Appendix A: Cummins Data Sheet

Model: 2000GQNC
Frequency: 50 Hz
Fuel Type: Natural Gas MI 75 +
Emissions Performance NOx: 250 mg/Nm^3 (0.6 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:	0500-5095

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	4943 (16.88)	4601 (15.71)	3851 (13.15)	2774 (9.47)
Mechanical Efficiency ISO3046/1, percent	2,4,7	41.5%	40.2%	40.2%	37.4%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	40.5%	39.1%	38.9%	36.1%

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)	2066 (2769)
BMEP, bar (psi)	18.3 (265)
Bore, mm (in)	180 (7.09)
Stroke, mm (in)	200 (7.87)
Rated Speed, rpm	1500
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	75

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)	6.07 (19.9)
Genset Width, m (ft)	2.16 (7.1)
Genset Height, m (ft)	2.78 (9.1)
Genset Weight (wet), kg (lbs)	20477 (45,144)

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	See Notes	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Energy Data					
Continuous Generator Electrical Output kWe @ 1.0 pf	6,10	2000	1800	1500	1000
Continuous Shaft Power, kWm (bhp)	2,10	2066.115702	1859.504132	1551.189245	1039.50104
Heat Dissipated in Lube Oil Cooler, kW (MMBTU/h)	5	273 (0.93)	250 (0.85)	226 (0.77)	186 (0.63)
Heat Dissipated in Block, kW (MMBTU/h)	5	542 (1.85)	519 (1.77)	465 (1.59)	386 (1.32)
Total Heat Rejected in LT Circuit, kW (MMBTU/h)	5	138 (0.47)	124 (0.42)	113 (0.39)	86 (0.29)
Total Heat Rejected in HT Circuit, kW (MMBTU/h)	5	1180 (4.03)	1062 (3.62)	881 (3.00)	622 (2.12)
Unburnt, kW (MMBTU/h)	13	134 (0.46)	124 (0.42)	106 (0.36)	74 (0.25)
Heat Radiated to Ambient, kW (MMBTU/h)	13	324 (1.11)	300 (1.02)	252 (0.86)	184 (0.63)
Available Exhaust heat to 105C, kW (MMBTU/h)	5	1283 (4.38)	1209 (4.13)	1016 (3.47)	792 (2.70)
Intake Air Flow					
Intake Air Flow Mass, kg/s (lb/hr)	4	3.20 (25366)	2.92 (23128)	2.44 (19293)	1.65 (13043)
Intake Air Flow Volume, m3/s @ 0°C (scfm)	4	2.48 (5531)	2.26 (5043)	1.88 (4207)	1.27 (2844)
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	3.31 (26246)	3.02 (23946)	2.52 (19987)	1.71 (13538)
Exhaust Gas Flow Volume, m3/s (cfm)	4	6.80 (14391)	6.29 (13318)	5.38 (11389)	3.86 (8176)
Exhaust Temperature After Turbine, °C (°F)	2,6	451 (844)	462 (863)	480 (895)	525 (976)
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	52.2 (126)	52.0 (126)	51.7 (125)	51.4 (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	78	78	78	78
NO_x Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	5	250 (0.50)	250 (0.50)	250 (0.50)	250 (0.50)
THC Emissions wet, ppm	13	1640	1665	1702	1765
THC Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	1792	1811	1836	1841
CH_4 Emissions wet, ppm	13	1241	1257	1277	1312
CH_4 Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	1378 3.01	1388 3.03	1399 3.09	1389 3.25
NMHC Emissions wet, ppm	13	399	409	425	454
NMHC Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	436	445	459	473
CO Emissions (dry), ppm	13	582	570	561	526
CO Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	1003 (2.19)	977 (2.13)	953 (2.10)	859 (2.01)
O2 Emissions (dry), percent	13	9.4	9.3	9.2	8.7
Particulates PM10, g/hp-h	13	Not recorded	Not recorded	Not recorded	Not recorded

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.

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.

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									

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.

Methane Number Capability

Load (Percent of Rated)			
100%	90%	75%	50%
75	69	n/a	n/a

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
380-440	Wye, 3 Phase	105	C	N/A	9720	517	B551-2
400-415	Wye, 3 Phase	105	C	N/A	6758	516	B792-2
380-440	Wye, 3 Phase	125	C	N/A	6758	516	B584-2
3300	Wye, 3 Phase	80	C	N/A	7040	520	B592-2
3300	Wye, 3 Phase	105	C	N/A	6316	519	B471-2
6600	Wye, 3 Phase	80C	C	N/A	7040	520	B828-2
6600	Wye, 3 Phase	105	C	N/A	6076	522	B793-2
6300-6600	Wye, 3 Phase	105	C	N/A	6932	523	B576-2
10000	Wye, 3 Phase	80	C	N/A	6627	523	B794-2
10000	Wye, 3 Phase	105	C	N/A	5812	522	B474-2
10.5-11.0 kV	Wye, 3 Phase	105	C	N/A	6784	523	B495-2
11000	Wye, 3 Phase	80	C	N/A	6784	523	B594-2
11000	Wye, 3 Phase	105	C	N/A	5896	522	B478-2

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% or efficiency tolerance of +0% -5%.

5) Production variation/tolerance ±5%.

6) At electrical output of 1.0 Power Factor.

7) Tested using pipeline natural gas with LHV of 33.44mJ/Nm3 (905BTU/ft3)

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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