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November 9, 2020

Air Permitting and Monitoring Branch
US EPA, Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Subject: Crusoe Energy Systems Inc. Permit Application for True Minor Source – Bird Bear 35-26
CTB McKenzie County, North Dakota

On behalf of Crusoe Energy Systems Inc., (Crusoe), please find enclosed a true minor source permit application for three (3) 2,500 horsepower Waukesha 9394GSI generator engines to be located on the Fort Berthold Indian Reservation at the WPX Bird Bear 35-26 CTB in McKenzie County, North Dakota. The generators will power small data centers and will be fueled by gas from the Bird Bear 35-26 CTB that would otherwise be flared. Each engine is built with a non-selective catalyst reduction (NSCR) device.

Should you have any questions or comments about the application, please contact Kaitlin Meszaros by email at meszaros@pinyon-env.com or by phone at 303-980-5200.

Sincerely,

PINYON ENVIRONMENTAL, INC.,

A handwritten signature in black ink that reads "Kaitlin Meszaros". The signature is written in a cursive, flowing style.

Kaitlin A Meszaros
Air Quality Specialist

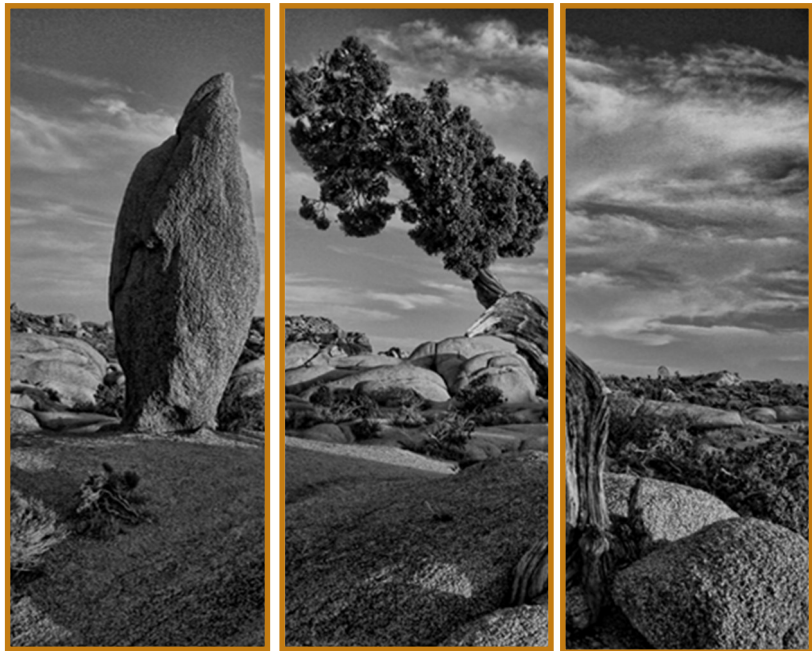
Cc: Ken Parker, Crusoe Energy Systems, Inc.

November 9, 2020

Air Quality Permit Application for True Minor Source on Tribal Lands

Crusoe Energy Systems Inc.
Bird Bear 35-26 CTB
McKenzie County, Montana

Pinyon Project No.:
1/19-1347-01



November 9, 2020

**Air Quality Permit Application for True Minor Source on
Tribal Lands**

Crusoe Energy Systems Inc.
Bird Bear 35-26 CTB
McKenzie County, Montana

Pinyon Project No.:
1/19-1347-01

Prepared by:

Anthony Der Tatevasion

Anthony Der Tatevasion

Reviewed by:

Kaitlin Meszaros

Kaitlin Meszaros

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EPA Registration Form

	United States Environmental Protection Agency Program Address Phone Fax Web address	<i>Reviewing Authority</i> <i>Program</i> <i>Address</i> <i>Phone</i> <i>Fax</i> <i>Web address</i>
FEDERAL MINOR NEW SOURCE REVIEW PROGRAM IN INDIAN COUNTRY Application for New Construction (Form NEW)		
<p style="text-align: center;">Please check all that apply to show how you are using this form:</p> <p style="text-align: center;"> <input checked="" type="checkbox"/> Proposed Construction of a New Source <input type="checkbox"/> Proposed Construction of New Equipment at an Existing Source <input type="checkbox"/> Proposed Modification of an Existing Source <input type="checkbox"/> Other – Please Explain </p>		

Please submit information to the following two entities:

Air Permitting and Monitoring Branch US EPA, Region 8 1595 Wynkoop Street Denver, CO 80202-1129 303-312-6312	The Tribal Environmental Contact for the specific reservation: Edmund Baker, Environmental Director and Air Coordinator
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A. GENERAL SOURCE INFORMATION

1. (a) Company Name (Who owns this facility?) Crusoe Energy Systems Inc. (b) Operator Name Crusoe Energy Systems Inc.		2. Source Name Bird Bear 35-26 CTB	
3. Type of Operation Oil & Gas Support Services		4. Portable Source? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No 5. Temporary Source? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
6. NAICS Code 213112		7. SIC Code 1389	
8. Physical Address (home base for portable sources) From the intersection of Main St N and 4 th Ave NE in Watford City, travel 3.2 miles and turn left onto ND-23 E for 12.8 miles. At the traffic circle, take the 2 nd exit onto ND-73 E for 11.3 miles. Turn right onto ND-22 S for 0.7 mile before turning left onto the farm road leading to the site.			
9. Reservation* Fort Berthold Indian Reservation	10. County* McKenzie	11a. Latitude* 47.764265	11b. Longitude* -102.684892
12a. Quarter Quarter Section* SW1/4 SW1/4	12b. Section* 35	12c. Township* 150N	12d. Range* 94W

*Provide all proposed locations of operation for portable sources

B. PREVIOUS PERMIT ACTIONS (Provide information in this format for each permit that has been issued to this source. Provide as an attachment if additional space is necessary)

Source Name on the Permit N/A
Permit Number (xx-xxx-xxxxx-xxxx.xx) N/A
Date of the Permit Action N/A

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

Source Name on the Permit
Permit Number (xx-xxx-xxxxx-xxxx.xx)
Date of the Permit Action

C. CONTACT INFORMATION

Company Contact Ken Parker		Title Vice President, Facilities Engineering and Operations	
Mailing Address 1660 17 th Street, Suite 350, Denver, CO 80202			
Email Address ken@crusoeenergy.com			
Telephone Number 720-495-3656		Facsimile Number	
Operator Contact (If different from company contact.)		Title	
Mailing Address			
Email Address			
Telephone Number		Facsimile Number	
Source Contact Ken Parker		Title Vice President, Facilities Engineering and Operations	
Mailing Address 1660 17 th Street, Suite 350			
Email Address ken@crusoeenergy.com			
Telephone Number 720-495-3656		Facsimile Number	
Compliance Contact (If different from company contact.)		Title	
Mailing Address			
Email Address			
Telephone Number		Facsimile Number	

D. ATTACHMENTS

Include all of the following information (see the attached instructions)

*Please do not send Part 71 Operating Permit Application Forms in lieu of the check list below.

☐ **FORM SYNMIN** - New Source Review Synthetic Minor Limit Request Form, only if synthetic minor limits are being requested.

☒ **Narrative description of the proposed production processes.** This description should follow the flow of the process flow diagram to be submitted with this application.

☒ **Process flow chart** identifying all proposed processing, combustion, handling, storage, and emission control equipment.

☒ **A list and descriptions of all proposed emission units and air pollution-generating activities.**

☒ **Type and quantity of fuels, including sulfur content of fuels,** proposed to be used on a daily, annual and maximum hourly basis.

☒ **Type and quantity of raw materials used or final product produced** proposed to be used on a daily, annual and maximum hourly basis.

☒ **Proposed operating schedule, including number of hours per day, number of days per week and number of weeks per year.**

☒ **A list and description of all proposed emission controls, control efficiencies, emission limits, and monitoring for each emission unit and air pollution generating activity.**

☒ **Criteria Pollutant Emissions** - Estimates of Current Actual Emissions, Current Allowable Emissions, Post- Change Uncontrolled Emissions, and Post-Change Allowable Emissions for the following air pollutants: particulate matter, PM₁₀, PM_{2.5}, sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compound (VOC), lead (Pb) and lead compounds, fluorides (gaseous and particulate), sulfuric acid mist (H₂SO₄), hydrogen sulfide (H₂S), total reduced sulfur (TRS) and reduced sulfur compounds, including all calculations for the estimates.

These estimates are to be made for each emission unit, emission generating activity, and the project/source in total.

☐ **Modeling – Air Quality Impact Analysis (AQIA)**

☒ **ESA (Endangered Species Act)**

☒ **NHPA (National Historic Preservation Act)**

E. TABLE OF ESTIMATED EMISSIONS

The following tables provide the total emissions in tons/year for all pollutants from the calculations required in Section D of this form, as appropriate for the use specified at the top of the form.

E(i) – Proposed New Source

Pollutant	Potential Emissions (tpy)	Proposed Allowable Emissions (tpy)	
PM	4.98	4.98	PM - Particulate Matter PM ₁₀ - Particulate Matter less than 10 microns in size PM _{2.5} - Particulate Matter less than 2.5 microns in size SO ₂ - Sulfur Dioxides NO _x - Nitrogen Oxides CO - Carbon Monoxide VOC - Volatile Organic Compound Pb - Lead and lead compounds Fluorides - Gaseous and particulates H ₂ SO ₄ - Sulfuric Acid Mist H ₂ S - Hydrogen Sulfide TRS - Total Reduced Sulfur RSC - Reduced Sulfur Compounds
PM ₁₀	4.98	4.98	
PM _{2.5}	4.98	4.98	
SO ₂	13.72	13.72	
NO _x	10.86	10.86	
CO	21.73	21.73	
VOC	0.72	0.72	
Pb	0.00	0.00	
Fluorides	0.00	0.00	
H ₂ SO ₄	0.00	0.00	
H ₂ S	0.00	0.00	
TRS	0.00	0.00	
RSC	0.00	0.00	

Emissions calculations must include fugitive emissions if the source is one the following listed sources, pursuant to CAA Section 302(j):

- | | |
|--|---|
| <ul style="list-style-type: none"> (a) Coal cleaning plants (with thermal dryers); (b) Kraft pulp mills; (c) Portland cement plants; (d) Primary zinc smelters; (e) Iron and steel mills; (f) Primary aluminum ore reduction plants; (g) Primary copper smelters; (h) Municipal incinerators capable of charging more than 250 tons of refuse per day; (i) Hydrofluoric, sulfuric, or nitric acid plants; (j) Petroleum refineries; (k) Lime plants; (l) Phosphate rock processing plants; (m) Coke oven batteries; (n) Sulfur recovery plants; (o) Carbon black plants (furnace process); (p) Primary lead smelters; (q) Fuel conversion plants; | <ul style="list-style-type: none"> (r) Sintering plants; (s) Secondary metal production plants; (t) Chemical process plants (u) Fossil-fuel boilers (or combination thereof) totaling more than 250 million British thermal units perhour heat input; (v) Petroleum storage and transfer units with a total storage capacity exceeding 300,000 barrels; (w) Taconite ore processing plants; (x) Glass fiber processing plants; (y) Charcoal production plants; (z) Fossil fuel-fired steam electric plants of more than 250 million British thermal units per hour heatinginput, and (aa) Any other stationary source category which, as of August 7, 1980, is being regulated under section 111 or 112 of the Act. |
|--|---|

E(ii) – Proposed New Construction at an Existing Source or Modification of an Existing Source

Pollutant	Current Actual Emissions (tpy)	Current Allowable Emissions (tpy)	Post-Change Potential Emissions (tpy)	Post-Change Allowable Emissions (tpy)
PM				
PM₁₀				
PM_{2.5}				
SO₂				
NO_x				
CO				
VOC				
Pb				
Fluorides				
H₂SO₄				
H₂S				
TRS				
RSC				

PM - Particulate Matter
PM₁₀ - Particulate Matter less than 10 microns in size
PM_{2.5} - Particulate Matter less than 2.5 microns in size
SO₂ - Sulfur Dioxides
NO_x - Nitrogen Oxides
CO - Carbon Monoxide
VOC - Volatile Organic Compound
Pb - Lead and lead compounds
Fluorides - Gaseous and particulates
H₂SO₄ - Sulfuric Acid Mist
H₂S - Hydrogen Sulfide
TRS - Total Reduced Sulfur
RSC - Reduced Sulfur Compounds

[\[Disclaimers\]](#) The public reporting and recordkeeping burden for this collection of information is estimated to average 20 hours per response, unless a modeling analysis is required. If a modeling analysis is required, the public reporting and recordkeeping burden for this collection of information is estimated to average 60 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

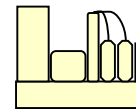
Process Description

Crusoe Energy Systems (Crusoe) plans to install and operate three (3) 2,500 horsepower Waukesha 9394GSI generator engines at the WPX Energy Williston, LLC (WPX) Bird Bear 35-26 Central Tank Battery (CTB). The purpose of the engines is to take gas from the CTB that would otherwise be flared to use as fuel in order to power small data centers. Each engine is built with a non-selective catalyst reduction (NSCR) device.

The sources under ownership and operatorship of Crusoe shall not be aggregated with the production facility sources on the same site location as they will be owned and operated by a separate company. Crusoe will not have environmental control over the other company's emissions sources and the other company will not have environmental control over Crusoe's emissions sources.

Process Flow Diagram

Gas from nearby Bird
Bear 35-26 Wells

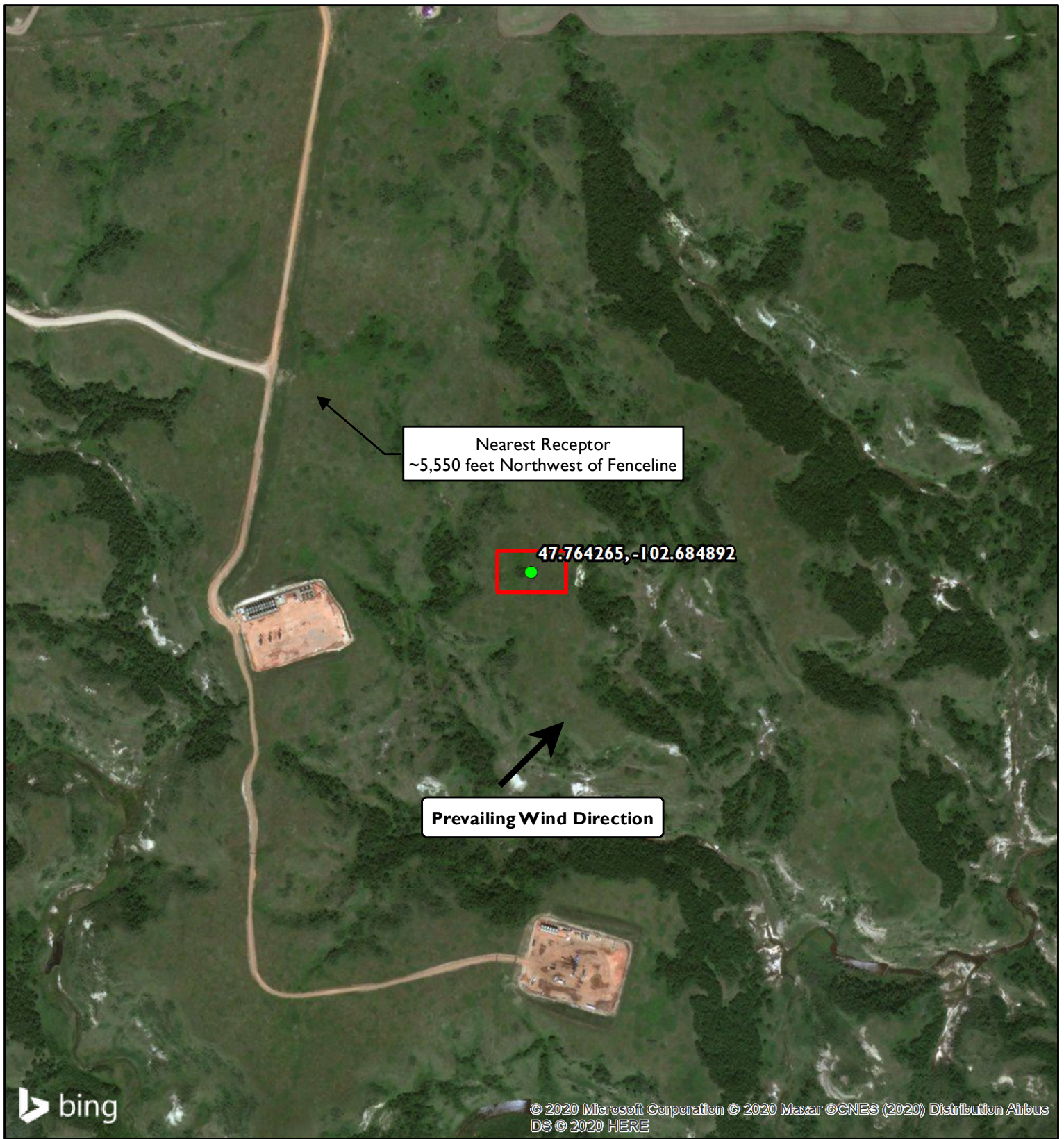


3 x Waukesha 9394 GSI Engines

— Gas

Process Flow Diagram
Crusoe Energy Systems Inc.
Bird Bear 35-26 CTB
McKenzie County, North Dakota

Site Location Map



Legend

Fenceline

0 500 1,000
Feet

Pinyon
Environmental, Inc.

SITE LOCATION

Bird Bear 35-26 CTB
Crusoe Energy Systems Inc.
McKenzie County, North Dakota

Site Location: McKenzie County, North Dakota

Pinyon Project Number: I/19-1347-01

Drawn By: JAF

Reviewed By: ADT

Figure 1

Date: 11/4/2020

Proposed Emission Units

Three (3) 4 stroke rich burn 2,500 horsepower Waukesha 9394GSI generator engines will be located at the Bird Bear 35-26 CTB. Each engine is subject to the reporting requirements of 40 CFR 60, Subpart JJJJ and 40 CFR 63, Subpart ZZZZ. The purpose of the engines is to take gas from the CTB that would otherwise be flared to use as fuel in order to power small data centers.

Fuel Type & Quantity: Each engine will have a field gas consumption rate of 114.1 million cubic feet per year (MMscf/yr), 0.31 million cubic feet per day (MMscf/d), or 31,023 cubic feet per hour (scf/hr). Therefore, the total field gas consumed as fuel is estimated at 342.3 MMscf/yr, 0.94 MMscf/d, and 39,070 scf/hr. The estimated heating value of the field gas is 1,500 British thermal units per standard cubic foot (Btu/scf). The percent sulfur of the fuel is assumed to be a maximum of 0.03% or 300 parts per million (ppm).

Raw Materials & Final Products: No raw materials will be used or final products created for these engines.

Operating Schedule: Each engine will have a normal operating schedule of 24 hours per day, 7 days per week, 52 weeks per year for a total of 8,760 hours per year.

Emission Controls & Factors: Each engine has been built with a NSRC device. The emission factors used to calculate actual emissions of each engine are provided in AP-42 Chapter 3.2, Table 3.2-3 and the following manufacturer specifications:

- NO_x: 0.15 g/hp-hr
- CO: 0.30 g/hp-hr
- VOC: 0.010 g/hp-hr
- Formaldehyde: 0.001 g/hp-hr

Emission Calculations

Engine Emissions

Source Information

Emission Unit ID:	EU01 - EU03	
Engine Make/Model	Waukesha 9394 GSI	
Service	Power Generation	
Controls - Y or N / Type	Y	NSCR
Number of Operational Units	3	engines
Horsepower Rating ¹	2,500	horsepower
Fuel Consumption (BSFC) ¹	7.814	Btu/(hp-hr)
Heat Rating ²	19.54	MMBtu/hr
Fuel Consumption ²	114.1	MMscf/yr
Fuel Consumption ²	13,023	scf/hr
Fuel Heating Value ³	1,500	Btu/scf
Operating Hours	8,760	hrs/yr

Pollutant	Emission Factor		Per Engine Emissions		Total Engine Emissions		Source of Emissions Factors
	lb/MMBtu	g/hp-hr	lb/hr	ton/yr	lb/hr	ton/yr	
NO _x	-	0.15	0.83	3.62	2.48	10.86	Manufacturer Specifications
CO	-	0.30	1.65	7.24	4.96	21.73	Manufacturer Specifications
VOC	-	0.01	0.055	0.24	0.17	0.72	Manufacturer Specifications
SO ₂	5.35E-02	-	1.04	4.57	3.13	13.72	AP-42, Chapter 3.2, Table 3.2-3 assuming 300 ppm H ₂ S in the gas based on footnote (e)
PM ₁₀	1.94E-02	-	0.38	1.66	1.14	4.98	AP-42, Chapter 3.2, Table 3.2-3
PM _{2.5}	1.94E-02	-	0.38	1.66	1.14	4.98	AP-42, Chapter 3.2, Table 3.2-3
1,3-Butadiene	6.63E-04	-	1.30E-02	5.67E-02	3.89E-02	1.70E-01	AP-42, Chapter 3.2, Table 3.2-3
Acetaldehyde	2.79E-03	-	5.45E-02	2.39E-01	1.64E-01	7.16E-01	AP-42, Chapter 3.2, Table 3.2-3
Acrolein	2.63E-03	-	5.14E-02	2.25E-01	1.54E-01	6.75E-01	AP-42, Chapter 3.2, Table 3.2-3
Benzene	1.58E-03	-	3.09E-02	1.35E-01	9.26E-02	4.06E-01	AP-42, Chapter 3.2, Table 3.2-3
Ethylbenzene	2.48E-05	-	4.84E-04	2.12E-03	1.45E-03	6.37E-03	AP-42, Chapter 3.2, Table 3.2-3
Formaldehyde	-	0.001	5.51E-03	2.41E-02	1.65E-02	7.24E-02	Manufacturer Specifications
Methanol	3.06E-03	-	5.98E-02	2.62E-01	1.79E-01	7.85E-01	AP-42, Chapter 3.2, Table 3.2-3
PAH	1.41E-04	-	2.75E-03	1.21E-02	8.26E-03	3.62E-02	AP-42, Chapter 3.2, Table 3.2-3
Toluene	5.58E-04	-	1.09E-02	4.77E-02	3.27E-02	1.43E-01	AP-42, Chapter 3.2, Table 3.2-3
Xylenes	1.95E-04	-	3.81E-03	1.67E-02	1.14E-02	5.01E-02	AP-42, Chapter 3.2, Table 3.2-3
Other HAPs ⁴	2.76E-04	-	5.40E-03	2.36E-02	1.62E-02	7.09E-02	AP-42, Chapter 3.2, Table 3.2-3
Total HAPS	1.19E-02		0.24	1.04	0.71	3.13	
Pollutant	Emission Factor		Per Engine Emissions		Total Engine Emissions		Source of Emissions Factors
	kg/MMBtu	g/hp-hr	lb/hr	ton/yr	lb/hr	ton/yr	
CO ₂	-	447.0	2,464	10,791	7,391	32,373	40 CFR Part 98 Subpart C Table C-1
CH ₄	-	0.33	1.82	7.97	5.46	23.90	40 CFR Part 98 Subpart C Table C-2
N ₂ O	0.0001	-	0.0043	0.019	0.013	0.057	40 CFR Part 98 Subpart C Table C-2
CO ₂ e	-	-	2,510	10,996	7,531	32,987	40 CFR Part 98 Subpart A Table A-1

Notes:

1. Manufacturer specifications.
2. Calculated values.
3. Estimated heating value of the fuel gas.
4. Other HAPs include those HAPs listed in AP-42 below the detection thresholds.

Example Calculations

lb/hr = (g/hp-hr) * (hp) * (1 lb/453.6 g) or (lb/MMBtu) * (MMBtu/hr)

tpy = (lb/hr) * (1 ton/2000 lb) * (hrs/yr) or (MMscf/yr) * (Btu/scf) * (lb/MMBtu) * (1 ton/2000 lb)

Crusoe Energy

VHP - P9394GSI S5

Power Generation

ENGINE SPEED (rpm):	1200	NOx SELECTION (g/bhp-hr):	0.15
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
FREQUENCY (Hz):	60	PHASE:	3
GENERATOR TYPE:	Synchronous	PHASE ROTATION:	T1-T2-T3
VOLTAGE:	4160		

SITE CONDITIONS:

FUEL:	Natural Gas	ALTITUDE (ft):	2000
FUEL PRESSURE RANGE (psig):	40 - 60	MAXIMUM INLET AIR TEMPERATURE (°F):	80
FUEL HHV (BTU/ft3):	1,035.2	FUEL WKI:	91.8
FUEL LHV (BTU/ft3):	935.8		

SITE SPECIFIC TECHNICAL DATA

POWER RATING	UNITS		MAX RATING AT 100 °F AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 80 °F		
				100%	85%	75%
CONTINUOUS ENGINE POWER	BHP		2500	2500	2125	1875
OVERLOAD	% 2/24 hr		0	0	-	-
ELECTRICAL EFFICIENCY (LHV)	%		34.6	34.5	34.4	34.1
GENERATOR OUTPUT	kWe		1784	1784	1516	1338
GENERATOR kVA	kVA		2230	2230	1895	1673
GENERATOR CURRENT	Amps		310	310	263	232
<i>based on 95.7% generator efficiency at 0.8 PF, no auxiliary engine driven equipment</i>						

FUEL CONSUMPTION						
FUEL CONSUMPTION (LHV)	BTU/BHP-hr		7044	7064	7076	7139
FUEL CONSUMPTION (HHV)	BTU/BHP-hr		7792	7814	7827	7898
FUEL FLOW	SCFM		314	315	268	238
<i>based on fuel analysis LHV</i>						

HEAT REJECTION						
JACKET WATER (JW)	BTU/hr x 1000		5028	4950	4296	3888
LUBE OIL (OC)	BTU/hr x 1000		677	674	630	600
INTERCOOLER (IC)	BTU/hr x 1000		844	761	520	386
EXHAUST	BTU/hr x 1000		4500	4645	3883	3422
RADIATION	BTU/hr x 1000		542	609	590	579

EMISSIONS (CATALYST OUT):						
NOx (NO + NO2)	g/bhp-hr		0.15	0.15	0.15	0.15
CO	g/bhp-hr		0.3	0.3	0.3	0.3
THC	g/bhp-hr		0.37	0.37	0.43	0.48
NMHC	g/bhp-hr		0.04	0.04	0.05	0.05
NM,NEHC (VOC)	g/bhp-hr		0.01	0.01	0.01	0.01
CO2	g/bhp-hr		445	447	447	451
CO2e	g/bhp-hr		453	455	457	462
CH2O	g/bhp-hr		0.001	0.001	0.001	0.001
CH4	g/bhp-hr		0.33	0.33	0.38	0.43

AIR INTAKE / EXHAUST GAS						
INDUCTION AIR FLOW	SCFM		3296	3305	2814	2506
EXHAUST GAS MASS FLOW	lb/hr		15324	15365	13083	11649
EXHAUST GAS FLOW	ACFM		10454	10544	8867	7838
EXHAUST TEMPERATURE	°F		1075	1084	1065	1054
<i>at exhaust temp, 14.5 psia</i>						

HEAT EXCHANGER SIZING ¹²			
TOTAL JACKET WATER CIRCUIT (JW)	BTU/hr x 1000		5702
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	BTU/hr x 1000		1724

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:	Natural Gas
Methane	CH4		93	FUEL PRESSURE RANGE (psig):	40 - 60
Ethane	C2H6		4	FUEL WKI:	91.8
Propane	C3H8		1		
Iso-Butane	I-C4H10		0	FUEL SLHV (BTU/ft3):	919.50
Normal Butane	N-C4H10		0	FUEL SLHV (MJ/Nm3):	36.16
Iso-Pentane	I-C5H12		0		
Normal Pentane	N-C5H12		0	FUEL LHV (BTU/ft3):	935.78
Hexane	C6H14		0	FUEL LHV (MJ/Nm3):	36.80
Heptane	C7H16		0		
Ethene	C2H4		0	FUEL HHV (BTU/ft3):	1035.15
Propene	C3H6		0	FUEL HHV (MJ/Nm3):	40.71
	SUM HYDROCARBONS		98	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		0		
Oxygen	O2		0		
Helium	He		0		
Carbon Dioxide	CO2		2		
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.

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

Requires option code 1005A for 0.15g/bhp-hr catalyst.

Regulatory Discussion

Endangered Species Act (ESA)

The equipment will be located on the existing WPX Bird Bear 35-26 CTB, and no additional site disturbance will take place beyond the current oil and gas site. Evaluations on impacts under this regulation are covered under WPX NEPA analyses.

National Historic Preservation Act (NHPA)

The equipment will be located on the existing WPX Bird Bear 35-26 CTB, and no additional site disturbance will take place beyond the current oil and gas site. Evaluations on impacts under this regulation are covered under WPX NEPA analyses.