

VHP - P9394GSI S5

Gas Compression

ENGINE SPEED (rpm):	1200	NOx SELECTION (g/bhp-hr):	Customer Catalyst
DISPLACEMENT (in3):	9388	COOLING SYSTEM:	JW, IC + OC
COMPRESSION RATIO:	9.7:1	INTERCOOLER WATER INLET (°F):	130
IGNITION SYSTEM:	ESM2	JACKET WATER OUTLET (°F):	180
EXHAUST MANIFOLD:	Water Cooled	JACKET WATER CAPACITY (gal):	148
COMBUSTION:	Rich Burn, Turbocharged	AUXILIARY WATER CAPACITY (gal):	16
ENGINE DRY WEIGHT (lbs):	33900	LUBE OIL CAPACITY (gal):	259
AIR/FUEL RATIO SETTING:	ESM2	MAX. EXHAUST BACKPRESSURE (in. H2O):	20
ENGINE SOUND LEVEL (dBA)	105	MAX. AIR INLET RESTRICTION (in. H2O):	15
IGNITION TIMING:	ESM2 Controlled	EXHAUST SOUND LEVEL (dBA)	108

SITE CONDITIONS:

FUEL:	Carraso Station	ALTITUDE (ft):	1200
FUEL PRESSURE RANGE (psig):	40 - 60	MAXIMUM INLET AIR TEMPERATURE (°F):	90
FUEL HHV (BTU/ft3):	1,026.2	FUEL WKI:	91.7
FUEL LHV (BTU/ft3):	927.7		

SITE SPECIFIC TECHNICAL DATA

POWER RATING	UNITS		MAX RATING AT 100 °F AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 90 °F		
				100%	75%	50%
CONTINUOUS ENGINE POWER	BHP		2500	2500	1875	1250
OVERLOAD	% 2/24 hr		0	0	-	-
MECHANICAL EFFICIENCY (LHV)	%		36.3	36.3	35.9	33.3
CONTINUOUS POWER AT FLYWHEEL	BHP		2500	2500	1875	1250
<i>based on no auxiliary engine driven equipment</i>						

AVAILABLE TURNDOWN SPEED RANGE	RPM	900 - 1200
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FUEL CONSUMPTION						
FUEL CONSUMPTION (LHV)	BTU/BHP-hr		7018	7023	7093	7639
FUEL CONSUMPTION (HHV)	BTU/BHP-hr		7763	7768	7847	8450
FUEL FLOW	SCFM	<i>based on fuel analysis LHV</i>	315	315	239	172

HEAT REJECTION						
JACKET WATER (JW)	BTU/hr x 1000		4984	4943	3884	2986
LUBE OIL (OC)	BTU/hr x 1000		679	676	594	516
INTERCOOLER (IC)	BTU/hr x 1000		817	771	396	155
EXHAUST	BTU/hr x 1000		4499	4566	3363	2365
RADIATION	BTU/hr x 1000		545	578	549	530

EMISSIONS (ENGINE OUT):						
NOx (NO + NO2)	g/bhp-hr		12.0	12.0	12.8	12.6
CO	g/bhp-hr		6.2	6.3	6.2	6.0
THC	g/bhp-hr		0.5	0.5	0.7	0.9
NMHC	g/bhp-hr		0.08	0.08	0.10	0.13
NM,NEHC (VOC)	g/bhp-hr		0.03	0.03	0.04	0.05
CO2	g/bhp-hr		431	431	436	469
CO2e	g/bhp-hr		443	443	451	489
CH2O	g/bhp-hr		0.050	0.050	0.050	0.050
CH4	g/bhp-hr		0.44	0.44	0.57	0.75

AIR INTAKE / EXHAUST GAS						
INDUCTION AIR FLOW	SCFM		3284	3286	2489	1787
EXHAUST GAS MASS FLOW	lb/hr		15267	15277	11573	8309
EXHAUST GAS FLOW	ACFM	<i>at exhaust temp, 14.5 psia</i>	10436	10477	7782	5513
EXHAUST TEMPERATURE	°F		1078	1083	1053	1033

HEAT EXCHANGER SIZING ¹²			
TOTAL JACKET WATER CIRCUIT (JW)	BTU/hr x 1000		5652
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	BTU/hr x 1000		1696

COOLING SYSTEM WITH ENGINE MOUNTED WATER PUMPS		
JACKET WATER PUMP MIN. DESIGN FLOW	GPM	850
JACKET WATER PUMP MAX. EXTERNAL RESTRICTION	psig	18
AUX WATER PUMP MIN. DESIGN FLOW	GPM	101
AUX WATER PUMP MAX. EXTERNAL RESTRICTION	psig	40

FUEL COMPOSITION

HYDROCARBONS:			Mole or Volume %	FUEL:	Carraso Station
Methane	CH4		92.78	FUEL PRESSURE RANGE (psig):	40 - 60
Ethane	C2H6		2.23	FUEL WKI:	91.7
Propane	C3H8		0.92		
Iso-Butane	I-C4H10		0.15	FUEL SLHV (BTU/ft3):	911.54
Normal Butane	N-C4H10		0.31	FUEL SLHV (MJ/Nm3):	35.85
Iso-Pentane	I-C5H12		0.11		
Normal Pentane	N-C5H12		0.13	FUEL LHV (BTU/ft3):	927.68
Hexane	C6H14		0.04	FUEL LHV (MJ/Nm3):	36.48
Heptane	C7H16		0		
Ethene	C2H4		0	FUEL HHV (BTU/ft3):	1026.19
Propene	C3H6		0	FUEL HHV (MJ/Nm3):	40.35
	SUM HYDROCARBONS		96.67	FUEL DENSITY (SG):	0.60
NON-HYDROCARBONS:				<p>Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].</p> <p>Based on the fuel composition, supply pressure and temperature, liquid hydrocarbons may be present in the fuel. No liquid hydrocarbons are allowed in the fuel. The fuel must not contain any liquid water. Waukesha recommends both of the following:</p> <p>1) Dew point of the fuel gas to be at least 20°F (11°C) below the measured temperature of the gas at the inlet of the engine fuel regulator.</p> <p>2) A fuel filter separator to be used on all fuels except commercial quality natural gas.</p> <p>Refer to the 'Fuel and Lubrication' section of 'Technical Data' or contact the Waukesha Application Engineering Department for additional information on fuels, or LHV and WKI* calculations.</p> <p>* Trademark of INNIO Waukesha Gas Engines Inc.</p>	
Nitrogen	N2		2.39		
Oxygen	O2		0		
Helium	He		0		
Carbon Dioxide	CO2		0.94		
Carbon Monoxide	CO		0		
Hydrogen	H2		0		
Water Vapor	H2O		0		
	TOTAL FUEL		100		

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume	Total Sulfur Compounds	0	µg/BTU
Total Halogen as Chloride	0	% volume	Total Halogen as Chloride	0	µg/BTU
Total Ammonia	0	% volume	Total Ammonia	0	µg/BTU
<u>Siloxanes</u>			Total Siloxanes (as Si)	0	µg/BTU
Tetramethyl silane	0	% volume			
Trimethyl silanol	0	% volume			
Hexamethyldisiloxane (L2)	0	% volume			
Hexamethylcyclotrisiloxane (D3)	0	% volume			
Octamethyltrisiloxane (L3)	0	% volume			
Octamethylcyclotetrasiloxane (D4)	0	% volume			
Decamethyltetrasiloxane (L4)	0	% volume			
Decamethylcyclopentasiloxane (D5)	0	% volume			
Dodecamethylpentasiloxane (L5)	0	% volume			
Dodecamethylcyclohexasiloxane (D6)	0	% volume			
Others	0	% volume			

Calculated fuel contaminant analysis will depend on the entered fuel composition and selected engine model.

No water or hydrocarbon condensates are allowed in the engine. Requires liquids removal.

NOTES

1. All data is based on engines with standard configurations unless noted otherwise.
2. Power rating is adjusted for fuel, site altitude, and site air inlet temperature, in accordance with ISO 3046/1 with tolerance of $\pm 3\%$.
3. Fuel consumption is presented in accordance with ISO 3046/1 with a tolerance of $-0 / +5\%$ at maximum rating. Fuel flow calculation based on fuel LHV and fuel consumption with a tolerance of $-0/+5\%$. For sizing piping and fuel equipment, it is recommended to include the 5% tolerance.
4. Heat rejection tolerances are $\pm 30\%$ for radiation, and $\pm 8\%$ for jacket water, lube oil, intercooler, and exhaust energy.
5. Emission levels for engines with Waukesha supplied 3-way catalyst are given at catalyst outlet flange. For all other engine models, emission levels are given at engine exhaust outlet flange prior to any after treatment. Values are based on a new engine operating at indicated site conditions, and adjusted to the specified timing and air/fuel ratio at rated load. Catalyst out emission levels represent emission levels the catalyst is sized to achieve. Manual adjustment may be necessary to achieve compliance as catalyst/engine age. Catalyst-out emission levels are valid for the duration of the engine warranty. Emissions are at an absolute humidity of 75 grains H₂O/lb (10.71 g H₂O/kg) of dry air. Emission levels may vary subject to instrumentation, measurement, ambient conditions, fuel quality, and engine variation. Engine may require adjustment on-site to meet emission values, which may affect engine performance and heat output. NO_x, CO, THC, and NMHC emission levels are listed as a not to exceed limit, all other emission levels are estimated. CO₂ emissions based on EPA Federal Register/Vol. 74, No. 209/Friday, October 30, 2009 Rules and Regulations 56398, 56399 (3) Tier 3 Calculation Methodology, Equation C-5.
6. Air flow is based on undried air with a tolerance of $\pm 7\%$.
7. Exhaust temperature given at engine exhaust outlet flange with a tolerance of $\pm 50^{\circ}\text{F}$ (28°C).
8. Exhaust gas mass flow value is based on a "wet basis" with a tolerance of $\pm 7\%$.
9. Inlet air restrictions based on full rated engine load. Exhaust backpressure based on 175.76 PSI BMEP and 1200 RPM. Refer to the engine specification section of Waukesha's standard technical data for more information.
10. Cooling circuit capacity, lube oil capacity, and engine dry weight values are typical.
11. Fuel must conform to Waukesha's "Gaseous Fuel Specification" S7884-7 or most current version. Fuel may require treatment to meet current fuel specification.
12. Heat exchanger sizing values given as the maximum heat rejection of the circuit, with applied tolerances and an additional 5% reserve factor.
13. Fuel volume flow calculation in english units is based on 100% relative humidity of the fuel gas at standard conditions of 60°F and 14.696 psia (29.92 inches of mercury; 101.325 kPa).
14. Fuel volume flow calculation in metric units is based on 100% relative humidity of the fuel gas at a combustion temperature of 25°C and metering conditions of 0°C and 101.325 kPa (14.696 psia; 29.92 inches of mercury). This is expressed as $[25, V(0;101.325)]$.
15. Engine sound data taken with the microphone at 1 m (3.3 ft) from the side of the engine at the approximate front-to-back centerline. Microphone height was at intake manifold level. Engine sound pressure data may be different at front, back and opposite side locations. Exhaust sound data taken with microphone 1 meter (3.3 ft) away and 1 meter (3.3 ft) to the side of the exhaust outlet.
16. Due to variation between test conditions and final site conditions, such as exhaust configuration and background sound level, sound pressure levels under site conditions may be different than those tabulated above.
17. Cooling system design flow is based on minimum allowable cooling system flow. Cooling system maximum external restriction is defined as the allowable restriction at the minimum cooling system flow.
18. Continuous Power Rating: The highest load and speed that can be applied 24 hours per day, seven days per week, 365 days per year except for normal maintenance at indicated ambient reference conditions and fuel. No engine overload power rating is available.
19. emPact emission compliance available for entire range of operable fuels; however, fuel system and/or O₂ set point may need to be adjusted in order to maintain compliance.
20. In cold ambient temperatures, heating of the engine jacket water, lube oil and combustion air may be required. See Waukesha Technical Data.
21. Available Turndown Speed Range refers to the constant torque speed range available. Reduced power may be available at speeds outside of this range. Contact application engineering.

SPECIAL REQUIREMENTS