G3612

GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1000	FUEL:	Nat Gas
COMPRESSION RATIO:	9:1	FUEL SYSTEM:	GAV
AFTERCOOLER WATER INLET (°F):	130		WITH AIR FUEL RATIO CONTROL
JACKET WATER OUTLET (°F):	190	FUEL PRESSURE RANGE(psi g):	42.8-47.0
COOLING SYSTEM:	JW , OC+AC	FUEL METHANE NUMBER:	80
IGNITION SYSTEM:	CIS/ADEM3	FUEL LHV (Btu/scf):	905
EXHAUST MANIFOLD:	DRY	ALTITUDE CAPABILITY (ft):	4419
COMBUSTION:	Low Emission	INLET AIR TEMP. (°F):	77
NOx EMISSION LEVEL (g/bhp-hr NOx):	0.5	APPLICATION:	Gas Compression

RATING		NOTES	LOAD	100%	75%	50%
ENGINE POWER	(WITHOUT FAN)	(1)	bhp	3550	2663	1775
ENGINE EFFICIENCY	(ISO 3046/1)	(2)	%	38.4	36.8	33.9
ENGINE EFFICIENCY	(NOMINAL)	(2)	%	37.5	35.9	33.1

ENGINE DATA						
FUEL CONSUMPTION	(ISO 3046/1)	(3)	Btu/bhp-hr	6629	6914	7501
FUEL CONSUMPTION	(NOMINAL)	(3)	Btu/bhp-hr	6791	7082	7684
AIR FLOW (77°F, 14.7 psia)	(WET)	(4) (5)	scfm	9358	7181	4912
AIR FLOW	(WET)	(4) (5)	lb/hr	41496	31841	21779
COMPRESSOR OUT PRESSURE			in Hg(abs)	76.1	59.4	42.6
COMPRESSOR OUT TEMPERATURE			°F	304	251	157
AFTERCOOLER AIR OUT TEMPERATURE			°F	138	134	132
INLET MAN. PRESSURE		(6)	in Hg(abs)	73.4	57.0	39.1
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(7)	°F	149	145	141
TIMING			°BTDC	18.3	17.6	16.2
EXHAUST STACK TEMPERATURE		(8)	°F	838	876	925
EXHAUST GAS FLOW (@stack temp, 14.5 psia)	(WET)	(9) (5)	ft3/min	24090	19033	13540
EXHAUST GAS MASS FLOW	(WET)	(9) (5)	lb/hr	42713	32793	22468

EMISSIONS DATA					
NOx (as NO2)	(10)	g/bhp-hr	0.50	0.50	0.50
CO	(11)	g/bhp-hr	2.75	2.75	2.75
THC (mol. wt. of 15.84)	(11)	g/bhp-hr	6.46	6.63	6.83
NMHC (mol. wt. of 15.84)	(11)	g/bhp-hr	0.97	0.99	1.02
NMNEHC (VOCs) (mol. wt. of 15.84)	(11)(12)	g/bhp-hr	0.65	0.66	0.68
HCHO (Formaldehyde)	(11)	g/bhp-hr	0.40	0.44	0.48
CO2	(11)	g/bhp-hr	441	460	499
EXHAUST OXYGEN	(13)	% DRY	12.8	12.1	11.0
LAMBDA	(13)		2.15	2.11	2.00

ENERGY BALANCE DATA					
LHV INPUT	(14)	Btu/min	401805	314280	227319
HEAT REJECTION TO JACKET WATER (JW)	(15)	Btu/min	36360	31191	29535
HEAT REJECTION TO ATMOSPHERE	(16)	Btu/min	14063	13200	12503
HEAT REJECTION TO LUBE OIL (OC)	(17)	Btu/min	18081	17285	17049
HEAT REJECTION TO EXHAUST (LHV TO 77°F)	(18)	Btu/min	152035	121730	87828
HEAT REJECTION TO EXHAUST (LHV TO 350°F)	(18)	Btu/mi n	91939	76204	57463
HEAT REJECTION TO AFTERCOOLER (AC)	(19)	Btu/min	27783	15016	2175
PUMP POWER	(20)	Btu/min	2957	2957	2957

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, 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 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	25	30	35	40	45	50	55	60	65	70	100
DERATION FACTOR	0	0	0	0	0.76	0.82	0.87	0.93	0.99	1	1

TOTAL DERATION FACTORS - ALTITUDE & COOLING AT RATED SPEED

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	0.90	0.87	0.83	0.79	0.76	0.72	0.69	0.66	0.63	0.60	0.57	0.54	0.51
120	0.96	0.92	0.88	0.84	0.80	0.77	0.73	0.70	0.67	0.63	0.60	0.57	0.55
110	1	0.97	0.93	0.89	0.85	0.81	0.78	0.74	0.71	0.67	0.64	0.61	0.58
100	1	1	0.98	0.94	0.90	0.86	0.82	0.79	0.75	0.72	0.68	0.65	0.62
90	1	1	1	1	0.96	0.91	0.87	0.83	0.80	0.76	0.72	0.69	0.66
80	1	1	1	1	1	0.97	0.93	0.89	0.85	0.81	0.77	0.73	0.70
70	1	1	1	1	1	0.99	0.95	0.92	0.88	0.84	0.81	0.78	0.75
60	1	1	1	1	1	1	0.97	0.93	0.90	0.86	0.83	0.79	0.76
50	1	1	1	1	1	1	0.99	0.95	0.91	0.88	0.84	0.81	0.78

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	1.42	1.49	1.55	1.62	1.69	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72
120	1.34	1.40	1.47	1.53	1.60	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
110	1.25	1.31	1.38	1.45	1.51	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
100	1.17	1.23	1.29	1.36	1.42	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
90	1.08	1.14	1.20	1.27	1.33	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
80	1	1.06	1.12	1.18	1.24	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
70	1	1	1.03	1.09	1.15	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
60	1	1	1	1	1.06	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
50	1	1	1	1	1	1	1	1	1	1	1	1	1

ALTITUDE (FEET ABOVE SEA LEVEL)

MINIMUM SPEED CAPABILITY AT THE RATED SPEED'S SITE TORQUE (RPM)

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	750	750	750	750	750	750	750	750	750	750	750	750	750
120	750	750	750	750	750	750	750	750	750	750	750	750	750
110	760	760	760	760	750	750	750	750	750	750	750	750	750
100	750	770	780	770	770	770	770	760	760	760	750	750	750
90	750	760	780	790	790	790	780	780	780	780	770	770	770
80	750	750	770	780	800	800	800	800	800	790	790	790	790
70	750	750	760	780	790	800	800	800	800	800	800	800	800
60	750	750	750	770	780	800	800	800	800	800	800	800	800
50	750	750	750	760	780	790	800	800	800	800	800	800	800

ALTITUDE (FEET ABOVE SEA LEVEL)

FUEL USAGE GUIDE:

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:

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):

Aftercooler heat rejection is given for standard conditions of 77°F 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 (ACHRF) to adjust for inlet air temp and altitude conditions. See Notes 21 and 22 below 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.

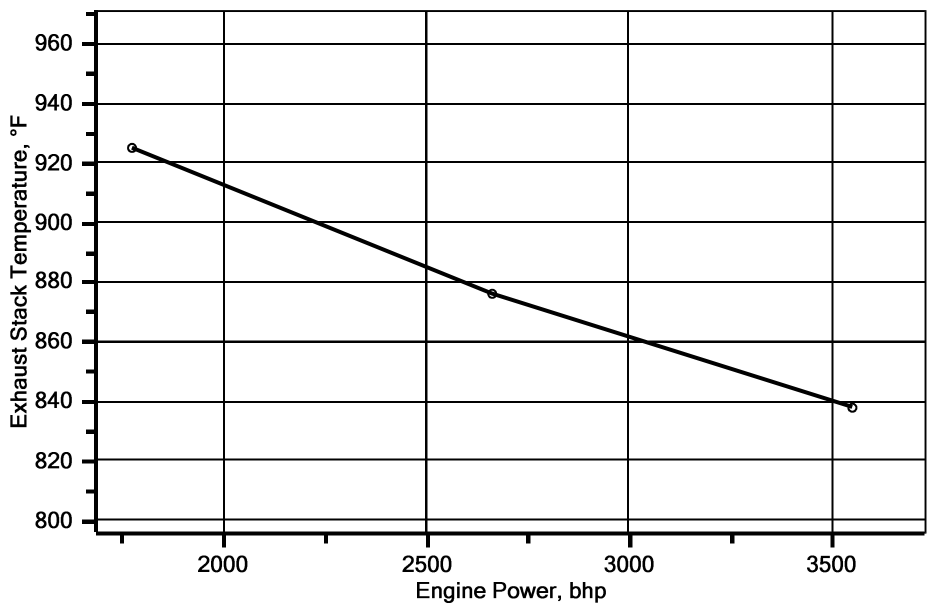
MINIMUM SPEED CAPABILITY AT MAX SITE TORQUE:

This table shows the minimum allowable engine turndown speed where the engine will maintain the Rated Speed's Torque for the given ambient conditions.

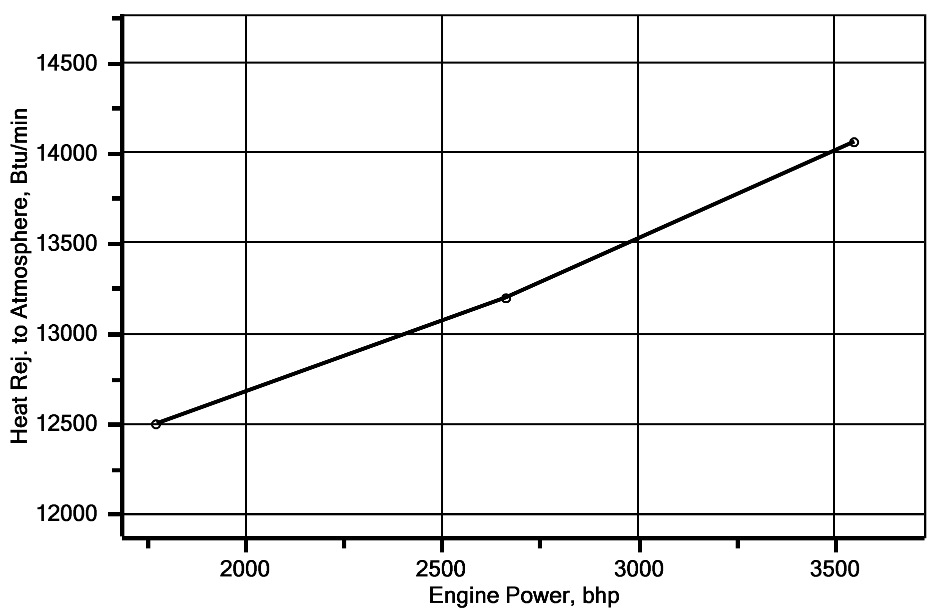
NOTES:

1. Engine rating is with two engine driven water pumps. Tolerance is ± 3% of full load.
2. ISO 3046/1 engine efficiency tolerance is (+)0, (-)5% of full load % efficiency value. Nominal engine efficiency tolerance is ± 2.5% of full load % efficiency value.
3. ISO 3046/1 fuel consumption tolerance is (+)5, (-)0% of full load data. Nominal fuel consumption tolerance is ± 2.5% of full load data.
4. Undried air. Flow is a nominal value with a tolerance of ± 5 %.
5. Inlet and Exhaust Restrictions must not exceed A&I limits based on full load flow rates from the standard technical data sheet.
6. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.
7. Inlet manifold temperature is a nominal value with a tolerance of ± 9°F.
8. Exhaust stack temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.
9. Exhaust flow value is on a 'wet' basis. Flow is a nominal value for total flow rate with a tolerance of ±6%. Exhaust gas vented through the wastegate flows only to the right exhaust outlet. The total flow through the wastegate may be as great as 15% of the total value for conditions under which the wastegate is open. For installations that use dual exhaust runs this difference must be taken into account when specifying any items to be connected to the exhaust outlets. The flow in the right exhaust outlet must be sized for at least 65% of the total flow to allow for the wastegate full open condition, while the left outlet must be sized for 50% of the total flow for the wastegate closed condition. Both runs must meet the allowable backpressure requirement as described in the Exhaust Systems A&I Guide.
10. NOx values are "Not to Exceed".
11. CO, CO2, THC, NMHC, NMNEHC, and HCHO values are "Not to Exceed" levels.
12. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
13. 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.
14. LHV rate tolerance is ± 2.5%.
15. 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.
16. Heat rejection to atmosphere based on treated water. Tolerance is ± 50% of full load data.
17. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
18. Exhaust heat rate based on treated water. Tolerance is ± 10% of full load data.
19. Heat rejection to aftercooler based on treated water. Tolerance is ±5% of full load data.
20. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.
21. Total Jacket Water Circuit heat rejection is calculated as: JW x 1.1. 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.
22. Total Aftercooler Circuit heat rejection is calculated as: (OC x 1.2) + (AC x ACHRF 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.

Engine Power vs. Exhaust Stack Temperature



Engine Power vs. Heat Rej. to Atmosphere



G3612

GAS COMPRESSION APPLICATION

GAS ENGINE SITE SPECIFIC TECHNICAL DATA
Niska

ENGINE SPEED (rpm): 1000
COMPRESSION RATIO: 9:1
AFTERCOOLER WATER INLET (°F): 130
JACKET WATER OUTLET (°F): 190
COOLING SYSTEM: JW , OC+AC
IGNITION SYSTEM: CIS/ADEM3
EXHAUST MANIFOLD: DRY
COMBUSTION: Low Emission
NOx EMISSION LEVEL (g/bhp-hr NOx): 0.5

FUEL SYSTEM: GAV
WITH AIR FUEL RATIO CONTROL

SITE CONDITIONS:
FUEL: Nat Gas
FUEL PRESSURE RANGE(psig): 42.8-47.0
FUEL METHANE NUMBER: 84.8
FUEL LHV (Btu/scf): 905
ALTITUDE(ft): 100
MAXIMUM INLET AIR TEMPERATURE(°F): 110
NAMEPLATE RATING: 3550 bhp@1000rpm

			MAXIMUM RATING	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE		
RATING	**NOTES**	**LOAD**	**100%**	**100%**	**75%**	**50%**
ENGINE POWER	(1)	bhp	3550	3550	2663	1775
INLET AIR TEMPERATURE		°F	109	110	110	110
ENGINE DATA						
FUEL CONSUMPTION (LHV)	(2)	Btu/bhp-hr	6791	6791	7082	7684
FUEL CONSUMPTION (HHV)	(2)	Btu/bhp-hr	7533	7533	7856	8523
AIR FLOW	(3)(4)	lb/hr	41496	41496	31841	21779
AIR FLOW WET (77°F, 14.7 psia)	(3)(4)	scfm	9358	9358	7181	4912
INLET MANIFOLD PRESSURE	(5)	in Hg(abs)	73.4	73.4	57.0	39.1
EXHAUST STACK TEMPERATURE	(6)	°F	838	838	876	925
EXHAUST GAS FLOW (@ stack temp, 14.5 psia)	(7)(4)	ft3/min	24090	24090	19033	13540
EXHAUST GAS MASS FLOW	(7)(4)	lb/hr	42713	42713	32793	22468
EMISSIONS DATA						
NOx (as NO2)	(8)	g/bhp-hr	0.50	0.50	0.50	0.50
CO	(8)	g/bhp-hr	2.75	2.75	2.75	2.75
THC (mol. wt. of 15.84)	(8)	g/bhp-hr	6.46	6.46	6.63	6.83
NMHC (mol. wt. of 15.84)	(8)	g/bhp-hr	0.97	0.97	0.99	1.02
NMNEHC (VOCs) (mol. wt. of 15.84)	(8)(9)	g/bhp-hr	0.65	0.65	0.66	0.68
HCHO (Formaldehyde)	(8)	g/bhp-hr	0.40	0.40	0.44	0.48
CO2	(8)	g/bhp-hr	441	441	460	499
EXHAUST OXYGEN	(10)	% DRY	12.8	12.8	12.1	11.0
HEAT REJECTION						
HEAT REJ. TO JACKET WATER (JW)	(11)	Btu/min	36360	36360	31192	29535
HEAT REJ. TO ATMOSPHERE	(11)	Btu/min	14063	14063	13200	12503
HEAT REJ. TO LUBE OIL (OC)	(11)	Btu/min	18081	18081	17285	17049
HEAT REJ. TO AFTERCOOLER (AC)	(11)(12)	Btu/min	34939	34939	18884	2735

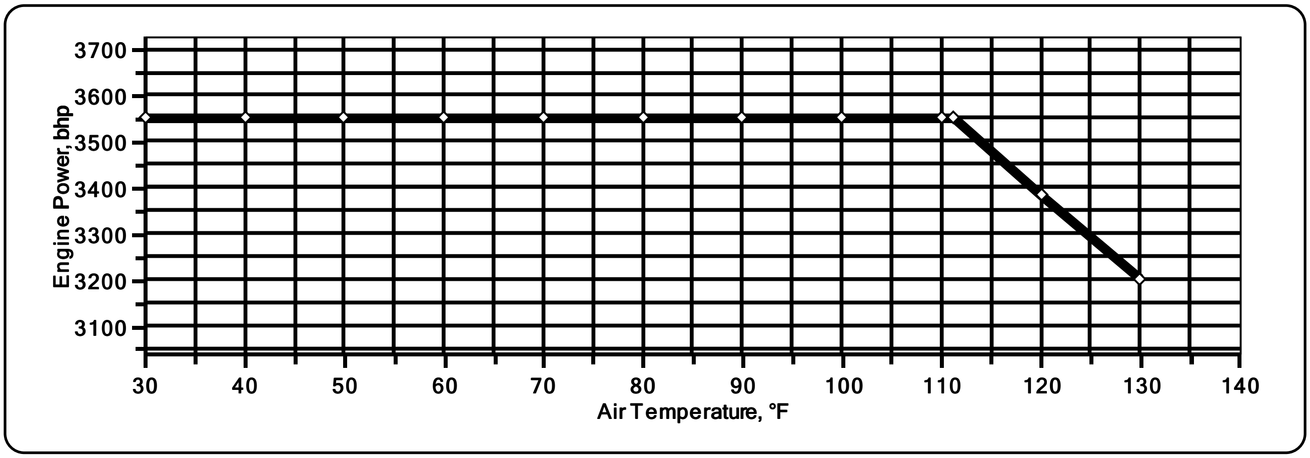
HEAT EXCHANGER SIZING CRITERIA			
TOTAL JACKET WATER CIRCUIT (JW)	(12)	Btu/min	39996
TOTAL AFTERCOOLER CIRCUIT (OC+AC)	(12)(13)	Btu/min	58383
A cooling system safety factor of 0% has been added to the heat exchanger sizing criteria.			

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.

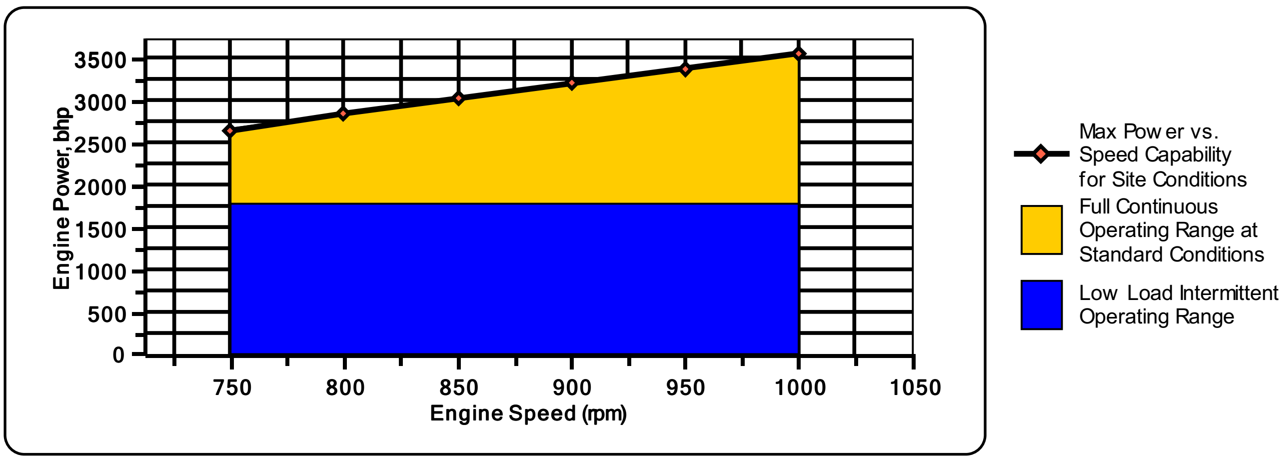
For notes information consult page three.

GAS ENGINE SITE SPECIFIC TECHNICAL DATA
Niska

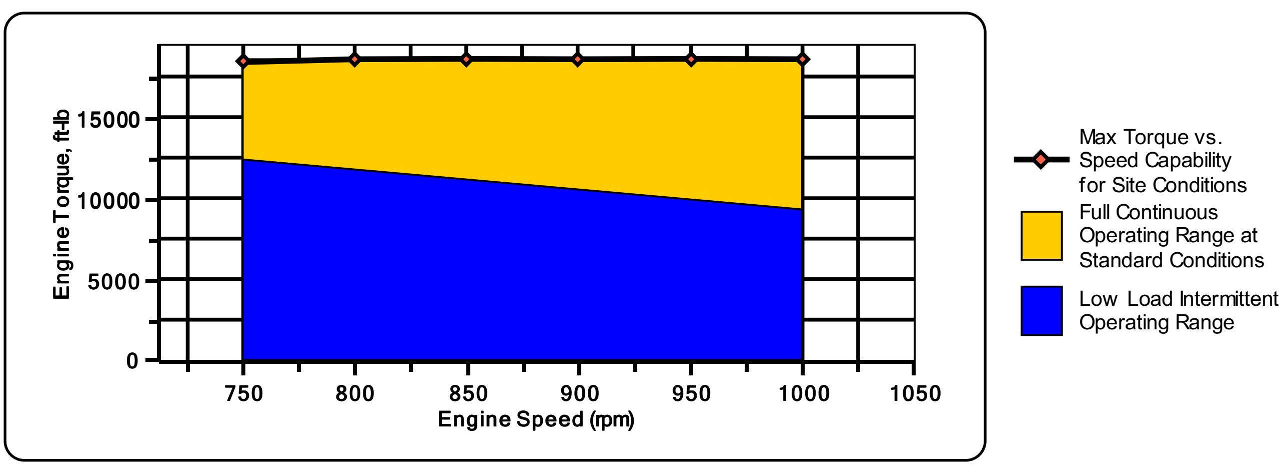
Engine Power vs. Inlet Air Temperature



Engine Power vs. Engine Speed



Engine Torque vs. Engine Speed



Note: At site conditions of 100 ft and 110°F inlet air temp., constant torque can be maintained down to 760 rpm.

PREPARED BY: Jerry Frank, Enerflex Systems Ltd.
Data generated by Gas Engine Rating Pro Version 3.02.00
Ref. Data Set DM8607-00-002, Printed 18Feb2009

NOTES

1. Engine rating is with two engine driven water pumps. Tolerance is ± 3% of full load.

2. Fuel consumption tolerance is ± 2.5% of full load data.

3. Undried air. Flow is a nominal value with a tolerance of ± 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 ± 5 %.

6. Exhaust stack temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.

7. Exhaust flow value is on a "wet" basis. Flow is a nominal value for total flow rate with a tolerance of ±6%. Exhaust gas vented through the wastegate flows only to the right exhaust outlet. The total flow through the wastegate may be as great as 15% of the total value for conditions under which the wastegate is open. For installations that use dual exhaust runs this difference must be taken into account when specifying any items to be connected to the exhaust outlets. The flow in the right exhaust outlet must be sized for at least 65% of the total flow to allow for the wastegate full open condition, while the left outlet must be sized for 50% of the total flow for the wastegate closed condition. Both runs must meet the allowable backpressure requirement as described in the Exhaust Systems A&I Guide.

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 ± 3. Values listed are higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations. They indicate "not to exceed" values.

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 ± 0.5.

11. Heat rejection values are nominal. Tolerances, based on treated water, are ± 10% for jacket water circuit, ± 50% for radiation, ± 20% for lube oil circuit, and ± 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.

G3612

GAS COMPRESSION APPLICATION

GAS ENGINE SITE SPECIFIC TECHNICAL DATA

Niska

Constituent	Abbrev	Mole %	Norm
Water Vapor	H2O	0.0000	0.0000
Methane	CH4	92.2700	92.2700
Ethane	C2H6	2.5000	2.5000
Propane	C3H8	0.5000	0.5000
Isobutane	iso-C4H1O	0.0000	0.0000
Norbutane	nor-C4H1O	0.2000	0.2000
Isopentane	iso-C5H12	0.0000	0.0000
Norpentane	nor-C5H12	0.1000	0.1000
Hexane	C6H14	0.0500	0.0500
Heptane	C7H16	0.0000	0.0000
Nitrogen	N2	3.4800	3.4800
Carbon Dioxide	CO2	0.9000	0.9000
Hydrogen Sulfide	H2S	0.0000	0.0000
Carbon Monoxide	CO	0.0000	0.0000
Hydrogen	H2	0.0000	0.0000
Oxygen	O2	0.0000	0.0000
Helium	HE	0.0000	0.0000
Neopentane	neo-C5H12	0.0000	0.0000
Octane	C8H18	0.0000	0.0000
Nonane	C9H20	0.0000	0.0000
Ethylene	C2H4	0.0000	0.0000
Propylene	C3H6	0.0000	0.0000
TOTAL (Volume %)		100.0000	100.0000

Fuel Makeup:	Nat Gas
Unit of Measure:	English

Calculated Fuel Properties

Caterpillar Methane Number:	84.8
Lower Heating Value (Btu/scf):	905
Higher Heating Value (Btu/scf):	1004
WOBBE Index (Btu/scf):	1168
THC: Free Inert Ratio:	0
RPC (%) (To 905 Btu/scf Fuel):	100%
Compressibility Factor:	0.998
Stoich A/F Ratio (Vol/Vol):	9.45
Stoich A/F Ratio (Mass/Mass):	15.75
Specific Gravity (Relative to Air):	0.600
Specific Heat Constant (K):	1.313

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.

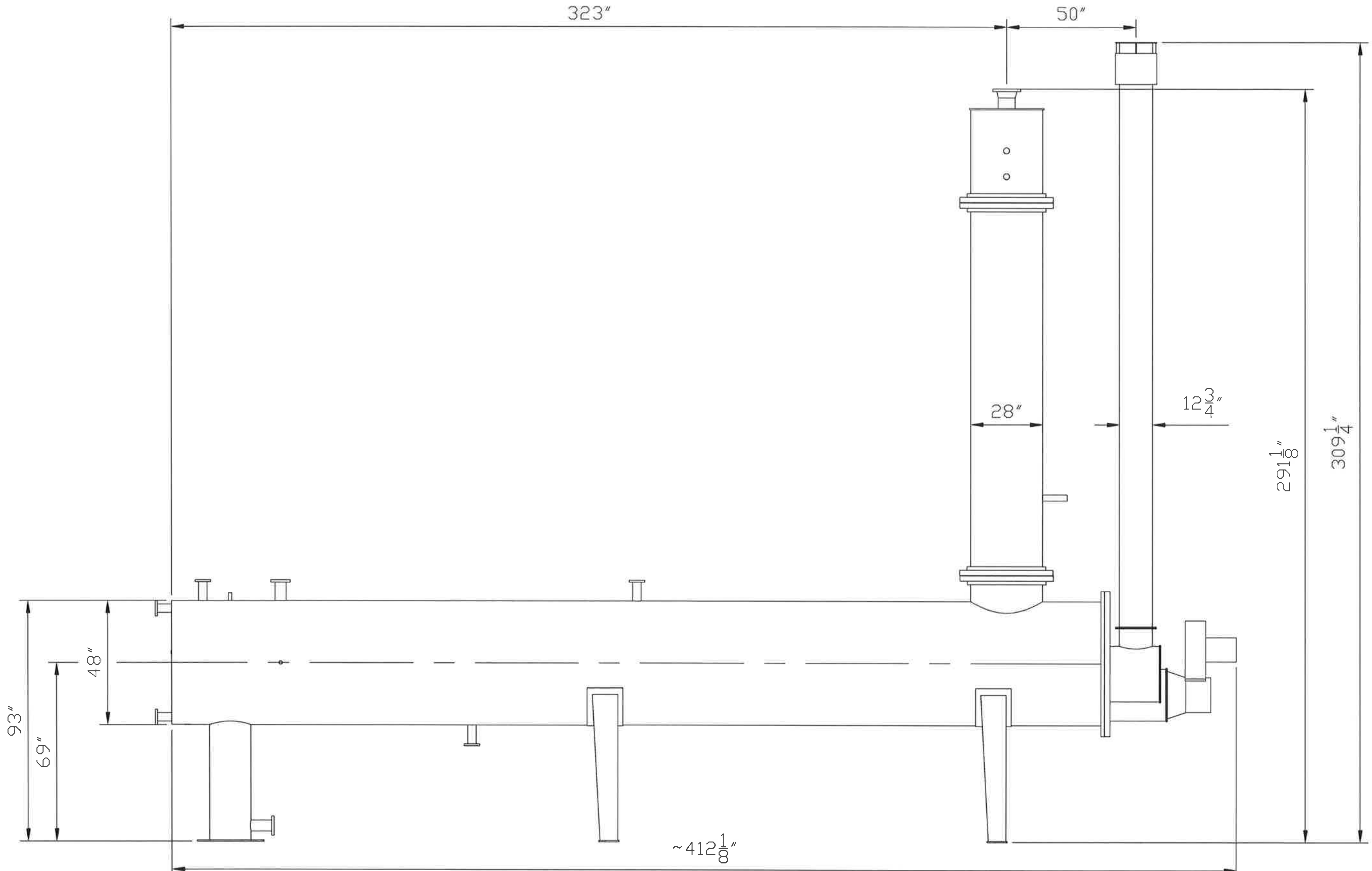
Project specific technical data sheets generated by the Caterpillar Gas Engine Rating Pro program take the Caterpillar Methane Number and RPC into account when generating a site rating.

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

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.



Scale:		Customer: NISKA GAS STORAGE
Drawn by: KLS	Date 4-19-11	REGENERATOR ELEVATION VIEW
Checked by:	Date	
Approved by:	Date	Drawing File Name: 12-45410-800 1 OF 1 — Rev. 0

Equipment Data Sheet	HORIZONTAL GLYCOL REBOILER / SURGE TANK			Sheet 1 of 1
Q.B. Johnson Mfg., Inc.	CLIENT:	Niska Gas Storage	DATE:	4/5/2011
P.O. Box 95129	PROJECT:	300 MMSCFD TEG Dehy	PROJECT NO:	12-45410
Oklahoma City, OK 73143 - USA	PLANT:	Wild Goose	ITEM NO:	U-201-4H1
Approved:	LOCATION CA		QUANTITY:	One

#					
1	EQUIPMENT NAME:	TEG Glycol Reboiler / Surge		POST WELD HEAT TREATMENT:	No
2	DIAMETER: 48" OD	POSITION:	Horizontal	RADIOGRAPHY:	None
3	LENGTH: 30'-0"			OTHER TESTING:	
4	TYPE OF SUPPORT:	Horizontal Supports			
5	TYPE OF HEADS:	Flat Heads		INSULATION:	2" Calcium Silicate insulation
6	PROCESS CONTENTS:	Rich TEG		SURFACE PREP:	SSPC SP-10
7	OPERATING CAPACITY	1500 gallons @ 72F		PAINT, SHOP:	Prime 1 to 2 mils DFT - Inorganic Zinc
8	DESIGN CODE: ASME Section VIII DIV 1	STAMPED:	No		High Temp. Black 1 to 2 mils DFT
9	NATIONAL BOARD REGISTRATION:		No	INTERNAL LINING:	None
10	**DESIGN AND OPERATING CONDITIONS**				
11	PRESSURE, DESIGN:	-	PSIG	**FIRE TUBE**	
12	PRESSURE, OPER.:	12	PSIG	DIAMETER	20" OD
13	TEMPERATURE, DESIGN:	-	Deg. F	IMMERSED LENGTH	75'-0"
14	TEMPERATURE, OPER:	450	Deg. F	THICKNESS	0.375
15	CORROSION ALLOWANCE:	0.0625"		FLUX	7000 Btu / hr / sq ft
16	SHELL THICKNESS	.375"		FLUX DENSITY	8500 Btu / hr / sq inch
17	CORRODED MAWP:	PSIG @	DEG. F	TYPE	Central flue multiple return
18	SPECIFIC GRAVITY OF CONTENT	9.35			
19	WIND LOAD:	Per CBC, 85 mph wind speed		**STILL COLUMN**	
20	SEISMIC:	ASCE 7-05		DIAMETER	28" OD
21				LENGTH	15'-0"

#	Mark	QTY	Size	Rating	Type	Service		
22	**NOZZLES**						THICKNESS	.375"
23	**Mark**	**QTY**	**Size**	**Rating**	**Type**	**Service**	PACKING	1-1/2" 316SS Pall Rings
24	N1	1	28"	150#	Flange	Still Column	REFLUX	(See Notes)
25	N2	1	20"	N/A	Flange	Removable Fire Tube	INSULATION:	2" Calcium Silicate insulation
26	N3	1	3"	150#	Flange	TEG Fill		
27	N4	1	1"	150#	Flange	TEG Drain	**MATERIALS:**	
28	N5	1	3"	150#	Flange	TEG Outlet	SHELL:	SA-516-70
29	N6	1	2"	150#	Flange	PRV	HEADS:	SA-516-70
30	N7	8	2"	150#	Flange	LLS	SUPPORTS:	SA-36
31	N8	1	1"	150#	Flange	LLG	PIPE:	SA-106-B
32	N9	1	1"	6000#	Cplg	Skimmer	FORGINGS:	SA-105
33	N10	1	2"	150#	Flange	Still Reflux TEG Inlet	GASKETS:	Compressed Non-asbestos
34	N11	1	2"	150#	Flange	Still Reflux TEG Outlet	BOLTS & STUDS:	SA-193-B7
35							NUTS:	SA-194-2H
36							INTERNALS:	SA-36

37 EMPTY WEIGHT: 13,000 lbs OPERATING WEIGHT: 27,700 lbs FULL OF WATER WEIGHT:

38 **NOTES:**

39

40 1 - Maxon (Oven Pack LE) Forced Draft Burner - Rated Duty = 2.75 MMBtu/hr

41 2 - Reflux section

42 a - ASME Code constructed & stamped for 150 psig @ 300 deg F

43 b - 69,580 BTU / hr shell and tube exchanger

44 c - 316 ss tubes , CS tubesheet

45 d - Stripping Column — Diameter 16" OD

46 Length 6'-0"

47 Thickness 0.375

48 Insulation 2"

56 e - 12" OD x .250" Exhaust stack X 14'-6" Overall length

REVISION:	Date	By	Checked	Description
1	4/12/2011	TC		For air quality permit
2				

QUESTOR TECHNOLOGY INC.

April 14, 2011

Kyle Jones
Project Technologist
Swift Engineering
Suite 900
736 – 8th Ave SW
Calgary, AB
T2P 1H4

Dear Kyle,

The emission summary for *Swift's Niska Gas* RFQ-WGX3A-006 project is:

NOx = 0.23 lb/MM Btu
CO = 0.0127 lb/MM Btu
THC = 0.00443 lb/MM Btu
NMHC = 0.000164 lb/MM Btu

Please note that these figures are based on the design combustion case or what would be considered the actual combustion.

In designing the solution for this project, 30% excess air was used in the combustion model

If any further information is required, please contact us.

Regards,

Ritchie Stagg
Director - Sales and Marketing

Questor Technology Inc.
Direct: (403) 539-4374
Cell: (403) 608-8601
Fax: (403) 571-1539

Email: rstagg@questortech.com

www.questortech.com

#1121, 940 – 6th Ave SW
Calgary, Alberta
Canada
T2R 3T1

QUESTOR TECHNOLOGY INC.

#420, 1414 – 8th Street S.W. Calgary, AB., T2R 1J6
Phone: (403) 571-1530 * Fax: (403) 571-1539

15214 A – 89th Street, Grande Prairie, AB., T8V 0V7
Phone: (780) 830-2797 * Fax: (780) 830-2799

March 23, 2011

Wayne Hrablok
Swift Engineering Inc.
#202, 924 – 7th Ave SW
Calgary, Alberta
T2P 1A4

Re: Swift Engineering Inc. Request for Proposal: Niska Gas RFQ-WGX3A-006
Questor Technology Inc. Proposal Number: 20110119-009

Dear Wayne,

Questor Technology Inc. ('*Questor*', '*QTI',* or the '*Company*') is pleased to respond to *Swift Engineering Inc.'s* request for proposal for Niska Gas. As per your request, we are providing you with information and pricing on a **Q250** incinerator the product specifications and pricing of which are outlined in this proposal.

The **Q250** incinerator has been selected to effectively combust 290 mscf/d of TEG regenerator vent gas leaving the knock-out vessel. The waste gas primarily consists of water vapour (95.7 mol%) and trace hydrocarbons. The **Q250** has been designed to accommodate for fluctuations in the waste gas composition and flowrate.

Questor specializes in and has a proven resume of combusting low heat content gases using minimal fuel while maintaining sufficient stack top temperature. Fuel gas is added to ensure that a minimum stack top temperature of 600° C is maintained and the low heat content waste gases remain well mixed and ignited. The design will include a 30 foot stack which will ensure adequate residence time to complete the combustion process. *QTI's* proprietary incineration design creates an internal vortex for thorough mixing of waste and fuel giving rise to a combustion efficiency of over 99.99%.

Questor works jointly with clients to design for the specific application and ensure compliance with the federal and regional regulations in Canada and the United States. *Questor Technology* specializes in sweet and sour hydrocarbon waste gas incineration at well test sites and at permanent facilities. One advantage of the proposed **Q250** incineration unit is in its flexibility to accept variances in production volumes and composition.

Many of our clients including *Shell, Vaquero, Dominion Exploration* and others have demonstrated that our incineration units reach a true combustion efficiency of >99.9% when combusting H_2S to SO_2.

Vaquero conducted extensive testing analyzing the components up to C_{30}+ with results indicating >99.9% combustion efficiency of heavier hydro-carbons. *Nexen Inc* has employed several of our incinerator units for use within the City of Calgary on the 34% H_2S wells with the acceptance and support of the surrounding community and the regulatory bodies.

Incineration Efficiency
Questor incinerators have been independently tested and verified that they combust waste gas streams at an efficiency rate of >99.9%.

The *QTI* incinerator uses nozzle geometry and natural draft to establish optimal mixing and combustion efficiency. Waste streams and fuel gas are not premixed in the *Questor* incinerators. Instead they are introduced to the incinerator through their own piping and manifold system. By doing so, the gas flows in pipe that is appropriately sized for the rates and then mixed inside the combustion chamber in a vortex manner which promotes efficient and orderly mixing. This minimizes fuel consumption and promotes optimal plume rise.

Factors contributing to the high combustion efficiency include:

- Separate manifolds introduce each waste gas stream and fuel stream into the combustion zone
- Lined refractory retains heat and minimizes losses from combustion to stack exit
- Kinetic energy (pressure) from either a fuel source or burnable waste stream contributes to high energy vortex within the incinerator to promote efficient mixing
- Air is naturally draw in proportionate to demand which optimizes air/fuel/waste ratio for efficient use of fuel

It is the combination of these factors that contribute to the combustions efficiency, the elimination of soot and harmful pollutants and optimal and compliant dispersion. *Questor* incinerators successfully operate in a broad spectrum of climates, temperatures and geography in a wide variety of process applications.

Power
The *QTI* system utilizes natural air draw and therefore avoids potential downtime that is often associated with assisted air and waste intakes systems such as blowers and fans. When applicable, the incorporation of a solar panel power system ensures reliable and remote operation with the capability of stored power for seven (7) days without direct sunlight.

Safety
As *QTI's* incineration process provides combustion efficiency in excess of 99.9%, waste gas is converted to less hazardous and manageable emissions, such as carbon dioxide, water vapour and sulfur dioxide. The incinerators operate with no visible flame, smoke or odour and will ensure the safe combustion of the waste stream for not only the public and but also for project personnel.

Compliant Sound Levels
Questor provides incineration solutions to numerous clients requiring safe, efficient and compliant combustion for both permanent and portable applications. The **Q250** incinerator offers a clean combustion solution while maintaining acceptable and compliant sound levels.

Light
Questor incinerators are fully enclosed and no flames or light normally emit from the stack top. Abnormal and upset conditions can be designed for so that no light is emitted under those circumstances as well.

Turndown
Turndown is typically is 10:1 and can be as high as 20:1, depending on the key parameters.

Value
Questor's highly reliable equipment provides additional value through minimizing downtime, facilitating swift moves and set up while providing clients with an opportunity for carbon credit generation. Our products enable our clients to operate cost effectively in an environmentally responsible and sustainable way.

The Company

Questor is an international environmental oil field service company that focuses on clean air technologies. With operations in Canada, the United States, Europe and Asia, *Questor* designs and manufactures high efficiency waste gas incinerators for sale or for use on a rental basis and provides field burner services as well. *The Company's* proprietary incinerator technology destroys noxious or toxic hydrocarbon gases. This ensures regulatory compliance, environmental protection, maintains public confidence and reduces operating costs for its clients. *Questor* is recognized for its particular expertise in the combustion of sour gas (H_2S). In today's environment of increasing regulation to protect air quality and address the public's concerns relating to climate change and global warming, *Questor's* product offerings are well positioned. While the *Company's* current client base is primarily in the oil and gas industry, this technology is applicable to other industries such as tire recycling, agriculture, landfills, water and sewage treatment.

The Company was formed in late 1994 and became public in 1998. *Questor* trades on the TSX Venture Exchange under the symbol "QST".

For further information, please refer to *Questor's* website, www.questortech.com, or to the company's profile on the SEDAR filing system, www.sedar.com.
We look forward to the possibility of working with you. If you have any questions or require further information, please contact us as follows:

We thank you for the opportunity to provide you with information and look forward to assisting you in future projects

Ritchie Stagg
Director of Sales and Marketing
Questor Technology Inc.
Phone: (403) 539-4374
Cellular:(403) 608-8601
Fax: (403) 571-1539
rstagg@questortech.com

Richard Jacobsen
Operations Manager
Questor Technology Inc.
Phone: (780) 830-2797
Cellular:(780) 978-1608
Fax: (780) 830-2799
rjacobsen@questortech.com

Yours truly,

Ritchie

Ritchie Stagg
Director of Sales and Marketing

QUESTOR TECHNOLOGY INC.

March 28, 2011

Kyle Jones
Swift Engineering Inc.
#202, 924 – 7 Ave SW
Calgary, Alberta
T2P 1A4

Re: Swift Engineering Inc. Request for Proposal: Niska Gas RFQ-WGX3A-006
Questor Technology Inc. Proposal Number: 20110119-009

Dear Kyle,

Questor confirms that the methane destruction efficiency will be greater than 99.956% in the Q250 proposed for the subject project.

We would be pleased to provide you with documentation confirming the efficiency rate if requested.

Regards,

John Sutherland
Vice President Engineering
Questor Technology Inc.
Suite 1000
960 – 4th Ave SW
Calgary, AB
T2P 3T1

David Lusk

From: Tim Charlton [tcharlton@qbjohnson.com]
Sent: Wednesday, March 16, 2011 3:17 PM
To: 'John Miller'
Cc: 'John R Burroughs'; 'Chuck Solt'; 'Gary Brown'
Subject: RE: Niska- dehy - Wild Goose - QBJ job 12-45110

Chuck/John,

The Maxon OvenPack LE forced draft burner that we plan on using has the following emissions data per Maxon.

-NO_x = 40 PPM
-CO = 200 PPM

The Maxon rep said these are conservative numbers and that they can usually get better than this provided the 30-40% excess air requirement is met.

Thanks,

Tim Charlton | Project Engineer
Q.B. JOHNSON MANUFACTURING, INC.
Q.B. Johnson MFG
9000 S. Sunnylane Rd.
OKC, OK - 73189
office - 405.677.6676
cell - 405.831.5694
tcharlton@qbjohnson.com

From: John Miller [mailto:john.miller@swift-eng.com]
Sent: Tuesday, March 15, 2011 4:05 PM
To: 'Tim Charlton'
Cc: 'John R Burroughs'; 'Chuck Solt'
Subject: RE: Niska- dehy - Wild Goose - QBJ job 12-45110

Tim could you please provide directly to our Air quality representative the emissions from the dehydrator burner system.

I have included Chuck on this Email.

Thanks in advance.

I am assuming you are using the Maxxon forced draft burner system which will most likely comply with B.A.C.T.

John R. Miller
Project Manager
Swift Engineering Inc.
Suite 202, 924-7th Avenue S.W.
Calgary, AB T2P 1A4
Dir: 403.536.7463
Cell: 403.975.4539
Off: 403.705.4800
Fax: 403.705.4805
email: john.miller@swift-eng.com

From: John R Burroughs [mailto:jrbrmts@msn.com]
Sent: Tuesday, March 15, 2011 1:30 PM
To: John Miller
Cc: Tim Charlton
Subject: Niska- dehy - Wild Goose - QBJ job 12-45110

John – please direct emissions data/requests to our PM, Tim Charlton @ QBJ. Also, I told Tim you elected to go with the forced draft burner system. Rgds-John-QBJ-DEN

Tim Charlton | Project Engineer

Q.B. Johnson MFG

9000 S. Sunnylane Rd.

OKC, OK - 73189

office - 405.677.6676

cell - 405.831.5694

tcharlton@qbjohnson.com

David Lusk

From: Tim Charlton [tcharlton@qbjohnson.com]
Sent: Friday, March 25, 2011 3:31 PM
To: 'Chuck Solt'
Subject: RE:

Chuck,

The maximum fuel flow to the Maxon Oven Pack LE is 3500 SCFH based on a standard natural gas HHV of 1000 Btu per cubic foot and a maximum gross burner capacity of 3.5 MMBtu/hr. The burner exhaust stack temperature is 450 deg F. The mass flow rate of gas to the burner is 154.35 lb/hr.

As far as the hours of annual operation, I am unsure how the client plans to run this unit. We based our GRI BTEX emission calculations on 8760 hrs annually. It could be less if they don't run year round.

I didn't get a chance to complete the spec sheet, but I am working this weekend if there is any additional info you need. Just let me know or call me on my cell phone.

Thanks,

Tim Charlton | Project Engineer
Q.B. JOHNSON
MANUFACTURING, INC.
Q.B. Johnson MFG
9000 S. Sunnylane Rd.
OKC, OK - 73189
office - 405.677.6676
cell - 405.831.5694
tcharlton@qbjohnson.com

From: Chuck Solt [mailto:chuck@csolt.net]
Sent: Tuesday, March 22, 2011 12:04 PM
To: 'Tim Charlton'; 'John Miller'; 'Gina Stone'
Cc: 'Gary Theberge'; 'Fred Cooper'; 'Bob Schiewe'
Subject: RE:

Tim:

Now how did I miss that? The drawing I only need for the submittal, so 4/15 is OK. But, the spec sheets will probably contain process information I need to calculate the unit and total emissions, so I would like that by 3/25.

Chuck

J. C. Solt
Lindh & Associates
7909 Walerga Rd. Suite 112 PMB 119
Antelope, CA 95843
Phone: 916.729.5004
Cell: 916.709.5004
Email: Chuck@CSolt.net
www.LindhandAssociates.com

From: Tim Charlton [mailto:tcharlton@qbjohnson.com]
Sent: Tuesday, March 22, 2011 6:25 AM
To: 'Chuck Solt'; 'John Miller'; 'Gina Stone'
Cc: 'Gary Theberge'; 'Fred Cooper'; 'Bob Schiewe'
Subject: RE:

I do not anticipant any problem with the shown due dates. There is no due date shown for the reboiler spec sheet, when do you require this?

Thanks,

Tim Charlton | Project Engineer
Q.B. JOHNSON MANUFACTURING, INC.
Q.B. Johnson MFG
9000 S. Sunnylane Rd.
OKC, OK - 73189
office - 405.677.6676
cell - 405.831.5694
tcharlton@qbjohnson.com

From: Chuck Solt [mailto:chuck@csolt.net]
Sent: Monday, March 21, 2011 4:35 PM
To: 'John Miller'; Gina Stone; 'Tim Charlton'
Cc: Gary Theberge; 'Fred Cooper'; Bob Schiewe
Subject:

I have been advised that Niska wants to start construction in early May. To start construction before the air permits are issued, we will need a *Pre-Authorization* from the air district, and that cannot be requested until the applications have been submitted. In order to meet construction schedule I have prepared the attached matrix showing the data required for the permit application including the due dates necessary to meet a late April submittal of the applications. If you are a primary recipient of this email, your name appears as the source of some information requirements for the air permits for the project. If so, please review the items that bear your name and indicate whether you concur. Failure to meet any of these dates will likely result in a day-for-day slippage in the construction schedule.

Please contact me if any of the items or the overall schedule is unclear or incorrect.

Chuck

J. C. Solt
Lindh & Associates
7909 Walerga Rd. Suite 112 PMB 119
Antelope, CA 95843
Phone: 916.729.5004
Cell: 916.709.5004
Email: Chuck@CSolt.net
www.LindhandAssociates.com

David Lusk

From: Tim Charlton [tcharlton@qbjohnson.com]
Sent: Wednesday, March 23, 2011 1:40 PM
To: 'Chuck Solt'; 'John Miller'; 'Kyle Jones'
Cc: 'John R Burroughs'; 'Bob Schiewe'
Subject: RE: Niska- dehy - Wild Goose - QBJ job 12-45110

Chuck,

All emission data provided pertains to the reboiler. The oxygen basis for the NO_x and CO is 3% 0_2 and the VOC and PM is less than .01 lb/MMBtu. Working on the rest of the info for you.

Thanks,

Tim Charlton | Project Engineer

Q.B. JOHNSON MANUFACTURING, INC.

Q.B. Johnson MFG
9000 S. Sunnylane Rd.
OKC, OK - 73189
office - 405.677.6676
cell - 405.831.5694
tcharlton@qbjohnson.com

From: Chuck Solt [mailto:chuck@csolt.net]
Sent: Friday, March 18, 2011 6:27 PM
To: 'Tim Charlton'; 'John Miller'; 'Kyle Jones'
Cc: 'John R Burroughs'; 'Gary Brown'; Bob Schiewe
Subject: RE: Niska- dehy - Wild Goose - QBJ job 12-45110

In the email response below, you gave me NOx and CO emission concentration. I am assumn;ing it is for the re-boiler. I will need these emission rates either in pounds per MMBtu or give me the oxygen basis used for the ppm values shown in your email.

I will need the NOx, CO, VOC and PM emission factors for both the reboiler and the Thermal Oxadizer. I will also need performance information including the maximum fuel flow, mass flow and stack temperature.

Chuck

J. C. Solt
Lindh & Associates
7909 Walerga Rd. Suite 112 PMB 119
Antelope, CA 95843
Phone: 916.729.5004
Cell: 916.709.5004
Email: Chuck@CSolt.net
www.LindhandAssociates.com

From: Tim Charlton [mailto:tcharlton@qbjohnson.com]
Sent: Wednesday, March 16, 2011 3:17 PM
To: 'John Miller'

Cc: 'John R Burroughs'; 'Chuck Solt'; 'Gary Brown'
Subject: RE: Niska- dehy - Wild Goose - QBJ job 12-45110

Chuck/John,

The Maxon OvenPack LE forced draft burner that we plan on using has the following emissions data per Maxon.

-NO_x = 40 PPM
-CO = 200 PPM

The Maxon rep said these are conservative numbers and that they can usually get better than this provided the 30-40% excess air requirement is met.

Thanks,

Tim Charlton | Project Engineer
Q.B. JOHNSON MANUFACTURING, INC.
Q.B. Johnson MFG
9000 S. Sunnylane Rd.
OKC, OK - 73189
office - 405.677.6676
cell - 405.831.5694
tcharlton@qbjohnson.com

From: John Miller [mailto:john.miller@swift-eng.com]
Sent: Tuesday, March 15, 2011 4:05 PM
To: 'Tim Charlton'
Cc: 'John R Burroughs'; 'Chuck Solt'
Subject: RE: Niska- dehy - Wild Goose - QBJ job 12-45110

Tim could you please provide directly to our Air quality representative the emissions from the dehydrator burner system.

I have included Chuck on this Email.

Thanks in advance.

I am assuming you are using the Maxxon forced draft burner system which will most likely comply with B.A.C.T.

John R. Miller
Project Manager
Swift Engineering Inc.
Suite 202, 924-7th Avenue S.W.
Calgary, AB T2P 1A4
Dir: 403.536.7463
Cell: 403.975.4539
Off: 403.705.4800
Fax: 403.705.4805
email: john.miller@swift-eng.com

From: John R Burroughs [mailto:jrbrmts@msn.com]
Sent: Tuesday, March 15, 2011 1:30 PM
To: John Miller
Cc: Tim Charlton
Subject: Niska- dehy - Wild Goose - QBJ job 12-45110

John – please direct emissions data/requests to our PM, Tim Charlton @ QBJ. Also, I told Tim you elected to go with the forced draft burner system. Rgds-John-QBJ-DEN

Tim Charlton | Project Engineer

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