

**ATTACHMENT D-1  
SUPPORTING DOCUMENTS**

**VENDOR DATA**

**COMPRESSOR ENGINES**

- CAT 1,340 bhp G3516LE Engine Specifications
- CAT 1,340 bhp G3516LE Engine Specifications
  - EMIT OxCat Specifications

Engine 3

CATERPILLAR

**G3516 LE**

GAS COMPRESSION APPLICATION

**GAS ENGINE SITE SPECIFIC TECHNICAL DATA**

ENGINE SPEED (rpm): 1400  
 COMPRESSION RATIO: 8:1  
 AFTERCOOLER WATER INLET (°F): 130  
 JACKET WATER OUTLET (°F): 210  
 COOLING SYSTEM: JW+OC, AC  
 IGNITION SYSTEM: ADEM3  
 EXHAUST MANIFOLD: ASWC  
 COMBUSTION: Low Emission  
 NOx EMISSION LEVEL (g/bhp-hr NOx): 2.0  
 SET POINT TIMING: 33.0

**FUEL SYSTEM:**

HPG IMPCO  
 WITH AIR FUEL RATIO CONTROL

**SITE CONDITIONS:**

FUEL: Williams Springfield  
 FUEL PRESSURE RANGE(psig): 35.0-40.0  
 FUEL METHANE NUMBER: 87.6  
 FUEL LHV (Btu/scf): 929  
 ALTITUDE(ft): 500  
 MAXIMUM INLET AIR TEMPERATURE(°F): 77  
 NAMEPLATE RATING: 1340 bhp@1400rpm

RATING	NOTES	LOAD	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE			
			100%	100%	75%	50%
ENGINE POWER	(1)	bhp	1340	1340	1005	670
INLET AIR TEMPERATURE		°F	77	77	77	77

ENGINE DATA						
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	7547	7547	7775	8326
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	8377	8377	8629	9241
AIR FLOW	(3)(4)	lb/hr	12619	12619	9519	6566
AIR FLOW WET (77°F, 14.7 psia)	(3)(4)	scfm	2846	2846	2147	1481
INLET MANIFOLD PRESSURE	(5)	in Hg(abs)	70.9	70.9	55.8	39.8
EXHAUST STACK TEMPERATURE	(6)	°F	873	873	873	877
EXHAUST GAS FLOW (@ stack temp, 14.5 psia)	(7)(4)	ft <sup>3</sup> /min	7646	7646	5774	4003
EXHAUST GAS MASS FLOW	(7)(4)	lb/hr	13095	13095	9887	6828

EMISSIONS DATA						
NOx (as NO2)	(8)	g/bhp-hr	2.00	2.00	2.00	2.00
CO	(8)	g/bhp-hr	1.85	1.85	1.94	2.09
THC (mol. wt. of 15.84)	(8)	g/bhp-hr	2.63	2.63	2.76	2.95
NMHC (mol. wt. of 15.84)	(8)	g/bhp-hr	0.40	0.40	0.41	0.44
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.26	0.26	0.28	0.29
HCHO (Formaldehyde)	(8)	g/bhp-hr	0.26	0.26	0.27	0.29
CO2	(8)	g/bhp-hr	470	470	478	503
EXHAUST OXYGEN	(10)	% DRY	8.1	8.1	8.0	7.8

HEAT REJECTION						
HEAT REJ. TO JACKET WATER (JW)	(11)	Btu/min	42218	42218	35156	29041
HEAT REJ. TO ATMOSPHERE	(11)	Btu/min	5313	5313	4428	3543
HEAT REJ. TO LUBE OIL (OC)	(11)	Btu/min	6296	6296	5243	4331
HEAT REJ. TO AFTERCOOLER (AC)	(11)(12)	Btu/min	9535	9535	6174	2150

HEAT EXCHANGER SIZING CRITERIA			
TOTAL JACKET WATER CIRCUIT (JW+OC)	(12)	Btu/min	53996
TOTAL AFTERCOOLER CIRCUIT (AC)	(12)(13)	Btu/min	10012

A cooling system safety factor of 0% has been added to the heat exchanger sizing criteria.

**CONDITIONS AND DEFINITIONS**

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature.  
 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature.  
 Max. rating is the maximum capability for the specified fuel at site altitude and reduced inlet air temperature.  
 Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

Engine 2

G3516 LE

GAS ENGINE TECHNICAL DATA  
DM5155 - 5



ENGINE SPEED (rpm):	1400	FUEL:	Nat Gas
COMPRESSION RATIO:	8:1	FUEL SYSTEM:	HPG IMPCO with Air Fuel Ratio Control
AFTERCOOLER WATER INLET (°F):	130	FUEL PRESSURE RANGE (psi):	35.0-40.0
JACKET WATER OUTLET (°F):	210	RATED METHANE NUMBER:	80
COOLING SYSTEM:	JW+OC, AC	FUEL LHV (Btu/acf):	905
IGNITION SYSTEM:	EIS	ALTITUDE CAPABILITY (ft):	4900
EXHAUST MANIFOLD:	ASWC	INLET AIR TEMP. (°F):	77
COMBUSTION:	Low Emission	APPLICATION:	Gas Compression
NOx EMISSION LEVEL (g/bhp-hr):	1.5		

TEST CONDITION	NO. TESTS	UNIT	1340	1805	670
ENGINE POWER (ISO 3046/1)	(1)	bhp	1340	1805	670
ENGINE EFFICIENCY (ISO 3046/1)	(2)	%	34.4	33.2	31.3
ENGINE EFFICIENCY (NOMINAL)	(2)	%	33.7	32.6	30.7

TEST CONDITION	NO. TESTS	UNIT	1340	1805	670
FUEL CONSUMPTION (ISO 3046/1)	(3)	Btu/bhp-hr	7401	7637	8128
FUEL CONSUMPTION (NOMINAL)	(3)	Btu/bhp-hr	7343	7806	8286
AIR FLOW (@ 0 C, 101.3 kPa) (WET)	(4)	Nm <sup>3</sup> /bhp-hr	4.5	4.64	4.4
AIR FLOW (@ 77 F, 14.7 psia) (WET)	(4)	scfm	2886	2232	1413
AIR FLOW (WET)	(4)	lb/hr	12795	9896	6263
COMPRESSOR OUT PRESSURE		Hg(aba)	79.9	76.2	57.3
COMPRESSOR OUT TEMPERATURE		F	334	306	228
AFTERCOOLER AIR OUT TEMPERATURE		F	132	129	129
INLET MAN. PRESSURE	(5)	Hg(aba)	69.9	55	39.1
INLET MAN. TEMPERATURE (MEASURED IN PLENUM)	(6)	F	139	137	136
TIMING	(7)	BTDC	33	33	33
EXHAUST STACK TEMPERATURE	(8)	F	854	840	842
EXHAUST GAS FLOW (@ 0 C 101.3 kPa) (WET)	(9)	Nm <sup>3</sup> /bhp-hr	4.8	4.96	4.74
EXHAUST GAS FLOW (@ Stack Temp. 14.5 psia) (WET)	(9)	ft <sup>3</sup> /min	765.1	783.3	373.8
EXHAUST MASS FLOW (WET)	(9)	lb/hr	13305	10292	6543

TEST CONDITION	NO. TESTS	UNIT	1340	1805	670
NOx (as NO2) (corr. 3% O2)	(10)	mg/kwh dry	604	574	598
NOx (as NO2) (uncorrected)	(10)	ppm dry exh	233	226	240
NOx (as NO2)	(10)	ton/year	19.4	14.56	9.7
NOx g/bhp-hr (as NO2)	(10)	g/bhp-hr	1.5	1.3	1.5
NOx g/bhp-hr (as NO2)	(10)	g/bhp-hr	2.01	2.01	2.01
NOx ppm (as NO2) (corr. 3% O2)	(10)	ppm dry exh	294	280	291
CO (corr. 3% O2)	(11)	mg/kwh dry	759	752	755
CO (uncorrected)	(11)	ppm dry exh	481	486	498
CO	(11)	ton/year	24.41	19.06	12.26
CO g/bhp-hr	(11)	g/bhp-hr	1.89	1.96	1.9
CO g/bhp-hr	(11)	g/bhp-hr	2.53	2.63	2.54
CO ppm (corr. 3% O2)	(11)	ppm dry exh	607	601	604
THC (molecular wt. of 15.84) (corr. 3% O2)	(11)	mg/kwh dry	1236	1301	1436
THC (molecular wt. of 15.84) (uncorrected)	(11)	ppm dry exh	1386	1488	1674
THC (molecular wt. of 15.84)	(11)	ton/year	39.75	33	23.31
THC g/bhp-hr (molecular wt. of 15.84)	(11)	g/bhp-hr	3.07	3.4	3.6
THC g/bhp-hr (molecular wt. of 15.84)	(11)	g/bhp-hr	4.12	4.56	4.83
THC ppm (molecular wt. of 15.84) (corr. 3% O2)	(11)	ppm dry exh	1749	1841	2032
NMHC (molecular wt. of 13.84) (corr. 3% O2)	(11)	mg/kwh dry	185	195	215
NMHC (molecular wt. of 13.84) (uncorrected)	(11)	ppm dry exh	208	223	251
NMHC (molecular wt. of 13.84)	(11)	ton/year	5.96	4.95	3.5
NMHC g/bhp-hr (molecular wt. of 13.84)	(11)	g/bhp-hr	0.46	0.51	0.54
NMHC g/bhp-hr (molecular wt. of 13.84)	(11)	g/bhp-hr	0.62	0.68	0.72
NMHC ppm (molecular wt. of 13.84) (corr. 3% O2)	(11)	ppm dry exh	262	276	305
NMNEHC (molecular wt. of 15.84) (corr. 3% O2)	(11)	mg/kwh dry	124	130	144
NMNEHC (molecular wt. of 15.84) (uncorrected)	(11)	ppm dry exh	139	149	167
NMNEHC (molecular wt. of 15.84)	(11)	ton/year	3.97	3.3	2.33
NMNEHC g/bhp-hr (molecular wt. of 15.84)	(11)	g/bhp-hr	0.31	0.34	0.36
NMNEHC g/bhp-hr (molecular wt. of 15.84)	(11)	g/bhp-hr	0.41	0.46	0.48
NMNEHC ppm (molecular wt. of 15.84) (corr. 3% O2)	(11)	ppm dry exh	175	184	203
HCHO (Formaldehyde) (corr. 3% O2)	(11)	mg/kwh dry	101	106	120
HCHO (Formaldehyde) (uncorrected)	(11)	ppm dry exh	60	64	74
HCHO (Formaldehyde)	(11)	ton/year	3.24	2.68	1.94
HCHO g/bhp-hr (Formaldehyde)	(11)	g/bhp-hr	0.25	0.28	0.3

# G3516 LE

## GAS ENGINE TECHNICAL DATA DM5155-5

CATERPILLAR®

EMISSIONS DATA (cont'd)		NOTE	LOAD	100%	75%	50%
HCHO g/bk-w-hr (Formaldehyde)		(11)	g/bk W-hr	0.34	0.37	0.4
HCHO ppm (Formaldehyde)	(cont. 5% O <sub>2</sub> )	(11)	ppm dry exh	75	79	89
CO <sub>2</sub>	(cont. 5% O <sub>2</sub> )	(11)	mg/m <sup>3</sup> dry	156	157	177
CO <sub>2</sub>		(11)	ton/year	6348	4926	3486
CO <sub>2</sub> % Dry	(uncorrected)	(11)	% Dry	7.97	7.99	9.01
CO <sub>2</sub> g/bhp-hr		(11)	g/bhp-hr	491	508	530
CO <sub>2</sub> g/bk-w-hr		(11)	g/bk W-hr	658	681	722
EXHAUST O <sub>2</sub>		(12)	% Dry	8.3	8	7.8
LAMBDA		(12)		1.58	1.57	1.41

ENERGY BALANCE		NOTE	LOAD	100%	75%	50%
LHV INPUT		(13)	Btu/min	168509	130756	92523
HEAT REJECTION TO JACKET		(14)	Btu/min	41216	34469	29653
HEAT REJECTION TO ATMOSPHERE		(15)	Btu/min	5313	4428	3543
HEAT REJECTION TO LUBE OIL		(16)	Btu/min	6517	5450	4689
HEAT REJECTION TO EXHAUST (LHV to 25C)		(17)	Btu/min	47381	35910	22892
HEAT REJECTION TO EXHAUST (LHV to 177C)		(17)	Btu/min	30096	22591	14530
HEAT REJECTION TO AFTERCOOLER		(18)	Btu/min	10426	7047	2497
PUMP POWER		(19)	Btu/min	838	838	838

### CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1. (Standard reference conditions of 77F, 29.6 in Hg barometric pressure, 500 ft altitude.) No overload permitted at rating shown. Consult altitude curves for applications above maximum rated altitude and/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 NO<sub>x</sub> level at 100% load. Tolerances specified are dependent upon fuel quality. Fuel methane number cannot vary more than +/- 3. Part load data may require engine adjustment.

FUEL USAGE GUIDE													
CAT METHANE NUMBER	25	30	35	40	45	50	55	60	65	70	75	80	100
IGNITION TIMING	0.00	19	21	22	23	24	26	27	28	30	31	33	33
DERATION FACTOR	0.00	0.90	0.90	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

AIR TO TURBO															
AIR TO TURBO *F	130	1.00	1.00	1.00	0.98	0.94	0.91	0.87	0.84	0.81	0.77	0.74	0.71	0.68	
	120	1.00	1.00	1.00	1.00	0.96	0.92	0.89	0.85	0.82	0.79	0.76	0.72	0.70	
	110	1.00	1.00	1.00	1.00	0.98	0.94	0.90	0.87	0.83	0.80	0.77	0.74	0.71	
	100	1.00	1.00	1.00	1.00	0.99	0.96	0.92	0.88	0.85	0.81	0.78	0.75	0.72	
	90	1.00	1.00	1.00	1.00	1.00	0.97	0.94	0.90	0.86	0.83	0.80	0.76	0.73	
	80	1.00	1.00	1.00	1.00	1.00	0.99	0.95	0.92	0.88	0.84	0.81	0.78	0.75	
	70	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.93	0.90	0.86	0.83	0.79	0.76	
	60	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.95	0.91	0.88	0.84	0.81	0.78	
	50	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.93	0.89	0.86	0.83	0.80	0.76	
			0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
	ALTITUDE (FEET ABOVE SEA LEVEL)														

AIR TO TURBO															
AIR TO TURBO *F	130	1.36	1.42	1.48	1.54	1.60	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	
	120	1.28	1.34	1.40	1.46	1.52	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	
	110	1.21	1.27	1.33	1.39	1.45	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	
	100	1.14	1.20	1.25	1.31	1.37	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	
	90	1.07	1.12	1.18	1.23	1.29	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	
	80	1.00	1.05	1.10	1.16	1.22	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	
	70	1.00	1.00	1.03	1.08	1.14	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	
	60	1.00	1.00	1.00	1.01	1.06	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	
	50	1.00	1.00	1.00	1.00	1.00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	
			0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
	ALTITUDE (FEET ABOVE SEA LEVEL)														

MINIMUM FUEL FLOW RATE															
AIR TO TURBO *F	130	1110	1190	1340	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	
	120	1060	1150	1270	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	
	110	1050	1120	1190	1350	1400	1400	1400	1400	1400	1400	1400	1400	1400	
	100	1020	1090	1160	1280	1400	1400	1400	1400	1400	1400	1400	1400	1400	
	90	1000	1060	1120	1200	1360	1400	1400	1400	1400	1400	1400	1400	1400	
	80	1000	1030	1090	1160	1290	1400	1400	1400	1400	1400	1400	1400	1400	
	70	1000	1000	1060	1120	1200	1370	1400	1400	1400	1400	1400	1400	1400	
	60	1000	1000	1050	1090	1160	1300	1400	1400	1400	1400	1400	1400	1400	
	50	1000	1000	1000	1060	1120	1200	1370	1400	1400	1400	1400	1400	1400	
			0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
	ALTITUDE (FEET ABOVE SEA LEVEL)														

SOUND PRESSURE LEVEL (SPL)											
		Octave Band Center Frequency (OBCF)									
100% Load Data		dBc	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	5 kHz	
EXHAUST SOUND	Distance From the Engine (ft.)	3.3	113.3	102.9	103.8	109.3	105.6	106.9	106.6	107.1	104
		23	100.1	94.1	94.6	94.9	91.6	94.3	93.2	93.8	89.1
MECHANICAL SOUND	Distance From the Engine (ft.)	49.2	93.5	81.5	87.9	88.2	84.9	87.6	86.6	87.2	82.3
		3.3	91.1	93.8	93.3	91.3	90	93.1	92.8	88.8	83.2
		23	88.3	84.2	83.7	81.9	80.4	83.3	83.2	79.2	73.6
		49.2	83.2	78.9	80.4	76.6	75.1	78.2	77.9	73.9	68.3

**FUEL USAGE GUIDE NOTE**

This table shows the derate factor required for a given fuel. Note that deration occurs 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 NOTE**

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 deration factor (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)  $1 - ((1 - \text{Altitude/Temperature Deration}) + (1 - \text{RPC}))$

**AFTERCOOLER HEAT REJECTION FACTORS NOTE**

Aftercooler heat rejection is given for standard conditions of 77F and 500 ft altitude. 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 to adjust for inlet air temp and altitude conditions. Multiply this factor by the standard aftercooler heat rejection. Failure to properly account for these factors could result in detonation and cause the engine to shutdown or fail.

**SOUND DATA NOTE**

Data determined by methods similar to ISO Standard D1S-8528-10. Accuracy Grade 3.

**MINIMUM SPEED CAPABILITY AT MAX SITE TORQUE NOTE**

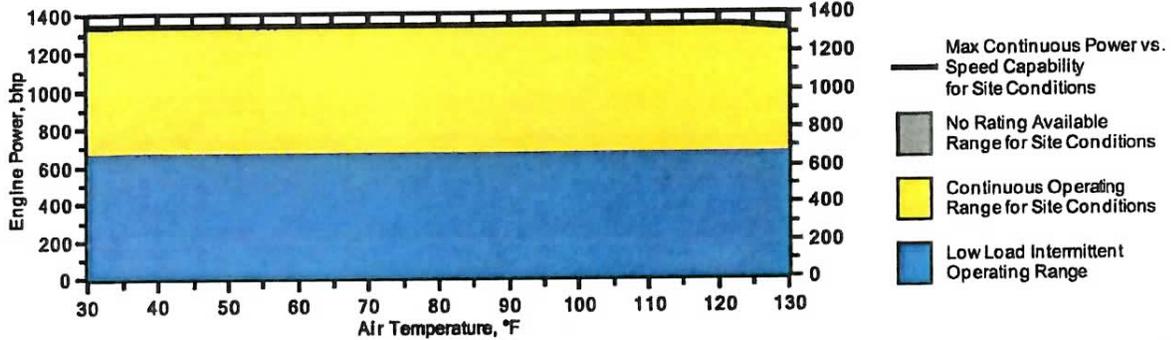
This table shows the minimum allowable engine operating speed for various air inlet temperatures and altitudes.

**Notes**

1. Engine rating is with two engine driven water pumps. Tolerance is +/- 3% of full load.
2. ISO 3046/1 engine efficiency tolerance is (+), (-)5% of full load % efficiency value. Nominal engine efficiency tolerance is +/- 3.0% of full load % efficiency value.
3. ISO 3046/1 fuel consumption tolerance is (+), (-)0% of full load data. Nominal fuel consumption tolerance is +/- 3.0% of full load data.
4. Undried air. Flow is a nominal value with a tolerance of +/- 5%.
5. Inlet manifold pressure is a nominal value with a tolerance of +/- 5%.
6. Inlet manifold temperature is a nominal value with a tolerance of +/- 9F.
7. Timing indicated is for use with the minimum fuel methane number specified. Consult the appropriate fuel usage guide for timing at other methane numbers.
8. Exhaust stack temperature is a nominal value with a tolerance of (+)63F, (-)54F.
9. Exhaust flow value is on a wet/dry basis. Flow is a nominal value with a tolerance of +/- 6%.
10. NOx tolerances are +11%, -9% of specified value.
11. CO, CO2, THC, NMHC, NMNEHC, and HCHO values are "not to exceed" levels.
12. 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.
13. LHV rate tolerance is +/- 3.0%.
14. 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. Total heat to jacket water circuit = Jacket Heat + Lube Oil Heat.
15. Heat rejection to atmosphere based on treated water. Tolerance is +/- 50% of full load data.
16. Lube oil heat rate based on treated water. Tolerance is +/- 20% of full load data.
17. Exhaust heat rate based on treated water. Tolerance is +/- 10% of full load data.
18. A/C Heat (based on treated water) = A/C Heat x A/C Heat Rej. Factor. Tolerance is +/- 5% of full load data.
19. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.

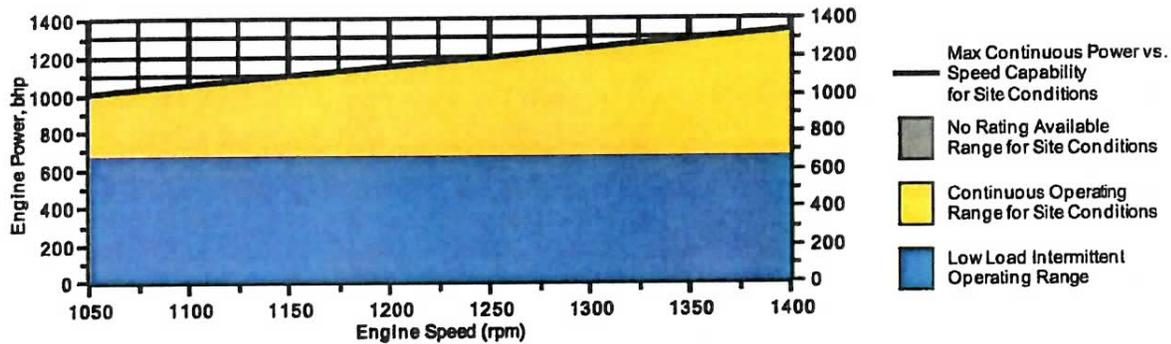
**Engine Power vs. Inlet Air Temperature**

Data represents temperature sweep at 500 ft and 1400 rpm



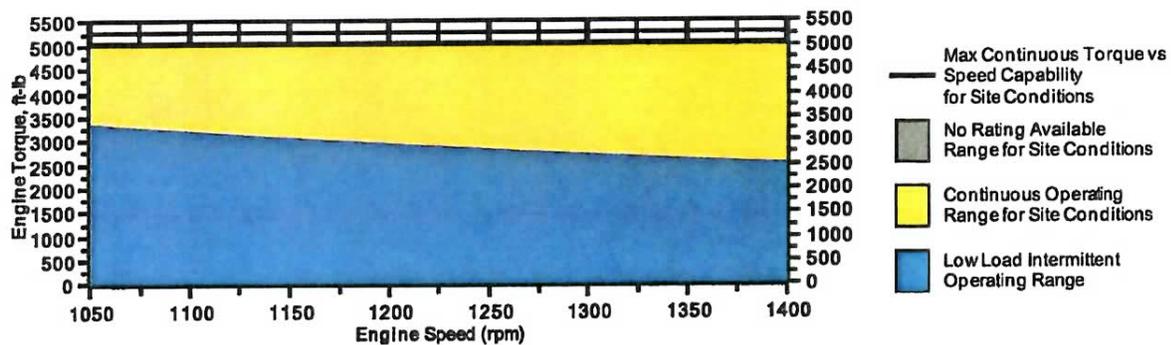
**Engine Power vs. Engine Speed**

Data represents speed sweep at 500 ft and 77 °F



**Engine Torque vs. Engine Speed**

Data represents speed sweep at 500 ft and 77 °F



Note: At site conditions of 500 ft and 77°F inlet air temp., constant torque can be maintained down to 1050 rpm. The minimum speed for loading at these conditions is 1050 rpm.

**NOTES**

1. Engine rating is with two engine driven water pumps. Tolerance is  $\pm 3\%$  of full load.
2. Fuel consumption tolerance is  $\pm 3.0\%$  of full load data.
3. Undried air. Flow is a nominal value with a tolerance of  $\pm 5\%$ .
4. Inlet and Exhaust Restrictions must not exceed A&I limits based on full load flow rates from the standard technical data sheet.
5. Inlet manifold pressure is a nominal value with a tolerance of  $\pm 5\%$ .
6. Exhaust stack temperature is a nominal value with a tolerance of  $(+)63^{\circ}\text{F}$ ,  $(-)54^{\circ}\text{F}$ .
7. Exhaust flow value is on a "wet" basis. Flow is a nominal value with a tolerance of  $\pm 6\%$ .
8. 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. Fuel methane number cannot vary more than  $\pm 3$ . Values listed are higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations. They indicate "Not to Exceed" values. THC, NMHC, and NMNEHC do not include aldehydes. An oxidation catalyst may be required to meet Federal, State or local CO or HC requirements.
9. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
10. Exhaust Oxygen level is the result of adjusting the engine to operate at the specified NOx level. Tolerance is  $\pm 0.5$ .
11. Heat rejection values are nominal. Tolerances, based on treated water, are  $\pm 10\%$  for jacket water circuit,  $\pm 50\%$  for radiation,  $\pm 20\%$  for lube oil circuit, and  $\pm 5\%$  for aftercooler circuit.
12. Aftercooler heat rejection includes an aftercooler heat rejection factor for the site elevation and inlet air temperature specified. Aftercooler heat rejection values at part load are for reference only. Do not use part load data for heat exchanger sizing.
13. Heat exchanger sizing criteria are maximum circuit heat rejection for the site, with applied tolerances.

Constituent	Abbrev	Mole %	Norm		
Water Vapor	H2O	0.0000	0.0000		
Methane	CH4	96.7637	96.7637	Fuel Makeup:	Williams Springfield
Ethane	C2H6	2.0705	2.0705	Unit of Measure:	English
Propane	C3H8	0.1603	0.1603		
Isobutane	iso-C4H10	0.0165	0.0165	<b>Calculated Fuel Properties</b>	
Norbutane	nor-C4H10	0.0298	0.0298	Caterpillar Methane Number:	87.6
Isopentane	iso-C5H12	0.0636	0.0636		
Norpentane	nor-C5H12	0.0305	0.0305	Lower Heating Value (Btu/scf):	929
Hexane	C6H14	0.1184	0.1184	Higher Heating Value (Btu/scf):	1031
Heptane	C7H16	0.0000	0.0000	WOBBE Index (Btu/scf):	1225
Nitrogen	N2	0.5440	0.5440		
Carbon Dioxide	CO2	0.1814	0.1814	THC: Free Inert Ratio:	153.83
Hydrogen Sulfide	H2S	0.0000	0.0000	RPC (%) (To 905 Btu/scf Fuel):	100%
Carbon Monoxide	CO	0.0000	0.0000		
Hydrogen	H2	0.0000	0.0000	Compressibility Factor:	0.998
Oxygen	O2	0.0213	0.0213	Stoich A/F Ratio (Vol/Vol):	9.71
Helium	HE	0.0000	0.0000	Stoich A/F Ratio (Mass/Mass):	16.88
Neopentane	neo-C5H12	0.0000	0.0000	Specific Gravity (Relative to Air):	0.575
Octane	C8H18	0.0000	0.0000	Specific Heat Constant (K):	1.312
Nonane	C9H20	0.0000	0.0000		
Ethylene	C2H4	0.0000	0.0000		
Propylene	C3H6	0.0000	0.0000		
TOTAL (Volume %)		100.0000	100.0000		

#### CONDITIONS AND DEFINITIONS

Caterpillar Methane Number represents the knock resistance of a gaseous fuel. It should be used with the Caterpillar Fuel Usage Guide for the engine and rating to determine the rating for the fuel specified. A Fuel Usage Guide for each rating is included on page 2 of its standard technical data sheet.

RPC always applies to naturally aspirated (NA) engines, and turbocharged (TA or LE) engines only when they are derated for altitude and ambient site conditions.

Project specific technical data sheets generated by the Caterpillar Gas Engine Rating Pro program take the Caterpillar Methane Number and RPC into account when generating a site rating.

Fuel properties for Btu/scf calculations are at 60F and 14.696 psia.

Caterpillar shall have no liability in law or equity, for damages, consequently or otherwise, arising from use of program and related material or any part thereof.

#### FUEL LIQUIDS

Field gases, well head gases, and associated gases typically contain liquid water and heavy hydrocarbons entrained in the gas. To prevent detonation and severe damage to the engine, hydrocarbon liquids must not be allowed to enter the engine fuel system. To remove liquids, a liquid separator and coalescing filter are recommended, with an automatic drain and collection tank to prevent contamination of the ground in accordance with local codes and standards.

To avoid water condensation in the engine or fuel lines, limit the relative humidity of water in the fuel to 80% at the minimum fuel operating temperature.