G3516H

GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1500	RATING STRATEGY:	HIGH EFFICIENCY
COMPRESSION RATIO:	12.1:1	FUEL:	Nat Gas
AFTERCOOLER TYPE:	SCAC	FUEL SYSTEM:	CAT LOW PRESSURE
AFTERCOOLER - STAGE 2 INLET (°C):	48		WITH AIR FUEL RATIO CONTROL
AFTERCOOLER - STAGE 1 INLET (°C):	92	FUEL PRESSURE RANGE(kPag):	10-35
JACKET WATER OUTLET (°C):	99	FUEL METHANE NUMBER:	85
ASPIRATION:	TA	FUEL LHV (MJ/Nm3):	35.64
COOLING SYSTEM:	JW+OC+1AC, 2AC	ALTITUDE CAPABILITY AT 25°C INLET AIR TEMP. (m):	1200
CONTROL SYSTEM:	ADEM4 W/ IM	APPLICATION:	Genset
EXHAUST MANIFOLD:	DRY	POWER FACTOR:	0.8
COMBUSTION:	Low Emission	VOLTAGE(V):	400-11000
NOx EMISSION LEVEL (mg/Nm3 NOx):	500		

RATING		NOTES	LOAD	100%	75%	50%
GENSET POWER	(WITHOUT FAN)	(1)(2)	ekW	2000	1500	1000
GENSET POWER	(WITHOUT FAN)	(1)(2)	kVA	2500	1875	1250
ENGINE POWER	(WITHOUT FAN)	(2)	bkW	2077	1553	1044
GENERATOR EFFICIENCY		(1)	%	96.3	96.6	95.8
GENSET EFFICIENCY(@ 1.0 Power Factor)	(ISO 3046/1)	(3)(4)	%	44.7	43.7	41.5
THERMAL EFFICIENCY		(3)(5)	%	41.8	43.4	46.1
TOTAL EFFICIENCY (@ 1.0 Power Factor)		(3)(6)	%	86.5	87.1	87.6
ENGINE DATA						
GENSET FUEL CONSUMPTION	(ISO 3046/1)	(7)	MJ/ekW-hr	8.16	8.32	8.77
GENSET FUEL CONSUMPTION	(NOMINAL)	(7)	MJ/ekW-hr	8.44	8.60	9.07
ENGINE FUEL CONSUMPTION	(NOMINAL)	(7)	MJ/bkW-hr	8.13	8.31	8.69
AIR FLOW (0°C, 101.3 kPa)	(WET)	(8)	Nm3/bkW-hr	3.81	3.82	3.86
AIR FLOW	(WET)	(8)	kg/bkW-hr	4.92	4.93	4.99
FUEL FLOW (0ºC, 101.3 kPa)			Nm3/hr	474	362	255
COMPRESSOR OUT PRESSURE			kPa(abs)	482	362	253
COMPRESSOR OUT TEMPERATURE			°C	238	195	143
AFTERCOOLER AIR OUT TEMPERATURE			°C	52	51	51
INLET MAN. PRESSURE		(9)	kPa(abs)	457	339	232
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(10)	°C	53	52	52
TIMING		(11)	°BTDC	22	20	16
EXHAUST TEMPERATURE - ENGINE OUTLET		(12)	°C	395	428	477
EXHAUST GAS FLOW (0 °C, 101.3 kPa)	(WET)	(13)	Nm3/bkW-hr	4.04	4.06	4.12
EXHAUST GAS MASS FLOW	(WET)	(13)	kg/bkW-hr	5.10	5.11	5.18
MAX INLET RESTRICTION		(14)	kPa	2.50	1.39	0.61
MAX EXHAUST RESTRICTION		(14)	kPa	5.00	2.78	1.31
EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)	(corr. to 5% O2)	(15)(16)	mg/Nm3 DRY	500	500	500
CO	(corr. to 5% O2)	(15)(17)	mg/Nm3 DRY	1164	1073	1009
THC (mol. wt. of 15.84)	(corr. to 5% O2)	(15)(17)	mg/Nm3 DRY	2313	2390	2351
NMHC (mol. wt. of 15.84)	(corr. to 5% O2)	(15)(17)	mg/Nm3 DRY	393	406	400
NMNEHC (VOCs) (mol. wt. of 15.84)	(corr. to 5% O2)	(15)(17)(18)	mg/Nm3 DRY	370	382	376
HCHO (Formaldehyde)	(corr. to 5% O2)	(15)(17)	mg/Nm3 DRY	195	197	201
CO2	(corr. to 5% O2)	(15)(17)	g/Nm3 DRY	213	209	208
EXHAUST OXYGEN		(15)(19)	% DRY	10.0	9.6	9.0
LAMBDA		(15)(19)		1.75	1.71	1.66
ENERGY BALANCE DATA						
LHV INPUT		(20)	kW	4690	3586	2521
HEAT REJECTION TO JACKET WATER (JW)		(21)(28)	kW	472	399	322
HEAT REJECTION TO ATMOSPHERE		(22)	kW	77	64	52
HEAT REJECTION TO LUBE OIL (OC)		(23)(28)	kW	185	166	144
HEAT REJECTION TO EXHAUST (LHV TO 25°C)		(24)(25)	kW	1283	1060	812
HEAT REJECTION TO EXHAUST (LHV TO 120°C)		(24)	kW	865	740	592
HEAT REJECTION TO A/C - STAGE 1 (1AC)		(26)(28)	kW	380	202	68
HEAT REJECTION TO A/C - STAGE 2 (2AC)		(27)(29)	kW	216	143	81

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1. (Standard reference conditions of 25°C, 100 kPa barometric pressure.) No overload permitted at rating shown. Consult the altitude deration factor chart for applications that exceed the rated altitude or temperature.

Emission levels are at engine exhaust flange prior to any after treatment. Values are based on engine operating at steady state conditions, adjusted to the specified NOx level at 100% load and corrected to 5 % exhaust oxygen. Tolerances specified are dependent upon fuel quality. Fuel methane number cannot vary more than ± 3.

For notes information consult page three.

FUEL USAGE GUIDE

CAT METHANE NUMBER	50	55	60	65	70	75	80	85	100
SET POINT TIMING	16	16	16	16	16	16	19	22	22
DERATION FACTOR	0.60	0.70	0.80	0.85	0.90	1	1	1	1

ALTITUDE DERATION FACTORS AT RATED SPEED

INLET AIR TEMP °C	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
50	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
45	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
40	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
35	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
30	1	1	1	1	0.97	0.93	0.90	0.86	0.82	0.79	0.75	0.71	0.67
25	1	1	1	1	1	0.99	0.97	0.94	0.91	0.88	0.85	0.82	0.80
20	1	1	1	1	1	0.99	0.97	0.94	0.91	0.88	0.85	0.82	0.80
15	1	1	1	1	1	0.99	0.97	0.94	0.91	0.88	0.85	0.82	0.80
10	1	1	1	1	1	0.99	0.97	0.94	0.91	0.88	0.85	0.82	0.80

ALTITUDE (METERS ABOVE SEA LEVEL)

AFTERCOOLER HEAT REJECTION FACTORS (ACHRF)

INLET AIR TEMP °C	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
50	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
45	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
40	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
35	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
30	1.03	1.06	1.08	1.11	1.14	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
25	1	1.01	1.04	1.07	1.09	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
20	1	1	1	1.02	1.05	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
15	1	1	1	1	1	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
10	1	1	1	1	1	1	1	1	1	1	1	1	1

ALTITUDE (METERS ABOVE SEA LEVEL)

FUEL USAGE GUIDE:

This table shows the derate factor and full load set point timing required for a given fuel. Note that deration and set point timing reduction may be required as the methane number decreases. Methane number is a scale to measure detonation characteristics of various fuels. The methane number of a fuel is determined by using the Caterpillar methane number calculation program.

ALTITUDE DERATION FACTORS:

This table shows the deration required for various air inlet temperatures and altitudes. Use this information along with the fuel usage guide chart to help determine actual engine power for your site.

ACTUAL ENGINE RATING:

To determine the actual rating of the engine at site conditions, one must consider separately, limitations due to fuel characteristics and air system limitations. The Fuel Usage Guide deration establishes fuel limitations. The Altitude/Temperature deration factors and RPC (reference the Caterpillar Methane Program) establish air system limitations. RPC comes into play when the Altitude/Temperature deration is less than 1.0 (100%). Under this condition, add the two factors together. When the site conditions do not require an Altitude/ Temperature derate (factor is 1.0), it is assumed the turbocharger has sufficient capability to overcome the low fuel relative power, and RPC is ignored. To determine the actual power available, take the lowest rating between 1) and 2).

1) Fuel Usage Guide Deration
2) 1-((1-Altitude/Temperature Deration) + (1-RPC))

AFTERCOOLER HEAT REJECTION FACTORS(ACHRF):

To maintain a constant air inlet manifold temperature, as the inlet air temperature goes up, so must the heat rejection. As altitude increases, the turbocharger must work harder to overcome the lower atmospheric pressure. This increases the amount of heat that must be removed from the inlet air by the aftercooler. Use the aftercooler heat rejection factor (ACHRF) to adjust for inlet air temp and altitude conditions. See notes 28 and 29 for application of this factor in calculating the heat exchanger sizing criteria. Failure to properly account for these factors could result in detonation and cause the engine to shutdown or fail.

INLET AND EXHAUST RESTRICTIONS FOR ALTITUDE CAPABILITY:

The altitude derate chart is based on the maximum inlet and exhaust restrictions provided on page 1. Contact factory for restrictions over the specified values. Heavy Derates for higher restrictions will apply.

NOTES:

1. Generator efficiencies, power factor, and voltage are based on standard generator. [Genset Power (ekW) is calculated as: Engine Power (bkW) x Generator Efficiency], [Genset Power (kVA) is calculated as: Engine Power (bkW) x Generator Efficiency / Power Factor]
2. Rating is without engine driven water pumps. Tolerance is (+)3, (-)0% of full load.
3. Efficiency represents a Closed Crankcase Ventalation (CCV) system installed on the engine.
4. ISO 3046/1 Genset efficiency tolerance is (+)0, (-)5% of full load % efficiency value based on a 1.0 power factor.
5. Thermal Efficiency is calculated based on energy recovery from the jacket water, lube oil, 1st stage aftercooler, and exhaust to 120ºC with engine operation at ISO 3046/1 Genset Efficiency, and assumes unburned fuel is converted in an oxidation catalyst.
6. Total efficiency is calculated as: Genset Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.
7. ISO 3046/1 Genset fuel consumption tolerance is (+)5, (-)0% of full load data. Nominal genset and engine fuel consumption tolerance is ± 1.5% of full load data.
8. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.
9. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.
10. Inlet manifold temperature is a nominal value with a tolerance of ± 5°C.
11. Timing indicated is for use with the minimum fuel methane number specified. Consult the appropriate fuel usage guide for timing at other methane numbers.
12. Exhaust temperature is a nominal value with a tolerance of (+)35°C, (-)30°C.
13. Exhaust flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 6 %.
14. Inlet and Exhaust Restrictions are maximum allowed values at the corresponding loads. Increasing restrictions beyond what is specified will result in a significant engine derate.
15. Emissions data is at engine exhaust flange prior to any after treatment.
16. NOx tolerances are ± 18% of specified value.
17. CO, CO2, THC, NMHC, NMNEHC, and HCHO values are "Not to Exceed" levels. THC, NMHC, and NMNEHC do not include aldehydes. An oxidation catalyst may be required to meet Federal, State or local CO or HC requirements.
18. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
19. Exhaust Oxygen tolerance is ± 0.5; Lambda tolerance is ± 0.05. Lambda and Exhaust Oxygen level are the result of adjusting the engine to operate at the specified NOx level.
20. LHV rate tolerance is ± 1.5%.
21. Heat rejection to jacket water value displayed includes heat to jacket water alone. Value is based on treated water. Tolerance is ± 10% of full load data.
22. Heat rejection to atmosphere based on treated water. Tolerance is ± 50% of full load data.
23. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
24. Exhaust heat rate based on treated water. Tolerance is ± 10% of full load data.
25. Heat rejection to exhaust (LHV to 25°C) value shown includes unburned fuel and is not intended to be used for sizing or recovery calculations.
26. Heat rejection to A/C - Stage 1 based on treated water. Tolerance is ±5% of full load data.
27. Heat rejection to A/C - Stage 2 based on treated water. Tolerance is ±5% of full load data.
28. Total Jacket Water Circuit heat rejection is calculated as: (JW x 1.1) + (OC x 1.2) + (1AC x 1.05) + [0.815 x (1AC + 2AC) x (ACHRF - 1) x 1.05]. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.
29. Total Second Stage Aftercooler Circuit heat rejection is calculated as: (2AC x 1.05) + [(1AC + 2AC) x 0.185 x (ACHRF - 1) x 1.05]. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.

FREE FIELD MECHANICAL & EXHAUST NOISE

MECHANICAL: Sound Power (1/3 Octave Frequencies)

Gen Power Without Fan	Percent Load	Engine Power	Overall	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
ekW	%	bkW	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2000	100	2077	122.8	89.1	88.5	93.6	94.9	95.7	99.9	100.2	102.8	103.3	104.0
1500	75	1553	118.4	87.5	85.1	92.3	91.6	93.8	97.6	97.5	100.6	102.3	103.4
1000	50	1044	115.4	85.8	82.0	89.0	89.8	92.8	96.8	95.3	100.3	100.8	103.0

MECHANICAL: Sound Power (1/3 Octave Frequencies)

Gen Power Without Fan	Percent Load	Engine Power	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz
ekW	%	bkW	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2000	100	2077	102.5	104.3	105.3	104.7	105.0	105.2	105.5	110.0	121.5	103.9	99.6
1500	75	1553	101.4	103.1	104.0	103.6	104.8	106.1	107.3	115.5	107.1	103.3	102.3
1000	50	1044	100.8	101.5	102.1	102.4	103.9	105.4	109.0	106.5	102.9	102.4	96.7

EXHAUST: Sound Power (1/3 Octave Frequencies)

Gen Power Without Fan	Percent Load	Engine Power	Overall	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
ekW	%	bkW	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2000	100	2077	125.5	98.9	102.2	108.0	109.8	106.2	109.2	110.4	112.2	113.5	112.4
1500	75	1553	121.4	98.4	102.7	107.7	107.8	101.0	100.5	99.6	103.1	105.2	102.8
1000	50	1044	119.3	99.0	100.4	102.5	106.6	97.3	95.2	95.1	102.8	100.3	101.9

EXHAUST: Sound Power (1/3 Octave Frequencies)

Gen Power Without Fan	Percent Load	Engine Power	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz
ekW	%	bkW	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2000	100	2077	112.9	113.7	113.8	115.0	115.9	115.6	114.1	111.4	115.6	109.0	105.4
1500	75	1553	105.2	107.3	109.3	110.8	112.8	113.0	111.6	112.1	108.9	105.7	103.4
1000	50	1044	103.1	104.8	108.4	108.9	110.1	110.9	110.6	109.6	105.9	104.3	101.1

SOUND PARAMETER DEFINITION:

Sound Power Level Data - DM8702-01

Sound power is defined as the total sound energy emanating from a source irrespective of direction or distance. Sound power level data is presented under two index headings:
Sound power level -- Mechanical
Sound power level -- Exhaust

Mechanical: Sound power level data is calculated in accordance with ISO 6798. The data is recorded with the exhaust sound source isolated.

Exhaust: Sound power level data is calculated in accordance with ISO 6798 Annex A.

Measurements made in accordance with ISO 6798 for engine and exhaust sound level only. No cooling system noise is included unless specifically indicated. Sound level data is indicative of noise levels recorded on one engine sample in a survey grade 3 environment.

How an engine is packaged, installed and the site acoustical environment will affect the site specific sound levels. For site specific sound level guarantees, sound data collection needs to be done on-site or under similar conditions.