Appendix DR2-D
Standby Generator Engine Datasheet

PRELIMINARY

SOCALGAS - VENTURA STN, CALIFORNIA

WPI FC 713-551-0714 CAMPAF@WPI.COM

VHP - F3524GSI

Power Generation

ENGINE SPEED (rpm):	1200	NOx SELECTION (g/bhp-hr):	Customer Catalyst
DISPLACEMENT (in3):	3520	COOLING SYSTEM:	JW, IC + OC
COMPRESSION RATIO:	8:1	INTERCOOLER WATER INLET (°F):	130
IGNITION SYSTEM:	ESM2	JACKET WATER OUTLET (°F):	180
EXHAUST MANIFOLD:	Water Cooled	JACKET WATER CAPACITY (gal):	49
COMBUSTION:	Rich Burn, Turbocharged	AUXILIARY WATER CAPACITY (gal):	8
ENGINE DRY WEIGHT (lbs):	16000	LUBE OIL CAPACITY (gal):	72
AIR/FUEL RATIO SETTING:	0.38% CO	MAX. EXHAUST BACKPRESSURE (in. H2O):	18
ENGINE SOUND LEVEL (dBA)	101	MAX. AIR INLET RESTRICTION (in. H2O):	15
IGNITION TIMING:	ESM2 Controlled	EXHAUST SOUND LEVEL (dBA)	110
FREQUENCY (Hz):	60	PHASE:	3
GENERATOR TYPE:	Synchronous	PHASE ROTATION:	T1-T2-T3

SITE CONDITIONS:

FUEL:	NATURAL GAS	ALTITUDE (ft):	260
FUEL PRESSURE RANGE (psig):	30 - 50	MAXIMUM INLET AIR TEMPERATURE (°F):	95
FUEL HHV (BTU/ft3):	1,038.9	FUEL WKI:	90.5
FUEL LHV (BTU/ft3):	939.1		

SITE SPECIFIC TECHNICAL DATA

POWER RATING	UNITS	110% OVERLOAD SITE DATA (See note 18)	MAX RATING AT 100 °F AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 95 °F		
				100%	75%	55%
CONTINUOUS ENGINE POWER	BHP	924	840	840	630	464
OVERLOAD	% 2/24 hr	Note 18	10	10	-	-
ELECTRICAL EFFICIENCY (LHV)	%	28.8	28.3	28.3	26.6	24.0
GENERATOR OUTPUT	kWe	620	560	560	411	294
GENERATOR kVA	kVA	775	700	700	514	368
based on 95.1% generator efficiency at 0.8 PF, 50 HP cooling fan						

FUEL CONSUMPTION						
FUEL CONSUMPTION (LHV)	BTU/BHP-hr	7946	8048	8049	8390	9020
FUEL CONSUMPTION (HHV)	BTU/BHP-hr	8790	8902	8903	9281	9978
FUEL FLOW *based on fuel analysis LHV*	SCFM	130	120	120	94	74

HEAT REJECTION						
JACKET WATER (JW)	BTU/hr x 1000	2236	2097	2088	1692	1395
LUBE OIL (OC)	BTU/hr x 1000	323	318	314	286	263
INTERCOOLER (IC)	BTU/hr x 1000	146	138	132	90	54
EXHAUST	BTU/hr x 1000	2069	1863	1873	1397	1072
RADIATION	BTU/hr x 1000	358	338	347	319	303

EMISSIONS (ENGINE OUT):						
NOx (NO + NO2)	g/bhp-hr	15.5	15.5	15.6	15.9	16.0
CO	g/bhp-hr	13.0	12.9	12.9	12.8	12.7
THC	g/bhp-hr	0.5	0.5	0.5	0.7	0.8
CO2	g/bhp-hr	486	493	493	514	552
CO2e	g/bhp-hr	498	505	505	528	571
CH2O	g/bhp-hr	0.05	0.050	0.050	0.050	0.050
CH4	g/bhp-hr	0.43	0.46	0.46	0.56	0.71

AIR INTAKE / EXHAUST GAS						
INDUCTION AIR FLOW	SCFM	1344	1238	1238	968	766
EXHAUST GAS MASS FLOW	lb/hr	6255	5761	5760	4504	3566
EXHAUST GAS FLOW *at exhaust temp, 14.5 psia*	ACFM	4648	4232	4234	3211	2491
EXHAUST TEMPERATURE	°F	1212	1193	1194	1144	1112

HEAT EXCHANGER SIZING[12]			
TOTAL JACKET WATER CIRCUIT (JW)	BTU/hr x 1000	2536	2378
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	BTU/hr x 1000	532	517

COOLING SYSTEM WITH ENGINE MOUNTED WATER PUMPS		
JACKET WATER PUMP MIN. DESIGN FLOW	GPM	225
JACKET WATER PUMP MAX. EXTERNAL RESTRICTION	psig	15
AUX WATER PUMP MIN. DESIGN FLOW	GPM	48
AUX WATER PUMP MAX. EXTERNAL RESTRICTION	psig	22

All data provided per the condtions listed in the notes section on page three.

Data Generated by EngCalc Program Version 4.0 INNIO Waukesha Gas Engines, Inc.

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VHP - F3524GSI

Power Generation

FUEL COMPOSITION

HYDROCARBONS:		Mole or Volume %
Methane	CH4	92.6
Ethane	C2H6	5
Propane	C3H8	0.45
Iso-Butane	I-C4H10	0.03
Normal Butane	N-C4H10	0.05
Iso-Pentane	I-C5H12	0.01
Normal Pentane	N-C5H12	0.01
Hexane	C6H14	0.01
Heptane	C7H16	0
Ethene	C2H4	0
Propene	C3H6	0
	SUM HYDROCARBONS	98.16
NON-HYDROCARBONS:		
Nitrogen	N2	1.15
Oxygen	O2	0
Helium	He	0
Carbon Dioxide	CO2	0.72
Carbon Monoxide	CO	0
Hydrogen	H2	0
Water Vapor	H2O	0
	TOTAL FUEL	100.03

FUEL:	NATURAL GAS
FUEL PRESSURE RANGE (psig):	30 - 50
FUEL WKI:	90.5
FUEL SLHV (BTU/ft3):	922.80
FUEL SLHV (MJ/Nm3):	36.29
FUEL LHV (BTU/ft3):	939.14
FUEL LHV (MJ/Nm3):	36.93
FUEL HHV (BTU/ft3):	1038.87
FUEL HHV (MJ/Nm3):	40.85
FUEL DENSITY (SG):	0.60

Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].
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:
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.
2) A fuel filter separator to be used on all fuels except commercial quality natural gas.
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.
* Trademark of INNIO Waukesha Gas Engines Inc.

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume
Total Halogen as Cloride	0	% volume
Total Ammonia	0	% volume
Siloxanes		
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

Total Sulfur Compounds	0 µg/BTU
Total Halogen as Cloride	0 µg/BTU
Total Ammonia	0 µg/BTU
Total Siloxanes (as Si)	0 µg/BTU

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 ± 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 ± 30% for radiation, and ± 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. NOx, 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 ± 7%.
7. Exhaust temperature given at engine exhaust outlet flange with a tolerance of ± 50°F (28°C).
8. Exhaust gas mass flow value is based on a "wet basis" with a tolerance of ± 7%.
9. Inlet air restrictions based on full rated engine load. Exhaust backpressure based on 158 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. It is permissible to operate the engine at the indicated overload power, for two hours in every 24 hour period.
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