GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1500	RATING STRATEGY:	HIGH RESPONSE
COMPRESSION RATIO:	12.1	PACKAGE TYPE:	WITHOUT RADIATOR
AFTERCOOLER TYPE:	SCAC	RATING LEVEL:	CONTINUOUS
AFTERCOOLER - STAGE 2 INLET (°C):	49	FUEL:	NAT GAS
AFTERCOOLER - STAGE 1 INLET (°C):	92	FUEL SYSTEM:	CAT LOW PRESSURE WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°C):	99		
ASPIRATION:	TA	FUEL PRESSURE RANGE(kPag): (See note 1)	10-35
COOLING SYSTEM:	JW+OC+1AC, 2AC	FUEL METHANE NUMBER:	85
CONTROL SYSTEM:	ADEM4 W/ IM	FUEL LHV (MJ/Nm3):	35.64
EXHAUST MANIFOLD:	DRY	ALTITUDE CAPABILITY AT 25°C INLET AIR TEMP. (m):	1750
COMBUSTION:	LOW EMISSION	POWER FACTOR:	0.8
NOx EMISSION LEVEL (mg/Nm3 NOx):	500	VOLTAGE(V):	400-11000

RATING		NOTES	LOAD	100%	75%	50%
GENSET POWER	(WITHOUT FAN)	(2)(3)	ekW	2000	1500	1000
GENSET POWER	(WITHOUT FAN)	(2)(3)	kVA	2500	1875	1250
ENGINE POWER	(WITHOUT FAN)	(3)	bkW	2077	1553	1044
GENERATOR EFFICIENCY		(2)	%	96.3	96.6	95.8
GENSET EFFICIENCY(@ 1.0 Power Factor)	(ISO 3046/1)	(4)(5)	%	45.0	44.1	42.0
THERMAL EFFICIENCY		(4)(6)	%	41.9	43.5	46.1
TOTAL EFFICIENCY (@ 1.0 Power Factor)		(4)(7)	%	86.9	87.6	88.1

ENGINE DATA						
GENSET FUEL CONSUMPTION	(ISO 3046/1)	(8)	MJ/ekW-hr	8.10	8.25	8.67
GENSET FUEL CONSUMPTION	(NOMINAL)	(8)	MJ/ekW-hr	8.38	8.53	8.97
ENGINE FUEL CONSUMPTION	(NOMINAL)	(8)	MJ/bkW-hr	8.07	8.24	8.60
AIR FLOW (0°C, 101.3 kPa)	(WET)	(9)	Nm3/bkW-hr	3.79	3.72	3.72
AIR FLOW	(WET)	(9)	kg/bkW-hr	4.90	4.81	4.81
FUEL FLOW (0°C, 101.3 kPa)			Nm3/hr	470	359	252
COMPRESSOR OUT PRESSURE			kPa(abs)	480	354	246
COMPRESSOR OUT TEMPERATURE			°C	239	198	146
AFTERCOOLER AIR OUT TEMPERATURE			°C	54	53	52
INLET MAN. PRESSURE		(10)	kPa(abs)	453	329	226
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(11)	°C	54	53	52
TIMING		(12)	°BTDC	22	20	16
EXHAUST TEMPERATURE - ENGINE OUTLET		(13)	°C	397	429	480
EXHAUST GAS FLOW (0°C, 101.3 kPa)	(WET)	(14)	Nm3/bkW-hr	4.03	3.96	3.98
EXHAUST GAS MASS FLOW	(WET)	(14)	kg/bkW-hr	5.07	4.99	5.00
MAX INLET RESTRICTION		(15)	kPa(abs)	2.50	1.39	0.61
MAX EXHAUST RESTRICTION		(15)	kPa(abs)	5.00	2.78	1.31

EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)	(corr. to 5% O2)	(16)(17)	mg/Nm3 DRY	500	500	500
CO	(corr. to 5% O2)	(16)(18)	mg/Nm3 DRY	926	861	806
THC (mol. wt. of 15.84)	(corr. to 5% O2)	(16)(18)	mg/Nm3 DRY	1486	1411	1300
NMHC (mol. wt. of 15.84)	(corr. to 5% O2)	(16)(18)	mg/Nm3 DRY	253	240	221
NMNEHC (VOCs) (mol. wt. of 15.84)	(corr. to 5% O2)	(16)(18)(19)	mg/Nm3 DRY	238	226	208
HCHO (Formaldehyde)	(corr. to 5% O2)	(16)(18)	mg/Nm3 DRY	102	102	103
CO2	(corr. to 5% O2)	(16)(18)	g/Nm3 DRY	218	215	212
EXHAUST OXYGEN		(16)(20)	% DRY	10.0	9.6	9.0
LAMBDA		(16)(20)		1.74	1.67	1.61

ENERGY BALANCE DATA						
LHV INPUT		(21)	kW	4656	3555	2493
HEAT REJECTION TO JACKET WATER (JW)		(22)(29)	kW	467	393	313
HEAT REJECTION TO ATMOSPHERE	(INCLUDES GENERATOR)	(23)	kW	140	105	86
HEAT REJECTION TO LUBE OIL (OC)		(24)(29)	kW	183	165	142
HEAT REJECTION TO EXHAUST (LHV TO 25°C)		(25)(26)	kW	1272	1049	803
HEAT REJECTION TO EXHAUST (LHV TO 120°C)		(25)	kW	900	777	621
HEAT REJECTION TO A/C - STAGE 1 (1AC)		(27)(29)	kW	385	205	70
HEAT REJECTION TO A/C - STAGE 2 (2AC)		(28)(30)	kW	209	139	79

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	1	1	0.97	0.94	0.92	0.89	0.86	0.83	0.81	0.78	0.75	0.73	0.71
35	1	1	1	1	0.98	0.95	0.93	0.90	0.88	0.85	0.83	0.81	0.78
30	1	1	1	1	1	1	1	0.97	0.94	0.92	0.89	0.86	0.83
25	1	1	1	1	1	1	1	1	0.97	0.94	0.92	0.89	0.86
20	1	1	1	1	1	1	1	1	0.97	0.94	0.92	0.89	0.86
15	1	1	1	1	1	1	1	1	0.97	0.94	0.92	0.89	0.86
10	1	1	1	1	1	1	1	1	0.97	0.94	0.92	0.89	0.86

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	1.12	1.15	1.18	1.21	1.24	1.27	1.30	1.33	1.33	1.33	1.33	1.33	1.33
35	1.08	1.10	1.13	1.16	1.19	1.22	1.25	1.28	1.28	1.28	1.28	1.28	1.28
30	1.03	1.06	1.09	1.11	1.14	1.17	1.20	1.23	1.23	1.23	1.23	1.23	1.23
25	1	1.01	1.04	1.07	1.10	1.12	1.15	1.18	1.18	1.18	1.18	1.18	1.18
20	1	1	1	1.02	1.05	1.08	1.11	1.13	1.13	1.13	1.13	1.13	1.13
15	1	1	1	1	1	1.03	1.06	1.09	1.09	1.09	1.09	1.09	1.09
10	1	1	1	1	1	1	1.01	1.04	1.04	1.04	1.04	1.04	1.04

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 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 do not account for the external cooling system capacity. The derate factors provided assume the external cooling system can maintain the specified cooling water temperatures at site conditions.

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 (29) and (30) 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. [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]
3. Rating is without engine driven water pumps. Tolerance is (+)3, (-)0% of full load. Engine is equipped with a Humidity Management Strategy that will optimize SCAC inlet water temperature and limit available power during periods of high ambient humidity to protect the engine. When operating in high humidity conditions, please contact dealer / A&I team for details.
4. Efficiency represents a Closed Crankcase Ventilation (CCV) system installed on the engine.
5. Genset Efficiency published in accordance with ISO 3046/1, based on a 0.8 power factor.
6. 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.
7. Total efficiency is calculated as: Genset Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.
8. ISO 3046/1 Genset fuel consumption tolerance is (+)5, (-)0% at the specified power factor. Nominal genset and engine fuel consumption tolerance is ± 1.5% 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 set point nominal value. Aftercooler Stage 2 inlet temperature should be controlled to the rated value with a tolerance of (+)3°C, (-)0°C to obtain nominal inlet manifold temperature with a tolerance of (+)3°C, (-)0°C.
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 (+)35°C, (-)30°C.
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. Emissions data is at engine exhaust flange prior to any after treatment.
17. NOx tolerances are ± 18% of specified value.
18. CO, CO2, THC, NMHC, NMNEHC, and HCHO are the maximum values expected under steady state conditions. THC, NMHC, and NMNEHC do not include aldehydes. An oxidation catalyst may be required to meet Federal, State or local CO or HC requirements.
19. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
20. 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.
21. LHV rate tolerance is ± 1.5%.
22. 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.
23. Heat rejection to atmosphere based on treated water. Tolerance is ±50% of full load data.
24. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
25. Exhaust heat rate based on treated water. Tolerance is ±10% of full load data.
26. 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.
27. Heat rejection to A/C - Stage 1 based on treated water. Tolerance is ±5% of full load data.
28. Heat rejection to A/C - Stage 2 based on treated water. Tolerance is ±5% of full load data.
29. Total Jacket Water Circuit heat rejection is calculated as: (JW x 1.1) + (OC x 1.2) + (1AC x 1.05) + [0.818 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.
30. Total Second Stage Aftercooler Circuit heat rejection is calculated as: (2AC x 1.05) + [(1AC + 2AC) x 0.182 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 - DM8702-03

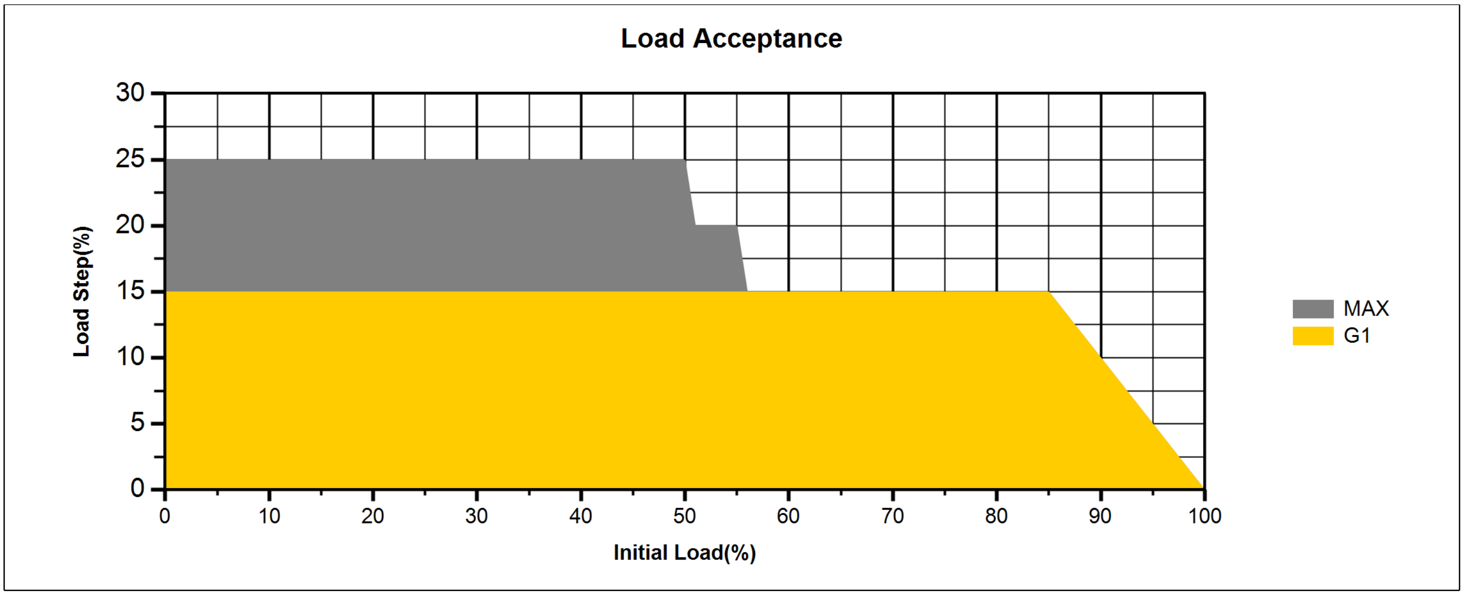
Sound power is defined as the total sound energy emanating from a source irrespective of direction or distance. Sound power level data is presented under two index headings:
Sound power level -- Mechanical
Sound power level -- Exhaust

Mechanical: Sound power level data is calculated in accordance with ISO 3747. The data is recorded with the exhaust sound source isolated.

Exhaust: Sound power level data is calculated in accordance with ISO 6798 Annex A. Exhaust data is post-catalyst on gas engine ratings labeled as "Integrated Catalyst".

Measurements made in accordance with ISO 3747 and ISO 6798 for mechanical and exhaust sound level only. Frequency bands outside the displayed ranges are not measured, due to physical test, and environmental conditions that affect the accuracy of the measurement. 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.



Transient Load Acceptance

Load Step	Frequency Deviation +/- (%)	Voltage Deviation +/- (%)	Recovery Time (sec)	Classification as Defined by ISO 8528 - 5	Notes
25	+3/-35	+18/-25	25		
20	+2/-23	+18/-25	25		
15	+2/-16	+12/-25	10	G1	(2)
10	+2/-12	+10/-25	10	G1	(2)
5	+1/-8	+1/-7	10	G1	(2)
-25	+23/-10	+18/-10	20		
Breaker Open	+21/-15	+18/-15	15		(1)
Recovery Specification	+1.75/-1.75	+5/-5			
Steady State Specification	+1.25/-1.25	+5/-5			(3)

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 +/- 1 kPa/sec
b. Transient fuel Pressure Stability +/- 1 kPa/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 180 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 60 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.Transient performance data is representative of a "Hot" (previously loaded or fully heat soaked) genset.

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. Steady state voltage and frequency stability specified at +/-2 sigma or better.