G3520

GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1800	RATING STRATEGY:	EMERGENCY
COMPRESSION RATIO:	11.5	PACKAGE TYPE:	WITH RADIATOR
AFTERCOOLER TYPE:	SCAC	RATING LEVEL:	STANDBY
AFTERCOOLER - STAGE 2 INLET (°F):	130	FUEL:	NAT GAS
AFTERCOOLER - STAGE 1 INLET (°F):	192	FUEL SYSTEM:	CAT LOW PRESSURE WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°F):	210		
ASPIRATION:	TA	FUEL PRESSURE RANGE(psig): (See note 1)	0.5-5.0
COOLING SYSTEM:	JW+OC+1AC, 2AC	FUEL METHANE NUMBER:	85
CONTROL SYSTEM:	ADEM4 W/ IM	FUEL LHV (Btu/scf):	905
EXHAUST MANIFOLD:	DRY	ALTITUDE CAPABILITY AT 77°F INLET AIR TEMP. (ft):	8825
COMBUSTION:	LOW EMISSION	POWER FACTOR:	0.8
FAN POWER (bhp):	139	VOLTAGE(V):	440-13800

RATING		NOTES	LOAD	100%	75%	50%
PACKAGE POWER	(WITH FAN)	(2)(3)	ekW	2000	1500	1000
PACKAGE POWER	(WITH FAN)	(2)(3)	kVA	2500	1875	1250
ENGINE POWER	(WITHOUT FAN)	(3)	bhp	2952	2252	1560
GENERATOR EFFICIENCY		(2)	%	95.4	95.2	94.4
PACKAGE EFFICIENCY(@ 1.0 Power Factor)	(ISO 3046/1)	(4)(5)	%	37.8	36.3	33.2
THERMAL EFFICIENCY		(4)(6)	%	44.9	45.5	47.3
TOTAL EFFICIENCY (@ 1.0 Power Factor)		(4)(7)	%	82.7	81.8	80.5

ENGINE DATA						
PACKAGE FUEL CONSUMPTION	(ISO 3046/1)	(8)	Btu/ekW-hr	9116	9465	10357
PACKAGE FUEL CONSUMPTION	(NOMINAL)	(8)	Btu/ekW-hr	9338	9696	10609
ENGINE FUEL CONSUMPTION	(NOMINAL)	(8)	Btu/bhp-hr	6326	6457	6801
AIR FLOW (77°F, 14.7 psia)	(WET)	(9)	ft3/min	6110	4831	3565
AIR FLOW	(WET)	(9)	lb/hr	27094	21420	15809
FUEL FLOW (60ºF, 14.7 psia)			scfm	344	268	195
COMPRESSOR OUT PRESSURE			in Hg(abs)	89.2	70.9	56.0
COMPRESSOR OUT TEMPERATURE			°F	333	277	215
AFTERCOOLER AIR OUT TEMPERATURE			°F	136	133	130
INLET MAN. PRESSURE		(10)	in Hg(abs)	78.2	60.6	43.7
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(11)	°F	136	133	130
TIMING		(12)	°BTDC	30	30	28
EXHAUST TEMPERATURE - ENGINE OUTLET		(13)	°F	881	889	917
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(14)	ft3/min	16407	13033	9816
EXHAUST GAS MASS FLOW	(WET)	(14)	lb/hr	28033	22151	16343
MAX INLET RESTRICTION		(15)	in H2O	10.04	10.04	10.04
MAX EXHAUST RESTRICTION		(15)	in H2O	20.07	20.07	20.07

REGULATORY INFORMATION

AGENCY	TIER/STAGE	REGULATION	LOCALITY		MAX LIMITS	YEAR IN	YEAR OUT
EPA		S.I. STATIONARY NON-EMERGENCY - NATURAL GAS	U.S. (EXCL CALIF)	(16)	g/bhp-hr - NOx: 1.0 CO: 2.0 VOC: 0.7	2011	----

ENERGY BALANCE DATA						
LHV INPUT		(17)	Btu/min	311282	242402	176822
HEAT REJECTION TO JACKET WATER (JW)		(18)(26)	Btu/min	34212	29180	24240
HEAT REJECTION TO ATMOSPHERE	(INCLUDES GENERATOR)	(19)	Btu/min	15092	12772	10959
HEAT REJECTION TO LUBE OIL (OC)		(20)(26)	Btu/min	9895	8918	7739
HEAT REJECTION TO EXHAUST (LHV TO 77°F)		(21)(22)	Btu/min	103705	82941	63420
HEAT REJECTION TO EXHAUST (LHV TO 248°F)		(21)	Btu/min	79154	63264	48796
HEAT REJECTION TO A/C - STAGE 1 (1AC)		(23)(26)	Btu/min	14732	7115	1289
HEAT REJECTION TO A/C - STAGE 2 (2AC)		(24)(27)	Btu/min	12763	9026	5161
PUMP POWER		(25)	Btu/min	1231	1231	1231

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1. (Standard reference conditions of 77°F, 29.60 in Hg 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. 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	<70	70	75	80	85	100
SET POINT TIMING	23	23	27	28	30	30
DERATION FACTOR	0	1	1	1	1	1

ALTITUDE DERATION FACTORS AT RATED SPEED

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
120	1	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
110	1	0.72	0.69	0.66	0.63	0.60	0.57	0.54	0.51	No Rating	No Rating	No Rating	No Rating
100	1	1	1	1	0.95	0.91	0.86	0.82	0.77	0.63	No Rating	No Rating	No Rating
90	1	1	1	1	1	1	0.96	0.89	0.81	0.71	No Rating	No Rating	No Rating
80	1	1	1	1	1	1	1	1	1	0.79	No Rating	No Rating	No Rating
70	1	1	1	1	1	1	1	1	1	0.94	No Rating	No Rating	No Rating
60	1	1	1	1	1	1	1	1	1	1	No Rating	No Rating	No Rating
50	1	1	1	1	1	1	1	1	1	1	No Rating	No Rating	No Rating

ALTITUDE (FEET ABOVE SEA LEVEL)

AFTERCOOLER HEAT REJECTION FACTORS (ACHRF)

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1.37	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
120	1.30	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating	No Rating
110	1.22	1.27	1.33	1.38	1.44	1.50	1.56	1.62	1.68	No Rating	No Rating	No Rating	No Rating
100	1.15	1.20	1.25	1.31	1.36	1.42	1.48	1.53	1.59	1.64	No Rating	No Rating	No Rating
90	1.07	1.12	1.18	1.23	1.28	1.34	1.40	1.45	1.51	1.56	No Rating	No Rating	No Rating
80	1	1.05	1.10	1.15	1.21	1.26	1.32	1.37	1.43	1.48	No Rating	No Rating	No Rating
70	1	1	1.02	1.07	1.13	1.18	1.23	1.29	1.35	1.39	No Rating	No Rating	No Rating
60	1	1	1	1	1.05	1.10	1.15	1.21	1.26	1.31	No Rating	No Rating	No Rating
50	1	1	1	1	1	1.02	1.07	1.13	1.18	1.23	No Rating	No Rating	No Rating

ALTITUDE (FEET 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 adjustment 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.

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. The derate factors shown take into account the standard packaged radiator. Additional rating may be available with a larger, custom radiator.

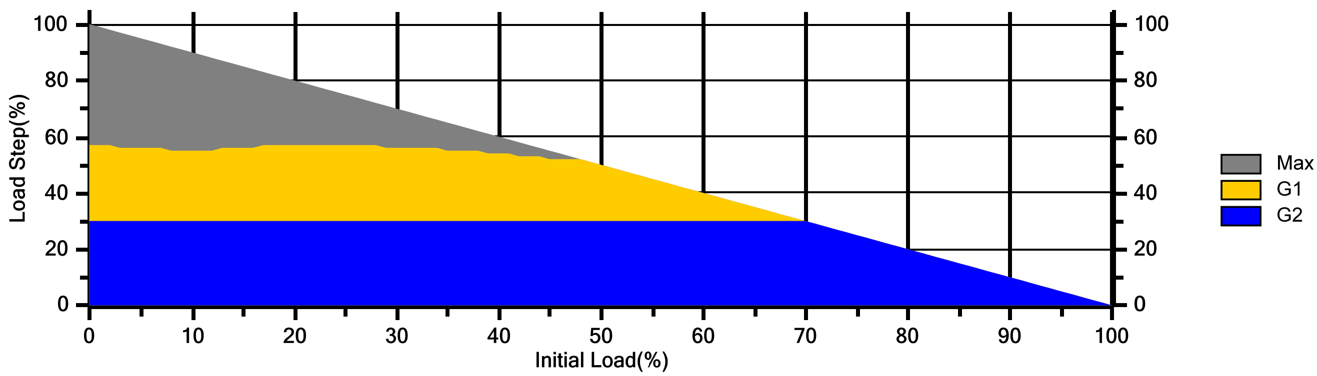
ACTUAL ENGINE RATING:
To determine the actual rating of the engine at site conditions, one must consider separately, limitations due to fuel characteristics and air system limitations. The Fuel Usage Guide deration establishes fuel limitations. The Altitude/Temperature deration factors and RPC (reference 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 26 and 27 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. Fuel pressure range specified is to the engine fuel control valve. Additional fuel train components should be considered in pressure and flow calculations.
2. Generator efficiencies, power factor, and voltage are based on standard generator. [Package Power (ekW) is calculated as: (Engine Power (bkW) - Fan Power (bkW)) x Generator Efficiency], [Package Power (kVA) is calculated as: (Engine Power (bkW) - Fan Power (bkw)) x Generator Efficiency / Power Factor]
3. Rating is with two engine driven water pumps. Tolerance is (+)3, (-)0% of full load.
4. Efficiency represents a Closed Crankcase Ventilation (CCV) system installed on the engine.
5. Package Efficiency published in accordance with ISO 3046/1, based on a 1.0 power factor.
6. Thermal Efficiency is calculated based on energy recovery from the jacket water, lube oil, 1st stage aftercooler, and exhaust to 248ºF with engine operation at ISO 3046/1 Package Efficiency, and assumes unburned fuel is converted in an oxidation catalyst.
7. Total efficiency is calculated as: Package Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.
8. ISO 3046/1 Package fuel consumption tolerance is (+)5, (-)0% at the specified power factor. Nominal package and engine fuel consumption tolerance is ± 2.5% of full load data at the specified power factor.
9. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.
10. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.
11. Inlet manifold temperature is a nominal value with a tolerance of ± 9°F.
12. Timing indicated is for use with the minimum fuel methane number specified. Consult the appropriate fuel usage guide for timing at other methane numbers.
13. Exhaust temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.
14. Exhaust flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 6 %.
15. 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.
16. Gaseous emissions data measurements are consistent with those described in EPA 40 CFR PART 60 SUBPART JJJJ and ISO 8178 for measuring VOC, CO, and NOx. Gaseous emissions values are weighted cycle averages and are in compliance with the stationary regulations.
17. LHV rate tolerance is ± 2.5%.
18. 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.
19. Heat rejection to atmosphere based on treated water. Tolerance is ± 50% of full load data.
20. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
21. Exhaust heat rate based on treated water. Tolerance is ± 10% of full load data.
22. Heat rejection to exhaust (LHV to 77°F) value shown includes unburned fuel and is not intended to be used for sizing or recovery calculations.
23. Heat rejection to A/C - Stage 1 based on treated water. Tolerance is ±5% of full load data.
24. Heat rejection to A/C - Stage 2 based on treated water. Tolerance is ±5% of full load data.
25. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.
26. Total Jacket Water Circuit heat rejection is calculated as: (JW x 1.1) + (OC x 1.2) + (1AC x 1.05) + [0.75 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.
27. Total Second Stage Aftercooler Circuit heat rejection is calculated as: (2AC x 1.05) + [(1AC + 2AC) x 0.25 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.

Load Acceptance



Load Acceptance chart represents the 'Standard' response for a heat soaked engine

Transient Load Acceptance					
Load Step	Frequency Deviation +/- (%)	Voltage Deviation +/- (%)	Recovery Time (sec)	Classification as Defined by ISO 8528 - 5	Notes
100	+0/-25	+1/-53	10.3/33.8		(4)
75	+0/-17	+1/-42	9/28.2		(4)
60	+0/-13	+1/-29	6.6/48.8		(4)
50	+0/-14	+1/-24	5.9/10	G1	(2)(4)
40	+1/-12	+1/-20	5.1/6.9	G1	(2)(4)
30	+1/-10	+1/-16	5	G2	(3)
25	+1/-8	+1/-13	5	G2	(3)
10	+1/-3	+1/-4	2.2	G2	(3)
-25	+6/-1	+2/-0	5		
-50	+7/-17	+11/-23	4.4		
Breaker Open	+12/-9	+10/-26	5.2		(1)
Recovery Specification	+1.75/-1.75	+5/-5			
Steady State Specification	+0.48/-0.48	+0.25/-0.25			

Transient Information

The transient load steps listed above are stated as a percentage of the engine’s full rated load as indicated in the appropriate performance technical data sheet. Site ambient conditions, fuel quality, inlet/exhaust restriction and emissions settings will all affect engine response to load change. Engines that are not operating at the standard conditions stated in the Technical data sheet should be set up according to the guidelines included in the technical data; applying timing changes and/or engine derates as needed. Adherence to the engine settings guidelines will allow the engines to retain the transient performance stated in the tables above as a percentage of the site derated power (where appropriate).Fuel supply pressure and stability is critical to transient performance. Proper installation requires that all fuel train components (including filters, shut off valves, and regulators) be sized to ensure adequate fuel be delivered to the engine. The following are fuel pressure requirements to be measured at the engine mounted fuel control valve.

a. Steady State Fuel Pressure Stability +/- .15 psi/sec
b. Transient fuel Pressure Stability +/- .15 psi/sec

Inlet water temperature to the SCAC must be maintained at specified value for all engines. It is important that the external cooling system design is able to maintain the Inlet water temp to the SCAC to within +/- 1 °C during all engine-operating cycles. The SCAC inlet temperature stability criterion is to maintain stable inlet manifold air temperature. The Air Fuel Ratio control system requires up to 30 seconds to converge after a load step has been performed for NOx to return to nominal setting. If the stabilization time is not met between load steps the transient performance listed in the document may not be met. Differences in generator inertia may change the transient response of engine. Engine Governor gains and Voltage regulator settings may need to be tuned for site conditions. The time needed to start and stabilize at rated engine speed is a minimum of 30 seconds after a successful crank cycle. Engines must be maintained in accordance to guidelines specified in the Caterpillar Service Manuals applicable to each engine. Wear of components outside of the specified tolerances will affect the transient capability of the engine. Steady state voltage and frequency stability specified at +/-2 sigma or better.

NOTES

1. For unloading the engine to 0% load from a loaded condition no external input is needed. The engine control algorithm employs a load sensing strategy to determine a load drop. In the event that the local generator breaker opens the strategy provides control to the engine that resets all control inputs to the rated idle condition. This prevents engine over speeding and will allow the engine to remain running unloaded at the rated synchronous speed.
2. The engines specified above have been tested against the voltage deviation, frequency deviation, and recovery time requirements defined in ISO 8528 - 5. At this time the engines stated above will meet class G1 transient performance as defined by ISO 8528 - 5 with exceptions.
3. The engines specified above have been tested against the voltage deviation, frequency deviation, and recovery time requirements defined in ISO 8528 - 5. At this time the engines stated above will meet class G2 transient performance as defined by ISO 8528 - 5 with exceptions.
4. Air flow is critical for turbocharged engines during transients. As the exhaust temperature increases, the air flow or turbo response increases to enhance the genset transient response. Therefore, the recovery time for an engine's "First" load step after start up may differ from the "Standard" response for a heat soaked engine. If different, the load step recovery times are illustrated as Standard/First .