [27]
- under frequency [81u]
- sync check, fail to sync [25]
- reverse power [32]
- loss of excitation [40]
- phase rotation
- CB fail to close
- alternator metering

2.3.5.1 Enclosure Environmental Hardening

The front panel of the unit is formed by a single membrane that covers the entire surface. The fascia is easy to clean and impervious to water spray, dust and oil/exhaust residue. Switches for control are incorporated into the door which is provided with a dual moisture and RFI/EMI gasket to protect internal components from airborne contaminants.

2.3.5.2 Controls and Adjustment Switches

Oil tight, three position switch starts and stops the generator set locally or enables start/stop control from a remote position. It provides the following functions:

- The **'OFF'** position de-energizes all primary DC circuits. When the switch is in this position, the non-automatic indicator will flash continuously.
- The **'RUN'** position energizes the control and initiates the genset starting operation.
- The **'AUTO'** position enables the control to receive a start signal from a remote location.

Emergency Stop Switch.
A two position safety 'mushroom' head switch provides an easy and obvious means to immediately shut down the genset in the event of an emergency condition.

System Control.
Control arrows on the screen lead the operator to information. The control switches provide the operator with a positive indication that the switch is operated. The switches are totally sealed and designed to provide reliable service.

Menu selection Switches.
These four switches allow the operator to select menu-driven control and monitoring information.

Menu 'HOME' Switch.
Returns the operator to the main menu selections screen regardless of the position in the menu logic.

Panel Lights Switch.
Turns the back-lit panel illumination on and off for easy reading of the entire facia in dark conditions. This feature automatically switches off after 5 minutes.

Test Switch.
Prompts the PowerCommand Control to perform a self test and displays all fault messages.

Reset Switch.
Clears the digital display and status panel and allows the genset to start after a fault condition has been corrected.

2.3.5.3 Adjustment Menu.
Allows the operator to set basic genset parameters. Adjustments are limited to help prevent operator error and potential damage to equipment. Critical parameters are adjustable only via a security access code. Adjustments include:

- Voltage (+/- 5%)
- Frequency (+/- 5%)
- Automatic voltage regulator gain (access code protected)

Critical service level adjustments are possible only after entering an access code. All adjustments are made through digital raise/lower switches from the front of the fascia, the adjustment being digitally displayed.

2.3.5.4 External Control Adjustments.
Adjustments for automatic voltage regulation are performed directly at the control fascia by using the security code without the need to enter the GCP enclosure.

2.3.5.5 Alarm and Status Message Display.
To compliment the HMI screen displays, PCS check data displays are provided for all critical genset parameters. Digital messages provide a clear indication of potential problems. A two line 16 character-per-line, LED alphanumeric screen displays alarm and status messages along with data regarding AC output.

2.3.5.6 Status Indicators.
Three dual element LED indicating lamps provide basic genset status data on the facia. Solid state indicators on internal circuit boards provide further status and diagnostic data.

Non-Automatic Indicator.
When the Run/Off/Auto switch is in the OFF or RUN position the red non-automatic indicator will flash on and off.

Warning Indicator.
An amber light indicates the status screen is displaying a warning condition. The reset switch is used to clear the message after the warning condition is corrected.

Shutdown Indicator.
A red light indicates the status screen is displaying a shutdown condition. The reset switch is used to clear the message after the shutdown condition is corrected.

2.3.5.7 Generator Set Monitoring - Warning and Shutdown Messages.
The digital display provides status of the following critical engine functions:

- battery voltage
- speed
- over speed (shutdown, engine speed >= 115% of nominal)
- Emergency stop (shutdown).
- magnetic pick up failure (shutdown)

On sensing a warning or shutdown condition the control displays the warning or shutdown message, lights the warning or shutdown indicator lamp on the front of the fascia and displays a code number which is interpreted by the PLC and displayed at the HMI in an easy to understand format. These codes are also displayed on the PCS fascia and can be cross-referenced using the genset manual.

The control has provisions for four programmable fault conditions. These may be either warning or shutdown conditions. Labels for customer faults can be programmed into the control.

The control maintains an historical data log of the latest alarm and status conditions on the genset.

2.3.5.8 Historical data
The control displays the last 20 alarm and/or shutdown messages.

2.3.5.9 AC Output Metering
Combines digital and analog metering to provide accurate digital readouts plus analog indication of trends and operating conditions.

2.3.5.9.1 Analog Meters.
Analog metering on the control fascia provides clear indication of generator set stability from a 'walk by' perspective and saves re-establishing the HMI screen if it is in screen save mode.

The kilowatt meter and ammeter are scaled in percent of AC output for easy recognition of genset status and load level:

0 - 90% of rating; green
90 - 100% of rating; amber
> 100% of rating; red.

Kilowatt Meter.
Indicates 3-phase AC power output as a percent of rated load. Provides a true indication of total kW load on the generator set, regardless of the load power factor. Scale is 0 - 125% Accuracy is +/- 5%

Frequency Meter.
Indicates generator set output frequency in hertz.. Scale is 45 - 65 Hz. Accuracy is +/- 5%.

AC Voltmeter.
Dual scale AC voltmeter indicates alternator output voltage. Accuracy is +/- 2%. Scales are 0 - 300VAC, 0 - 600VAC, 0 - 400 VAC, 0 - 750VAC, 0 - 5260VAC, 0 - 15,000VAC.

AC Ammeter.
Indicates current output in percent of maximum rated standby current. Accuracy is +/- 2%. Scale is 0 - 125%

2.3.5.10 DIGITAL Metering

The digital metering display provides access to alternator performance data and a more accurate readout of the AC output information displayed on the analog meters. The following outputs are displayed:

- generator set output voltage (3-phase, line to line or line to neutral)
- generator set output current (3-phase)
- power factor
- a.c. kilowatts
- a.c. kilowatt-hours
- alternator exciter duty and governor duty (%)
- generator set output frequency (Hz)

The voltage and current data for all three phases is displayed simultaneously on a single screen so load and voltage balance is readily apparent.

2.3.5.11 DIGITAL Voltage Regulation, Synchronizing and Load Sharing Controls

The PCS module includes all voltage regulation, synchronizing and load sharing control required for isolated or infinite bus paralleling applications, including demanding UPS and non-linear load applications.

2.3.5.11.1 Paralleling.

Infinite Bus Paralleling control (set to set synchronizing, isochronous kW and kVAR load sharing) and Base Load Utility Paralleling (synchronizing to utility, base load kW control, VAR/PF control) features are provided.

2.3.5.11.2 Isochronous real load sharing.

Load sharing to within as low as 1% of equal. Load sharing controls operate directly on the engine governor actuator to provide zero droop in frequency for loads from zero to 100% of rated genset capacity.

2.3.5.11.3 Droop reactive load sharing.

Control may be configured for operation in droop mode, adjustable for no load to full load droop from 1% to 10%.

2.3.5.11.4 Not used

2.3.5.11.6 Synchronizer.

Range:
The synchronizer can drive the generator set frequency and voltage to a bus value which is 40% to +10% of selected voltage and frequency. Ramp speed for matching is 4% per second.

Frequency differential:
The set is controlled to match the bus frequency.

Voltage differential:
The set voltage is controlled to within 1% of system bus voltage with checks for correct phase rotation to bus.

Permissive protection:
Adjustable for a phase difference of 5 to 20 degrees with phase difference decreasing. Time delay is adjustable from 0.5 to 5 seconds.

Control System :
Automatically resets bus frequency and voltage to preset values after the paralleling breaker closes.

'Dead Bus' Sensor :
Allows closure of the generator set to an de-energized system bus.

2.3.5.11.7 Digital Biasing Performance.

The PCS provides a biasing signal to the MCM700 speed governor to perform load control, synchronizing and load govern operations. Variation of the 'Duty Cycle' output, between 10 and 90%, by the PCS determines the required change in load/speed rating of the engine governor. This required change can be between -40% and +10% of rated value.

2.3.5.11.8 Voltage Regulation Performance.

Voltage Regulation :
+/- 5% from no load to full load.
Voltage Drift :
+/- 0.5% for 60°F (33°C) change in ambient over 8 hours with temperature stabilization at each point.
Random Voltage Variation:
For constant loads from no load to full load will not exceed +/- 0.5% of its mean.

2.3.5.12 BATTERY Monitoring System

The control continually monitors the battery charging system for low and high DC Voltage and runs battery loads test every time the engine is started. Functions and messages include:

- low d.c. voltage (battery voltage less than 25VDC except during engine cranking)
- high d.c. voltage (battery voltage greater than 32 VDC)
- weak battery (battery voltage less than 14.4 VDC for more than 2 seconds during engine cranking)

2.3.5.13 AmpSentry™ Protection

AmpSentry™ protection is a comprehensive power monitoring and control system integral to the PCS that guards the electrical integrity of the alternator and power system from the effects of over current, short circuit, over/under voltage, under frequency and overload. Current is regulated to 300% for both single phase and 3 phase faults when a short circuit condition is sensed. An over current alarm will sound if the generator set is operating for an extended period at a potentially damaging current level, to warn the operator of an impending problem before it causes a system failure. If an over current condition persists for the time pre-programmed in the time current characteristic for the alternator, the PMG excitation system is de-energized to avoid alternator damage. The over current protection is time delayed in accordance with the alternator thermal capacity allowing current to flow until secondary fuses or circuit breakers operate, isolating the fault and thus achieving selective co-ordination (discrimination). This enhances power service continuity by eliminating the need for a main line breaker mounted on the generator set for generator set protection and the possibility of nuisance tripping of that breaker.

After the fault is cleared AmpSentry™ Protection softly loads the generator set by a controlled ramping of output voltage to rated level, allowing the generator set to resume normal operation without potentially damaging voltage overshoot.

Fixed over/under voltage and under frequency time delayed set points also provide a degree of protection for load equipment. Over/under voltage conditions trigger a shutdown message on the digital display screen. Under frequency condition prompts both a warning

and shutdown message depending upon the length of time and magnitude of variance under rated frequency.

AmpSentry™ Protection includes an overload signal that can be used in conjunction with proprietary transfer switches to automatically shed load, preventing a potential generator set shutdown. The overload signal is programmable for operation at a specific kW level, on the basis of an under frequency condition, or both.

2.3.5.15.1 Charger:

The 10 Amp charger is of the constant voltage, current limited type designed for the charging of vented or sealed lead acid or NiCad batteries. It is capable of supplying a standing load while simultaneously maintaining the battery to its fully charged state. Its features include:

- boost charge facility
- charge fail facility
- short circuit protected
- reverse power protected
- constant voltage
- current limited
- R.F. suppression

Supply Voltage: 220 to 257 Volts 50 - 60 Hz AC as standard, up to 277 Volts 50 - 60 Hz AC upon request.
Output Transistors: Rated at 15 amps RMS electronically regulated to the current set by control circuitry.
Boost: Increase of 0.35V per cell on connection of the "Boost" terminals.
Charge Failure: Relay energizes 10 seconds after charge failure.
Temp Range: 14 to 140^0 F.

2.3.5.15.2 Batteries:
Two off sealed lead acid maintenance free batteries. These batteries use a thixotropic gel electrolyte which holds the acid in contact with the flat plate electrodes, maximising the contact surface area therefore the available capacity. They are supplied with safety vents which enable the battery to gas if misused and then re-seal automatically.

Max Discharge Current: 80 Amps.
Discharge Current for 20h: 500 mA.

2.3.5.16 Warning and Shutdown Messages

Overload:	When total kW load exceeds 110% of the COP rating of the generator set for 5 seconds a load shed signal is issued and a warning alarm activated.
Over current (51):	When the current on any phase exceeds 110% of the generator set rated current for more than 60 seconds a warning alarm is activated.
Over current (51):	The generator set is shutdown when the current on any phase is between 110 - 175% of rated and the time/current integral approaches alternator thermal limits.
Short Circuit (50):	The generator set is shutdown when the current on any phase exceeds 175% of rated and the time/current integral approaches alternator thermal limits.
High AC Voltage (59):	Generator set is shutdown when AC voltage exceeds 110% for 10 seconds or with no delay when voltage exceeds 130% of nominal.
Low AC Voltage (27):	Generator set is shutdown when AC voltage falls below 85% of rated voltage for more than 10 seconds.
Under Frequency (81U):	Generator set is shutdown when AC frequency falls below 90% of rated frequency for more than 20 seconds.
Reverse Power (32):	Generator set is shut down when kW flow into the genset exceeds an adjustable set point (5 - 15% of genset rating) for an adjustable amount of time (1 - 15 seconds).
Loss of Excitation (40):	Generator set is shut down when Kvar is less than 0.16 - 0.41 per unit Kvar (adjustable) for more than 2 - 10 seconds (adjustable).

2.3.6 PLC (Programmable Logic Controller)

Auxiliary generator set controls, the communication handling procedures and the protocol interfaces are all provided by a programmable logic controller.

Auxiliary control is provided for the following functions:

- engine heater control
- alternator heater control
- coolant circulation pump
- oil priming pump
- alarm/data handling

The PLC directly interfaces with the system touchscreen (HMI) as well as both PCS and the engine protection module (CENSE). It interfaces with the PCS via a CPG developed RS232 (MON) protocol and to the CENSE module via a CPG developed RS422 medium. Communication to the HMI is provided by means of a MODBUS RTU, RS485 link.

The PLC uses a DIN rail mounted card and rack arrangement to allow easy servicing and identification of system components. Other features to enhance serviceability include:

- capability for on-line program/data changes using a personal computer directly connected to the PLC,
- LED status indicators on each board for use in diagnosis of system condition and board level service,
- I/O cards include integral surge suppressors for greater system reliability,
- program output information is available in the form of an easy to understand flow chart as well as the more common fully annotated ladder logic.

2.3.6.1 PLC Specification.

Manufacturer:	Group Schneider	
Processor:	Type:	TSX Premium type 57-20
	Temperature - operation:	14°F to 140° F.
	- storage	-13° F to +158° F.
	Humidity (without condensation)	
	- Operation	30% to 95%.
	- Storage	5% to 90%.

2.3.6.3 GCP to Generator Set Cable Connections

A 10 meter interconnection cable is provided to be installed by others in the field.

2.3.7 Codes and Standards

The GCP meets or exceeds the requirements of the following codes and standards:

UL508: for US and Canadian Usage

2.4 PCS Paralleling Control Features

- Microprocessor based control.
- AC Metering; both analog (% load, Hz, AC Volts, % Amperes) and RMS digital metering (AC Amps, AC Volts, Hz, KW, kW-hours, Power factor).
- Generator Protection with Alarm and Status Indication.
- Engine Protection with Alarm and Status Indication.
- LED Alphanumeric Display - 2 lines, 16 characters per line.
- Amp Sentry™ for Paralleling Protection.
- Single membrane, dust-tight control face with gasket enclosure.
- Standard Emergency Stop.
- Genset "Run/Off/Auto" Selector Switch.
- Voltage Regulator.
- Isochronous Governor Control.
- Isochronous Paralleled Load Sharing.
- Breaker Control Push-Buttons.
- Automatic Synchronizer – Voltage and Phase Matching.
- Permissive Synchronizing Check Relay.
- Smart Starting Control System – Fuel ramping and Cold Starting
- Battery Monitoring System – Weak Battery Indication.
- Engine start and stop (cooldown) time delays.
- Self Test Diagnostics.
- Service Diagnostic RS232 Port.
- Customer auxiliary contacts:

Amp Sentry™ Protective Features:

- Generator Set Overload
- Alternator Over current
- Alternator Short Circuit
- Fail to Synchronize
- Circuit Breaker Fail to Close
- High and Low AC Voltage
- Reverse Power
- Under frequency
- Loss of Excitation
- Phase Rotation

5.0 HT & LT Heat Recovery System

5.1 HT Circuit – Plate & Frame Process Heat Exchanger – Included

5.2 LT Circuit – Process Plate & Frame Heat Exchanger – Not Used

5.3 Remote Cooling System for HT & LT Circuits – Shipped Loose

ENGINE: QSV91G - C2000N6C		
COOLING DUTY	**HT CIRCUIT**	**LT CIRCUIT**
HEAT REJECTION (BTU/MIN)	74,155*	14,871*
COOLANT TYPE	50% EG	50% EG
COOLANT FLOW (GPM)	308	220
COOLANT PRESSURE DROP (PSI)	2.5	5.2
TEMPERATURE IN (F)	198	122.4
TEMPERATURE OUT (F)	164.9	113
**** Heat Rejection Rates include 3% ambient and altitude adjustment, 5% tolerance and 10% safety margin built-in (19% total safety margin).***		
DESIGN AMBIENT TEMPERATURE (F)	105	
DESIGN ELEVATION (FT ASL)	600	
FAN(S) – NUMBER / DIAMETER	30" Diameter	
MOTOR(S) – NUMBER / HP	2 HP Direct Drive	
MOTOR PHASE / HERTZ / VOLTAGE	3 / 60 / 208-230/460	
AIRFLOW (CFM)	TBD	
NOISE LEVEL (DBA @ DISTANCE)	**85 dBA @ 7 meters**	
RADIATOR MODEL	TBD	
OVERALL DIMENSIONS (INCHES) (Total over both sections)	Approx. 164" W x 186" L x 90" H (without expansion tank)	

6.0 Not used

7.0 Operation & Maintenance Manuals

- Two (2) complete sets of Operator's & Maintenance Manuals for all major equipment supplied.

8.0 Start-Up & Commissioning (Ten Man Days)

- Check all fluids for proper level (lube oil, coolant, battery acid)
- Confirm proper pressure and volume of gas supply
- Check all Cummins alarm points for proper signals
- Start Engine Generator Set according to attached Cummins Start-Up Checklist
- Check generator phase rotation verses utility
- Check for proper circuit breaker operation
- Start and load engine generator in steps up to 100% load
- Assist in checking cooling radiators, circulator pumps and boiler for proper operation
- Load engine generator and set/confirm utility import level
- See Start-up & Operation Manual for additional details

9.0 Operator Training

- Provide classroom training.
- Provide hands-on training for all equipment provided.
- Provide Operation and Maintenance Manuals covering all equipment provided.
- Operator and maintenance training not to exceed 16 hours.

10.0 Delivery:

Delivery to jobsite is approximately 32-36 weeks after receipt of approved submittals and written release for fabrication. Freight included to Jobsite(s). Offloading, rigging and installation by others.

Power Generation

POWER SYSTEMS
PARALLELING EQUIPMENT QUOTATION

RFQ: Gephart Electric
Rev #:
Date: July 19, 2010
Project: Stiles
Distributor: Cummins ESB – NA
Contact: Jim Beam

TABLE OF CONTENT **Page #**

SCOPE OF PROJECT:

PCC Utility Paralleling Equipment – (S-1004d)	**Qty**
• Paralleling Breaker Section	1
CPG System Architecture Type	*#1-MV*
System Voltage	12.47kV
System Frequency	60 Hz
System Phase and Wire	***3P/3W***
System Gensets (not provided in this proposal):	**Qty**
New Cummins Power Generation PCC 2,000kW Genset	1
Genset Mounted Paralleling Control	1
Existing Gensets	0
Future Gensets	1
System ATS's (not provided in this proposal):	
Hardwired	0
Networked	0
Not Known at This Time	0

System Load Add/Shed Scheme:

□ – Feeder Breaker Level

□ – ATS Level

□ – Not Known at This Time

"Special State/City/County Type Codes"

□ – Yes – Describe

X - No

CSA Field Inspection Required

□ – Yes

X - No

BILL OF MATERIAL

Qty	Item
1	**PCC Paralleling Control**

PCC Features:

- Microprocessor based control.
- AC Metering; both analog (% load, Hz, AC Volts, % Amperes) and RMS digital metering (AC Amps, AC Volts, Hz, KW, KWhours, Power factor).
- Generator Protection with Alarm and Status Indication.
- Engine Protection with Alarm and Status Indication.
- LED Alphanumeric Display – 2 lines, 16 characters per line.
- Amp Sentry™ for Paralleling Protection.
- Single membrane, dust-tight control face with gasket enclosure.
- Standard Emergency Stop.
- Genset "Run/Off/Auto" Selector Switch.
- Voltage Regulator.
- Isochronous Governor Control.
- Isochronous Paralleled Load Sharing.
- Breaker Control Push-Buttons.
- Automatic Synchronizer – Voltage and Phase Matching.
- Permissive Synchronizing Check Relay.
- Master First Start Sensor
- Smart Starting Control System - Fuel ramping, Cold Starting, Reduced Black Smoke.
- Battery Monitoring System – Weak Battery Indication.
- Engine start and stop (cooldown) time delays.
- Self Test Diagnostics.
- Service Diagnostic RS232 Port.
- Customer auxiliary contacts & NFPA 110 Alarm Relays

Amp Sentry™ Protective Features:

- Generator Set Overload
- Alternator Overcurrent
- Alternator Short Circuit
- Fail to Synchronize
- Circuit Breaker Fail to Close
- High and Low AC Voltage
- Reverse Power
- Under frequency
- Loss of Excitation
- Phase Rotation

POWERCOMMAND ™ MV PARALLELING METAL-CLAD SWITCHGEAR

Equipment Ratings	The paralleling equipment shall be rated for operation at the voltage, bus rating and configured as shown in the attached bill of material.
Equipment Construction	The Cummins Power Generation metal-clad switchgear with (one-high) construction and shall consist of a (indoor) enclosure containing circuit breakers and the necessary accessory components all factory assembled (except for necessary shipping splits) and operationally checked. The switchgear shall consist of separate compartments. These compartments shall be Circuit breaker, Main bus, and Cable each surrounded by grounded metal barriers. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating. ***The switchgear shall meet all applicable ANSI C37.20 standards***
Maximum Design Voltage	15.0kV
System Voltage	12.47kV
Main Bus Design	1200 Amp, 3 phase, 3 wire with 600 amp gnd bus
Circuit Breakers	1200 Amp, 500 mVA
Basic Impulse Level	60kV BIL
Power Frequency Withstand	19kV, 1 minute test
Main Bus Ampacity	1200 Amp, silver plated copper, continuous rated and insulated by a fluidized bed epoxy process.
Bus Supports	Glass Polyester
Control Power	The breaker shall be equipped with a capacitor trip unit (240vAC/20 second charge) fed by the switchgear 15kVA CPT.
Lugs	Terminator Pad with NEMA 4 Hole Pattern – No lugs provided.
Distribution Class Lightning Arrestor	(No)

Generator Paralleling Breaker Section: (Qty 1)

1 – 1200 Amp Vacuum Circuit Breaker - (electrically operated)
1 – Set Current Transformers
1 – Set of Potential Transformers: (120V Secondary)
1 – SEL-351-7 Multifunction Relay
1 – Breaker O/C Lights & Switch
1 – #86, Lockout Relay

Material/Accessories

1 – Charging handle to be furnished on the breaker mechanism

1 – Portable lifting device
1 – Set of spare control fuses for PT's
1 – Set of spare fuses for CPT's

Please Refer to the "Pricing Page" and the "Special Terms and Conditions" section, Item #12

Start-up - Start-up supervision by our service department for one trip. There is no additional charge for start-up supervision if additional time at the site or additional trips are required due to problems in our equipment. Start-up assistance is based on normal work week hours. Overtime, weekends, and holidays will require separate purchase order per published factory field service rates.

Start-up supervision must be scheduled by contacting the System Start-up Scheduler in the Service Department. The desired start-up date must be scheduled with four weeks advance notification if the start-up date is deemed critical. A start-up checklist, available from the Service Department at the time of scheduling, must be completed by the customer to confirm that the site is ready for start-up. Any additional trips which are required due to incomplete site preparation (i.e. incomplete interconnection wiring, incomplete retrofit of existing equipment, etc.) will require a separate purchase order.

3 **Operator's Manual -** Complete set of operator's manuals.

SEQUENCE OF OPERATION:

Utility Parallel Base Load:

Upon receipt of a remote start signal the paralleling equipment will start the genset. When the genset has reached proper voltage and frequency it will be synchronized with the utility source. When in phase, the Generator Paralleling Circuit Breaker will be closed.

The genset will gradually assume load and stop at the appropriate kW level depending on the locally (via genset control panel) adjustable Base Load percent level.

If the genset fails during paralleled operation the Generator Paralleling Circuit Breaker is opened and locked out. An alarm is displayed in this mode.

If the utility source fails during paralleled operation with the genset, protective relays will trip the Generator Paralleling Circuit Breaker and lock it out. An alarm is displayed in this mode.

Removal of Utility Parallel Base Load Signal:

If the remote start signal is removed, load will be gradually transferred back to the utility source. When the genset is sufficiently unloaded, the Generator Paralleling Circuit Breaker is opened. The genset will then go through a cooldown period before shutting down.

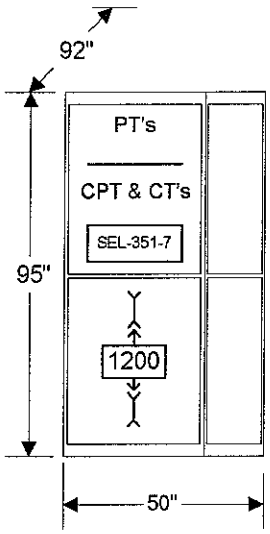
Manual Operation:

When the genset controls' mode select switch is placed in the "Run" position, the genset will start and accelerate to the correct operating frequency and voltage and automatically synchronize to the utility source. A trained operator then pushes the breaker close button on the genset and closes the Generator Paralleling Circuit Breaker. Once the breaker has been closed, the genset loading controls will load the genset to the pre-selected base load level.

Manual Shutdown:

The operator can manually open the Generator Paralleling Circuit Breaker and shut down the genset after an appropriate cooldown period.

SYSTEM LAYOUT



15kV
Power Section
&
Circuit Breaker

Drawing's Notes:

1. For Proposal use only. **Do not use for construction.** The information is preliminary and not final.
2. The customer/contractor is responsible for installing this equipment per applicable local codes.
3. The drawing is Not to scale.
4. Equipment requires front access only.

- **Enclosure - Power Section;** Rigid, free standing, metal enclosed steel structure with hinged key locking front doors for access to control circuitry; Control components are grouped together for convenient and safe access. Power circuit breakers and buswork are mounted in an adjacent structure.
- **Field Wiring** - Interconnections between genset and paralleling controls are made on a terminal block in the control section. Wiring, installation and termination shall be by others.

SPECIFICATION COMMENTS AND CLARIFICATIONS

- No drawings or specifications were provided.
- Approval from the local utility ***MUST*** be obtained before this equipment may be connected, and/or operated with the facility bus.
- This proposal is based upon using a Square D vacuum circuit breaker for the circuit breaker described. If a different brand and/or model of circuit breaker is required, additional pricing will be necessary.
- The price contained in this quotation is based on the sequence of operation either referenced to, and/or described in this document as it pertains to the equipment indicated on page 7. Any variations to this sequence, and/or any additional circuit breakers, switches, fuses, etc., to supply, monitor and/or control will require re-pricing.
- The supply and specification compliance of the generator sets, any ATS's, enclosures, annunciator panels, and their associated accessories will be the responsibility of the quoting distributor.
- Engine/Generator control and monitoring, voltage regulation, paralleling, synchronizing, and some protective circuits will be accomplished via PowerCommand™ Control and/or PowerCommand™ Paralleling.
    1. The digital display on the PowerCommand genset paralleling control includes a synchroscope function for monitoring the phase difference (in degrees, faster or slower than bus) between the generator set and the system bus. An indicator is provided to advise the operator when the generator set is within specified paralleling parameters.
    2. Paralleling control functions (synchronizing, load sharing, etc.) and paralleling protective functions (O/U bus voltage/frequency, overload, and phase protection) are provided by the PowerCommand generator set controls that are resident on the gensets.
- ***UL1670 Label Clarification*** – Information per the UL Website: SU 1670, Medium Voltage Circuit Breakers and Metal-Clad Switchgear (Being developed, no scope available). *The Cummins Power Generation File, E212682 allows us to purchase UR switchgear from Square D, Cutler-Hammer, GE, Siemens and any other vendor that provides Listed DLAH Switchgear, add any UL listed components and put our UL label on the switchgear.*