APPENDIX F

AIR EMISSIONS MODELING REPORT

Air Quality Dispersion Modeling Report for the Liberty Development Project Development and Production Plan

Revision 1

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LIST OF ABBREVIATIONS AND ACRONYMS

30 CFR	Title 30 Code of Federal Regulations
40 CFR	Title 40 Code of Federal Regulations
AERMOD	Near-field dispersion model developed by American Meteorological Society and U.S. Environmental Protection Agency
AERMET	Meteorological processor for AERMOD
AMS	American Meteorological Society
ARM	Ambient Ratio Method
ASOS	Automated Surface Observing Systems
bhp	Brake-Horsepower
BOEM	Bureau of Ocean Energy Management
BPXA	BP Exploration (Alaska) Inc.
CO	Carbon Monoxide
CTG	Combustion Turbine Generator
D	Distance between OCS Facility and Nearest Onshore Area
DOI	Department of the Interior
DPP	Development and Production Plan
EPA	Environmental Protection Agency
EU	Emission Unit
g/s	Grams per Second
HAK	Hilcorp Alaska, LLC
hp	Horsepower
hr/yr	Hours per Year
ICE	Internal Combustion Engine
K	Kelvin
km	Kilometer
kW	Kilowatt
LDPI	Liberty Drilling and Production Island
m	Meter
MMBtu/hr	Million British Thermal Units per Hour
MMscf	Million Standard Cubic Feet
MPI	Main Production Island
m/s	Meters per Second

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

MW	Megawatt
NA	Not Available
NDBC	National Data Buoy Center
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OCD	Offshore and Coastal Dispersion Model
OCS	Outer Continental Shelf
PBU	Prudhoe Bay Unit
PE	Projected Emissions
PM_{10}	Particulate Matter with Diameter Less than or Equal to 10 Micrometers
$PM_{2.5}$	Particulate Matter with Diameter Less than 2.5 Micrometers
PRDA2	Prudhoe Bay Buoy
PSD	Prevention of Significant Deterioration
RH	Relative Humidity
SDI	Satellite Drilling Island
SO_2	Sulfur Dioxide
SST	Sea Surface Temperature
TPY	Tons per Year
TSP	Total Suspended Particulate
ULSD	Ultra-low Sulfur Diesel
VOC	Volatile Organic Compounds

1.0 Introduction

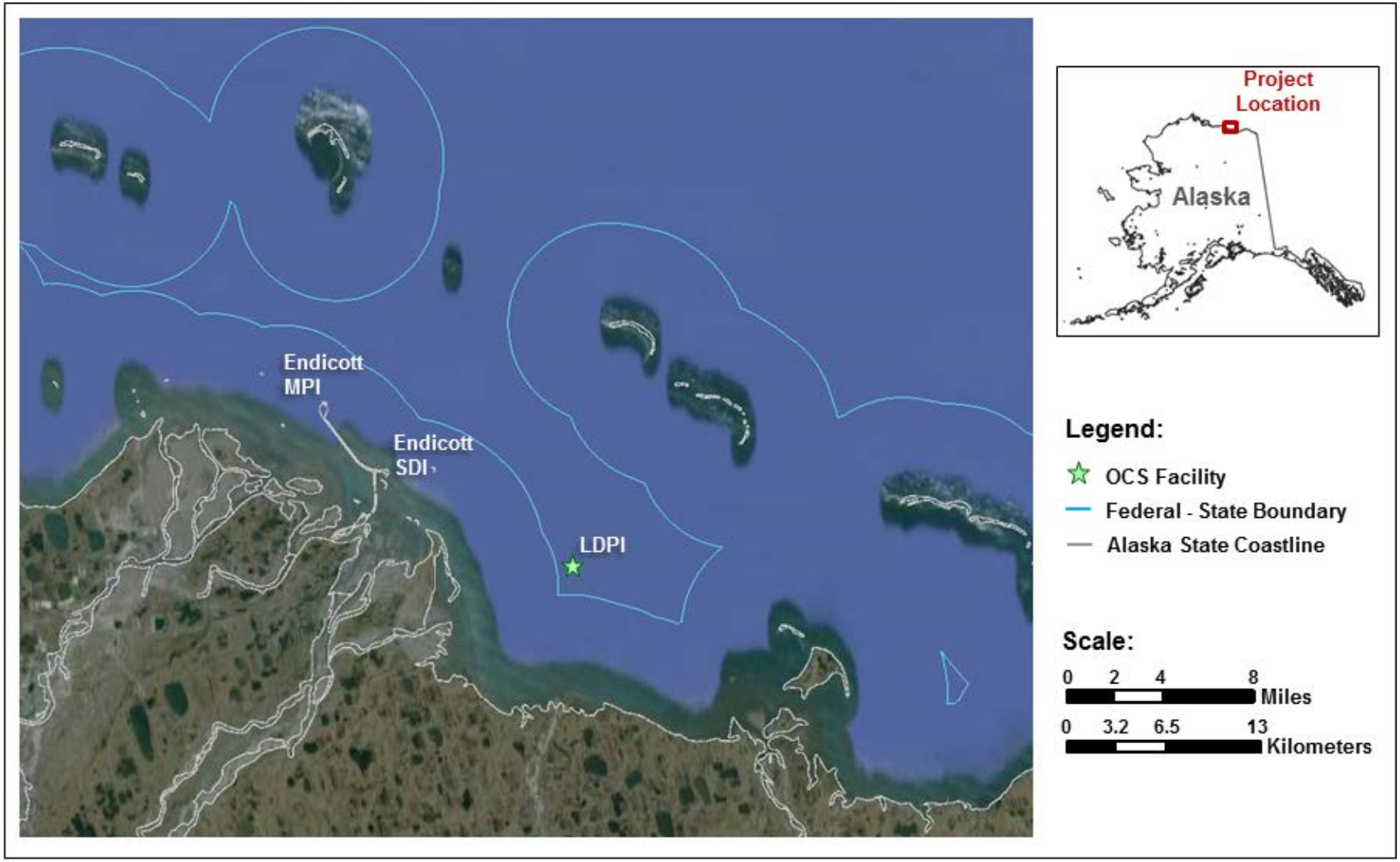
The Liberty Development Project triggers the dispersion modeling requirements described in Title 30 Code of Federal Regulations Part 550, Subpart C, Section 249 (30 CFR 550.249) and Section 303 (30 CFR 550.303) based on the maximum projected emissions (PE) from the proposed outer continental shelf (OCS) facility and the distance between the OCS facility and the closest onshore area.

This report describes the air dispersion model analysis that has been conducted to determine the onshore ambient air impacts due to emissions of nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM_{10}), and particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$) from the OCS facility. The modeling report is being submitted by Hilcorp Alaska, LLC (HAK), which is the Liberty Operator and working partner with BP Exploration (Alaska), Inc. (BPXA), to the U.S. Department of the Interior (DOI) Bureau of Ocean Energy Management (BOEM) pursuant to 30 CFR 550.249. As required by 30 CFR 550.249(e), the modeling approach is consistent with the U.S. Environmental Protection Agency (EPA) *Guideline on Air Quality Models* (Title 40 Code of Federal Regulations Part 51 (40 CFR 51), Appendix W) and EPA and BOEM air dispersion modeling guidance.

1.1 Project Overview

The Liberty Prospect is located on two leases: OCS-Y1650 (acquired in the Beaufort Sea OCS Lease Sale 144) and OCS-Y1585 (Beaufort Sea OCS Lease Sale 124). The Liberty Development Project will involve the construction of a gravel island located approximately 4.0 statute miles from the closest onshore area and 7 statute miles east of the Endicott Satellite Drilling Island (SDI). The Liberty Drilling and Production Island (LDPI) will include production wells and related infrastructure for drilling and production processing activities. Figure 1-1 is a map showing the approximate location of the LDPI with respect to the Alaska State coastline and the boundary between Federal and State waters. A single-phase subsea pipe-in-pipe pipeline will transport sales quality crude oil from the LDPI to the Alaska State shore and the existing Badami pipeline.

Figure 1-1. Liberty Development Project OCS Facility Location



1.2 Regulatory Basis

This report provides an emission inventory and air quality impact analysis for submittal with the Liberty Development Project Development and Production Plan (DPP) and includes information sufficient to make an affirmative demonstration of compliance with 30 CFR 550.303, which applies only to an OCS facility as defined in 30 CFR 550.302. The definition of facility provided in 30 CFR 550.302 is:

> *…any installation or device permanently or temporarily attached to the seabed which is used for exploration, development, and production activities for oil, gas or sulphur, and which emits or has the potential to emit any air pollutant from one or more sources. All equipment directly associated with the installation or device shall be considered part of a single facility if the equipment is dependent on, or affects the processes of, the installation or device. During production, multiple installations or devices will be considered to be a single facility if the installations or devices are directly related to the production of oil, gas, or sulphur at a single site. Any vessel used to transfer production from an offshore facility shall be considered part of the facility while physically attached to it.*

This definition excludes support vessels, which are neither dependent on nor affect the processes of the OCS facility. Because no support vessels are planned to be used for transferring production from the LDPI, the modeled emission unit inventory does not include support vessels.

Table 1-1 provides the emission exemption thresholds calculated per 30 CFR 550.303(d) for the LDPI, which will be located at a distance (D) of 4.0 statute miles from the nearest onshore area. Based on these thresholds, a dispersion modeling analysis is required to evaluate the onshore impacts of air emissions from the OCS facility if the OCS facility projected emissions (PE) of total suspended particulate (TSP, which includes PM_{10} and $PM_{2.5}$), SO_2, NO_X, or volatile organic compounds (VOC) exceeds 133.2 tons per year (tpy), or if the PE of CO exceed 8,567.5 tpy, per 30 CFR 550.249(e).

Table 1-1. Emission Exemption Thresholds for the LDPI

Distance (D), Miles	Emission Thresholds, tons per year (tpy)				
	CO	TSP[1]	SO_2	NO_X	VOC
4.1	8,567.5	133.2	133.2	133.2	133.2

1 Emission threshold is based on total suspended particulate (TSP) emissions, per 30 CFR 50.303, and includes PM_{10} and $PM_{2.5}$.

2.0 OCS Facility Emission Unit Inventory and Projected Emissions

The emission unit (EU) inventory for the OCS facility is provided in Table 2-1 and includes only the EUs that meet the definition of facility provided in 30 CFR 550.302. The EU inventory includes five gas-fired combustion turbine driven power generators (CTG), three gas-fired combustion turbine driven compressor mechanical drives, three backup/standby ultra-low sulfur diesel (ULSD)-fired reciprocating internal combustion engines (RICE), three ULSD-fired RICE that will operate at the LDPI grind and inject facility, a solid waste incinerator, and a flare. In addition, the EU inventory includes EUs that will operate on a production well drill rig and miscellaneous drilling support equipment. The drill rig will be equipped with ULSD-fired and fuel gas-fired RICE for primary power generation, a ULSD-fired cold start RICE, and dual fuel-fired boilers and heaters. The drilling support equipment is comprised of ULSD-fired equipment that includes small portable heaters, light plants, loaders, cranes, and other mobile RICE.

The gas-fired turbines will be compliant with the emission limits under Title 40 Code of Federal Regulations (40 CFR) Part 60 Subpart KKKK, Standards of Performance for Stationary Combustion Turbines. The fuel gas burned in the gas-fired turbines will contain no more than 320 ppmv hydrogen sulfide (H_2S) to ensure compliance with the 40 CFR 60 Subpart KKKK SO_2 emission standards. Additional pollutant emission reduction measures on the gas-fired turbines include Dry Low Emission (DLE) systems to optimize combustion and reduce NO_X and CO emissions.

All ULSD-fired and gas-fired RICE at the LDPI will be compliant with the emission limits and other requirements in 40 CFR 60, Subpart IIII, Standards of Performance for Stationary Compression Ignition Internal Combustion Engines and in 40 CFR 60 Subpart JJJJ, Standards of Performance for Stationary Spark Ignition Internal Combustion Engines, respectively.

The waste incinerator will be compliant with the emission limits and other requirements under 40 CFR 60 Subpart CCCC, Standards of Performance for Commercial and Industrial Solid Waste Incineration Units.

The LDPI flare will be rated for a maximum daily flaring rate of 40 million standard cubic feet per day (MMscf/day), but actual daily flaring is not planned to exceed 4.0 MMscf/day. The annual flaring rate is expected not to exceed 140 million standard cubic feet per year (MMscf/yr).

Table 2-2 provides the PE for CO, PM (PM_{10} and $PM_{2.5}$), SO_2, NO_X, and VOC for each emission unit and the cumulative OCS facility PE. Emission calculations, including emission factors, emission factor references, and additional supporting information are provided in Appendix A. The emission calculations conservatively assume that each EU operates continuously and concurrently during the entire year at maximum operating capacity.

Table 2-3 provides a comparison of the BOEM exemption thresholds with the cumulative OCS facility PE. As shown, the OCS facility will exceed the BOEM exemption threshold for SO_2 and NO_X based on the OCS facility distance to shore and projected SO_2 and NO_X emissions, respectively.

Table 2-1. Liberty Development Project OCS Facility Emission Unit Inventory

Description	Make / Model	Rating / Capacity	Fuel Type	Maximum Fuel Consumption
Power Generation Turbine 1	Siemens SGT-300	7.9 MW	Fuel Gas	88.1 MMBtu/hr
Power Generation Turbine 2	Siemens SGT-300	7.9 MW	Fuel Gas	88.1 MMBtu/hr
Power Generation Turbine 3	Siemens SGT-300	7.9 MW	Fuel Gas	88.1 MMBtu/hr
Power Generation Turbine 4	Siemens SGT-300	7.9 MW	Fuel Gas	88.1 MMBtu/hr
Power Generation Turbine 5	Siemens SGT-300	7.9 MW	Fuel Gas	88.1 MMBtu/hr
Rig Diesel Engine 1	MTU 16V2000	1,085 bhp	ULSD[1]	53 gal/hr
Rig Diesel Engine 2	MTU 16V2000	1,085 bhp	ULSD	53 gal/hr
Rig Diesel Engine 3	MTU 16V2000	1,085 bhp	ULSD	53 gal/hr
Rig Diesel Engine 4	MTU 16V2000	1,085 bhp	ULSD	53 gal/hr
Rig Gas Engine 1	Caterpillar G3516H	2,762 bhp	Fuel Gas	16.7 MMBtu/hr
Rig Gas Engine 2	Caterpillar G3516H	2,762 bhp	Fuel Gas	16.7 MMBtu/hr
Rig Gas Engine 3	Caterpillar G3516H	2,762 bhp	Fuel Gas	16.7 MMBtu/hr
Rig Cold Start Engine	Caterpillar 3304	150 bhp	ULSD	8 gal/hr
Rig Boiler 1	NA[2]	6.3 MMBtu/hr	Fuel Gas	0.013 MMscf/hr
			ULSD	46 gal/hr
Rig Boiler 2	NA	6.3 MMBtu/hr	Fuel Gas	0.013 MMscf/hr
			ULSD	46 gal/hr
Rig Heater 1	NA	5.0 MMBtu/hr	Fuel Gas	0.010 MMscf/hr
			ULSD	37 gal/hr
Rig Heater 2	NA	5.0 MMBtu/hr	Fuel Gas	0.010 MMscf/hr
			ULSD	37 gal/hr
G&I Diesel Engine 1	Caterpillar 3512	1,650 bhp	ULSD	85 gal/hr
G&I Diesel Engine 2	Caterpillar 3512	1,650 bhp	ULSD	85 gal/hr
G&I Diesel Engine 3	Caterpillar 3512	1,650 bhp	ULSD	85 gal/hr
Compressor Turbine 1	Siemens SGT-300	11,000 bhp[2]	Fuel Gas	80.9 MMBtu/hr
Compressor Turbine 2	Siemens SGT-300	11,000 bhp	Fuel Gas	80.9 MMBtu/hr
Compressor Turbine 3	Siemens SGT-300	11,000 bhp	Fuel Gas	80.9 MMBtu/hr

1 Ultra-low sulfur diesel.
2 Not available.

Table 2-1 (Continued). Liberty Development Project OCS Facility Emission Unit Inventory

Description	Make / Model	Rating / Capacity	Fuel Type	Maximum Fuel Consumption
Standby Generator Engine 1	Caterpillar 3512	1,650 bhp	ULSD[1]	85 gal/hr
Standby Generator Engine 2	Caterpillar 3512	1,650 bhp	ULSD	85 gal/hr
Standby Generator Engine 3	Caterpillar 3512	1,650 bhp	ULSD	85 gal/hr
Incinerator	NA[2]	220 lb/hr	Waste	1.1 MMBtu/hr
Flare	NA	40 MMscf/day[3]	Fuel Gas	140 MMscf/yr
Drilling Support Equipment				
Portable Heater	Tioga IDF 3 SCOK	1.0 MMBtu/hr	ULSD	7 gal/hr
Portable Heater	Tioga IDF 3 SCOK	1.0 MMBtu/hr	ULSD	7 gal/hr
Portable Heater	Tioga IDF 3 SCOK	1.0 MMBtu/hr	ULSD	7 gal/hr
Portable Heater	Tioga IDF 3 SCOK	1.0 MMBtu/hr	ULSD	7 gal/hr
Portable Heater	Tioga IDF 3 SCOK	1.0 MMBtu/hr	ULSD	7 gal/hr
Cement Pump Engine	NA	300 hp	ULSD	15 gal/hr
Cement Pump Engine	NA	300 hp	ULSD	15 gal/hr
Light Plant Engine	Ingersol Rand L6-4MH	7 hp	ULSD	0.4 gal/hr
Light Plant Engine	Ingersol Rand L6-4MH	7 hp	ULSD	0.4 gal/hr
Light Plant Engine	Ingersol Rand L6-4MH	7 hp	ULSD	0.4 gal/hr
Large Crane Engine	Manitowoc 999	400 hp	ULSD	21 gal/hr
Small Crane Engine	Grove 80 Ton	275 hp	ULSD	14 gal/hr
Loader	Caterpillar 966	286 hp	ULSD	15 gal/hr
Loader	Caterpillar 966	286 hp	ULSD	15 gal/hr
Zoom Boom	Carelift ZB-10044	110 hp	ULSD	6 gal/hr
Hot Oil Unit	NA	485 hp	ULSD	25 gal/hr
Super Sucker Truck	NA	485 hp	ULSD	25 gal/hr
Super Sucker Truck	NA	485 hp	ULSD	25 gal/hr
Mobile Cement Van	NA	485 hp	ULSD	25 gal/hr
Mobile E-Line Unit	NA	485 hp	ULSD	25 gal/hr
Crew Van	NA	485 hp	ULSD	25 gal/hr

1 ULSD = Ultra-low sulfur diesel.

2 Not available.

3 The flare rate is not expected to exceed 4.0 MMscf/day.

Table 2-2. Liberty Development Project OCS Facility Projected Emissions

Description	Make / Model	Projected Emissions (tpy)				
		CO	PM	SO_2	NO_X	VOC
Power Generation Turbine 1	Siemens SGT-300	10.80	2.55	21.02	26.60	0.81
Power Generation Turbine 2	Siemens SGT-300	10.80	2.55	21.02	26.60	0.81
Power Generation Turbine 3	Siemens SGT-300	10.80	2.55	21.02	26.60	0.81
Power Generation Turbine 4	Siemens SGT-300	10.80	2.55	21.02	26.60	0.81
Power Generation Turbine 5	Siemens SGT-300	10.80	2.55	21.02	26.60	0.81
Rig Diesel Engine 1	MTU 16V2000	27.34	0.23	0.05	5.23	1.48
Rig Diesel Engine 2	MTU 16V2000	27.34	0.23	0.05	5.23	1.48
Rig Diesel Engine 3	MTU 16V2000	27.34	0.23	0.05	5.23	1.48
Rig Diesel Engine 4	MTU 16V2000	27.34	0.23	0.05	5.23	1.48
Rig Gas Engine 1	Caterpillar G3516H	68.01	0.73	3.99	13.34	19.47
Rig Gas Engine 2	Caterpillar G3516H	68.01	0.73	3.99	13.34	19.47
Rig Gas Engine 3	Caterpillar G3516H	68.01	0.73	3.99	13.34	19.47
Rig Cold Start Engine	Caterpillar 3304	5.40	0.02	0.01	0.43	0.21
Rig Boiler 1[1]	NA[2]	2.34	0.21	1.50	4.03	0.15
Rig Boiler 2[1]	NA	2.34	0.21	1.50	4.03	0.15
Rig Heater 1[1]	NA	1.86	0.17	1.19	3.20	0.12
Rig Heater 2[1]	NA	1.86	0.17	1.19	3.20	0.12
G&I Diesel Engine 1	Caterpillar 3512	41.58	1.19	0.08	7.96	2.26
G&I Diesel Engine 2	Caterpillar 3512	41.58	1.19	0.08	7.96	2.26
G&I Diesel Engine 3	Caterpillar 3512	41.58	1.19	0.08	7.96	2.26
Compressor 1	Siemens SGT-300	10.51	2.34	19.28	25.88	0.74
Compressor 2	Siemens SGT-300	10.51	2.34	19.28	25.88	0.74
Compressor 3	Siemens SGT-300	10.51	2.34	19.28	25.88	0.74

1 Emissions for dual-fuel units are represented by the greater of the emissions during ULSD-fired or gas-fired mode.
2 Not Available.

Table 2-2 (continued). Liberty Development Project OCS Facility Projected Emissions

EU ID	Rating / Capacity	Projected Emissions (tpy)				
		CO	PM	SO_2	NO_X	VOC
Standby Generator Engine 1	Caterpillar 3512	41.58	1.19	0.08	7.96	2.26
Standby Generator Engine 2	Caterpillar 3512	41.58	1.19	0.08	7.96	2.26
Standby Generator Engine 3	Caterpillar 3512	41.58	1.19	0.08	7.96	2.26
Incinerator	NA[2]	0.06	0.77	0.01	1.39	1.45
Flare	NA	26.60	1.90	3.80	4.89	0.01
Drilling Support Equipment						
Portable Heater	Tioga IDF 3 SCOK	0.161	0.032	0.007	0.644	0.011
Portable Heater	Tioga IDF 3 SCOK	0.161	0.032	0.007	0.644	0.011
Portable Heater	Tioga IDF 3 SCOK	0.161	0.032	0.007	0.644	0.011
Portable Heater	Tioga IDF 3 SCOK	0.161	0.032	0.007	0.644	0.011
Portable Heater	Tioga IDF 3 SCOK	0.161	0.032	0.007	0.644	0.011
Cement Pump	NA	7.556	0.503	0.014	8.646	0.517
Cement Pump	NA	7.556	0.503	0.014	8.646	0.517
Light Plant	Ingersol Rand L6-4MH	0.137	0.019	0.0003	0.126	0.017
Light Plant	Ingersol Rand L6-4MH	0.137	0.019	0.0003	0.126	0.017
Light Plant	Ingersol Rand L6-4MH	0.137	0.019	0.0003	0.126	0.017
Large Crane	Manitowoc 999	1.607	0.224	0.019	4.187	0.305
Small Crane	Grove 80 Ton	0.985	0.154	0.013	2.879	0.222
Loader	Caterpillar 966	2.138	0.386	0.014	4.286	0.335
Loader	Caterpillar 966	2.138	0.386	0.014	4.286	0.335
Zoom Boom	Carelift ZB-10044	0.458	0.109	0.005	1.151	0.089
Hot Oil Unit	NA	0.080	0.039	0.023	0.202	0.011
Super Sucker Truck	NA	0.080	0.039	0.023	0.202	0.011
Super Sucker Truck	NA	0.080	0.039	0.023	0.202	0.011
Mobile Cement Van	NA	0.080	0.039	0.023	0.202	0.011
Mobile E-Line Unit	NA	0.080	0.039	0.023	0.202	0.011
Crew Van	NA	0.062	0.013	0.023	0.460	0.005
	TOTAL	**713**	**36**	**185**	**380**	**89**

1 Emissions for dual-fuel units are represented by the greater of the emissions during ULSD-fired or gas-fired mode.
2 Not Available.

Table 2-3. Comparison of Projected Emissions to BOEM Exemption Thresholds

Pollutant	BOEM Exemption Formula[1]	Exemption Threshold, E (tpy)	OCS Facility Projected Emissions (tpy)	Exceeds Exemption Threshold?
SO_2	E = 33.3 x D	133.2	185	**YES**
TSP[2]	E = 33.3 x D	133.2	36	No
NO_X	E = 33.3 x D	133.2	380	**YES**
VOC	E = 33.3 x D	133.2	89	No
CO	$E = 3,400 \times D^{2/3}$	8,567.5	713	No

1 Source: 30 CFR 550.303(d). D is equal to 4.0 statute miles, which is the distance between OCS facility and closest onshore location.

2 Emission threshold is based on total suspended particulate (TSP) emissions, per 30 CFR 50.303, and includes PM10 and PM2.5.

3.0 Modeling Approach

Per 30 CFR 550.249, when dispersion modeling requirements are triggered, the modeling procedures must follow the guidelines in 40 CFR 51, Appendix W using a model approved by the BOEM Director. Additionally, 30 CFR 550.249(e) requires the use of the best available meteorological data that are consistent with the air dispersion model(s) used. Currently, the Offshore and Coastal Dispersion (OCD) model, version 5.0 is the only dispersion model approved for use by the BOEM Director for emission sources on the Alaska OCS (50 FR 12248; 28 March 1985). The OCD model is designed to model the near-field dispersion (less than 50 kilometers (km) from the emission source) of emissions over open water and characterizes changes in plume dispersion as a plume passes over the shoreline. Therefore, the OCD model is applicable for modeling emission sources located on open water, such as platforms and vessels (40 CFR 51, Appendix W).

The Liberty Development Project is located on the Beaufort Sea and experiences an open water season, defined as the period when total ice cover is less than ten percent, typically from July through October. Because plume dispersion characteristics over snow and ice are similar to dispersion characteristics over land, OCD is not well-suited to model the dispersion of emissions during periods when the open water is covered by snow and ice. The American Meteorological Society (AMS) and EPA AERMOD model is recommended in 40 CFR 51, Appendix W for characterizing the dispersion of emissions over land at distances less than or equal to 50 km from the source. Therefore, the latest version of AERMOD (version 14134) was used to model the dispersion of emissions from the project sources during the period when the open water is covered with snow and ice, which typically occurs from November through June at the project location.

Because the distance between the OCS facility and the Alaska State coastline is 4.0 statute miles (6.5 km), the maximum emission impacts are captured within the near-field model domain. Therefore, a far-field dispersion model, which is recommended under the guidance in 40 CFR 51, Appendix W for modeling impacts at distances greater than 50 km from the emission source, is not necessary for the air quality impact analysis.

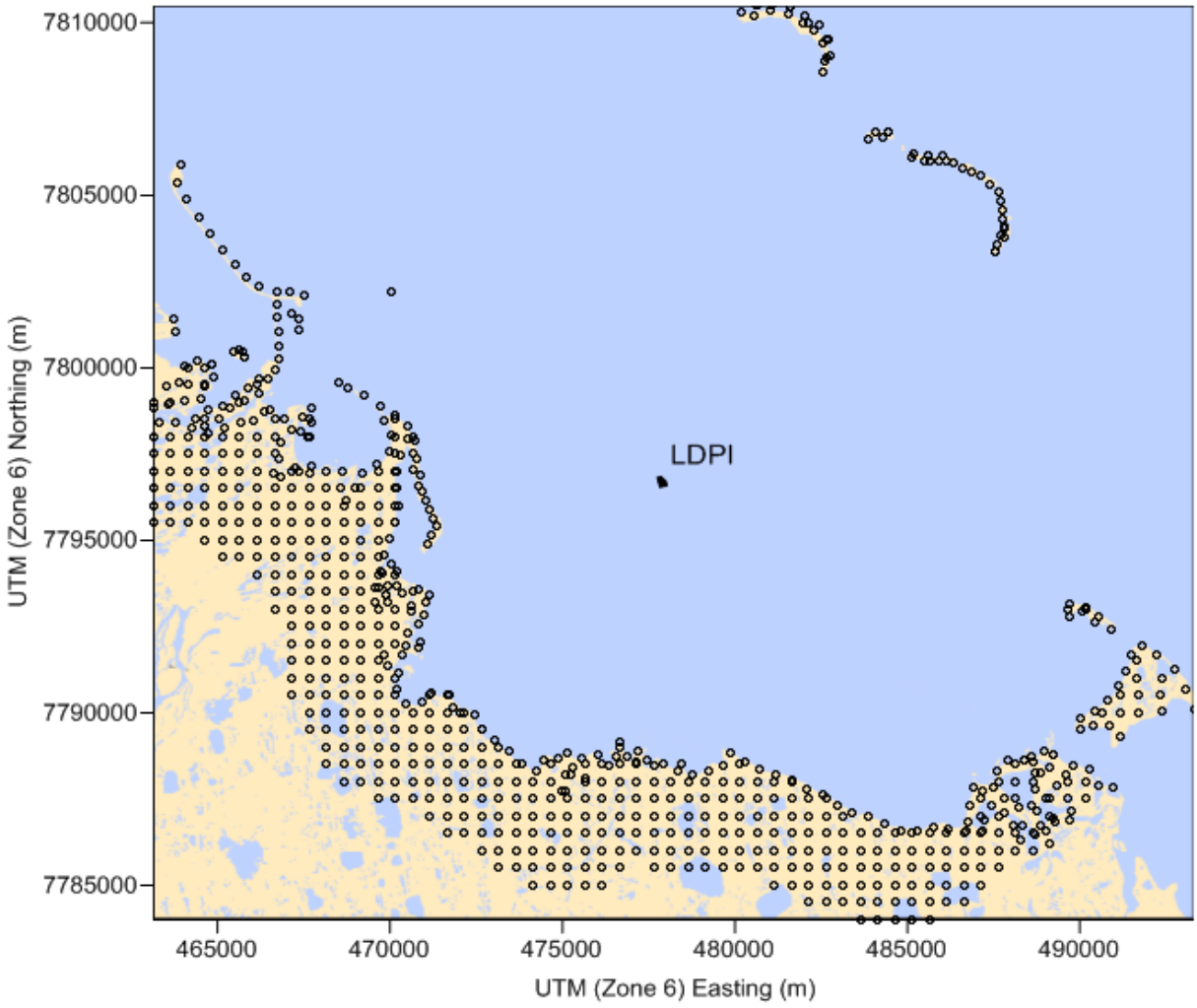
3.1 Offshore and Coastal Dispersion Model

The latest version of the OCD model (version 5.0) was used to characterize the dispersion of emissions from the development and production activities at the LDPI based on meteorological data collected during the 2010 open water season (July through October 2010).

3.1.1 OCD Domain and Receptor Fields

Figure 3.1 shows the emission dispersion model receptor field, which is comprised of receptors placed at 500 m intervals along the Alaska State coastline. The receptors span a sufficient distance to capture the modeled maximum onshore impacts. Additional receptors are located 1.5 km inland from the coastal boundary with 500-meter spacing and also along the boundaries of barrier islands located within the near-field model domain.

Figure 3-1. Dispersion Model Receptor Field



3.1.2 OCD Model Meteorological Data

The provisions of 40 CFR 51, Appendix W require the use of at least one-year of site specific data that meets EPA Prevention of Significant Deterioration (PSD) quality assurance standards or at least five-years of National Weather Service (NWS) automated surface observing station (ASOS) data that adequately represents the project location. Therefore, the criteria used to determine the best meteorological data for the Liberty Development Project ambient air quality impact analysis include proximity of the meteorological monitoring site to the OCS facility, data quality and completeness, the period of time the data were collected, and availability. With the exception of data availability, these criteria are addressed in 40 CFR 51, Appendix W and the EPA guidance document, Meteorological Monitoring Guidance for Regulatory Modeling Applications, *EPA-454/R-99-005*, February 2000.

The OCD model requires hourly meteorological data from both onshore and offshore locations. The required land-based OCD meteorological inputs include ambient air temperature, horizontal wind speed, horizontal wind direction, and stability class. The mandatory OCD overwater meteorological inputs are relative humidity (RH), ambient air temperature, horizontal wind speed, horizontal wind direction, overwater mixing height, and sea surface temperature (SST).

The overland meteorological input data for the OCD model were prepared using meteorological data from two stations; the BPXA Prudhoe Bay Unit (PBU) A-Pad Meteorological Station (70° 16.02' N, 148° 45.18' W) and the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Automated Surface Observation Systems (ASOS) station located at the airport in Deadhorse, Alaska (ID 27406; 70° 11.46' N, 148° 28.62' W). Ambient air temperature, horizontal wind speed, and wind direction data were obtained from the PBU A-Pad Meteorological Station while observed cloud cover and ceiling height, relative humidity (RH), and station pressure were obtained from the Deadhorse NWS ASOS site.

The overwater meteorological input data for the OCD model were prepared using site-specific hourly air temperature, wind speed, and wind direction data collected from the Shell Endicott Main Production Island (MPI) Meteorological Monitoring Program station (70° 21.21' N, 147° 57.96' W). SST data collected during the 2010 open water season (July through October 2010) at the NOAA National Data Buoy Center (NDBC) Prudhoe Bay Buoy (PRDA2; 70° 24' N, 148° 31.6' W) were used for the air dispersion model analyses. Hourly relative humidity data were not collected during the Shell Endeavor Island Meteorological Monitoring Program during the 2010 open water season, so concurrent one-hour relative humidity measurements from the NWS Deadhorse ASOS site were used in the OCD model.

3.1.3 OCD Model Options

The OCD model inputs were configured following BOEM and EPA guidance. The OCD model has the ability to simulate the effects of building downwash on the dispersion of emissions. This phenomenon increases the initial rate of plume dispersion in the turbulent wake and restricts plume rise, which results in greater modeled pollutant impacts at the ground level. The OCD model downwash algorithm is based on a single building height input and width input for each modeled emission source. The island base height input is equal to the mean height of the island pad grade base above mean sea level (4.57 m).

3.2 AERMOD Dispersion Model

The latest version of AERMOD (14134) was used to assess emission impacts during periods when the project area experiences snow and ice-covered water conditions (November through June). AERMOD is a steady-state, Gaussian dispersion model developed by AMS and EPA and recommended for characterizing transport of emissions over land at distances less than or equal to 50 km from the source.

3.2.1 AERMOD Domain and Receptor Fields

The receptor fields for the analysis prepared using AERMOD are identical to the receptor fields used for the analysis conducted using OCD as described in Section 3.1.1.

3.2.2 AERMET Meteorological Data

AERMOD requires hourly surface meteorological data and upper air meteorological data to characterize air dispersion over land and snow and ice-covered water surfaces. The meteorological input data for AERMOD was processed by the most recent version of AERMET (14134). Hourly surface meteorological data collected at Endicott MPI from May 2010 and November 2010 through April 2011, were used with corresponding upper air data collected at the Endicott MPI Temperature Profiler station.

3.2.3 AERMOD Rural Dispersion Option

AERMOD includes an urban option to account for the dispersion of pollutants during night-time convective conditions that occur due to "urban heat island" effects. 40 CFR 51, Appendix W, Section 7.2.3 provides the basis for determining whether the source is classified as an urban or rural area. Specifically, a circular area (A_o) with a 3-km radius is used for the determination and either the land use or population density within A_o is used to determine the urban or rural classification. The area within a 3-km radius from the planned location of the LDPI consists of only open water. Therefore, the urban dispersion coefficients were not used in the analysis.

3.3 Modeled Emission Unit Input Parameters

Table 3-1 and Table 3-2 provide the physical parameters and pollutant emission rates, respectively, for the LDPI EUs. All EUs were modeled with a base elevation of 4.57 m above mean sea level, which is consistent with the LDPI design. Pollutant emission rates are based on the information provided in Section 2.0 and Appendix A and all emission units were modeled as stationary point sources. Because the drilling support equipment inventory is comprised of a number of transient mobile sources, the source group was aggregated to provide a comprehensive, accurate representation of emission impacts from this source group while minimizing the number of modeling scenarios. The OCD model can be used to characterize emission sources as point sources, line sources, or area sources. However, the OCD User Guide (DiCristofaro and Hanna, 1989) states that the OCD area source calculations should be used for guidance purposes only. Therefore, the aggregated drilling support equipment was characterized as a point source for the air dispersion model analysis.

3.4 Conversion of NO_X to NO_2

For modeling purposes, additional calculations were used to determine NO_2 impacts from modeled NO_X emissions. The Ambient Ratio Method (ARM) was used as a conservative method to estimate the conversion of emitted NO_X emissions to NO_2. The ARM has been approved for use by EPA in Supplement C to the Guideline on Air Quality Modeling (August 1995). A NO_2-to-NO_X ratio of 0.75 was used for estimating annual average NO_2 impacts consistent with the guidance in 40 CFR 51, Appendix W.

Table 3-1. Modeled Emission Unit Physical Input Parameters

Emission Unit Description	Model ID	UTM (Zone 6) Easting (m)	UTM (Zone 6) Northing (m)	Stack Height[1] (m)	Temperature (K)	Velocity (m/s)	Stack Diameter (m)
Power Generation Turbine 1	Turbine1	477,930.00	7,796,676.87	10.97	815	31.7	1.676
Power Generation Turbine 2	Turbine2	477,928.89	7,796,680.99	10.97	815	31.7	1.676
Power Generation Turbine 3	Turbine3	477,927.79	7,796,685.11	10.97	815	31.7	1.676
Power Generation Turbine 4	Turbine4	477,926.69	7,796,689.23	10.97	815	31.7	1.676
Power Generation Turbine 5	Turbine5	477,925.58	7,796,693.36	10.97	815	31.7	1.676
Rig Diesel Engine 1	RigDie_1	477,959.84	7,796,696.22	15.82	833	48.0	0.305
Rig Diesel Engine 2	RigDie_2	477,961.90	7,796,696.78	15.82	833	48.0	0.305
Rig Diesel Engine 3	RigDie_3	477,963.96	7,796,697.33	15.82	833	48.0	0.305
Rig Diesel Engine 4	RigDie_4	477,966.02	7,796,697.88	15.82	833	48.0	0.305
Rig Gas Engine 1	RigGas_1	477,953.66	7,796,694.57	15.82	820	36.3	0.305
Rig Gas Engine 2	RigGas_2	477,955.72	7,796,695.12	15.82	820	36.3	0.305
Rig Gas Engine 3	RigGas_3	477,957.78	7,796,695.67	15.82	820	36.3	0.305
Rig Cold Start Engine	ColdStar	477,965.43	7,796,697.72	15.82	755	39.1	0.102
Rig Boiler 1	Boiler_1	477,967.26	7,796,712.10	17.04	461	11.5	0.406
Rig Boiler 2	Boiler_2	477,967.89	7,796,709.74	17.04	461	11.5	0.406
Rig Heater 1[2]	Heater_1	477,969.31	7,796,704.44	17.04	461	13.1	0.356
Rig Heater 2[2]	Heater_2	477,962.71	7,796,710.25	17.04	461	13.1	0.356
G&I Diesel Engine 1	G&I_1	477,954.76	7,796,725.79	12.65	833	48.0	0.305
G&I Diesel Engine 2	G&I_2	477,955.39	7,796,723.43	12.65	833	48.0	0.305
G&I Diesel Engine 3	G&I_3	477,956.02	7,796,721.08	12.65	833	48.0	0.305
Compressor 1	Compres1	478,046.25	7,796,631.65	8.38	771	28.8	1.676
Compressor 2	Compres2	478,050.66	7,796,632.84	8.38	771	28.8	1.676
Compressor 3	Compres3	478,055.08	7,796,634.02	8.38	771	28.8	1.676

1 Stack height above LDPI pad surface.
2 EU modeled as point source outfitted with a raincap.
3 Aggregate of drilling support equipment.

Table 3-1 (continued). Modeled Emission Unit Physical Input Parameters

Emission Unit Description	Model ID	UTM (Zone 6) Easting (m)	UTM (Zone 6) Northing (m)	Stack Height[1] (m)	Temperature (K)	Velocity (m/s)	Stack Diameter (m)
Standby Generator Engine 1	Standby1	477,899.27	7,796,763.30	8.08	683	48.8	0.152
Standby Generator Engine 2	Standby2	477,905.16	7,796,764.88	8.08	683	48.8	0.152
Standby Generator Engine 3	Standby3	477,911.04	7,796,766.46	8.08	683	48.8	0.152
Incinerator	Incinera	477,908.84	7,796,739.36	5.64	784	12.6	0.305
Southeast Flare	Flare	478,086.20	7,796,647.41	40.99	1,273	20.0	2.243
Drilling Support Equipment[3]	DrillSup	477,970.63	7,796,748.97	4.27	755	61.8	0.279

1 Stack height above LDPI pad surface.
2 EU modeled as point source outfitted with a raincap.
3 Aggregate of drilling support equipment.

Table 3-2. Modeled Emission Rates

Emission Unit Description	Model ID	Long-Term NO_X (g/s)	Short-Term CO (g/s)	Long-Term PM (g/s)	Short-Term PM (g/s)	Long-Term SO_2 (g/s)	Short-Term SO_2 (g/s)
Power Generation Turbine 1	Turbine1	0.765	0.311	0.073	0.073	0.605	0.605
Power Generation Turbine 2	Turbine2	0.765	0.311	0.073	0.073	0.605	0.605
Power Generation Turbine 3	Turbine3	0.765	0.311	0.073	0.073	0.605	0.605
Power Generation Turbine 4	Turbine4	0.765	0.311	0.073	0.073	0.605	0.605
Power Generation Turbine 5	Turbine5	0.765	0.311	0.073	0.073	0.605	0.605
Rig Diesel Engine 1	RigDie_1	0.151	0.787	0.007	0.007	0.001	0.001
Rig Diesel Engine 2	RigDie_2	0.151	0.787	0.007	0.007	0.001	0.001
Rig Diesel Engine 3	RigDie_3	0.151	0.787	0.007	0.007	0.001	0.001
Rig Diesel Engine 4	RigDie_4	0.151	0.787	0.007	0.007	0.001	0.001
Rig Gas Engine 1	RigGas_1	0.384	1.956	0.021	0.021	0.115	0.115
Rig Gas Engine 2	RigGas_2	0.384	1.956	0.021	0.021	0.115	0.115
Rig Gas Engine 3	RigGas_3	0.384	1.956	0.021	0.021	0.115	0.115
Rig Cold Start Engine	ColdStar	0.012	0.155	0.001	0.001	0.0002	0.0002
Rig Boiler 1[1]	Boiler_1	0.116	0.067	0.006	0.006	0.043	0.043
Rig Boiler 2[1]	Boiler_2	0.116	0.067	0.006	0.006	0.043	0.043
Rig Heater 1[1]	Heater_1	0.092	0.053	0.005	0.005	0.034	0.034
Rig Heater 2[1]	Heater_2	0.092	0.053	0.005	0.005	0.034	0.034
G&I Diesel Engine 1	G&I_1	0.229	1.196	0.034	0.034	0.002	0.002
G&I Diesel Engine 2	G&I_2	0.229	1.196	0.034	0.034	0.002	0.002
G&I Diesel Engine 3	G&I_3	0.229	1.196	0.034	0.034	0.002	0.002
Compressor 1	Compres1	0.745	0.302	0.067	0.067	0.555	0.555
Compressor 2	Compres2	0.745	0.302	0.067	0.067	0.555	0.555
Compressor 3	Compres3	0.745	0.302	0.067	0.067	0.555	0.555

1 Emission rate is based on the greater emission rate from either the ULSD-fired or fuel-gas fired operating mode.
2 Aggregate of drilling support equipment.

Table 3-2 (continued). Modeled Emission Rates

Emission Unit Description	Model ID	Long-Term NO_X (g/s)	Short-Term CO (g/s)	Long-Term PM (g/s)	Short-Term PM (g/s)	Long-Term SO_2 (g/s)	Short-Term SO_2 (g/s)
Standby Generator Engine1	Standby1	0.229	1.196	0.034	0.034	0.002	0.002
Standby Generator Engine 2	Standby2	0.229	1.196	0.034	0.034	0.002	0.002
Standby Generator Engine 3	Standby3	0.229	1.196	0.034	0.034	0.002	0.002
Incinerator	Incinera	0.040	0.002	0.022	0.022	0.0004	0.0004
Southeast Flare	Flare	0.141	7.931	0.055	0.566	0.109	1.133
Drilling Support Equipment[2]	DrillSup	1.126	0.694	0.077	0.077	0.008	0.008

1 Emission rate is based on the greater emission rate from either the ULSD-fired or fuel-gas fired operating mode.
2 Aggregate of drilling support equipment.

4.0 Dispersion Modeling Results

Table 4-1 provides the BOEM Significance Levels (SL) from 30 CFR 550.303(e). If the modeled onshore impacts from the OCS facility exceed the SL, then the LDPI will be deemed to significantly affect the ambient air quality of the onshore area.

Table 4-1. BOEM Air Pollutant Significance Levels

Pollutant	Averaging Time				
	Annual	24-Hour	8-Hour	3-Hour	1-Hour
SO_2	1 µg/m^3	5 µg/m^3	NA	25 µg/m^3	NA
TSP[1]	1 µg/m^3	5 µg/m^3	NA	NA	NA
NO_2	1 µg/m^3	NA	NA	NA	NA
CO	NA[2]	NA	500 µg/m^3	NA	2,000 µg/m^3

1 Total suspended particulate, which includes PM10 and PM2.5.
2 Not applicable.

Table 4-2 provides a summary of the modeled maximum onshore impacts from the LDPI EU inventory. As shown, the model results demonstrate that the LDPI EU inventory will not cause an onshore impact that will exceed the BOEM SLs for any air pollutant (NO_2, CO, PM_{10}, $PM_{2.5}$, and SO_2). Therefore, a Best Available Control Technology (BACT) analysis is not required for the Liberty Development Project DPP per 30 CFR 550.303(g). Figure 4-1 through Figure 4-8 show maps of the modeled maximum onshore impacts for each modeled air pollutant and their respective applicable averaging period.

Table 4-2. Dispersion Modeling Results

Pollutant	Averaging Period	BOEM Significance Level (SL) (µg/m^3)	Maximum Onshore Impact (µg/m^3)	Exceed BOEM SL? (Y/N)
NO_2	Annual	1	0.52	No
CO	8-Hour	500	65.1	No
	1-Hour	2,000	191.3	No
PM	Annual	1	0.1	No
	24-Hour	5	0.9	No
SO_2	Annual	1	0.2	No
	24-Hour	5	3.5	No
	3-Hour	25	13.6	No

Figure 4-1. Maximum Modeled Annual Average NO_2 Impacts (µg/m^3)

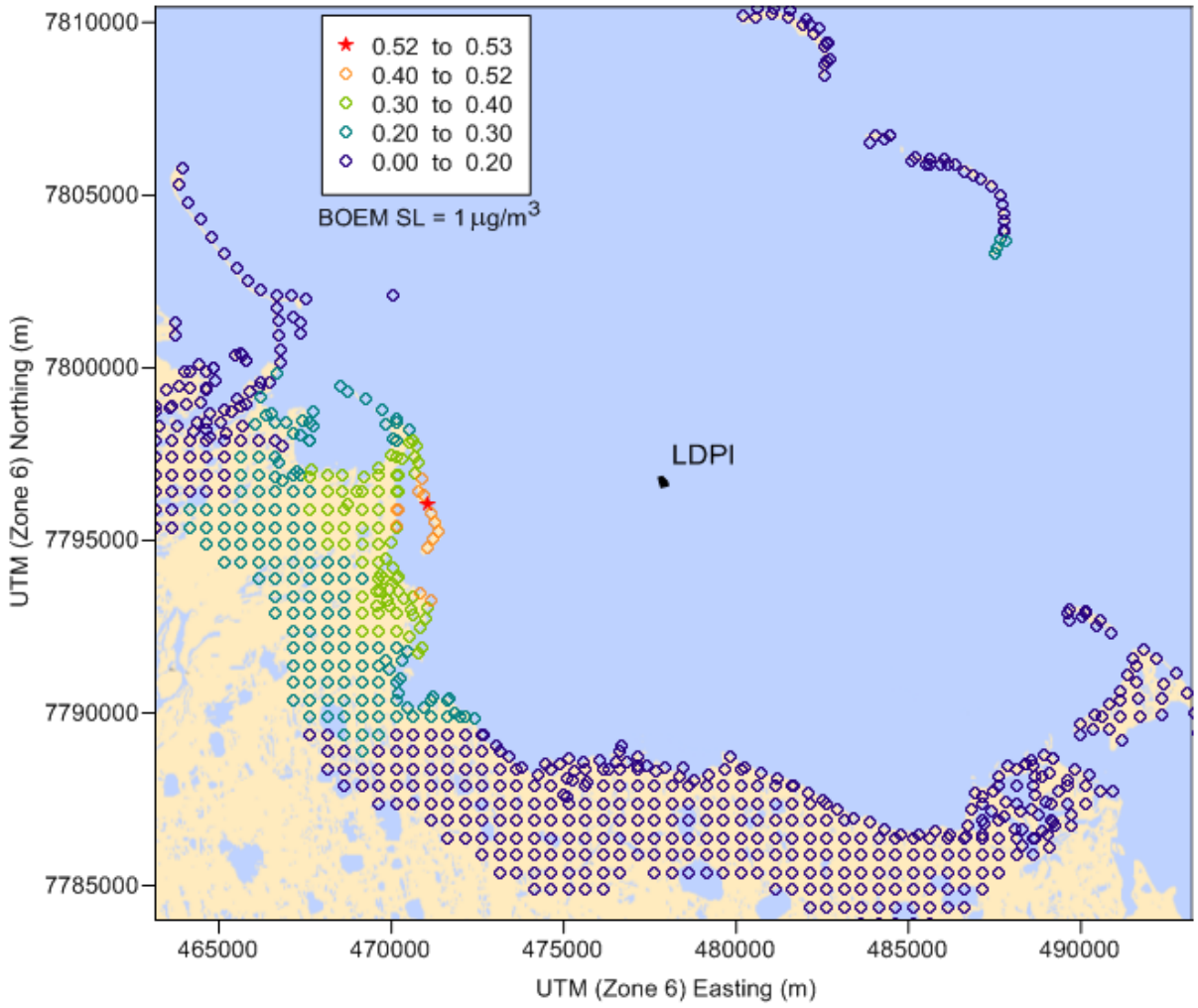


Figure 4-2. Maximum Modeled 8-Hour Average CO Impacts (µg/m^3)

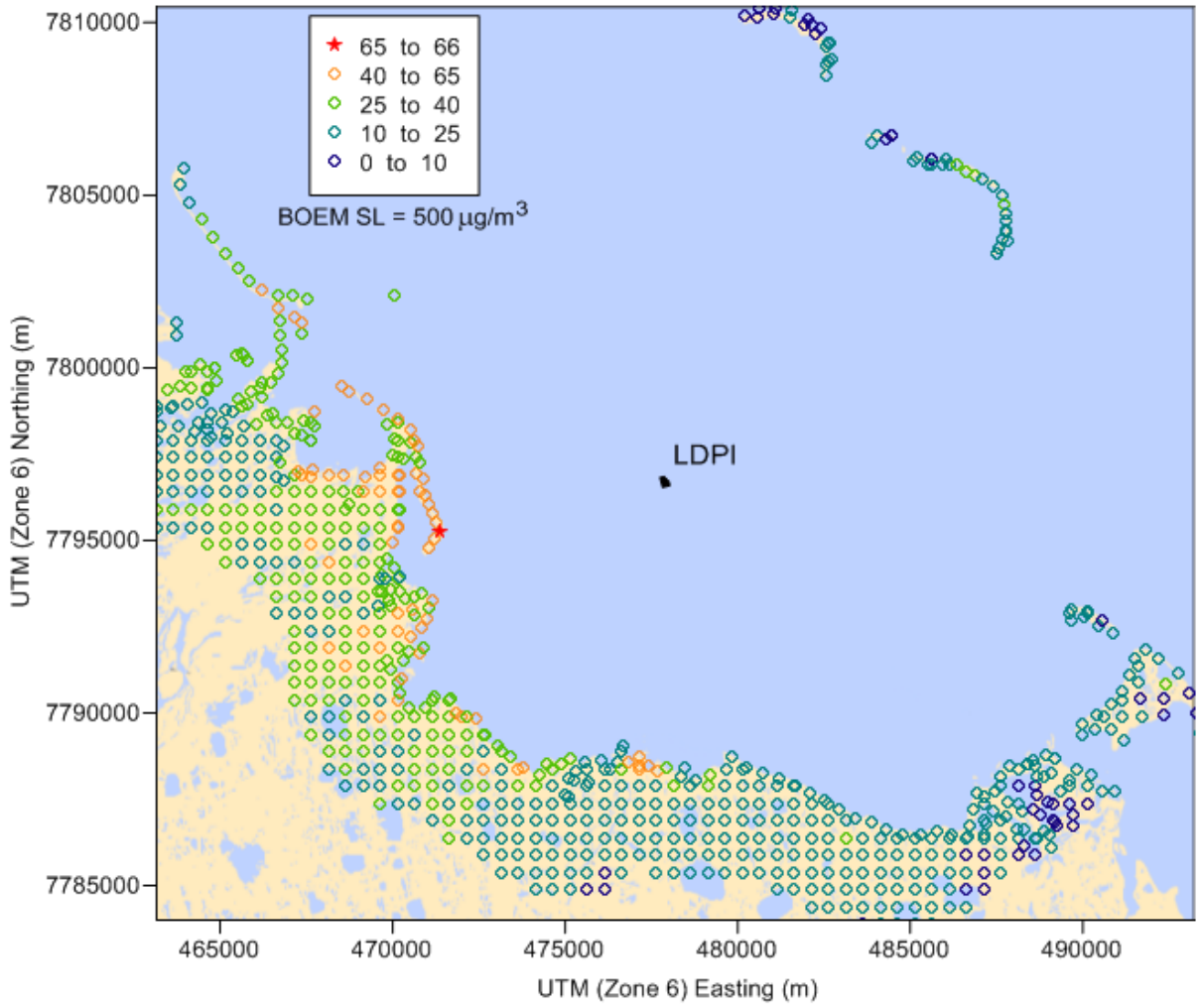


Figure 4-3. Maximum Modeled 1-Hour Average CO Impacts (µg/m^3)

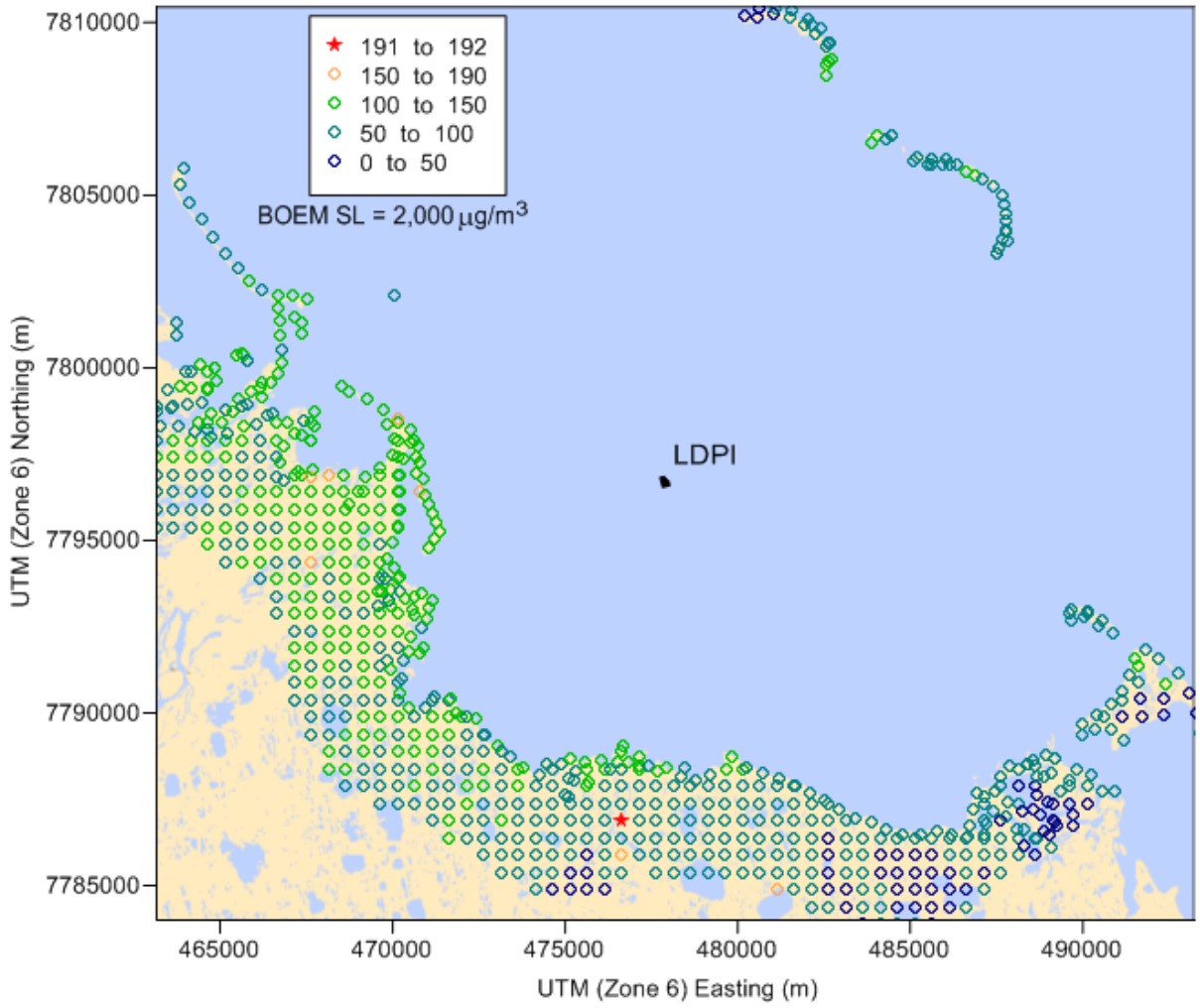


Figure 4-4. Maximum Modeled Annual Average PM Impacts (µg/m^3)

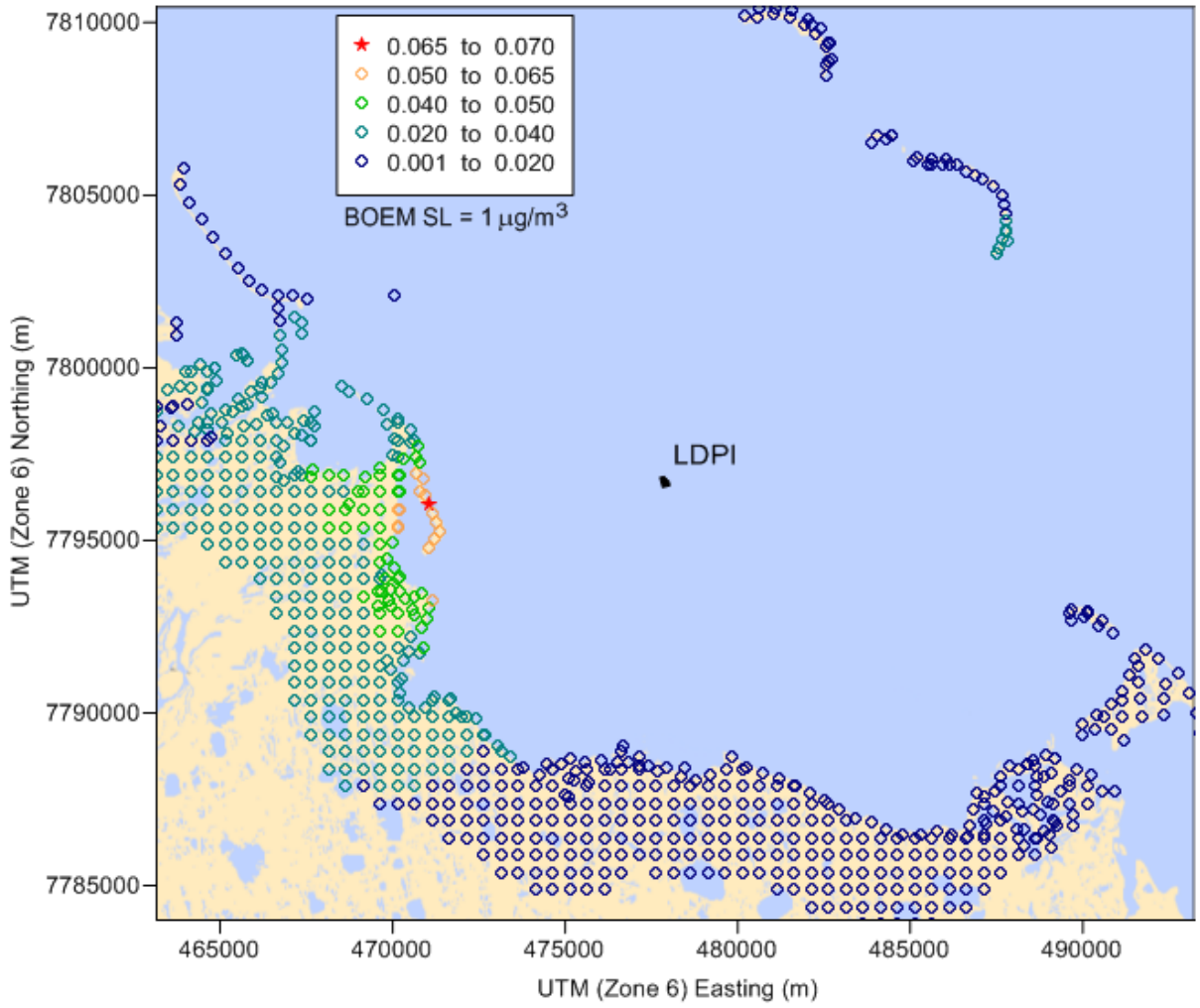


Figure 4-5. Maximum Modeled 24-Hour Average PM Impacts (µg/m^3)

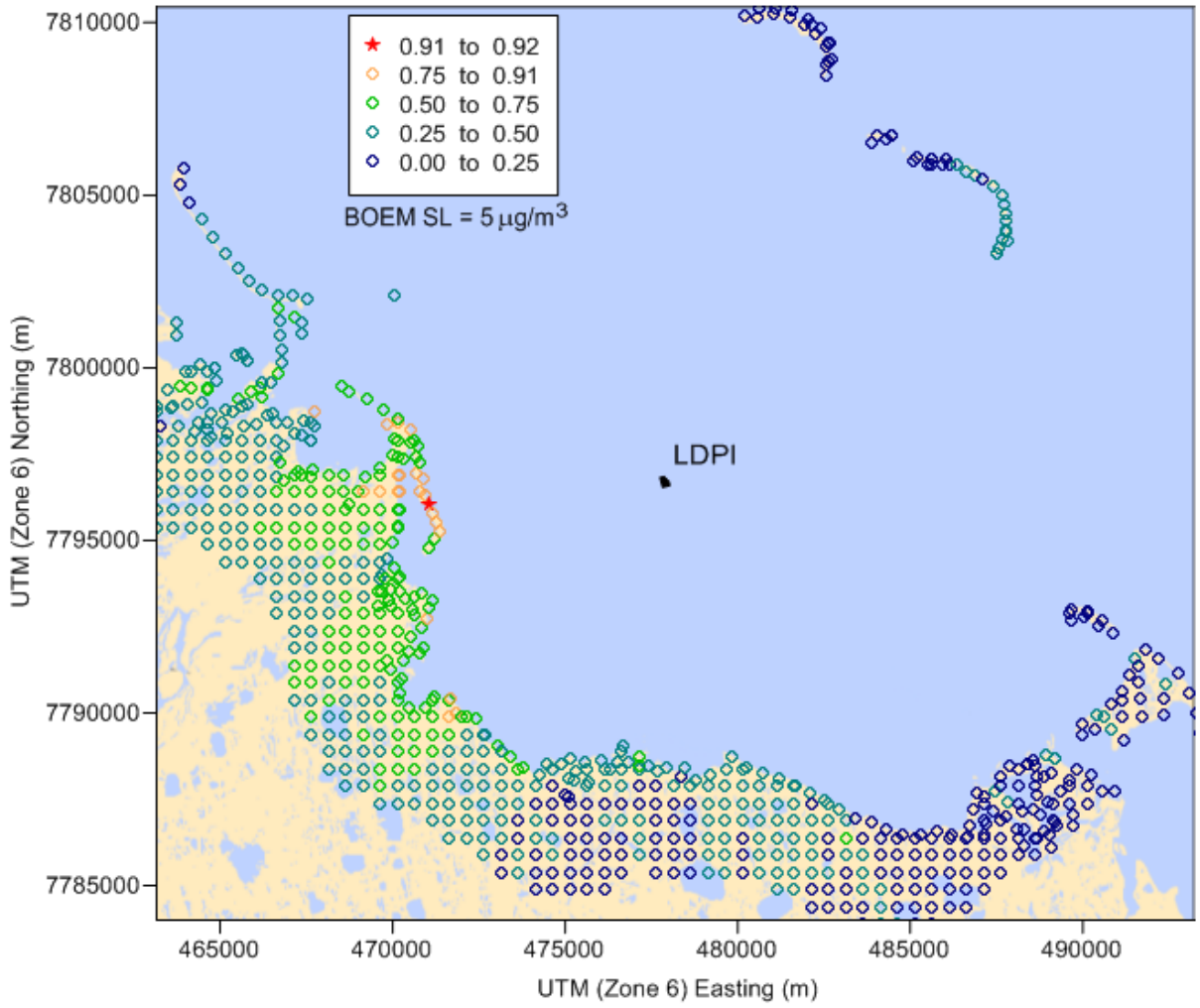


Figure 4-6. Maximum Modeled Annual Average SO_2 Impacts (µg/m^3)

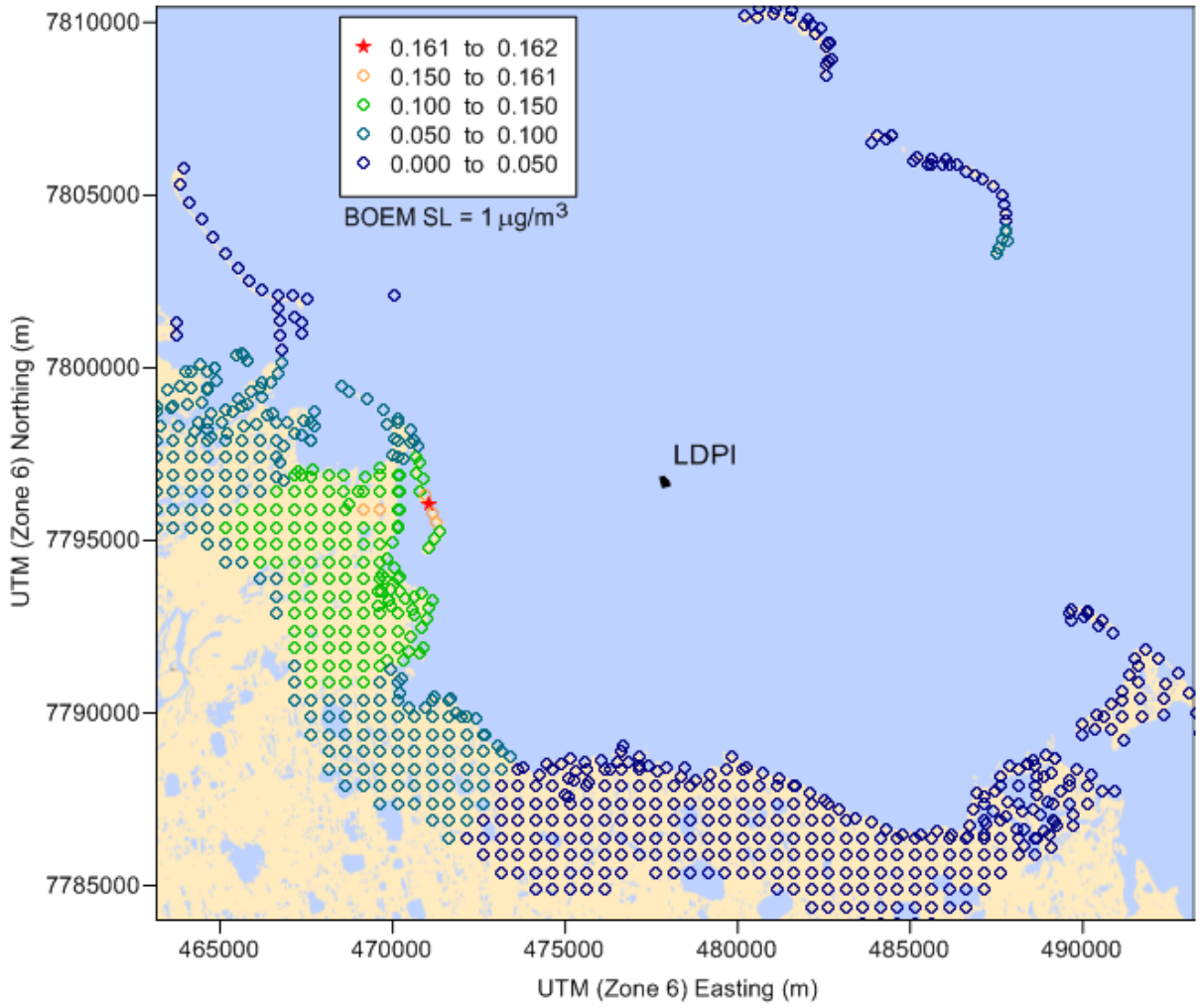


Figure 4-7. Maximum Modeled 24-Hour Average SO_2 Impacts (µg/m^3)

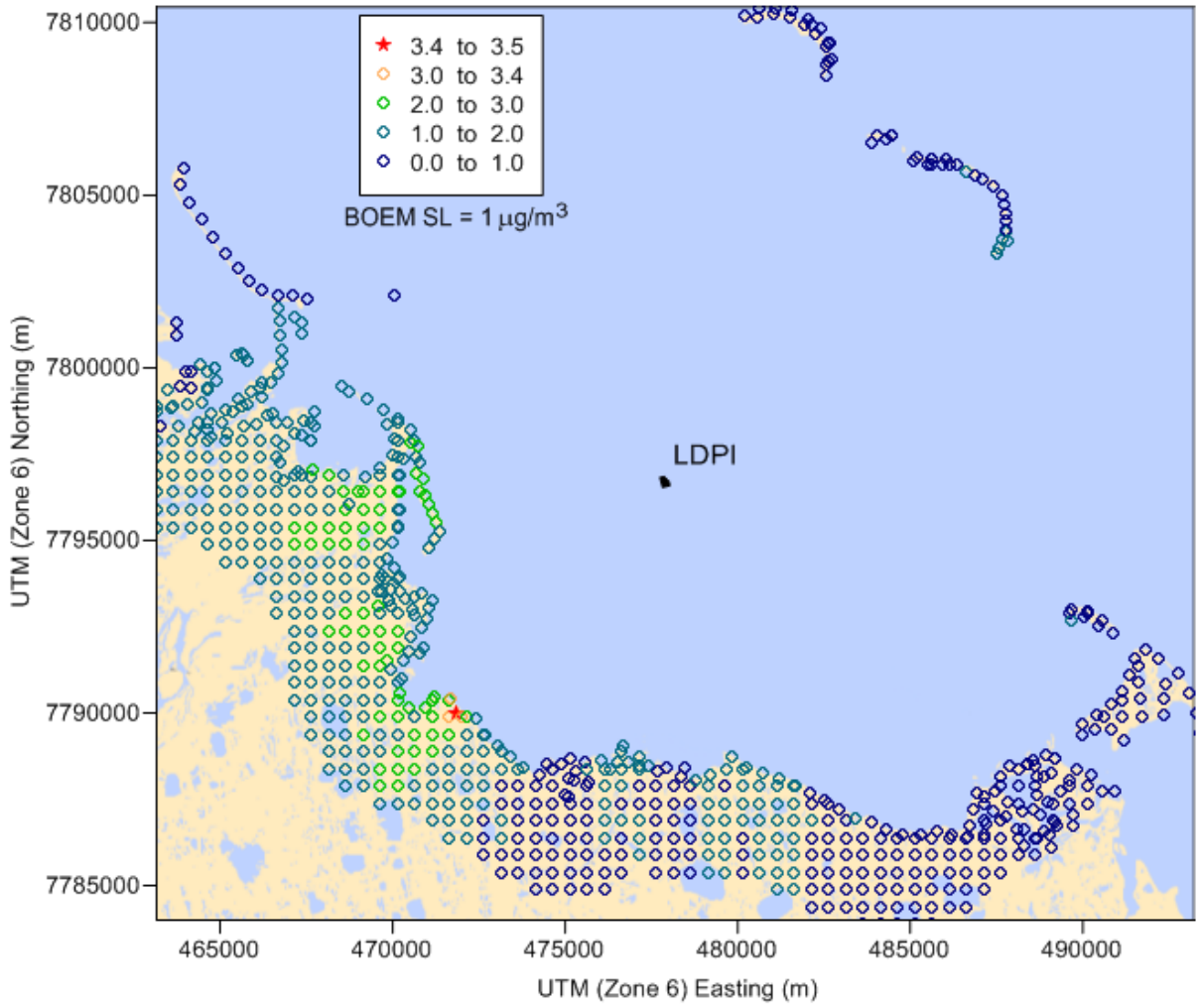
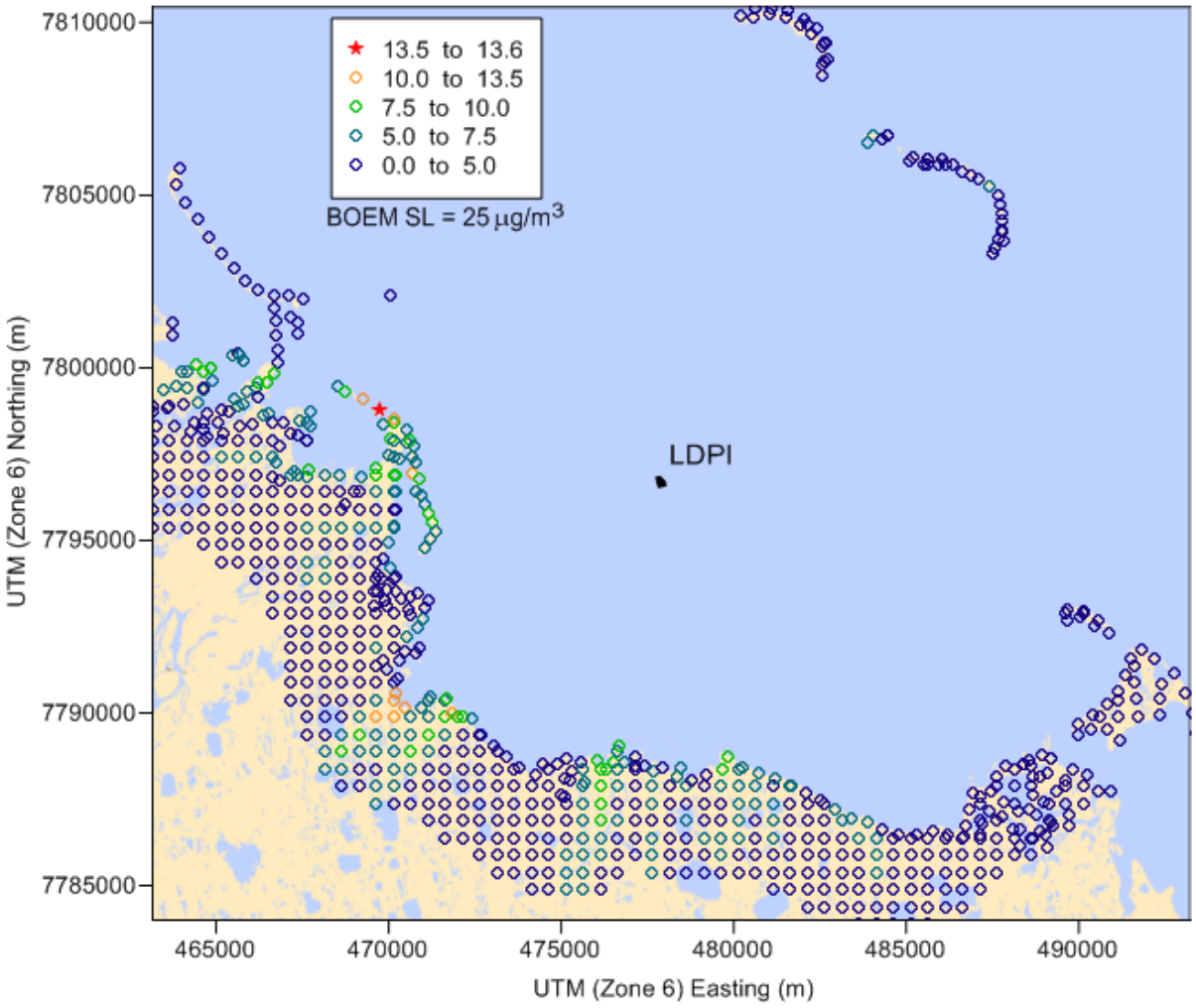


Figure 4-8. Maximum Modeled 3-Hour Average SO_2 Impacts (µg/m^3)



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Appendix A

Emission Calculations and Supporting Information

Appendix A-1

Projected Emission Calculations

Table A-1. Hilcorp Alaska - Liberty Development Project
Liberty Drilling and Production Island Emission Unit Inventory

Emission Unit			Fuel	Maximum Fuel	Maximum	Allowable
EU ID	Description	Make/Model	Type	Consumption	Capacity	Operation
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr[1]	7.9 MW	8,760 hr/yr
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	7.9 MW	8,760 hr/yr
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	7.9 MW	8,760 hr/yr
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	7.9 MW	8,760 hr/yr
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	7.9 MW	8,760 hr/yr
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[2]	53 gal/hr[3,4]	1,085 bhp	8,760 hr/yr
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	53 gal/hr	1,085 bhp	8,760 hr/yr
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	53 gal/hr	1,085 bhp	8,760 hr/yr
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	53 gal/hr	1,085 bhp	8,760 hr/yr
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	16.7 MMBtu/hr[5]	2,762 bhp	8,760 hr/yr
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	16.7 MMBtu/hr	2,762 bhp	8,760 hr/yr
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	16.7 MMBtu/hr	2,762 bhp	8,760 hr/yr
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	8 gal/hr[4]	150 bhp	8,760 hr/yr
20	Rig Boiler 1	NA[6]	Fuel Gas	0.013 MMscf/hr[7]	6.3 MMBtu/hr	8,760 hr/yr
			ULSD	46 gal/hr		
21	Rig Boiler 2	NA	Fuel Gas	0.013 MMscf/hr[7]	6.3 MMBtu/hr	8,760 hr/yr
			ULSD	46 gal/hr		
22	Rig Heater 1	NA	Fuel Gas	0.010 MMscf/hr[7]	5.0 MMBtu/hr	8,760 hr/yr
			ULSD	37 gal/hr		
23	Rig Heater 2	NA	Fuel Gas	0.010 MMscf/hr[7]	5.0 MMBtu/hr	8,760 hr/yr
			ULSD	37 gal/hr		
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	85 gal/hr[4]	1,650 bhp	8,760 hr/yr
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	85 gal/hr	1,650 bhp	8,760 hr/yr
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	85 gal/hr	1,650 bhp	8,760 hr/yr
6	Compressor 1	Siemens SGT-300	Fuel Gas	80.9 MMBtu/hr[8]	11,000 bhp	8,760 hr/yr
7	Compressor 2	Siemens SGT-300	Fuel Gas	80.9 MMBtu/hr	11,000 bhp	8,760 hr/yr
8	Compressor 3	Siemens SGT-300	Fuel Gas	80.9 MMBtu/hr	11,000 bhp	8,760 hr/yr
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	85 gal/hr	1,650 bhp	8,760 hr/yr
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	85 gal/hr	1,650 bhp	8,760 hr/yr
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	85 gal/hr	1,650 bhp	8,760 hr/yr
27	Incinerator	NA	Waste	1.1 MMBtu/hr[9]	220 lb/hr	8,760 hr/yr
30	Flare	NA	Fuel Gas	140 MMscf/yr[10]	40 MMscf/day[11]	8,760 hr/yr
31	Flare - Pilot/Purge		Fuel Gas	1.0 MMscf/yr	0.003 MMscf/day	
Drilling Support Equipment						
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr[4]	1.0 MMBtu/hr	8,760 hr/yr
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	1.0 MMBtu/hr	8,760 hr/yr
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	1.0 MMBtu/hr	8,760 hr/yr
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	1.0 MMBtu/hr	8,760 hr/yr
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	1.0 MMBtu/hr	8,760 hr/yr
502A	Cement Pump	NA	ULSD	15 gal/hr	300 hp	8,760 hr/yr
502B	Cement Pump	NA	ULSD	15 gal/hr	300 hp	8,760 hr/yr
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	0.4 gal/hr	7 hp	8,760 hr/yr
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	0.4 gal/hr	7 hp	8,760 hr/yr
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	0.4 gal/hr	7 hp	8,760 hr/yr
504	Large Crane	Manitowoc 999	ULSD	21 gal/hr	400 hp	8,760 hr/yr
505	Small Crane	Grove 80 Ton	ULSD	14 gal/hr	275 hp	8,760 hr/yr
506A	Loader	Caterpillar 966	ULSD	15 gal/hr	286 hp	8,760 hr/yr
506B	Loader	Caterpillar 966	ULSD	15 gal/hr	286 hp	8,760 hr/yr
507	Zoom Boom	Carelift ZB-10044	ULSD	6 gal/hr	110 hp	8,760 hr/yr
508	Hot Oil Unit	NA	ULSD	25 gal/hr	485 hp	8,760 hr/yr
509A	Super Sucker Truck	NA	ULSD	25 gal/hr	485 hp	8,760 hr/yr
509B	Super Sucker Truck	NA	ULSD	25 gal/hr	485 hp	8,760 hr/yr
510	Mobile Cement Van	NA	ULSD	25 gal/hr	485 hp	8,760 hr/yr
511	Mobile E-Line Unit	NA	ULSD	25 gal/hr	485 hp	8,760 hr/yr
512	Crew Van	NA	ULSD	25 gal/hr	485 hp	8,760 hr/yr
Storage Tanks						
T-001	Sales Oil Tank 1	NA	Crude Oil	N/A[12]	15,000 barrels	8,760 hr/yr
T-002	Sales Oil Tank 2	NA	Crude Oil	N/A	15,000 barrels	8,760 hr/yr
T-003	Off-Spec Oil Tank	NA	Crude Oil	N/A	5,000 barrels	8,760 hr/yr
T-004	Pipeline Diesel Tank	NA	Diesel	N/A	96,722 gallons	8,760 hr/yr
T-005a	Backup Generator Diesel Tank 1	NA	ULSD	N/A	26,000 gallons	8,760 hr/yr
T-005b	Backup Generator Diesel Tank 2	NA	ULSD	N/A	26,000 gallons	8,760 hr/yr

Notes:

[1] Manufacturer specified heat rate equal to 11,158 Btu/kW-hr.

[2] Ultra-low Sulfur Diesel.

[3] Maximum fuel consumption based on manufacturer specification.

[4] Diesel fuel heat content is assumed to equal 19,300 Btu/lb, ULSD density equal to 7.05 lb/gal. Engine brake-specific fuel consumption is assumed to equal to 7,000 Btu/hp-hr.

[5] Manufacturer specified engine heat rate equal to 6,064 Btu/bhp-hr.

[6] Not available.

[7] Fuel gas is assumed to have a Lower Heat Value (LHV) equal to 990 Btu/scf. Heaters and Boilers are assumed to have an efficiency equal to 50 percent.

[8] Manufacturer specified heat rate equal to 7,350 Btu/bhp-hr.

[9] Incinerator waste has an assumed heat rate of 9.85 MMBtu/ton.

[10] Expected actual annual flare rate of fuel gas.

[11] Expected actual maximum daily flare rate is equal to 4.0 MMscf/day.

[12] Not applicable.

Table A-2. Hilcorp Alaska - Liberty Development Project
Potential NO_X Emission Calculations

Emission Unit			Fuel	NO_X Emission Factor		Maximum	Maximum or	Potential NO_X
EU ID	Description	Make/Model	Type		Reference	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas	15 ppmv NO_x @15% O_2	Vendor Data[1,2]	7.9 MW	8,760 hr/yr	26.6 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	15 ppmv NO_x @15% O_2	Vendor Data	7.9 MW	8,760 hr/yr	26.6 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	15 ppmv NO_x @15% O_2	Vendor Data	7.9 MW	8,760 hr/yr	26.6 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	15 ppmv NO_x @15% O_2	Vendor Data	7.9 MW	8,760 hr/yr	26.6 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	15 ppmv NO_x @15% O_2	Vendor Data	7.9 MW	8,760 hr/yr	26.6 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[3]	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	5.2 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	5.2 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	5.2 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	5.2 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	0.50 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	13.3 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	0.50 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	13.3 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	0.50 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	13.3 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	0.40 g/kW-hr	EPA Tier 4 Emission Limit	150 bhp	8,760 hr/yr	0.4 tpy
20	Rig Boiler 1	NA[4]	Fuel Gas	100 lb/MMscf	Table 1.4-1, AP-42	6.3 MMBtu/hr	8,760 hr/yr	4.0 tpy[5,6,7]
			ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42			
21	Rig Boiler 2	NA	Fuel Gas	100 lb/MMscf	Table 1.4-1, AP-42	6.3 MMBtu/hr	8,760 hr/yr	4.0 tpy[5,6,7]
			ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42			
22	Rig Heater 1	NA	Fuel Gas	100 lb/MMscf	Table 1.4-1, AP-42	5.0 MMBtu/hr	8,760 hr/yr	3.2 tpy[5,6,7]
			ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42			
23	Rig Heater 2	NA	Fuel Gas	100 lb/MMscf	Table 1.4-1, AP-42	5.0 MMBtu/hr	8,760 hr/yr	3.2 tpy[5,6,7]
			ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42			
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	8.0 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	8.0 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	8.0 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	15 ppmv NO_x @15% O_2	Vendor Data[1,2]	11,000 bhp	8,760 hr/yr	25.9 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	15 ppmv NO_x @15% O_2	Vendor Data	11,000 bhp	8,760 hr/yr	25.9 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	15 ppmv NO_x @15% O_2	Vendor Data	11,000 bhp	8,760 hr/yr	25.9 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	8.0 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	8.0 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	0.67 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	8.0 tpy
27	Incinerator	NA	Waste	170 ppm	NSPS Subpart CCCC	220 lb/hr	8,760 hr/yr	1.4 tpy[8]
30	Flare	NA	Fuel Gas	0.068 lb/MMBtu	Table 13.5-1, AP-42	40 MMscf/day	140 MMscf/yr	4.9 tpy[9]
31	Flare - Pilot/Purge		Fuel Gas	0.068 lb/MMBtu	Table 13.5-1, AP-42	0.003 MMscf/day	0.003 MMscf/day	0.03 tpy[9]
Drilling Support Equipment								
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.6 tpy[10]
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.6 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.6 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.6 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	20 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.6 tpy
502A	Cement Pump	NA	ULSD	6.6E-03 lb/hp-hr	EPA Tier 3 Emission Limit	300 hp	8,760 hr/yr	8.6 tpy
502B	Cement Pump	NA	ULSD	6.6E-03 lb/hp-hr	EPA Tier 3 Emission Limit	300 hp	8,760 hr/yr	8.6 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	1.86 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.1 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	1.86 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.1 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	1.86 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.1 tpy
504	Large Crane	Manitowoc 999	ULSD	1.08 g/hp-hr	EPA-420-B-09-015	400 hp	8,760 hr/yr	4.2 tpy
505	Small Crane	Grove 80 Ton	ULSD	1.08 g/hp-hr	EPA-420-B-09-015	275 hp	8,760 hr/yr	2.9 tpy
506A	Loader	Caterpillar 966	ULSD	1.55 g/hp-hr	EPA-420-B-09-015	286 hp	8,760 hr/yr	4.3 tpy
506B	Loader	Caterpillar 966	ULSD	1.55 g/hp-hr	EPA-420-B-09-015	286 hp	8,760 hr/yr	4.3 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	1.08 g/hp-hr	EPA-420-B-09-015	110 hp	8,760 hr/yr	1.2 tpy
508	Hot Oil Unit	NA	ULSD	20.9 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.2 tpy
509A	Super Sucker Truck	NA	ULSD	20.9 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.2 tpy
509B	Super Sucker Truck	NA	ULSD	20.9 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.2 tpy
510	Mobile Cement Van	NA	ULSD	20.9 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.2 tpy
511	Mobile E-Line Unit	NA	ULSD	20.9 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.2 tpy
512	Crew Van	NA	ULSD	47.6 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.5 tpy
							Total	379.7 tpy

Notes:

[1] Based on typical emissions levels for Siemens SGT-300 tubrines.

[2] Emission rates based on manufacturer's performance data (See Table A-21).

[3] Ultra-Low Sulfur Diesel.

[4] Not available.

[5] Fuel gas is assumed to have a lower heat value of 990 Btu/scf.

[6] Diesel fuel is assumed to have a heat value equal to 137,000 Btu/gal.

[7] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

[8] Based on a solid waste high heat value equal to 9.85 MMBtu/ton and a fuel factor for waste equal to 9,570 dscf/MMBtu.

[9] Flared gas is assumed to have a high heat value equal to 1,020 Btu/scf.

[10] Diesel fuel heat content is assumed to equal 19,300 Btu/lb, ULSD density equal to 7.05 lb/gal.

Table A-3. Hilcorp Alaska - Liberty Development Project
Potential CO Emission Calculations

Emission Unit			Fuel	CO Emission Factor		Maximum	Maximum or	Potential CO
EU ID	Description	Make/Model	Type		Reference	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas	10 ppmv CO @15% O_2	Vendor Data[1,2]	7.9 MW	8,760 hr/yr	10.8 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	10 ppmv CO @15% O_2	Vendor Data	7.9 MW	8,760 hr/yr	10.8 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	10 ppmv CO @15% O_2	Vendor Data	7.9 MW	8,760 hr/yr	10.8 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	10 ppmv CO @15% O_2	Vendor Data	7.9 MW	8,760 hr/yr	10.8 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	10 ppmv CO @15% O_2	Vendor Data	7.9 MW	8,760 hr/yr	10.8 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[3]	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	27.3 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	27.3 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	27.3 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	27.3 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	2.6 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	68.0 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	2.6 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	68.0 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	2.6 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	68.0 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	5.0 g/kW-hr	EPA Tier 4 Emission Limit	150 bhp	8,760 hr/yr	5.4 tpy
20	Rig Boiler 1	NA[4]	Fuel Gas	84 lb/MMscf	Table 1.4-1, AP-42	6.3 MMBtu/hr	8,760 hr/yr	2.3 tpy[5,6,7]
			ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42			
21	Rig Boiler 2	NA	Fuel Gas	84 lb/MMscf	Table 1.4-1, AP-42	6.3 MMBtu/hr	8,760 hr/yr	2.3 tpy[5,6,7]
			ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42			
22	Rig Heater 1	NA	Fuel Gas	84 lb/MMscf	Table 1.4-1, AP-42	5.0 MMBtu/hr	8,760 hr/yr	1.9 tpy[5,6,7]
			ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42			
23	Rig Heater 2	NA	Fuel Gas	84 lb/MMscf	Table 1.4-1, AP-42	5.0 MMBtu/hr	8,760 hr/yr	1.9 tpy[5,6,7]
			ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42			
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	41.6 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	41.6 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	41.6 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	10 ppmv CO @15% O_2	Vendor Data[1,2]	11,000 bhp	8,760 hr/yr	10.5 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	10 ppmv CO @15% O_2	Vendor Data	11,000 bhp	8,760 hr/yr	10.5 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	10 ppmv CO @15% O_2	Vendor Data	11,000 bhp	8,760 hr/yr	10.5 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	41.6 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	41.6 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	3.5 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	41.6 tpy
27	Incinerator	NA	Waste	13 ppm	NSPS Subpart CCCC	220 lb/hr	8,760 hr/yr	0.1 tpy[8]
30	Flare	NA	Fuel Gas	0.37 lb/MMBtu	Table 13.5-1, AP-42	40 MMscf/day	140 MMscf/yr	26.4 tpy[9]
31	Flare - Pilot/Purge		Fuel Gas	0.37 lb/MMBtu	Table 13.5-1, AP-42	0.003 MMscf/day	0.003 MMscf/day	0.19 tpy[9]
Drilling Support Equipment								
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.2 tpy[10]
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.2 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.2 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.2 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	5 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.2 tpy
502A	Cement Pump	NA	ULSD	5.8E-03 lb/hp-hr	EPA Tier 3 Emission Limit	300 hp	8,760 hr/yr	7.6 tpy
502B	Cement Pump	NA	ULSD	5.8E-03 lb/hp-hr	EPA Tier 3 Emission Limit	300 hp	8,760 hr/yr	7.6 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	2.03 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.1 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	2.03 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.1 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	2.03 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.1 tpy
504	Large Crane	Manitowoc 999	ULSD	0.42 g/hp-hr	EPA-420-B-09-015	400 hp	8,760 hr/yr	1.6 tpy
505	Small Crane	Grove 80 Ton	ULSD	0.37 g/hp-hr	EPA-420-B-09-015	275 hp	8,760 hr/yr	1.0 tpy
506A	Loader	Caterpillar 966	ULSD	0.77 g/hp-hr	EPA-420-B-09-015	286 hp	8,760 hr/yr	2.1 tpy
506B	Loader	Caterpillar 966	ULSD	0.77 g/hp-hr	EPA-420-B-09-015	286 hp	8,760 hr/yr	2.1 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	0.43 g/hp-hr	EPA-420-B-09-015	110 hp	8,760 hr/yr	0.5 tpy
508	Hot Oil Unit	NA	ULSD	8.3 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.1 tpy
509A	Super Sucker Truck	NA	ULSD	8.3 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.1 tpy
509B	Super Sucker Truck	NA	ULSD	8.3 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.1 tpy
510	Mobile Cement Van	NA	ULSD	8.3 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.1 tpy
511	Mobile E-Line Unit	NA	ULSD	8.3 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.1 tpy
512	Crew Van	NA	ULSD	6.4 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.1 tpy
							Total	713.0 tpy

Notes:

[1] Based on typical emissions levels for Siemens SGT-300 tubrines.

[2] Emission rates based on manufacturer's performance data (See Table A-21).

[3] Ultra-Low Sulfur Diesel.

[4] Not available.

[5] Fuel gas is assumed to have a lower heat value of 990 Btu/scf.

[6] Assumes diesel fuel has a heating value equal to 137,000 Btu/gal.

[7] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

[8] Based on a solid waste high heat value equal to 9.85 MMBtu/ton and a fuel factor for waste equal to 9,570 dscf/MMBtu.

[9] Assumes flared gas has a high heat value equal to 1,020 Btu/scf.

[10] Diesel fuel heat content is assumed to equal 19,300 Btu/lb, ULSD density equal to 7.05 lb/gal.

Table A-4. Hilcorp Alaska - Liberty Development Project
Potential PM Emission Calculations

Emission Unit			Fuel	PM Emission Factor		Maximum	Maximum or	Potential PM
EU ID	Description	Make/Model	Type		Reference	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas	6.6E-03 lb/MMBtu[1]	Table 3.1-2a, AP-42	88.1 MMBtu/hr[2]	8,760 hr/yr	2.5 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	6.6E-03 lb/MMBtu	Table 3.1-2a, AP-42	88.1 MMBtu/hr	8,760 hr/yr	2.5 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	6.6E-03 lb/MMBtu	Table 3.1-2a, AP-42	88.1 MMBtu/hr	8,760 hr/yr	2.5 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	6.6E-03 lb/MMBtu	Table 3.1-2a, AP-42	88.1 MMBtu/hr	8,760 hr/yr	2.5 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	6.6E-03 lb/MMBtu	Table 3.1-2a, AP-42	88.1 MMBtu/hr	8,760 hr/yr	2.5 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[3]	0.03 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	0.2 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	0.03 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	0.2 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	0.03 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	0.2 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	0.03 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	0.2 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	0.01 lb/MMBtu	Table 3.2-2, AP-42	16.7 MMBtu/hr	8,760 hr/yr	0.7 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	0.01 lb/MMBtu	Table 3.2-2, AP-42	16.7 MMBtu/hr	8,760 hr/yr	0.7 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	0.01 lb/MMBtu	Table 3.2-2, AP-42	16.7 MMBtu/hr	8,760 hr/yr	0.7 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	0.0 g/kW-hr	EPA Tier 4 Emission Limit	150 bhp	8,760 hr/yr	0.02 tpy
20	Rig Boiler 1	NA[4]	Fuel Gas	7.6 lb/MMscf	Table 1.4-2, AP-42	6.3 MMBtu/hr	8,760 hr/yr	0.2 tpy[5,6,7]
			ULSD	1.00 lb/10^3 gal	Table 1.3-6, AP-42			
21	Rig Boiler 2	NA	Fuel Gas	7.6 lb/MMscf	Table 1.4-2, AP-42	6.3 MMBtu/hr	8,760 hr/yr	0.2 tpy[5,6,7]
			ULSD	1.00 lb/10^3 gal	Table 1.3-6, AP-42			
22	Rig Heater 1	NA	Fuel Gas	7.6 lb/MMscf	Table 1.4-2, AP-42	5.0 MMBtu/hr	8,760 hr/yr	0.2 tpy[5,6,7]
			ULSD	1.00 lb/10^3 gal	Table 1.3-6, AP-42			
23	Rig Heater 2	NA	Fuel Gas	7.6 lb/MMscf	Table 1.4-2, AP-42	5.0 MMBtu/hr	8,760 hr/yr	0.2 tpy[5,6,7]
			ULSD	1.00 lb/10^3 gal	Table 1.3-6, AP-42			
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	0.1 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	1.2 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	0.1 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	1.2 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	0.1 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	1.2 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	6.6E-03 lb/MMBtu	Table 3.1-2a, AP-42	80.9 MMBtu/hr[2]	8,760 hr/yr	2.3 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	6.6E-03 lb/MMBtu	Table 3.1-2a, AP-42	80.9 MMBtu/hr	8,760 hr/yr	2.3 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	6.6E-03 lb/MMBtu	Table 3.1-2a, AP-42	80.9 MMBtu/hr	8,760 hr/yr	2.3 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	0.1 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	1.2 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	0.1 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	1.2 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	0.1 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	1.2 tpy
27	Incinerator	NA	Waste	270 mg/dscm	NSPS Subpart CCCC	1.1 MMBtu/hr	8,760 hr/yr	0.8 tpy[8]
30	Flare	NA	Fuel Gas	0.0264 lb/MMBtu	Table 13.5-1, AP-42	40 MMscf/day	140 MMscf/yr	1.9 tpy[9]
31	Flare - Pilot/Purge		Fuel Gas	0.0264 lb/MMBtu	Table 13.5-1, AP-42	0.003 MMscf/day	0.003 MMscf/day	0.01 tpy[9]
Drilling Support Equipment								
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	1.00 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.03 tpy[10]
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	1.00 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.03 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	1.00 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.03 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	1.00 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.03 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	1.00 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.03 tpy
502A	Cement Pump	NA	ULSD	3.8E-04 lb/hp-hr	EPA Tier 3 Emission Limit	300 hp	8,760 hr/yr	0.5 tpy
502B	Cement Pump	NA	ULSD	3.8E-04 lb/hp-hr	EPA Tier 3 Emission Limit	300 hp	8,760 hr/yr	0.5 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	0.28 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.02 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	0.28 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.02 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	0.28 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.02 tpy
504	Large Crane	Manitowoc 999	ULSD	0.06 g/hp-hr	EPA-420-B-09-015	400 hp	8,760 hr/yr	0.2 tpy
505	Small Crane	Grove 80 Ton	ULSD	0.06 g/hp-hr	EPA-420-B-09-015	275 hp	8,760 hr/yr	0.2 tpy
506A	Loader	Caterpillar 966	ULSD	0.14 g/hp-hr	EPA-420-B-09-015	286 hp	8,760 hr/yr	0.4 tpy
506B	Loader	Caterpillar 966	ULSD	0.14 g/hp-hr	EPA-420-B-09-015	286 hp	8,760 hr/yr	0.4 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	0.10 g/hp-hr	EPA-420-B-09-015	110 hp	8,760 hr/yr	0.1 tpy
508	Hot Oil Unit	NA	ULSD	4.02 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.04 tpy
509A	Super Sucker Truck	NA	ULSD	4.02 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.04 tpy
509B	Super Sucker Truck	NA	ULSD	4.02 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.04 tpy
510	Mobile Cement Van	NA	ULSD	4.02 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.04 tpy
511	Mobile E-Line Unit	NA	ULSD	4.02 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.04 tpy
512	Crew Van	NA	ULSD	1.38 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.01 tpy
							Total	36.1 tpy

Notes:

[1] Emission factor for natural gas-fired turbines with no emission controls.

[2] Based on manufacturer specifications.

[3] Ultra-Low Sulfur Diesel.

[4] Not available.

[5] Fuel gas has a lower heat value of 990 Btu/scf.

[6] Diesel fuel has a heating value equal to 137,000 Btu/gal.

[7] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

[8] Based on a fuel factor for waste equal to 9,570 dscf/MMBtu.

[9] Flared gas has a high heat value equal to 1,020 Btu/scf.

[10] Diesel fuel heat content is assumed to equal 19,300 Btu/lb, ULSD density equal to 7.05 lb/gal.

Table A-5. Hilcorp Alaska - Liberty Development Project
Potential VOC Emission Calculations

Emission Unit			Fuel	VOC Emission Factor		Maximum	Maximum or	Potential VOC
EU ID	Description	Make/Model	Type		Reference	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas	2.1E-03 lb/MMBtu[1]	Table 3.1-2a, AP-42	88.1 MMBtu/hr[2]	8,760 hr/yr	0.8 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	2.1E-03 lb/MMBtu	Table 3.1-2a, AP-42	88.1 MMBtu/hr	8,760 hr/yr	0.8 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	2.1E-03 lb/MMBtu	Table 3.1-2a, AP-42	88.1 MMBtu/hr	8,760 hr/yr	0.8 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	2.1E-03 lb/MMBtu	Table 3.1-2a, AP-42	88.1 MMBtu/hr	8,760 hr/yr	0.8 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	2.1E-03 lb/MMBtu	Table 3.1-2a, AP-42	88.1 MMBtu/hr	8,760 hr/yr	0.8 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[3]	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	1.5 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	1.5 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	1.5 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,085 bhp	8,760 hr/yr	1.5 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	0.73 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	19.5 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	0.73 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	19.5 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	0.73 g/bhp-hr	Vendor Data	2,762 bhp	8,760 hr/yr	19.5 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	150 bhp	8,760 hr/yr	0.2 tpy
20	Rig Boiler 1	NA[4]	Fuel Gas	5.5 lb/MMscf	Table 1.4-2, AP-42	6.3 MMBtu/hr	8,760 hr/yr	0.15 tpy[5,6,7]
			ULSD	0.34 lb/10^3 gal	Table 1.3-3, AP-42			
21	Rig Boiler 2	NA	Fuel Gas	5.5 lb/MMscf	Table 1.4-2, AP-42	6.3 MMBtu/hr	8,760 hr/yr	0.15 tpy[5,6,7]
			ULSD	0.34 lb/10^3 gal	Table 1.3-3, AP-42			
22	Rig Heater 1	NA	Fuel Gas	5.5 lb/MMscf	Table 1.4-2, AP-42	5.0 MMBtu/hr	8,760 hr/yr	0.12 tpy[5,6,7]
			ULSD	0.34 lb/10^3 gal	Table 1.3-3, AP-42			
23	Rig Heater 2	NA	Fuel Gas	5.5 lb/MMscf	Table 1.4-2, AP-42	5.0 MMBtu/hr	8,760 hr/yr	0.12 tpy[5,6,7]
			ULSD	0.34 lb/10^3 gal	Table 1.3-3, AP-42			
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	2.3 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	2.3 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	2.3 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	2.1E-03 lb/MMscf	Table 3.1-2a, AP-42	80.9 MMBtu/hr	8,760 hr/yr	0.7 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	2.1E-03 lb/MMscf	Table 3.1-2a, AP-42	80.9 MMBtu/hr	8,760 hr/yr	0.7 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	2.1E-03 lb/MMscf	Table 3.1-2a, AP-42	80.9 MMBtu/hr	8,760 hr/yr	0.7 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	2.3 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	2.3 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	0.19 g/kW-hr	EPA Tier 4 Emission Limit	1,650 bhp	8,760 hr/yr	2.3 tpy
27	Incinerator	NA	Waste	3 lb/ton	Table 2.1-12, AP-42	220 lb/hr	8,760 hr/yr	1.4 tpy
30	Flare	NA	Fuel Gas	0.14 lb/MMscf	Table 13.5-1, AP-42	40 MMscf/day	140 MMscf/yr	0.01 tpy
31	Flare - Pilot/Purge		Fuel Gas	0.14 lb/MMscf	Table 13.5-1, AP-42	0.003 MMscf/day	0.003 MMscf/day	0.0001 tpy
Drilling Support Equipment								
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.34 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.011 tpy
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.34 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.011 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.34 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.011 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.34 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.011 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.34 lb/10^3 gal	Table 1.3-1, AP-42	1.0 MMBtu/hr	8,760 hr/yr	0.011 tpy
502A	Cement Pump	NA	ULSD	3.9E-04 lb/hp-hr	EPA Tier 3 Emission Limit	300 hp	8,760 hr/yr	0.52 tpy
502B	Cement Pump	NA	ULSD	3.9E-04 lb/hp-hr	EPA Tier 3 Emission Limit	300 hp	8,760 hr/yr	0.52 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	0.26 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.02 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	0.26 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.02 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	0.26 g/hp-hr	EPA-420-B-09-015	7 hp	8,760 hr/yr	0.02 tpy
504	Large Crane	Manitowoc 999	ULSD	0.08 g/hp-hr	EPA-420-B-09-015	400 hp	8,760 hr/yr	0.31 tpy
505	Small Crane	Grove 80 Ton	ULSD	0.08 g/hp-hr	EPA-420-B-09-015	275 hp	8,760 hr/yr	0.22 tpy
506A	Loader	Caterpillar 966	ULSD	0.12 g/hp-hr	EPA-420-B-09-015	286 hp	8,760 hr/yr	0.33 tpy
506B	Loader	Caterpillar 966	ULSD	0.12 g/hp-hr	EPA-420-B-09-015	286 hp	8,760 hr/yr	0.33 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	0.08 g/hp-hr	EPA-420-B-09-015	110 hp	8,760 hr/yr	0.09 tpy
508	Hot Oil Unit	NA	ULSD	1.13 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.01 tpy
509A	Super Sucker Truck	NA	ULSD	1.13 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.01 tpy
509B	Super Sucker Truck	NA	ULSD	1.13 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.01 tpy
510	Mobile Cement Van	NA	ULSD	1.13 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.01 tpy
511	Mobile E-Line Unit	NA	ULSD	1.13 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.01 tpy
512	Crew Van	NA	ULSD	0.50 g/hr	EPA-420-B-12-001b	485 hp	8,760 hr/yr	0.005 tpy
Storage Tanks								
T-001	Sales Oil Tank 1	NA	Crude Oil	13,212 lb/yr	EPA Tanks 4.0.9d	15,000 barrels	8,760 hr/yr	6.6 tpy
T-002	Sales Oil Tank 2	NA	Crude Oil	13,212 lb/yr	EPA Tanks 4.0.9d	15,000 barrels	8,760 hr/yr	6.6 tpy
T-003	Off-Spec Oil Tank	NA	Crude Oil	4,404 lb/yr	EPA Tanks 4.0.9d	5,000 barrels	8,760 hr/yr	2.2 tpy
T-004	Pipeline Diesel Tank	NA	Diesel	43 lb/yr	EPA Tanks 4.0.9d	96,722 gallons	8,760 hr/yr	0.02 tpy
T-005a	Backup Generator Diesel Tank 1	NA	ULSD	2.68 lb/yr	EPA Tanks 4.0.9d	26,000 gallons	8,760 hr/yr	0.001 tpy
T-005b	Backup Generator Diesel Tank 2	NA	ULSD	2.68 lb/yr	EPA Tanks 4.0.9d	26,000 gallons	8,760 hr/yr	0.001 tpy
							Total	104.3 tpy

Notes:

[1] Emission factor for natural gas-fired turbines with no emission controls.

[2] Based on manufacturer specification.

[3] Ultra-Low Sulfur Diesel. ULSD has a fuel sulfur content equal to 15 ppmv H_2S

[4] Not available.

[5] Fuel gas has a lower heat value of 990 Btu/scf.

[6] Diesel fuel heat content is assumed to equal 19,300 Btu/lb, ULSD density equal to 7.05 lb/gal.

[7] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

Table A-6. Hilcorp Alaska - Liberty Development Project
Potential SO_2 Emission Calculations

Emission Unit			Fuel	SO_2 Emission Factor		Maximum	Maximum or	Potential SO_2
EU ID	Description	Make/Model	Type		Reference	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas[1]	53.9 lb/MMscf	Mass Balance	88.1 MMBtu/hr[2]	8,760 hr/yr	21.0 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	53.9 lb/MMscf	Mass Balance	88.1 MMBtu/hr	8,760 hr/yr	21.0 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	53.9 lb/MMscf	Mass Balance	88.1 MMBtu/hr	8,760 hr/yr	21.0 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	53.9 lb/MMscf	Mass Balance	88.1 MMBtu/hr	8,760 hr/yr	21.0 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	53.9 lb/MMscf	Mass Balance	88.1 MMBtu/hr	8,760 hr/yr	21.0 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[3,4]	0.0002 lb/gal	Mass Balance	53 gal/hr	8,760 hr/yr	0.05 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	0.0002 lb/gal	Mass Balance	53 gal/hr	8,760 hr/yr	0.05 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	0.0002 lb/gal	Mass Balance	53 gal/hr	8,760 hr/yr	0.05 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	0.0002 lb/gal	Mass Balance	53 gal/hr	8,760 hr/yr	0.05 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	53.9 lb/MMscf	Mass Balance	16.7 MMBtu/hr	8,760 hr/yr	4.0 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	53.9 lb/MMscf	Mass Balance	16.7 MMBtu/hr	8,760 hr/yr	4.0 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	53.9 lb/MMscf	Mass Balance	16.7 MMBtu/hr	8,760 hr/yr	4.0 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	0.0002 lb/gal	Mass Balance	8 gal/hr	8,760 hr/yr	0.01 tpy
20	Rig Boiler 1	NA[5]	Fuel Gas	53.9 lb/MMscf	Mass Balance	6.3 MMBtu/hr	8,760 hr/yr	1.50 tpy[6,7,8]
			ULSD	0.0002 lb/gal	Mass Balance			
21	Rig Boiler 2	NA	Fuel Gas	53.9 lb/MMscf	Mass Balance	6.3 MMBtu/hr	8,760 hr/yr	1.50 tpy[6,7]
			ULSD	0.0002 lb/gal	Mass Balance			
22	Rig Heater 1	NA	Fuel Gas	53.9 lb/MMscf	Mass Balance	5.0 MMBtu/hr	8,760 hr/yr	1.19 tpy[6,7]
			ULSD	0.0002 lb/gal	Mass Balance			
23	Rig Heater 2	NA	Fuel Gas	53.9 lb/MMscf	Mass Balance	5.0 MMBtu/hr	8,760 hr/yr	1.19 tpy[6,7]
			ULSD	0.0002 lb/gal	Mass Balance			
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	0.0002 lb/gal	Mass Balance	85 gal/hr	8,760 hr/yr	0.08 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	0.0002 lb/gal	Mass Balance	85 gal/hr	8,760 hr/yr	0.08 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	0.0002 lb/gal	Mass Balance	85 gal/hr	8,760 hr/yr	0.08 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	53.9 lb/MMscf	Mass Balance	80.9 MMBtu/hr	8,760 hr/yr	19.3 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	53.9 lb/MMscf	Mass Balance	80.9 MMBtu/hr	8,760 hr/yr	19.3 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	53.9 lb/MMscf	Mass Balance	80.9 MMBtu/hr	8,760 hr/yr	19.3 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	0.0002 lb/gal	Mass Balance	85 gal/hr	8,760 hr/yr	0.08 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	0.0002 lb/gal	Mass Balance	85 gal/hr	8,760 hr/yr	0.08 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	0.0002 lb/gal	Mass Balance	85 gal/hr	8,760 hr/yr	0.08 tpy
27	Incinerator	NA	Waste	1.2 ppm	NSPS Subpart CCCC	220 lb/hr	8,760 hr/yr	0.01 tpy[8]
30	Flare	NA	Fuel Gas	53.9 lb/MMscf	Mass Balance	40 MMscf/day	140 MMscf/yr	3.8 tpy
31	Flare - Pilot/Purge		Fuel Gas	53.9 lb/MMscf	Mass Balance	0.003 MMscf/day	0.003 MMscf/day	0.03 tpy
Drilling Support Equipment								
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.0002 lb/gal	Mass Balance	7 gal/hr	8,760 hr/yr	0.01 tpy
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.0002 lb/gal	Mass Balance	7 gal/hr	8,760 hr/yr	0.01 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.0002 lb/gal	Mass Balance	7 gal/hr	8,760 hr/yr	0.01 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.0002 lb/gal	Mass Balance	7 gal/hr	8,760 hr/yr	0.01 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	0.0002 lb/gal	Mass Balance	7 gal/hr	8,760 hr/yr	0.01 tpy
502A	Cement Pump	NA	ULSD	0.0002 lb/gal	Mass Balance	15 gal/hr	8,760 hr/yr	0.01 tpy
502B	Cement Pump	NA	ULSD	0.0002 lb/gal	Mass Balance	15 gal/hr	8,760 hr/yr	0.01 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	0.0002 lb/gal	Mass Balance	0.4 gal/hr	8,760 hr/yr	0.00 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	0.0002 lb/gal	Mass Balance	0.4 gal/hr	8,760 hr/yr	0.00 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	0.0002 lb/gal	Mass Balance	0.4 gal/hr	8,760 hr/yr	0.00 tpy
504	Large Crane	Manitowoc 999	ULSD	0.0002 lb/gal	Mass Balance	21 gal/hr	8,760 hr/yr	0.02 tpy
505	Small Crane	Grove 80 Ton	ULSD	0.0002 lb/gal	Mass Balance	14 gal/hr	8,760 hr/yr	0.01 tpy
506A	Loader	Caterpillar 966	ULSD	0.0002 lb/gal	Mass Balance	15 gal/hr	8,760 hr/yr	0.01 tpy
506B	Loader	Caterpillar 966	ULSD	0.0002 lb/gal	Mass Balance	15 gal/hr	8,760 hr/yr	0.01 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	0.0002 lb/gal	Mass Balance	6 gal/hr	8,760 hr/yr	0.01 tpy
508	Hot Oil Unit	NA	ULSD	0.0002 lb/gal	Mass Balance	25 gal/hr	8,760 hr/yr	0.02 tpy
509A	Super Sucker Truck	NA	ULSD	0.0002 lb/gal	Mass Balance	25 gal/hr	8,760 hr/yr	0.02 tpy
509B	Super Sucker Truck	NA	ULSD	0.0002 lb/gal	Mass Balance	25 gal/hr	8,760 hr/yr	0.02 tpy
510	Mobile Cement Van	NA	ULSD	0.0002 lb/gal	Mass Balance	25 gal/hr	8,760 hr/yr	0.02 tpy
511	Mobile E-Line Unit	NA	ULSD	0.0002 lb/gal	Mass Balance	25 gal/hr	8,760 hr/yr	0.02 tpy
512	Crew Van	NA	ULSD	0.0002 lb/gal	Mass Balance	25 gal/hr	8,760 hr/yr	0.02 tpy
							Total	185.1 tpy

Notes:

[1] Fuel gas is assumed to have a lower heat value of 990 Btu/scf and a fuel sulfur content equal to 320 ppmv S.

[2] Based on manufacturer specification.

[3] Ultra-Low Sulfur Diesel. ULSD has a fuel sulfur content equal to 15 ppmv H_2S

[4] ULSD has a density equal to 7.05 lb/gal.

[5] Not available.

[6] Diesel fuel heat content is assumed to equal 19,300 Btu/lb, ULSD density equal to 7.05 lb/gal.

[7] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

[8] Based on a solid waste high heat value equal to 9.85 MMBtu/ton and a fuel factor for waste equal to 9,570 dscf/MMBtu.

Table A-7. Hilcorp Alaska - Liberty Development Project
Potential CO_2 Emission Calculations

Emission Unit			Fuel	CO_2 Emission Factor		Maximum	Maximum or	Potential CO_2
EU ID	Description	Make/Model	Type		Reference	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas[1]	53.06 kg/MMBtu	Table C-1, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	45,164 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	45,164 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	45,164 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	45,164 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	45,164 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[2,3]	73.96 kg/MMBtu	Table C-1, 40 CFR 98	53 gal/hr	8,760 hr/yr	5,187 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	53 gal/hr	8,760 hr/yr	5,187 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	53 gal/hr	8,760 hr/yr	5,187 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	53 gal/hr	8,760 hr/yr	5,187 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	8,581 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	8,581 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	8,581 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	8 gal/hr	8,760 hr/yr	761 tpy
20	Rig Boiler 1	NA[4]	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	6.3 MMBtu/hr	8,760 hr/yr	4,499 tpy[5]
			ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98			
21	Rig Boiler 2	NA	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	6.3 MMBtu/hr	8,760 hr/yr	4,499 tpy[5]
			ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98			
22	Rig Heater 1	NA	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	5.0 MMBtu/hr	8,760 hr/yr	3,571 tpy[5]
			ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98			
23	Rig Heater 2	NA	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	5.0 MMBtu/hr	8,760 hr/yr	3,571 tpy[5]
			ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98			
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	85 gal/hr	8,760 hr/yr	8,366 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	85 gal/hr	8,760 hr/yr	8,366 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	85 gal/hr	8,760 hr/yr	8,366 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	41,425 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	41,425 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	41,425 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	85 gal/hr	8,760 hr/yr	8,366 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	85 gal/hr	8,760 hr/yr	8,366 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	85 gal/hr	8,760 hr/yr	8,366 tpy
27	Incinerator	NA	Waste[6]	90.7 kg/MMBtu	Table C-1, 40 CFR 98	220 lb/hr	8,760 hr/yr	949 tpy
30	Flare	NA	Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	40 MMscf/day	140 MMscf/yr	8,418 tpy
31	Flare - Pilot/Purge		Fuel Gas	53.06 kg/MMBtu	Table C-1, 40 CFR 98	0.003 MMscf/day	0.003 MMscf/day	59 tpy
Drilling Support Equipment								
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	7 gal/hr	8,760 hr/yr	724 tpy
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	7 gal/hr	8,760 hr/yr	724 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	7 gal/hr	8,760 hr/yr	724 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	7 gal/hr	8,760 hr/yr	724 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	7 gal/hr	8,760 hr/yr	724 tpy
502A	Cement Pump	NA	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	15 gal/hr	8,760 hr/yr	1,521 tpy
502B	Cement Pump	NA	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	15 gal/hr	8,760 hr/yr	1,521 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	35 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	35 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	35 tpy
504	Large Crane	Manitowoc 999	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	21 gal/hr	8,760 hr/yr	2,028 tpy
505	Small Crane	Grove 80 Ton	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	14 gal/hr	8,760 hr/yr	1,394 tpy
506A	Loader	Caterpillar 966	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	15 gal/hr	8,760 hr/yr	1,450 tpy
506B	Loader	Caterpillar 966	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	15 gal/hr	8,760 hr/yr	1,450 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	6 gal/hr	8,760 hr/yr	558 tpy
508	Hot Oil Unit	NA	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	25 gal/hr	8,760 hr/yr	2,459 tpy
509A	Super Sucker Truck	NA	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	25 gal/hr	8,760 hr/yr	2,459 tpy
509B	Super Sucker Truck	NA	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	25 gal/hr	8,760 hr/yr	2,459 tpy
510	Mobile Cement Van	NA	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	25 gal/hr	8,760 hr/yr	2,459 tpy
511	Mobile E-Line Unit	NA	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	25 gal/hr	8,760 hr/yr	2,459 tpy
512	Crew Van	NA	ULSD	73.96 kg/MMBtu	Table C-1, 40 CFR 98	25 gal/hr	8,760 hr/yr	2,459 tpy
							Total	501,513 tpy

Notes:

[1] Fuel gas is assumed to have a heat content equal to 0.001028 MMBtu/scf (Pipeline natural gas default HHV).

[2] Ultra low sulfur diesel.

[3] ULSD is assumed to have a heat content of 0.138 MMBtu/gal (Distillate No. 2 default HHV).

[4] Not available.

[5] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

[6] Solid waste heat content is assumed to equal 9.85 MMBtu/short ton (Municipal solid waste default HHV).

Table A-8. Hilcorp Alaska - Liberty Development Project
Potential CH_4 Emission Calculations

Emission Unit			Fuel	CH_4 Emission Factor		Maximum	Maximum or	Potential CH_4
EU ID	Description	Make/Model	Type		Reference	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas[1]	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.85 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.85 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.85 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.85 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.85 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[2,3]	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	53 gal/hr	8,760 hr/yr	0.21 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	53 gal/hr	8,760 hr/yr	0.21 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	53 gal/hr	8,760 hr/yr	0.21 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	53 gal/hr	8,760 hr/yr	0.21 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	0.16 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	0.16 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	0.16 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	8 gal/hr	8,760 hr/yr	0.03 tpy
20	Rig Boiler 1	NA[4]	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	6.3 MMBtu/hr	8,760 hr/yr	0.18 tpy[5]
			ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98			
21	Rig Boiler 2	NA	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	6.3 MMBtu/hr	8,760 hr/yr	0.18 tpy[5]
			ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98			
22	Rig Heater 1	NA	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	5.0 MMBtu/hr	8,760 hr/yr	0.14 tpy[5]
			ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98			
23	Rig Heater 2	NA	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	5.0 MMBtu/hr	8,760 hr/yr	0.14 tpy[5]
			ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98			
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.34 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.34 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.34 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	0.78 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	0.78 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	0.78 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.34 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.34 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.34 tpy
27	Incinerator	NA	Waste[6]	3.2E-02 kg/MMBtu	Table C-2, 40 CFR 98	220 lb/hr	8,760 hr/yr	0.33 tpy
30	Flare	NA	Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	40 MMscf/day	140 MMscf/yr	0.16 tpy
31	Flare - Pilot/Purge		Fuel Gas	1.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	0.003 MMscf/day	0.003 MMscf/day	0.001 tpy
Drilling Support Equipment								
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.03 tpy
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.03 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.03 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.03 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.03 tpy
502A	Cement Pump	NA	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	15 gal/hr	8,760 hr/yr	0.06 tpy
502B	Cement Pump	NA	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	15 gal/hr	8,760 hr/yr	0.06 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	0.001 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	0.001 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	0.001 tpy
504	Large Crane	Manitowoc 999	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	21 gal/hr	8,760 hr/yr	0.08 tpy
505	Small Crane	Grove 80 Ton	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	14 gal/hr	8,760 hr/yr	0.06 tpy
506A	Loader	Caterpillar 966	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	15 gal/hr	8,760 hr/yr	0.06 tpy
506B	Loader	Caterpillar 966	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	15 gal/hr	8,760 hr/yr	0.06 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	6 gal/hr	8,760 hr/yr	0.02 tpy
508	Hot Oil Unit	NA	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.10 tpy
509A	Super Sucker Truck	NA	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.10 tpy
509B	Super Sucker Truck	NA	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.10 tpy
510	Mobile Cement Van	NA	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.10 tpy
511	Mobile E-Line Unit	NA	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.10 tpy
512	Crew Van	NA	ULSD	3.0E-03 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.10 tpy
							Total	12.3 tpy

Notes:

[1] Fuel gas is assumed to have a heat content equal to 0.001028 MMBtu/scf (Pipeline natural gas default HHV).

[2] Ultra low sulfur diesel.

[3] ULSD is assumed to have a heat content of 0.138 MMBtu/gal (Distillate No. 2 default HHV).

[4] Not available.

[5] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

[6] Solid waste heat content is assumed to equal 9.85 MMBtu/short ton (Municipal solid waste default HHV).

Table A-9. Hilcorp Alaska - Liberty Development Project
Potential N_2O Emission Calculations

Emission Unit			Fuel	N_2O Emission Factor		Maximum	Maximum or	Potential N_2O
EU ID	Description	Make/Model	Type		Reference	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas[1]	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.09 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.09 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.09 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.09 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	88.1 MMBtu/hr	8,760 hr/yr	0.09 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[2,3]	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	53 gal/hr	8,760 hr/yr	0.04 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	53 gal/hr	8,760 hr/yr	0.04 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	53 gal/hr	8,760 hr/yr	0.04 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	53 gal/hr	8,760 hr/yr	0.04 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	0.02 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	0.02 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	16.7 MMBtu/hr	8,760 hr/yr	0.02 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	8 gal/hr	8,760 hr/yr	0.01 tpy
20	Rig Boiler 1	NA[4]	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	6.3 MMBtu/hr	8,760 hr/yr	0.04 tpy[5]
			ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98			
21	Rig Boiler 2	NA	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	6.3 MMBtu/hr	8,760 hr/yr	0.04 tpy[5]
			ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98			
22	Rig Heater 1	NA	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	5.0 MMBtu/hr	8,760 hr/yr	0.03 tpy[5]
			ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98			
23	Rig Heater 2	NA	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	5.0 MMBtu/hr	8,760 hr/yr	0.03 tpy[5]
			ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98			
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.07 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.07 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.07 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	0.08 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	0.08 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	80.9 MMBtu/hr	8,760 hr/yr	0.08 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.07 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.07 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	85 gal/hr	8,760 hr/yr	0.07 tpy
27	Incinerator	NA	Waste[6]	4.20E-03 kg/MMBtu	Table C-2, 40 CFR 98	220 lb/hr	8,760 hr/yr	0.04 tpy
30	Flare	NA	Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	40 MMscf/day	140 MMscf/yr	0.02 tpy
31	Flare - Pilot/Purge		Fuel Gas	1.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	0.003 MMscf/day	0.003 MMscf/day	0.000 tpy
Drilling Support Equipment								
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.01 tpy
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.01 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.01 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.01 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	7 gal/hr	8,760 hr/yr	0.01 tpy
502A	Cement Pump	NA	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	15 gal/hr	8,760 hr/yr	0.01 tpy
502B	Cement Pump	NA	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	15 gal/hr	8,760 hr/yr	0.01 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	0.000 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	0.000 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	0.4 gal/hr	8,760 hr/yr	0.000 tpy
504	Large Crane	Manitowoc 999	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	21 gal/hr	8,760 hr/yr	0.02 tpy
505	Small Crane	Grove 80 Ton	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	14 gal/hr	8,760 hr/yr	0.01 tpy
506A	Loader	Caterpillar 966	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	15 gal/hr	8,760 hr/yr	0.01 tpy
506B	Loader	Caterpillar 966	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	15 gal/hr	8,760 hr/yr	0.01 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	6 gal/hr	8,760 hr/yr	0.00 tpy
508	Hot Oil Unit	NA	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.02 tpy
509A	Super Sucker Truck	NA	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.02 tpy
509B	Super Sucker Truck	NA	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.02 tpy
510	Mobile Cement Van	NA	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.02 tpy
511	Mobile E-Line Unit	NA	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.02 tpy
512	Crew Van	NA	ULSD	6.00E-04 kg/MMBtu	Table C-2, 40 CFR 98	25 gal/hr	8,760 hr/yr	0.02 tpy
							Total	1.7 tpy

Notes:

[1] Fuel gas is assumed to have a heat content equal to 0.001028 MMBtu/scf (Pipeline natural gas default HHV).

[2] Ultra low sulfur diesel.

[3] ULSD is assumed to have a heat content of 0.138 MMBtu/gal (Distillate No. 2 default HHV).

[4] Not available.

[5] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

[6] Solid waste heat content is assumed to equal 9.85 MMBtu/short ton (Municipal solid waste default HHV).

Table A-10. Hilcorp Alaska - Liberty Development Project
Potential CO_2e Emission Calculations

Emission Unit			Fuel	Maximum	Maximum or	Potential CO_2e[1]
EU ID	Description	Make/Model	Type	Capacity	Allowable Operation	Emissions
1	Power Generation Turbine 1	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	8,760 hr/yr	45,211 tpy
2	Power Generation Turbine 2	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	8,760 hr/yr	45,211 tpy
3	Power Generation Turbine 3	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	8,760 hr/yr	45,211 tpy
4	Power GenerationTurbine 4	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	8,760 hr/yr	45,211 tpy
5	Power Generation Turbine 5	Siemens SGT-300	Fuel Gas	88.1 MMBtu/hr	8,760 hr/yr	45,211 tpy
12	Rig Diesel Engine 1	MTU 16V2000	ULSD[2]	53 gal/hr	8,760 hr/yr	5,205 tpy
13	Rig Diesel Engine 2	MTU 16V2000	ULSD	53 gal/hr	8,760 hr/yr	5,205 tpy
14	Rig Diesel Engine 3	MTU 16V2000	ULSD	53 gal/hr	8,760 hr/yr	5,205 tpy
15	Rig Diesel Engine 4	MTU 16V2000	ULSD	53 gal/hr	8,760 hr/yr	5,205 tpy
16	Rig Gas Engine 1	Caterpillar G3516H	Fuel Gas	16.7 MMBtu/hr	8,760 hr/yr	8,590 tpy
17	Rig Gas Engine 2	Caterpillar G3516H	Fuel Gas	16.7 MMBtu/hr	8,760 hr/yr	8,590 tpy
18	Rig Gas Engine 3	Caterpillar G3516H	Fuel Gas	16.7 MMBtu/hr	8,760 hr/yr	8,590 tpy
19	Rig Cold Start Engine	Caterpillar 3304	ULSD	8 gal/hr	8,760 hr/yr	763 tpy
20	Rig Boiler 1	NA[3]	Fuel Gas ULSD	6.3 MMBtu/hr	8,760 hr/yr	4,515 tpy[4]
21	Rig Boiler 2	NA	Fuel Gas ULSD	6.3 MMBtu/hr	8,760 hr/yr	4,515 tpy[4]
22	Rig Heater 1	NA	Fuel Gas ULSD	5.0 MMBtu/hr	8,760 hr/yr	3,583 tpy[4]
23	Rig Heater 2	NA	Fuel Gas ULSD	5.0 MMBtu/hr	8,760 hr/yr	3,583 tpy[4]
9	G&I Diesel Engine 1	Caterpillar 3512	ULSD	85 gal/hr	8,760 hr/yr	8,395 tpy
10	G&I Diesel Engine 2	Caterpillar 3512	ULSD	85 gal/hr	8,760 hr/yr	8,395 tpy
11	G&I Diesel Engine 3	Caterpillar 3512	ULSD	85 gal/hr	8,760 hr/yr	8,395 tpy
6	Compressor 1	Siemens SGT-300	Fuel Gas	80.9 MMBtu/hr	8,760 hr/yr	41,467 tpy
7	Compressor 2	Siemens SGT-300	Fuel Gas	80.9 MMBtu/hr	8,760 hr/yr	41,467 tpy
8	Compressor 3	Siemens SGT-300	Fuel Gas	80.9 MMBtu/hr	8,760 hr/yr	41,467 tpy
24	Standby/Emergency Generator 1	Caterpillar 3512	ULSD	85 gal/hr	8,760 hr/yr	8,395 tpy
25	Standby/Emergency Generator 2	Caterpillar 3512	ULSD	85 gal/hr	8,760 hr/yr	8,395 tpy
26	Standby/Emergency Generator 3	Caterpillar 3512	ULSD	85 gal/hr	8,760 hr/yr	8,395 tpy
27	Incinerator	NA	Waste	220 lb/hr	8,760 hr/yr	970 tpy
30	Flare	NA	Fuel Gas	40 MMscf/day	140 MMscf/yr	8,426 tpy
31	Flare - Pilot/Purge		Fuel Gas	0.003 MMscf/day	0.003 MMscf/day	59 tpy
Drilling Support Equipment						
501A	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	8,760 hr/yr	727 tpy
501B	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	8,760 hr/yr	727 tpy
501C	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	8,760 hr/yr	727 tpy
501D	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	8,760 hr/yr	727 tpy
501E	Portable Heater	Tioga IDF 3 SCOK	ULSD	7 gal/hr	8,760 hr/yr	727 tpy
502A	Cement Pump	NA	ULSD	15 gal/hr	8,760 hr/yr	1,526 tpy
502B	Cement Pump	NA	ULSD	15 gal/hr	8,760 hr/yr	1,526 tpy
503A	Light Plant	Ingersol Rand L6-4MH	ULSD	0.4 gal/hr	8,760 hr/yr	36 tpy
503B	Light Plant	Ingersol Rand L6-4MH	ULSD	0.4 gal/hr	8,760 hr/yr	36 tpy
503C	Light Plant	Ingersol Rand L6-4MH	ULSD	0.4 gal/hr	8,760 hr/yr	36 tpy
504	Large Crane	Manitowoc 999	ULSD	21 gal/hr	8,760 hr/yr	2,035 tpy
505	Small Crane	Grove 80 Ton	ULSD	14 gal/hr	8,760 hr/yr	1,399 tpy
506A	Loader	Caterpillar 966	ULSD	15 gal/hr	8,760 hr/yr	1,455 tpy
506B	Loader	Caterpillar 966	ULSD	15 gal/hr	8,760 hr/yr	1,455 tpy
507	Zoom Boom	Carelift ZB-10044	ULSD	6 gal/hr	8,760 hr/yr	560 tpy
508	Hot Oil Unit	NA	ULSD	25 gal/hr	8,760 hr/yr	2,468 tpy
509A	Super Sucker Truck	NA	ULSD	25 gal/hr	8,760 hr/yr	2,468 tpy
509B	Super Sucker Truck	NA	ULSD	25 gal/hr	8,760 hr/yr	2,468 tpy
510	Mobile Cement Van	NA	ULSD	25 gal/hr	8,760 hr/yr	2,468 tpy
511	Mobile E-Line Unit	NA	ULSD	25 gal/hr	8,760 hr/yr	2,468 tpy
512	Crew Van	NA	ULSD	25 gal/hr	8,760 hr/yr	2,468 tpy
					Total	502,331 tpy

Notes:

[1] Potential CO_2e emissions assume 100-year Global Warming Potential values for CO_2, CH_4 and N_2O are equal to 1, 25, and 298, respectively (IPCC Fourth Assessment Report (AR-4), 2007).

[2] Ultra low sulfur diesel.

[3] Not available.

[4] Maximum emission rate (lb/hr) for either ULSD-fired or gas-fired operating mode.

Table A-11. Hilcorp Alaska - Liberty Development Project
Potential HAPs Emission Calculations

Hazardous Air Pollutant	HAP Emissions by Unit Category (tons per year)[1,2]									Total PTE HAPs (tpy)
	Gas-fired Turbines	ULSD-fired Engines >600 hp	ULSD-fired Engines <600 hp	Gas-fired Engines	Rig Dual Fuel (Gas) Heaters/Boilers	Rig Dual Fuel (ULSD) Heaters/Boilers	Solid Waste Incinerator	ULSD-fired Heaters/Boilers	Flare	
Acetaldehyde	1.20E-01	1.10E-02	1.12E-01	2.35E-02	----	----	----	----	3.03E-03	2.69E-01
Acrolein	1.92E-02	3.44E-03	1.35E-02	1.74E-03	----	----	----	----	7.05E-04	3.85E-02
Benzene	3.59E-02	3.39E-01	1.36E-01	9.43E-03	4.20E-04	1.56E-04	----	3.44E-05	1.12E-02	5.32E-01
Biphenyl	----	----	----	9.33E-03	----	----	----	----	----	9.33E-03
1,3-Butadiene	1.29E-03	----	5.70E-03	1.68E-02	----	----	----	----	----	2.38E-02
Carbon Tetrachloride	----	----	----	1.62E-03	----	----	----	----	----	1.62E-03
Chlorobenzene	----	----	----	1.34E-03	----	----	----	----	----	1.34E-03
Chloroform	----	----	----	1.25E-03	----	----	----	----	----	1.25E-03
1,4-Dichlorobenzene(p)	----	----	----	----	2.40E-04	----	----	----	----	2.40E-04
1,3-Dichloropropene	----	----	----	1.16E-03	----	----	----	----	----	1.16E-03
Ethylbenzene	9.58E-02	----	----	3.11E-03	----	4.63E-05	----	1.02E-05	1.02E-01	2.01E-01
Ethylene dibromide (Dibromoethane)	----	----	----	1.95E-03	----	----	----	----	----	1.95E-03
Formaldehyde	2.12E+00	3.44E-02	1.72E-01	2.32E+00	1.50E-02	2.40E-02	----	5.31E-03	8.24E-02	4.77E+00
HCl	----	----	----	----	----	----	3.08E+00	----	----	3.08E+00
Methanol	----	----	----	1.10E-01	----	----	----	----	----	1.10E-01
n-Hexane	----	----	----	4.89E-02	3.60E-01	----	----	----	2.04E-03	4.11E-01
Naphthalene	3.89E-03	----	1.24E-02	1.04E-03	1.22E-04	8.22E-04	----	1.82E-04	----	1.83E-02
Polycyclic Organic Matter[3]	6.58E-03	9.26E-02	----	2.69E-03	1.76E-05	2.40E-03	----	5.31E-04	9.87E-04	1.06E-01
Propylene Oxide	8.68E-02	----	----	----	----	----	----	----	----	8.68E-02
Toluene	3.89E-01	1.23E-01	5.96E-02	1.15E-02	6.80E-04	4.51E-03	----	9.98E-04	4.09E-03	5.92E-01
1,1,1-Trichloroethane	----	----	----	----	----	1.72E-04	----	3.80E-05	----	2.10E-04
1,1,2-Trichloroethane	----	----	----	1.40E-03	----	1.72E-04	----	3.80E-05	----	1.61E-03
Xylenes	1.92E-01	8.43E-02	4.15E-02	3.05E-02	----	7.93E-05	----	1.75E-05	2.04E-03	3.50E-01
Arsenic Compounds	----	----	----	----	4.00E-05	3.96E-04	2.11E-03	8.76E-05	----	2.59E-03
Beryllium Compounds	----	----	----	----	2.40E-06	2.97E-04	----	6.57E-05	----	3.62E-04
Cadmium Compounds	----	----	----	----	2.20E-04	2.97E-04	5.25E-03	6.57E-05	----	5.61E-03
Chromium Compounds	----	----	----	----	2.80E-04	2.97E-04	4.32E-03	6.57E-05	----	4.68E-03
Cobalt Compounds	----	----	----	----	1.68E-05	----	----	----	----	1.68E-05
Lead Compounds	----	----	----	----	----	8.90E-04	1.03E-01	1.97E-04	----	1.04E-01
Manganese Compounds	----	----	----	----	7.60E-05	5.94E-04	----	1.31E-04	----	7.25E-04
Mercury Compounds	----	----	----	----	5.20E-05	2.97E-04	2.70E-03	6.57E-05	----	3.06E-03
Nickel Compounds	----	----	----	----	4.20E-04	2.97E-04	3.78E-03	6.57E-05	----	4.27E-03
Selenium Compounds	----	----	----	----	4.80E-06	1.48E-03	----	3.28E-04	----	1.81E-03
Total - Unit Category/Source	**3.07**	**0.69**	**0.55**	**2.60**	**0.38**	**0.04**	**3.20**	**0.01**	**0.21**	**10.71**

Notes:
1. Emissions from all units are potential emissions based on full time or permitted operation.
2. See individual emissions unit category emissions calculations for details on methodology and assumptions.
3. AP-42 is unclear if the value for PAH includes naphthalene. The emission factor for PAH is included and listed under polycylic organic matter.

Table A-12. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Fuel Gas-Fired Turbines

Maximum Total Heat Input: 5,985,629 **MMBtu/yr**

Section 112 Hazardous Air Pollutants			Source Category Emission Calculations	
No.	**CAS No.**	**Chemical Name**	**Emission Factor**	**Estimated Emissions**
9	106990	1,3-Butadiene	4.30E-07 lb/MMBtu	1.29E-03 tpy
35	75070	Acetaldehyde	4.00E-05 lb/MMBtu	1.20E-01 tpy
39	107028	Acrolein	6.40E-06 lb/MMBtu	1.92E-02 tpy
48	71432	Benzene	1.20E-05 lb/MMBtu	3.59E-02 tpy
99	100414	Ethylbenzene	3.20E-05 lb/MMBtu	9.58E-02 tpy
109	5000	Formaldehyde	7.10E-04 lb/MMBtu	2.12E+00 tpy
145	91203	Naphthalene	1.30E-06 lb/MMBtu	3.89E-03 tpy
162	N/A	Polycylic Organic Matter	2.20E-06 lb/MMBtu	6.58E-03 tpy
167	75569	Propylene oxide	2.90E-05 lb/MMBtu	8.68E-02 tpy
176	108883	Toluene	1.30E-04 lb/MMBtu	3.89E-01 tpy
185	1330207	Xylenes (isomers and mixture)	6.40E-05 lb/MMBtu	1.92E-01 tpy
			Total HAP Emissions	**3.07 tpy**

Notes/Comments:

1. Reference: AP-42, Table 3.1-3.
2. AP-42, Table 3.1-3 is unclear if the value for PAH includes Naphthalene.
   The emission factor for PAH is included and listed under Polycylic Organic Matter.
3. Total heat consumption based on maximum full-time or permit-limited operation as noted below:

(5) 7.9 MW Siemens SGT-300 Turbines (Power Generation)	88.1 MMBtu/hr, each, maximum heat consumption	
Potential Fuel Use	3,860,891 MMBtu/yr	
(3) 1,650 bhp Siemens SGT-300 Turbines (Compressor)	80.9 MMBtu/hr, each, maximum heat consumption	
Potential Fuel Use	2,124,738 MMBtu/yr	
Total Potential Fuel Use	TOTAL:	5,985,629 MMBtu/yr

4. Capacity of the turbines is the nominal capacity at ISO conditions.

Table A-13. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Diesel-Fired RICE (>600 hp)

Maximum Total Heat Input: 873,197 **MMBtu/yr**

Section 112 Hazardous Air Pollutants			Source Category Emission Calculations	
No.	**CAS No.**	**Chemical Name**	**Emission Factor**	**Estimated Emissions**
1	75070	Acetaldehyde	2.52E-05 lb/MMBtu	1.10E-02 tpy
6	107028	Acrolein	7.88E-06 lb/MMBtu	3.44E-03 tpy
48	71432	Benzene	7.76E-04 lb/MMBtu	3.39E-01 tpy
120	5000	Formaldehyde	7.89E-05 lb/MMBtu	3.44E-02 tpy
185	108883	Toluene	2.81E-04 lb/MMBtu	1.23E-01 tpy
202	1330207	Xylenes (isomers and mixture)	1.93E-04 lb/MMBtu	8.43E-02 tpy
220	N/A	Polycylic Organic Matter	2.12E-04 lb/MMBtu	9.26E-02 tpy
			TOTAL HAP Emissions	**0.69 tpy**

Notes/Comments:

1. Reference: AP-42, Table 3.4-3, 3.4-4.
2. Total heat consumption based on maximum full-time or permit-limited operation as noted below:

(4) 810 kW Rig Engines (MTU 16V 2000)	7.6	MMBtu/hr, each	
Potential Fuel Use		266,129	MMBtu/yr
(6) 1,230 kW Caterpillar 3512 Generator Engines	11.6	MMBtu/hr, each	
Potential Fuel Use		607,068	MMBtu/yr
Total Potential Fuel Use	TOTAL:	873,197	MMBtu/yr

3. 7,000 Btu/hp-hr engine heat rate is assumed.

Table A-14. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Diesel-Fired RICE (<600 hp)

Maximum Total Heat Input: 291,393 **MMBtu/yr**

Section 112 Hazardous Air Pollutants			Source Category Emission Calculations	
No.	**CAS No.**	**Chemical Name**	**Emission Factor**	**Estimated Emissions**
1	75070	Acetaldehyde	7.67E-04 lb/MMBtu	1.12E-01 tpy
6	107028	Acrolein	9.25E-05 lb/MMBtu	1.35E-02 tpy
15	71432	Benzene	9.33E-04 lb/MMBtu	1.36E-01 tpy
23	106990	1,3-Butadiene	3.91E-05 lb/MMBtu	5.70E-03 tpy
87	5000	Formaldehyde	1.18E-03 lb/MMBtu	1.72E-01 tpy
119	91203	Naphthalene	8.48E-05 lb/MMBtu	1.24E-02 tpy
152	108883	Toluene	4.09E-04 lb/MMBtu	5.96E-02 tpy
169	1330207	Xylenes (isomers and mixture)	2.85E-04 lb/MMBtu	4.15E-02 tpy
			TOTAL HAP Emissions	**0.55 tpy**

Notes/Comments:

1. Reference: AP-42, Table 3.3-2.
2. Total heat consumption based on maximum full-time or permit-limited operation as noted below:

(1) 150 bhp Caterpillar 3304 Cold Start Engine	1.1	MMBtu/hr
Potential Fuel Use	9,198.0	MMBtu/yr
(2) 300 hp Cement Pump Engines (TBD)	2.1	MMBtu/hr, each
Potential Fuel Use	36,792.0	MMBtu/yr
(3) 7 hp Ingersol Rand L6-4MH Light Plant	0.05	MMBtu/hr, each
Potential Fuel Use	1,287.7	MMBtu/yr
(1) 400 hp Manitowoc 999 Crane	2.8	MMBtu/hr
Potential Fuel Use	24,528.0	MMBtu/yr
(1) 275 hp Grove 80 Ton Crane	1.9	MMBtu/hr
Potential Fuel Use	16,863.0	MMBtu/yr
(2) 286 hp Caterpillar 966 Loaders	2.0	MMBtu/hr, each
Potential Fuel Use	17,537.5	MMBtu/yr
(1) 110 hp Carelift ZB-10044 Zoom Boom	0.8	MMBtu/hr
Potential Fuel Use	6,745.2	MMBtu/yr
(6) 485 hp Drilling Support Vehicle Engine	3.4	MMBtu/hr, each
Potential Fuel Use	178,441.2	MMBtu/yr
Total Potential Fuel Use TOTAL:	291,393	MMBtu/yr

3. 7,000 Btu/hp-hr engine heat rate is assumed.

Table A-15. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Fuel Gas-Fired RICE

Maximum Total Heat Input:	440,158	**MMBtu/yr**[1]
Maximum Total Fuel Consumption:	445	**MMscf/yr**

		Source Category Emission Calculations		
CAS No.	**Chemical Name**	**Emission Factor**	**Factor Reference**[2]	**Emissions**[3]
75-07-0	Acetaldehyde	5.29E-01 lb/MMscf	CATEF Database	0.02 tpy
107-02-8	Acrolein	3.92E-02 lb/MMscf	CATEF Database	0.00 tpy
71-43-2	Benzene	2.12E-01 lb/MMscf	CATEF Database	0.01 tpy
92524	Biphenyl	2.12E-04 lb/MMBtu	Table 3.2-2, AP-42	0.01 tpy
106-99-0	1,3-Butadiene	3.78E-01 lb/MMscf	CATEF Database	0.02 tpy
56235	Carbon tetrachloride	3.67E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
108907	Chlorobenzene	3.04E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
67663	Chloroform	2.85E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
542756	1,3-Dichloropropene	2.64E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
100414	Ethyl benzene	7.00E-02 lb/MMscf	CATEF Database	0.00 tpy
1006934	Ethylene dibromide (Dibromoethane)	4.43E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
5-00-0	Formaldehyde	5.28E-02 lb/MMBtu	Table 3.2-2, AP-42	2.32 tpy
110543	Hexane	1.11E-03 lb/MMBtu	Table 3.2-2, AP-42	0.05 tpy
67561	Methanol	2.50E-03 lb/MMBtu	Table 3.2-2, AP-42	0.11 tpy
75092	Methylene chloride(Dichloromethane)	2.00E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
108952	Phenol	2.40E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
100425	Styrene	2.36E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
79345	1,1,2,2-Tetrachloroethane	4.00E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
108-88-3	Toluene	2.59E-01 lb/MMscf	CATEF Database	0.01 tpy
79005	1,1,2-Trichloroethane	3.18E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
540841	2,24-Trimethylpentane	2.50E-04 lb/MMBtu	Table 3.2-2, AP-42	0.01 tpy
75014	Vinyl chloride	1.49E-05 lb/MMBtu	Table 3.2-2, AP-42	0.00 tpy
1330-20-7	Xylenes (isomers and mixture)	6.85E-01 lb/MMscf	CATEF Database	0.03 tpy
N/A	Polycylic Organic Matter	6.12E-05 lb/MMBtu		0.00 tpy
	Polycyclic aromatic compounds(PAH)	6.12E-05 lb/MMBtu		
	Acenaphthene	1.56E-04 lb/MMscf	CATEF Database	
	Acenaphthylene	5.16E-04 lb/MMscf	CATEF Database	
	Benzo(b)fluoranthene	1.66E-07 lb/MMBtu	Table 3.2-2, AP-42	
	Benzo(k)fluoranthene	8.54E-06 lb/MMscf	CATEF Database	
	Benzo(e)pyrene	4.15E-07 lb/MMBtu	Table 3.2-2, AP-42	
	Benzo(g,h,i)perylene	4.14E-07 lb/MMBtu	Table 3.2-2, AP-42	
	Chrysene	1.58E-05 lb/MMscf	CATEF Database	
	Dibenz(a,h)anthracene	2.52E-06 lb/MMscf	CATEF Database	
	Fluoranthene	2.99E-04 lb/MMscf	CATEF Database	
	Fluorene	3.49E-04 lb/MMscf	CATEF Database	
	Ideno(1,2,3-cd)pyrene	8.06E-06 lb/MMscf	CATEF Database	
	2-Methylnaphthalene	3.32E-05 lb/MMBtu	Table 3.2-2, AP-42	
91-20-3	Naphthalene	2.34E-02 lb/MMscf	CATEF Database	0.00 tpy
	Phenanathrene	1.80E-03 lb/MMscf	CATEF Database	
	Pyrene	1.91E-04 lb/MMscf	CATEF Database	
			Total Potential HAP Emissions:	**2.6 tpy**

Notes:

1. Total heat consumption based on full-time or permit-limited operation for the following:
   (3) Gas-fired Generator Engines - Caterpillar G3516H 16.7 MMBtu/hr, each
   Potential Heat Consumption: 440,158 MMBtu/yr

   Total Potential Fuel Use: 440,158 MMBtu/yr

   Annual fuel use converted to MMBtu/yr based on a natural gas fuel heat content: 990 Btu/scf
2. References: AP-42, Table 3.2-2 and median values from California Air Toxics Emission Factors (CATEF) database (4S/Lean/>650Hp).
3. HAP emission control efficiency estimated at 80 percent for catalytic oxidation.

Table A-16. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Rig Boilers and Heaters (Gas-Fired)

Maximum Total Fuel Use: 400 **MMscf/yr**

Section 112 Hazardous Air Pollutants			Source Category Emission Calculations	
No.	**CAS No.**	**Chemical Name**	**Emission Factor**	**Estimated Emissions**
12	106467	1,4-Dichlorobenzene(p)	1.20E-03 lb/MMscf	2.400E-04 tpy
46	N/A	Arsenic Compounds	2.00E-04 lb/MMscf	4.000E-05 tpy
48	71432	Benzene	2.10E-03 lb/MMscf	4.199E-04 tpy
52	N/A	Beryllium Compounds	1.20E-05 lb/MMscf	2.400E-06 tpy
58	N/A	Cadmium Compounds	1.10E-03 lb/MMscf	2.200E-04 tpy
75	N/A	Chromium Compounds	1.40E-03 lb/MMscf	2.800E-04 tpy
76	N/A	Cobalt Compounds	8.40E-05 lb/MMscf	1.680E-05 tpy
109	5000	Formaldehyde	7.52E-02 lb/MMscf	1.504E-02 tpy
118	110543	Hexane	1.80E+00 lb/MMscf	3.600E-01 tpy
127	N/A	Manganese Compounds	3.80E-04 lb/MMscf	7.599E-05 tpy
128	N/A	Mercury Compounds	2.60E-04 lb/MMscf	5.199E-05 tpy
145	91203	Naphthalene	6.10E-04 lb/MMscf	1.220E-04 tpy
146	N/A	Nickel Compounds	2.10E-03 lb/MMscf	4.199E-04 tpy
162	N/A	Polycylic Organic Matter	8.82E-05 lb/MMscf	1.764E-05 tpy
		2-Methylnaphthalene	2.4E-05 lb/MMscf	
		3-Methylchloranthrene	1.8E-06 lb/MMscf	
		7,12-Dimethylbenz(a)anthracene	1.6E-05 lb/MMscf	
		Acenaphthene	1.8E-06 lb/MMscf	
		Acenaphthylene	1.8E-06 lb/MMscf	
		Anthracene	2.4E-06 lb/MMscf	
		Benz(a)anthracene	1.8E-06 lb/MMscf	
		Benzo(a)pyrene	1.2E-06 lb/MMscf	
		Benzo(a)fluoranthene	1.8E-06 lb/MMscf	
		Benzo(g,h,i)perylene	1.2E-06 lb/MMscf	
		Benzo(k)fluroanthene	1.8E-06 lb/MMscf	
		Chrysene	1.8E-06 lb/MMscf	
		Dibenzo(a,h)anthracene	1.2E-06 lb/MMscf	
		Fluoranthene	3.0E-06 lb/MMscf	
		Fluorene	2.8E-06 lb/MMscf	
		Indeno(1,2,3-cd)pyrene	1.8E-06 lb/MMscf	
		Phenanathrene	1.7E-05 lb/MMscf	
		Pyrene	5.0E-06 lb/MMscf	
171	N/A	Selenium Compounds	2.4E-05 lb/MMscf	4.799E-06 tpy
176	108883	Toluene	3.40E-03 lb/MMscf	6.799E-04 tpy
			Total HAP Emissions	**0.38 tpy**

Notes/Comments:

1. Reference: AP-42, Tables 1.4-3, 1.4-4.
2. Total fuel use based on maximum full-time operation or permit-limited operation as noted below:

(2) 6.3 MMBtu/hr Boilers	12,727 scf/hr, each	
Potential Fuel Use		222,981,818 scf/yr
(2) 5.0 MMBtu/hr Heaters	10,101 scf/hr, each	
Potential Fuel Use		176,969,697 scf/yr
Total Potential Fuel Use	**TOTAL**	399,951,515 scf/yr

Table A-17. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Rig Boilers and Heaters (Gas-Fired)

Maximum Total Fuel Use: 1,455 **kgal/yr**
Maximum Total Heat Input: 0.198 **10^{12} Btu/yr**

Section 112 Hazardous Air Pollutants			Source Category Emission Calculations		
No.	**CAS No.**	**Chemical Name**	**Emission Factor**		**Estimated Emissions**
2	79005	1,1,2-Trichloroethane	2.36E-04	lb/kgal	1.717E-04 tpy
46	N/A	Arsenic Compounds	4.0	lb/10^{12} Btu	3.958E-04 tpy
48	71432	Benzene	2.14E-04	lb/kgal	1.557E-04 tpy
52	N/A	Beryllium Compounds	3	lb/10^{12} Btu	2.968E-04 tpy
58	N/A	Cadmium Compouns	3	lb/10^{12} Btu	2.968E-04 tpy
75	N/A	Chromium Compounds	3	lb/10^{12} Btu	2.968E-04 tpy
99	100414	Ethyl benzene	6.36E-05	lb/kgal	4.627E-05 tpy
109	5000	Formaldehyde	3.30E-02	lb/kgal	2.401E-02 tpy
124	N/A	Lead Compounds	9	lb/10^{12} Btu	8.905E-04 tpy
127	N/A	Manganese Compounds	6	lb/10^{12} Btu	5.936E-04 tpy
128	N/A	Mercury Compounds	3	lb/10^{12} Btu	2.968E-04 tpy
132	71556	Methyl chloroform (1,1,1-Trichloroethane)	2.36E-04	lb/kgal	1.717E-04 tpy
145	91203	Naphthalene	1.13E-03	lb/kgal	8.221E-04 tpy
146	N/A	Nickel Compounds	3	lb/10^{12} Btu	2.968E-04 tpy
162	N/A	Polycylic Organic Matter	0.0033	lb/kgal	2.401E-03 tpy
171	N/A	Selenium Compounds	15	lb/10^{12} Btu	1.484E-03 tpy
176	108883	Toluene	6.20E-03	lb/kgal	4.511E-03 tpy
185	1330207	Xylenes (isomers and mixture)	1.09E-04	lb/kgal	7.930E-05 tpy
			Total HAP Emissions		**0.037 tpy**

Notes/Comments:

1. Reference: AP-42, Tables 1.3-8, 1.3-9, and 1.3-10.
2. Total fuel use based on maximum full-time operation or permit-limited operation as noted below:

(2) 6.3 MMBtu/hr Boilers	46	gal/hr, each	
Potential Fuel Use		811,201	gal/yr
(2) 5.0 MMBtu/hr Heaters	37	gal/hr	
Potential Fuel Use		643,810	gal/yr
Total Potential Fuel Use	TOTAL	1,455,010	gal/yr

3. Annual fuel use converted to MMBtu/yr based on a diesel fuel heat content of 136,000 Btu/gal.

Table A-18. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Incinerator

Maximum Total Usage: 1,927,200 **lb/yr**

Section 112 Hazardous Air Pollutants			Source Category Emission Calculations		
No.	**CAS No.**	**Chemical Name**	**Emission Factor**		**Estimated Emissions**
46	N/A	Arsenic Compounds	4.37E-03	lb/ton	2.11E-03 tpy
58	N/A	Cadmium Compounds	1.09E-02	lb/ton	5.25E-03 tpy
75	N/A	Chromium Compounds	8.97E-03	lb/ton	4.32E-03 tpy
128	N/A	Mercury Compounds	5.60E-03	lb/ton	2.70E-03 tpy
146	N/A	Nickel Compounds	7.85E-03	lb/ton	3.78E-03 tpy
124	N/A	Lead Compounds	2.13E-01	lb/ton	1.03E-01 tpy
N/A	7647	HCl	6.40E+00	lb/ton	3.08E+00 tpy
		TOTAL HAP Emissions			**3.20 tpy**

Notes/Comments:
1. Reference: AP-42, Table 2.1-2
2. Total heat consumption based on maximum full-time or maximum allowable operation as noted below:
   (1) Waste Incinerator
   Potential Use 1,927,200 lb/yr @ 8,760 hr/yr

Total Potential Use TOTAL: 1,927,200 lb/yr @ 8,760 hr/yr

Table A-19. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Rig Boilers and Heaters (Gas-Fired)

Maximum Total Fuel Use: 322 **kgal/yr**
Maximum Total Heat Input: 0.044 **10^{12} Btu/yr**

Section 112 Hazardous Air Pollutants			Source Category Emission Calculations		
No.	**CAS No.**	**Chemical Name**	**Emission Factor**		**Estimated Emissions**
2	79005	1,1,2-Trichloroethane	2.36E-04	lb/kgal	3.798E-05 tpy
46	N/A	Arsenic Compounds	4.0	lb/10^{12} Btu	8.756E-05 tpy
48	71432	Benzene	2.14E-04	lb/kgal	3.444E-05 tpy
52	N/A	Beryllium Compounds	3	lb/10^{12} Btu	6.567E-05 tpy
58	N/A	Cadmium Compouns	3	lb/10^{12} Btu	6.567E-05 tpy
75	N/A	Chromium Chompounds	3	lb/10^{12} Btu	6.567E-05 tpy
99	100414	Ethyl benzene	6.36E-05	lb/kgal	1.024E-05 tpy
109	5000	Formaldehyde	3.30E-02	lb/kgal	5.311E-03 tpy
124	N/A	Lead Compounds	9	lb/10^{12} Btu	1.970E-04 tpy
127	N/A	Manganese Compounds	6	lb/10^{12} Btu	1.313E-04 tpy
128	N/A	Mercury Compounds	3	lb/10^{12} Btu	6.567E-05 tpy
132	71556	Methyl chloroform (1,1,1-Trichloroethane)	2.36E-04	lb/kgal	3.798E-05 tpy
145	91203	Naphthalene	1.13E-03	lb/kgal	1.819E-04 tpy
146	N/A	Nickel Compounds	3	lb/10^{12} Btu	6.567E-05 tpy
162	N/A	Polycylic Organic Matter	0.0033	lb/kgal	5.311E-04 tpy
171	N/A	Selenium Compounds	15	lb/10^{12} Btu	3.283E-04 tpy
176	108883	Toluene	6.20E-03	lb/kgal	9.979E-04 tpy
185	1330207	Xylenes (isomers and mixture)	1.09E-04	lb/kgal	1.754E-05 tpy
			Total HAP Emissions		**0.01 tpy**

Notes/Comments:

1. Reference: AP-42, Tables 1.3-8, 1.3-9, and 1.3-10.
2. Total fuel use based on maximum full-time operation or permit-limited operation as noted below:

(5) 1.0 MMBtu/hr Portable Heaters	7 gal/hr, each		
Potential Fuel Use		321,905	gal/yr
Total Potential Fuel Use	TOTAL	321,905	gal/yr

3. Annual fuel use converted to MMBtu/yr based on a diesel fuel heat content of 136,000 Btu/gal.

Table A-20. Hilcorp Alaska - Liberty Development Project
Potential HAP Emissions - Flares

Maximum Total Capacity: 141 **MMscf/yr**

Section 112 Hazardous Air Pollutants			Source Category Emission Calculations	
No.	**CAS No.**	**Chemical Name**	**Emission Factor**	**Estimated Emissions**
35	75070	Acetaldehyde	4.30E-02 lb/MMscf	3.03E-03 tpy
39	107028	Acrolein	1.00E-02 lb/MMscf	7.05E-04 tpy
99	100414	Ethylbenzene	1.44E+00 lb/MMscf	1.02E-01 tpy
109	5000	Formaldehyde	1.17E+00 lb/MMscf	8.24E-02 tpy
176	108883	Toluene	5.80E-02 lb/MMscf	4.09E-03 tpy
185	1330207	Xylenes (isomers and mixture)	2.90E-02 lb/MMscf	2.04E-03 tpy
48	71432	Benzene	1.59E-01 lb/MMscf	1.12E-02 tpy
1	NA	Polycylic Organic Matter	1.40E-02 lb/MMscf	9.87E-04 tpy
NA	NA	n-Hexane	2.90E-02 lb/MMscf	2.04E-03 tpy
			Total HAP Emissions	**0.21 tpy**

Notes/Comments:

1. Reference: VCAPCD
2. Total heat consumption based on maximum full-time or permit-limited operation as noted below:
   (2) Flares

Potential Fuel Use	Flare	140	MMscf/yr
Potential Fuel Use	Flare Pilot/Purge	1	MMscf/yr
	TOTAL:	141	MMscf/yr

Table A-21. Hilcorp Alaska - Liberty Development Project
Siemens SGT-300 Emissions Data[1,2]

For Power Generation Maximum Emissions at 100% Operating Load				
Ambient Temperature (deg F)	60	40	20	0
Ambient Temperature (deg C)	16	4	-7	-18
Tubrine Operating Load %	100	100	100	100
Exhaust Flow (kg/s)	29.8	30.5	31.5	33
Exhaust Flow (lb/hr)	236,513	242,069	250,006	261,911
NO_X ppmvd, ref 15% O_2	15	15	15	15
NO_X lb/hr[3]	5.6	5.8	6.0	6.2
CO ppmvd, ref 15% O_2	10	10	10	10
CO lb/hr[3]	2.3	2.3	2.4	2.5

Notes:
[1] NO_X and CO emissions based on manufacturer's typical emission rate for SGT-300 .
[2] Exhaust flows based on manufacturer's specifications.
[3] Assumes molecular weight of air is equal to 28.966 g/mol.

For Mechanical Drives Maximum Emissions at 100% Operating Load				
Ambient Temperature (deg F)	60	40	20	0
Ambient Temperature (deg C)	16	4	-7	-18
Tubrine Operating Load %	100	100	100	100
Exhaust Flow (kg/s)	29	29.7	30.6	32.1
Exhaust Flow (lb/hr)	230,164	235,533	243,255	254,839
NO_X ppmvd, ref 15% O_2	15	15	15	15
NO_X lb/hr[3]	5.5	5.6	5.8	6.1
CO ppmvd, ref 15% O_2	10	10	10	10
CO lb/hr[3]	2.2	2.3	2.4	2.5

Notes:
[1] NO_X and CO emissions based on manufacturer's typical emission rate for SGT-300 .
[2] Exhaust flows based on manufacturer's specifications.
[3] Assumes molecular weight of air is equal to 28.966 g/mol.

Potential Emissions (Power Generation)
Based on Ambient Temperature
Distribution at Deadhorse Airport (2008-2012)

NO_X	26.6 TPY
CO	10.8 TPY

Potential Emissions (Mechanical Drives)
Based on Ambient Temperature
Distribution at Deadhorse Airport (2008-2012)

NO_X	25.9 TPY
CO	10.5 TPY

Table A-22. Hilcorp Alaska - Liberty Development Project
Probability Distribution of Deadhorse Airport Hourly Ambient Temperatures

Temperature (deg F)	Number of Hours[1] From 2008 - 2012	Percent of Five Year Average	Temperature (deg F) at which Vendor Data Was Selected
Less than -40	768	1.8%	-60
-40 to -30	2,064	4.7%	-40
-30 to -20	3,568	8.2%	-40
-20 to -10	3,766	8.6%	-20
-10 to 0	5,194	11.9%	-20
0 to 10	3,897	8.9%	0
10 to 20	4,405	10.1%	0
20 to 30	3,781	8.6%	20
30 to 40	8,315	19.0%	20
40 to 50	5,096	11.7%	40
50 to 60	2,111	4.8%	40
60 to 70	674	1.5%	60
70 to 80	73	0.2%	60
Total	43,712	100%	

Notes:

[1] Based on valid NWS data collected at Deadhorse Airport (PASC) from January 1, 2008 through December 31, 2012.

Appendix A-2

Vendor Data and Supporting Information

SGT-300 Industrial Gas Turbine

Power Generation: (ISO) 7.90MW(e)

The SGT-300 has a rugged industrial design which enables high efficiency (nominal 31 %) and excellent emissions performance. These characteristics provide the flexibility to meet the needs of a broad spectrum of power generation applications.

The Siemens SGT-300 single-shaft industrial gas turbine is a proven unit for all electrical power generation and cogeneration applications. It offers high efficiency and reliability on a wide range of gaseous and liquid fuels.

For industrial cogeneration, the high steam-raising capability of more than 18 tonnes per hour contributes towards achieving overall plant efficiencies of 80 % or higher. In addition, the compact arrangement, on-site maintainability and inherent reliability of the SGT-300 have made it an ideal gas turbine for the demanding oil and gas industry.

Incorporating proven gas turbine technology, the SGT-300 offers cost-effective power for a wide range of duties including:

Industrial Power Generation

- Simple-cycle and combined-cycle power plants for base load, standby power and peak lopping
- Cogeneration for industrial plants with high heat load and district heating schemes

Power Generation in the Oil and Gas Industry

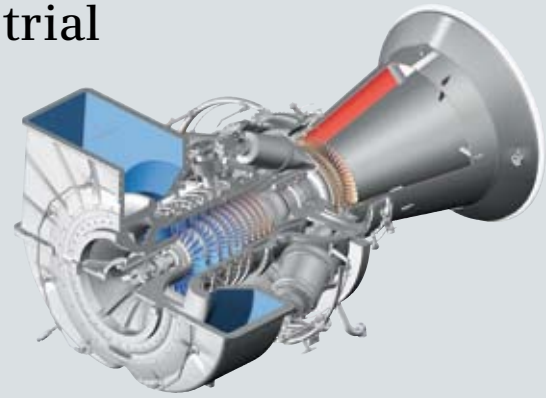
- Offshore: on oil platforms and FPSO (Floating Production, Storage and Offloading) vessels
- Onshore: for oil field service, refinery application, emergency and standby power generation
- Highly efficient cogeneration solutions for oil and gas applications

Industrial Gas Turbines

Answers for energy.

SIEMENS

SGT-300 Industrial Gas Turbine



SGT-300 core engine test facility.

Technical specifications

Overview

- Single-shaft, industrial gas turbine
- Power generation: 7.90 MW(e) (ISO zero loss)
- Frequency: 50 or 60 Hz
- Electrical efficiency: 31 %
- Heat rate: 11,773 kJ/kWh (11,158 Btu/kWh)
- Compressor pressure ratio: 14:1
- Exhaust gas flow: 30.2 kg/s (66.6 lb/s)
- Exhaust temperature: 542° C (1008° F)
- Typical emissions: NO_x <15 ppmV and CO: <10 ppmV (corrected to 15 % O_2 dry)
- Medium-calorific value fuels capability (>32 MJ/Nm^3 Wobbe index)

Axial compressor

- 10-stage
- Variable inlet guide vanes
- Air flow: (ISO) 29.9 kg/s
- Nominal speed: 14,010 rpm

Combustion

- 6 reverse-flow cannular combustion chambers
- Lean-burn Dry Low Emissions (DLE) or conventional diffusion flame system
- High-energy ignitor system

Turbine

- 2-stage overhung turbine
  - First stage air-cooled

Bearings

- Tilt-pad radial and thrust
- Vibration- and temperature-monitoring as standard

Main reduction gearbox

- Speeds of 1500 rpm and 1800 rpm

Generator

- Voltages: 6 to 13.8 kV
- Frequency: 50 or 60 Hz

Package

- Fabricated steel underbase
  - Integral oil tank
  - Multi-point mounting
  - Optional 3-point mounting
- Modular fluid systems
- Lubricating oil system
  - Gearbox-driven main pump
  - AC motor-driven auxiliary pump
  - DC motor-driven emergency pump
- Oil cooler and oil heater
- Electrically-driven hydraulic start system
- Hydrocarbon drains tank on package
- Control system
  - Siemens SIMATIC PLC-based with distributed control and processing capability installed on package
  - Optional Allen-Bradley system
  - Optional off-package systems
- Vibration monitoring system
  - BN 1701: Standard
  - BN 3500: Optional
- Fire and gas detection equipment
- Fire suppression equipment
- On- and off-line compressor cleaning options availble
- Combustion-air inlet-filtration options:
  - Simple static
  - Pulse cleaning
  - HEPA
- Enclosure
  - Painted carbon steel or stainless steel
  - Noise level options (85 dB(A) standard)

Gas turbine

Key features

- High simple-cycle and cogeneration efficiencies, cutting fuel costs
- Dual-fuel Dry Low Emissions (DLE) combustion system, meeting stringent legislation

Maintenance

- Site maintainability or optional rapid core exchange as required by customer
- Designed for maintenance:
  - Horizontally split compressor casing
  - Horizontally and vertically split inlet casing
  - Combustion chambers, flame tubes and ignitors easily accessible for inspection
  - Large side-doors on enclosure for equipment change-out
  - Package designed for gas turbine removal on either side
- Multiple boroscope-inspection ports

Customer Support

- Global support network of Authorized Service Centers
- Emergency service - 24/7 specialist helpdesk
- Full field service
- Full diagnostic support, remote monitoring
- OEM modernizations and upgrades
- In-house or on-site training programs
- Range of maintenance and service contracts available

SGT-300 package.

Two SGT-300 gas turbines provide Norbord with electricity and heat at their board manufacturing plant in Scotland, UK.

Package

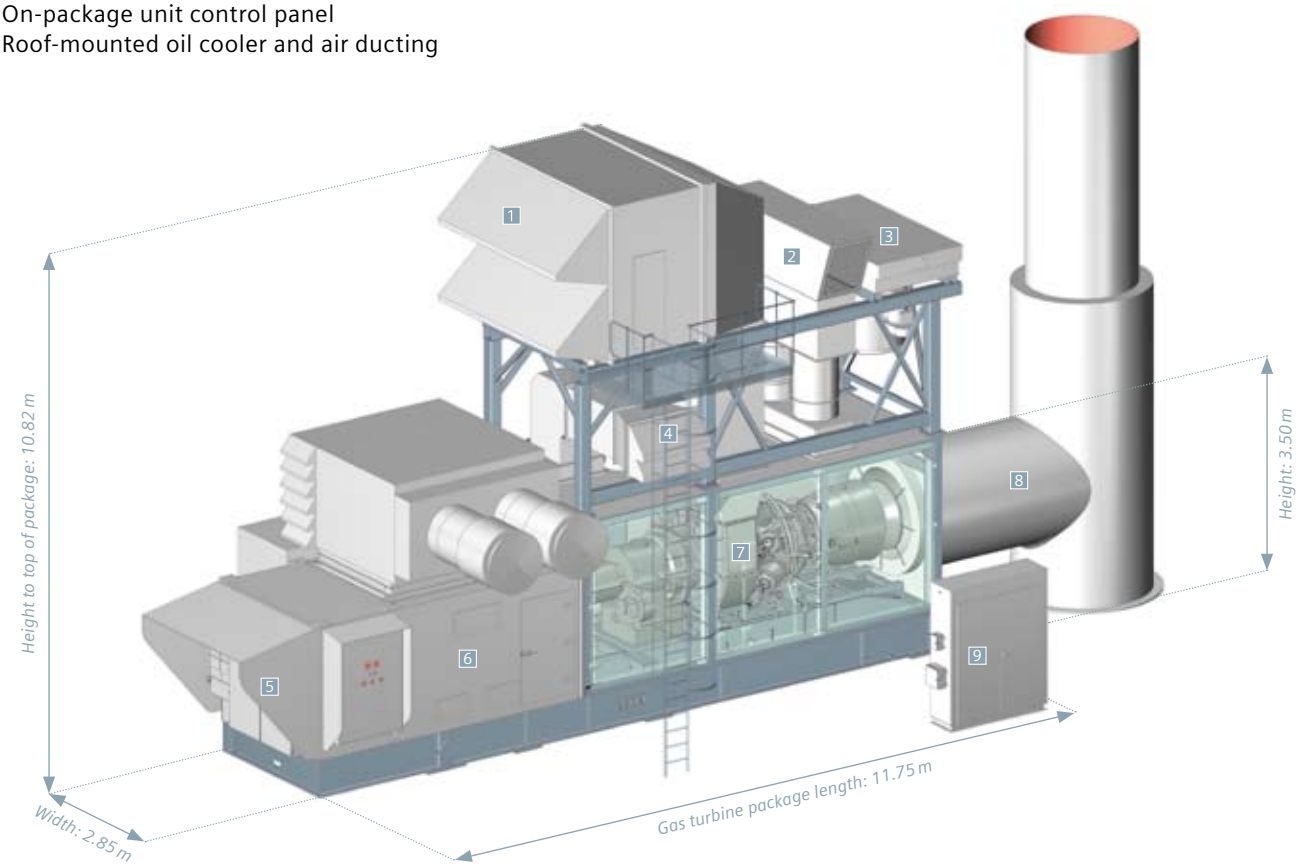
Key features

- Short installation time
- Compact package size, high power-to-weight ratio
- Factory testing:
  - Core engine
  - Functional testing of modules as standard
  - Pre-commissioning of package
  - Optional core customer-witness test
  - Optional complete package test
- Minimized customer interfaces
  - On-package drains tank
  - On-package unit control panel
  - Roof-mounted oil cooler and air ducting

Cogeneration with the SGT-300

In cogeneration configuration, with its excellent efficiency and steam-raising capability, the SGT-300 provides the core of a reliable, efficient and powerful SSC-300 plant. When compared with conventional energy supplies, an SSC-300 cogeneration plant will provide electrical power, heating and/or cooling with benefits of:

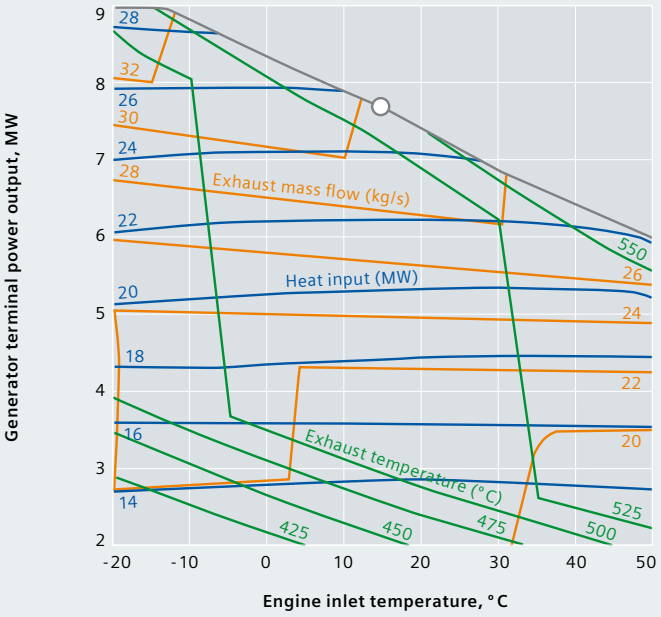
- Significant reductions in energy costs
- Security of energy supplies
- Reductions in total emissions of carbon dioxide, and improved flexibility



SGT-300 standard package

1 Combustion air inlet
2 Enclosure air outlet
3 Lube oil cooler
4 Enclosure air inlet
5 Unit control panel
6 AC generator
7 Core engine
8 Combustion exhaust
9 Fire extinguishant

SGT-300 Performance

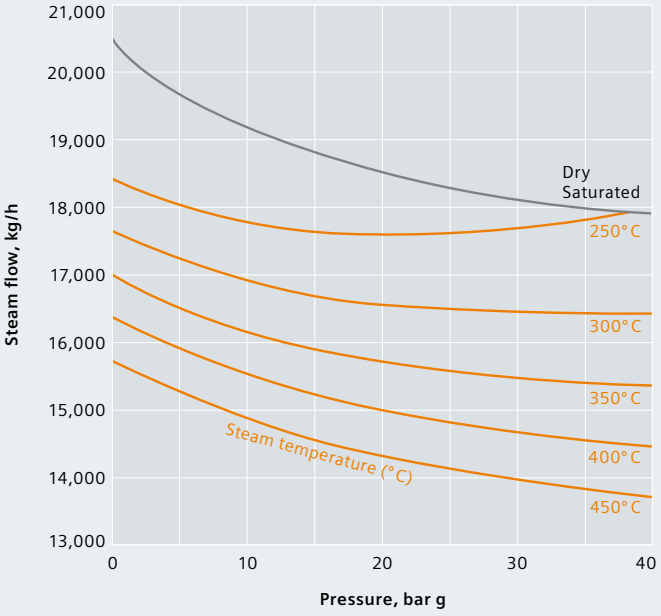


Nominal generator output and heat rate

Conditions/assumptions:

Altitude:	Sea level
Ambient pressure:	101.3 kPa
Inlet ducting loss:	1.0 kPa*
Exhaust ducting loss (assumes waste-heat recovery):	2.0 kPa*
Natural gas fuel.	
Gearbox efficiency:	99.0 %
Generator efficiency:	97.0 %
Relative humidity:	60 %

** Duct losses are site-specific according to application. Please contact your local Siemens representative or our Customer Support Center for performance quotations.*



Unfired heat-recovery steam generation

Conditions/assumptions:

Exhaust gas mass flow:	29.8 kg/s
Assumed feed water temperature:	100 °C
Exhaust gas temperature:	542 °C

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SGT-300 Industrial Gas Turbine

Mechanical Drive: (ISO) 8.20MW (11,000bhp)

Siemens has expanded its gas turbine portfolio with the introduction of the SGT-300 mechanical drive (SGT-300 MD). The product provides users with a highly efficient, highly available, robust gas turbine for their mechanical drive requirements.

The twin-shaft SGT-300 MD is derived from the highly successful and reliable SGT-300 single-shaft machine. Many of the components are common to the two machines. This commonality in conjunction with components derived from other Siemens gas turbines provides the SGT-300 MD with assured reliability.

The SGT-300 MD can operate over a wide load and speed range. The two-stage power turbine design facilitates this capability.

The SGT-300 MD is focused on high availability. The core engine has an advanced modular design. Modules can be changed easily, on site, or alternatively a complete core engine exchange can be carried out quickly. The core engine has been designed to operate without any major overhaul for four years.

The package provides for quick installation and easy maintenance being mounted on a single underbase.

The SGT-300 MD delivers;

- excellence in Health and Safety during installation, operation and maintenance
- high availability
  - using well proven designs
  - with advanced features for ease of maintenance
  - including rapid core exchange capability
- environmental excellence
  - high efficiency reducing fuel burn
  - low emissions meeting stringent legislation
  - wide fuel flexibility
- simplicity
  - easy to transport
  - simple and quick to install
  - low manpower requirements for operation

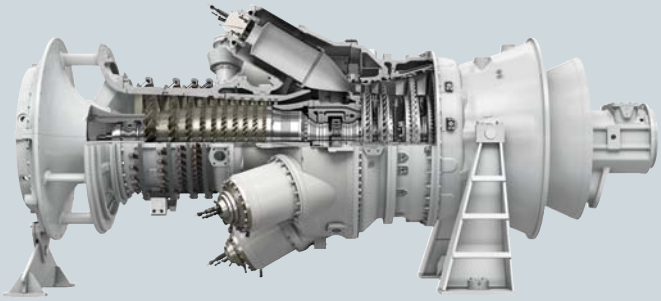
These benefits secure the gas compressing, or oil pumping drive availability, minimizing the impact on the environment and providing real added value to the users' business.

Industrial Gas Turbines

Answers for energy.

SIEMENS

SGT-300 Industrial Gas Turbine



SGT-300 MD core engine.

Technical specifications

Overview

- Twin-shaft, industrial
- Mechanical drive: 8.20MW
- Shaft efficiency: 34.6%
- Heat rate: 10,400kJ/kWh
- Power turbine speed: Up to 12,000rpm
- Compressor pressure ratio: 13.3:1
- Exhaust gas flow: 29.0kg/s (65.5lb/s)
- Exhaust temperature: 498°C (925°F)
- Typical emissions: NO_x: <15ppmV and CO: <10ppmV (corrected to 15% O_2 dry)
- Medium-calorific value fuels capability (>32MJ/Nm³ Wobbe index)

Axial compressor

- 10-stage
- Variable inlet guide vanes

Combustion

- 6 reverse-flow combustion chambers
- Lean-burn Dry Low Emissions (DLE) or conventional diffusion flame system
- High-energy ignitor system

Turbine

- 2-stage overhung compressor turbine
  - First stage air-cooled
- 2-stage high-efficiency power turbine
  - Rotor blades have interlocking shrouds for mechanical integrity

Bearings

- Tilt-pad radial and thrust
- Standard vibration- and temperature-monitoring

Package

- Fabricated steel underbase
  - Integral oil tank
  - Multi-point mounting
  - Optional 3-point mounting
- Modular fluid systems incorporating:
  - Lubricating oil system
  - Gearbox-driven main pump
  - AC motor-driven auxiliary pump
  - DC motor-driven emergency pump
- Oil cooler and oil heater
- Electrically driven hydraulic start system
- Hydrocarbon drains tank on package
- Control system
  - Siemens SIMATIC PLC-based with distributed control and processing capability installed on package
  - Optional Allen-Bradley system
  - Optional off-package systems
- Vibration monitoring system
- Fire and gas detection equipment
- Fire suppression equipment
- On- and off-line compressor cleaning options available
- Combustion air inlet filtration options:
  - Simple static
  - Pulse cleaning
  - HEPA
- Enclosure
  - Painted carbon steel or stainless steel
  - Noise level options (85dB(A) standard)

Gas turbine

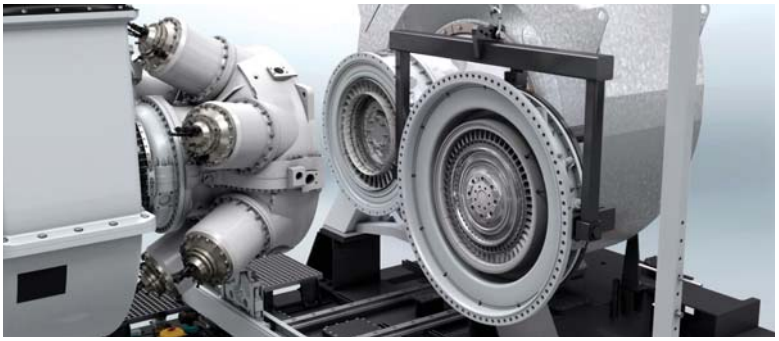
Key features

- Excellence in health and safety for personnel
- High availability
- Environmentally friendly
- Simplicity in installation, operation and maintenance

Maintenance

Key features

- Focus on health and safety of maintenance personnel:
  - Internal cell maintenance platforms
  - External access ladders and platforms
  - Internal lifting equipment
  - Large access doors
  - Designed in accordance with ISO21789:2009 gas turbine applications safety
- Core engine on-site maintenance, module exchange or core exchange



SGT-300 MD core engine module removal.

SGT-300 MD package.

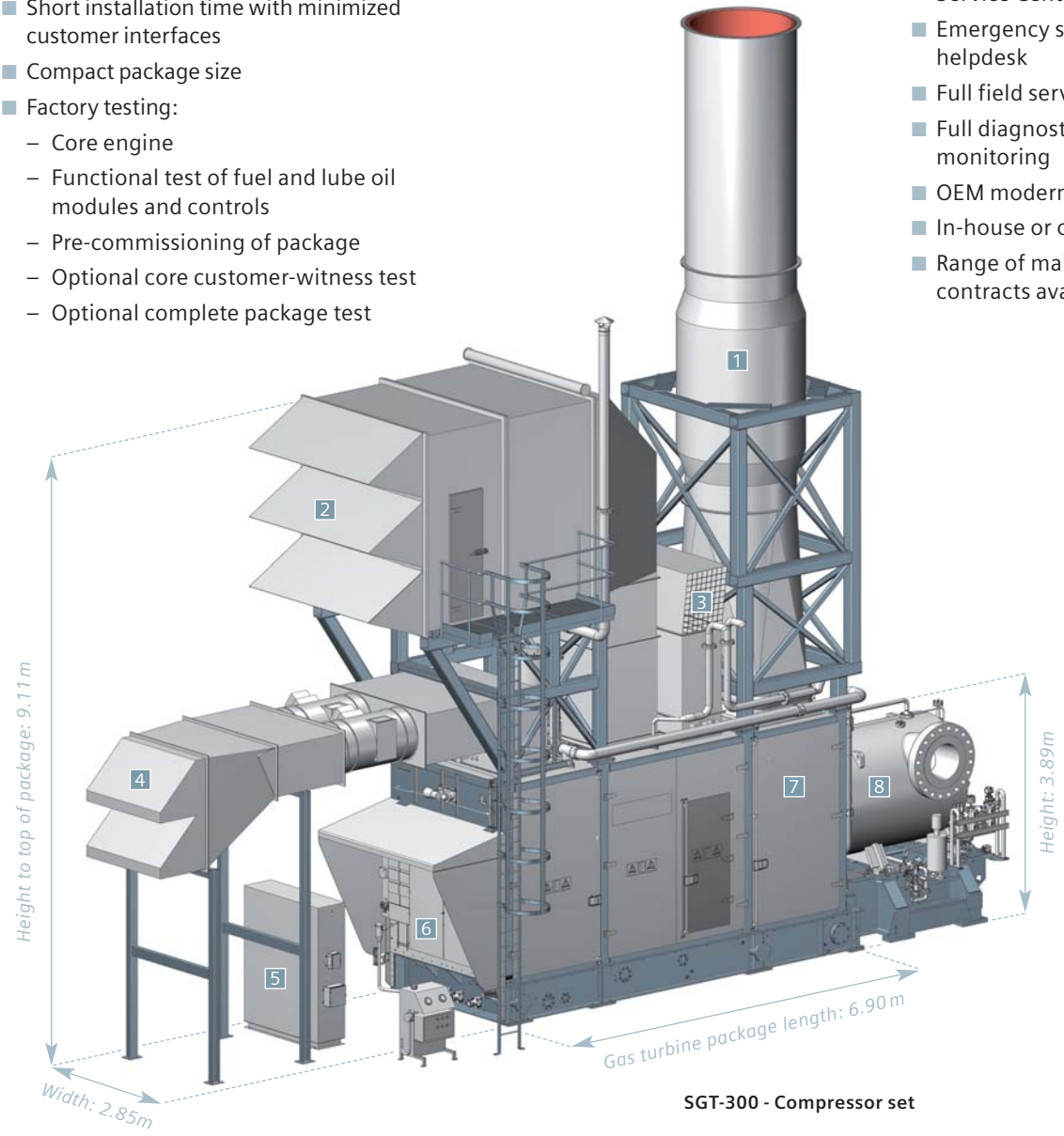
Package

Key features

- Short installation time with minimized customer interfaces
- Compact package size
- Factory testing:
  - Core engine
  - Functional test of fuel and lube oil modules and controls
  - Pre-commissioning of package
  - Optional core customer-witness test
  - Optional complete package test

Customer Support

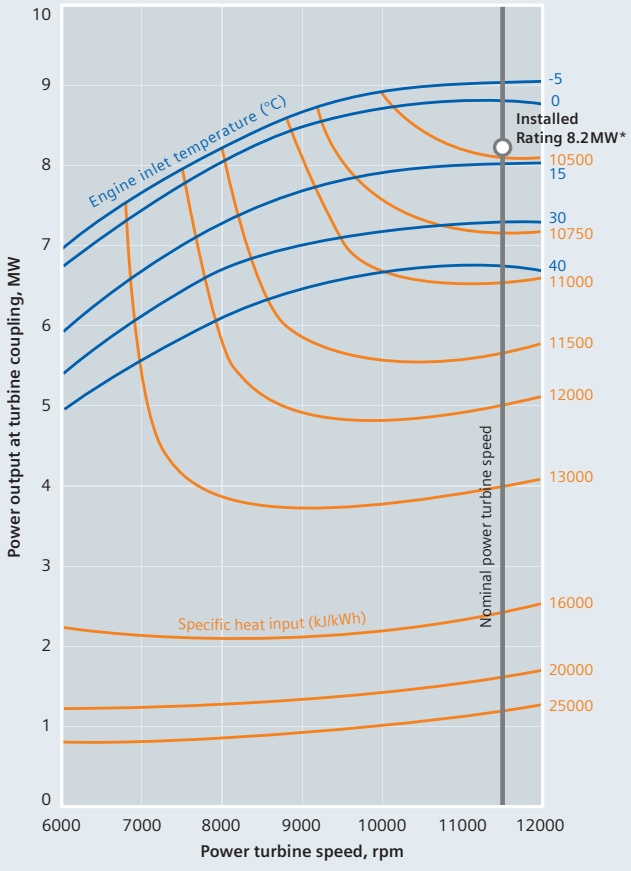
- Global support network of Authorized Service Centers
- Emergency service - 24/7 specialist helpdesk
- Full field service
- Full diagnostic support, remote monitoring
- OEM modernizations and upgrades
- In-house or on-site training programs
- Range of maintenance and service contracts available



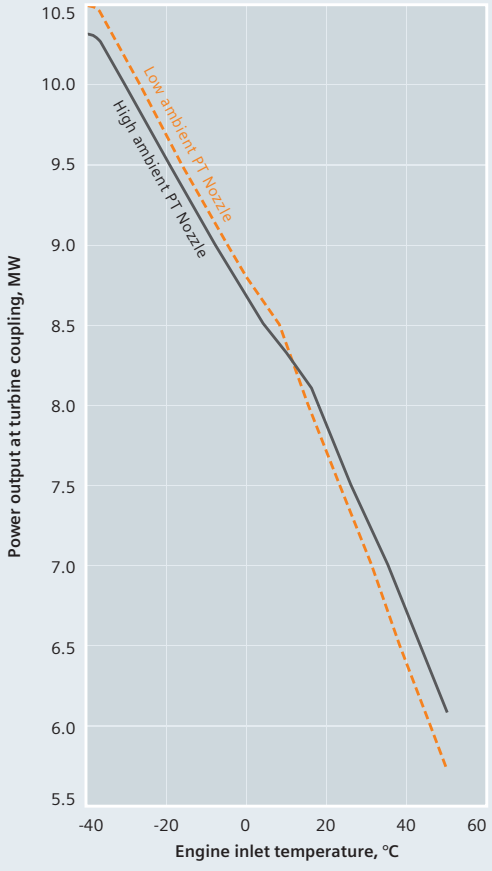
SGT-300 - Compressor set

1 Combustion exhaust
2 Combustion air inlet
3 Enclosure air outlet
4 Enclosure air inlet
5 Fire extinguishant
6 On-package controls
7 Core engine acoustic enclosure
8 Driven compressor

SGT-300 mechanical drive performance



Nominal performance
Power and specific heat input and speed



Power output at turbine coupling and engine inlet temperature

SGT-300 Mechanical drive performance

Conditions/assumptions

Direct drive - no output gearbox.
Altitude: Sea level
*Inlet and exhaust ducting losses have not been debited.
Natural gas fuel.
Ambient pressure: 101.3kPa
Relative humidity: 60%
No CO turndown in operation.

Specific heat input is drawn for an engine inlet temperature of 15°C but is approximately correct for other temperatures and is based on the LCV of the fuel.

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Oil & Gas Division

Technical Sales Document

- Product Data -

Date 8/14/2014

Name	**16V2000G56S**	**Speed[rpm]**	**1800**
Application Group	**3B**	**Rating[KW]**	**809**
Dataset	**Ref. 25°C/55°C; Water charge air cooling (external)**	**Rating[bhp]**	**1085**
		Frequency[Hz]	**60**
	US EPA "Nonroad" Tier 4i (40 CFR 1039);		

Reference conditions

No.	Description	Index	Value	Unit
6	Intake air temperature		25	°C
7	Charge-air coolant temperature		45	°C
8	Barometric pressure		1000	mbar
9	Site altitude above sea level		100	m
10	Raw-water inlet temperature		-	°C

Technical Sales Document

- Product Data -

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0. Data-relevant engine design configuration

No.	Description	Index	Value	Unit
2	Exhaust-emissions optimized (limit values see Exhaust Emissions, Chapter 21)		X	-
56	Complies with: US EPA, regulation for nonroad engines (40 CFR 1039 - Tier 4i -)		X	-
13	Engine without sequential turbocharging (turbochargers without cut-in/cut-out control)		X	-
31	Engine with air-cooled charge air		-	-
61	Engine with water/charge air cooling (LT, on-engine)		X	-

Technical Sales Document

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Date 8/14/2014

1. Power-related data (power ratings are net brake power to ISO 3046)

No.	Description	Index	Value	Unit
1	Engine rated speed	A	1800	rpm
4	Continuous power ISO 3046 (10% overload capability) (design power DIN 6280, ISO 8528)	A	809	kW
5	Fuel stop power ISO 3046	A	890	kW
8	Mean effective pressure (MEP) (Continuous power ISO 3046)		15.1	bar
9	Mean effective pressure (MEP) (Fuel stop power ISO 3046)		16.6	bar
18	Performance map No.		-	-
38	Performance map No. (cont.)		-	-
20	Performance map, amendment index		-	-

2. General Conditions (for maximum power)

No.	Description	Index	Value	Unit
1	Intake air depression (new filter)	A	13	mbar
2	Intake air depression, max.	L	30	mbar
3	Exhaust back pressure	A	26	mbar
4	Exhaust back pressure, max.	L	60	mbar
5	Fuel temperature at fuel feed connection	R	37	°C

3. Consumption

No.	Description	Index	Value	Unit
17	Specific fuel consumption (be) - 100 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	208	g/kWh
18	Specific fuel consumption (be) - 75 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	217	g/kWh
19	Specific fuel consumption (be) - 50 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	230	g/kWh
20	Specific fuel consumption (be) - 25 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	287	g/kWh
21	Specific fuel consumption (be) - FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	206	g/kWh
73	No-load fuel consumption	R	20	kg/h
62	Lube oil consumption after 100 h of operation, max. (B = fuel consumption per hour)	L	0.8	% of B

4. Model-related data (basic design)

No.	Description	Index	Value	Unit
3	Engine with exhaust turbocharger (ETC) and intercooler		X	-
4	Exhaust piping, non-cooled		X	-
33	Working method: four-cycle, diesel, single-acting		X	-
34	Combustion method: direct injection		X	-
36	Cooling system: conditioned water		X	-
37	Direction of rotation: c.c.w. (facing driving end)		X	-
6	Number of cylinders		16	-
7	Cylinder configuration: V angle		90	degrees (°)
10	Bore		135	mm
11	Stroke		156	mm
12	Displacement, cylinder		2.233	liter
13	Displacement, total		35.7	liter
14	Compression ratio		16.5	-
40	Cylinder heads: single-cylinder		X	-
41	Cylinder liners: wet, replaceable		X	-
24	Number of inlet valves, per cylinder		2	-
25	Number of exhaust valves, per cylinder		2	-
15	Number of turbochargers		3	-
18	Number of intercoolers		2	-
28	Standard flywheel housing flange (engine main PTO)		0	SAE
43	Flywheel interface (DISC)		18"	-
46	Engine mass diagram, drawing No.		N	-
47	Engine mass diagram, drawing No. (cont.)		N	-

5. Combustion air / exhaust gas

No.	Description	Index	Value	Unit
8	Charge-air pressure before cylinder - CP	R	3.31	bar abs
27	Charge-air pressure before cylinder - FSP	R	3.55	bar abs
9	Combustion air volume flow - CP	R	1.0	m³/s
10	Combustion air volume flow - FSP	R	1.1	m³/s
11	Exhaust volume flow (at exhaust temperature) - CP	R	2.1	m³/s
12	Exhaust volume flow (at exhaust temperature) - FSP	R	2.2	m³/s

6. Heat dissipation

No.	Description	Index	Value	Unit
26	Charge-air heat dissipation - CP	R	120	kW
27	Charge-air heat dissipation - FSP	R	130	kW
33	Radiation and convection heat, engine - CP	R	25	kW
34	Radiation and convection heat, engine - FSP	R	27	kW

7. Coolant system (high-temperature circuit)

No.	Description	Index	Value	Unit
17	Coolant temperature (at engine outlet to cooling equipment)	A	90	°C
20	Coolant temperature after engine, alarm	L	105	°C
21	Coolant temperature after engine, shutdown	L	107	°C
25	Coolant antifreeze content, max.	L	50	%
30	Cooling equipment: coolant flow rate	A	51	m^3/h
35	Coolant pump: inlet pressure, min.	L	0.4	bar
36	Coolant pump: inlet pressure, max.	L	1.5	bar
41	Pressure loss in off-engine cooling system, max.	L	0.7	bar
47	Breather valve (expansion tank) opening pressure (excess pressure)	R	N	bar
54	Cooling equipment: height above engine, max.	L	15	m

8. Coolant system (low-temperature circuit)

No.	Description	Index	Value	Unit
9	Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	45	°C
13	Coolant antifreeze content, max.	L	50	%
17	Charge-air temperature after intercooler, max.	L	75	°C
76	Temperature differential between intake air and charge-air coolant before intercooler	A	N	K
20	Cooling equipment: coolant flow rate	A	19	m^3/h
24	Coolant pump: inlet pressure, min.	L	0.4	bar
25	Coolant pump: inlet pressure, max.	L	1.5	bar
29	Pressure loss in off-engine cooling system, max.	L	0.7	bar
43	Cooling equipment: height above engine, max.	L	15	m
36	Breather valve (expansion tank) opening pressure (excess pressure)	R	N	bar

10. Lube oil system

No.	Description	Index	Value	Unit
1	Lube oil operating temp. before engine, from	R	80	°C
2	Lube oil operating temp. before engine, to	R	104	°C
5	Lube oil temperature before engine, alarm	L	105	°C
6	Lube oil temperature before engine, shutdown	L	107	°C
8	Lube oil operating press. bef. engine, from	R	7	bar
9	Lube oil operating press. bef. engine, to	R	9	bar
10	Lube oil pressure before engine, alarm	L	7	bar
11	Lube oil pressure before engine, shutdown	L	6.5	bar
19	Lube oil fine filter (main circuit): number of units		1	-
20	Lube oil fine filter (main circuit): number of elements per unit		3	-
32	Lube oil fine filter (main circuit): pressure differential, max.	L	1.7	bar

11. Fuel system

No.	Description	Index	Value	Unit
1	Fuel pressure at fuel feed connection, min. (when engine is starting)	L	-0.5	bar
2	Fuel pressure at fuel feed connection, max. (when engine is starting)	L	0.5	bar
37	Fuel supply flow, max.	A	34	liter/min
8	Fuel return flow, max.	A	34	liter/min
10	Fuel pressure at return connection on engine, max.	L	0.5	bar
18	Fuel fine filter (main circuit): number of units	A	1	-
19	Fuel fine filter (main circuit): number of elements per unit	A	2	-
20	Fuel fine filter (main circuit): particle retention	A	0.005	mm
21	Fuel fine filter (main circuit): pressure differential, max.	L	1.5	bar

12. General operating data

No.	Description	Index	Value	Unit
22	Coolant preheating, preheating temperature (min.)	L	32	°C
28	Breakaway torque (without driven machinery) coolant temperature +5°C	R	580*	Nm
30	Breakaway torque (without driven machinery) coolant temperature +40°C	R	330*	Nm
29	Cranking torque at firing speed (without driven machinery) coolant temperature +5°C	R	380*	Nm
31	Cranking torque at firing speed (without driven machinery) coolant temperature +40°C	R	305*	Nm
96	Starting is blocked if the engine coolant temperature is below		-40	°C
37	High idling speed, max. (static)	L	1985	rpm
38	Limit speed for overspeed alarm / emergency shutdown	L	2100	rpm
42	Firing speed, from	R	100	rpm
43	Firing speed, to	R	120	rpm
44	Engine coolant temperature before starting full-load operation, recommended min. (for emergency/standby sets with coolant preheating: at least the preheating temperature)	R	40	°C
48	Minimum continuous load	R	20	%
49	Extended low or no-load operation possible (consultation required)		X	-
69	Speed droop (with electronic governor) adjustable, from	R	0	%
70	Speed droop (with electronic governor) adjustable, to	R	5	%

13. Starting (electric)

No.	Description	Index	Value	Unit
2	Starter, rated voltage (standard design)	R	.	V=
18	Start attempt duration, max.	L	.	s

16. Inclinations - standard oil system (ref.: waterline)

No.	Description	Index	Value	Unit
15	Longitudinal inclination, continuous max. driving end down (Option: max. operating inclinations)	L	10	degrees (°)
17	Longitudinal inclination, continuous max. driving end up (Option: max. operating inclinations)	L	10	degrees (°)
19	Transverse inclination, continuous max. (Option: max. operating inclinations)	L	10	degrees (°)

18. Capacities

No.	Description	Index	Value	Unit
1	Engine coolant capacity (without cooling equipment)	R	83	liter
10	Intercooler coolant capacity	R	57	liter
11	On-engine fuel capacity	R	4.5	liter
14	Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	154	liter
20	Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	130	liter
28	Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	109	liter
29	Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	120	liter

19. Weights / dimensions

No.	Description	Index	Value	Unit
9	Engine weight, dry (basic engine configuration acc. to scope of supply specification)	R	3350	kg
10	Engine weight, wet (basic engine configuration acc. to scope of supply specification)	R	3600	kg

20. Fan / fan cooler

No.	Description	Index	Value	Unit
3	Fan, pusher-type		X	-
9	Fan drive: mechanical via V-belt		X	-

22. Acoustics

No.	Description	Index	Value	Unit
101	Exhaust noise, unsilenced - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	105	dB(A)
201	Exhaust noise, unsilenced - CP (sound power level LW, ISO 6798, +3dB(A) tolerance)	R	118	dB(A)
103	Exhaust noise, unsilenced - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	736601e	-
109	Engine surface noise with attenuated intake noise (filter) - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	102	dB(A)
209	Engine surface noise with attenuated intake noise (filter) - CP (sound power level LW, ISO 6798, +2dB(A) tolerance)	R	120	dB(A)
111	Engine surface noise with attenuated intake noise (filter) - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	736599e	-

23. TBO and load profile (case A)

No.	Description	Index	Value	Unit
15	Maintenance schedule No.		N	-
16	Maintenance schedule No. (cont.)		N	-

Technical Sales Document

- Product Data -

Date 8/14/2014

Description:

CP = Ref. value: Continuous power

FSP = Ref. value: Fuel stop power

A = Design value

R = Guideline value

L = limit value

N = Not yet defined value

- = Not applicable

X = Applicable

Gas Sample provided from a past Alpine project.

G3516H

GENSET APPLICATION

GAS ENGINE SITE SPECIFIC TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1500	RATING STRATEGY:	HIGH RESPONSE
COMPRESSION RATIO:	12.1:1	RATING LEVEL:	CONTINUOUS
AFTERCOOLER TYPE:	SCAC	FUEL SYSTEM:	CAT LOW PRESSURE WITH AIR FUEL RATIO CONTROL
AFTERCOOLER - STAGE 2 INLET (°F):	118		
AFTERCOOLER - STAGE 1 INLET (°F):	198	**SITE CONDITIONS:**	
JACKET WATER OUTLET (°F):	210	FUEL:	Alpine - 11-13-2008
ASPIRATION:	TA	FUEL PRESSURE RANGE(psig):	1.5-5.0
COOLING SYSTEM:	JW+OC+1AC, 2AC+GB	FUEL METHANE NUMBER:	76.9
CONTROL SYSTEM:	ADEM4 W/ IM	FUEL LHV (Btu/scf):	968
EXHAUST MANIFOLD:	DRY	ALTITUDE(ft):	500
COMBUSTION:	LOW EMISSION	MAXIMUM INLET AIR TEMPERATURE(°F):	70
NOx EMISSION LEVEL (g/bhp-hr NOx):	0.5	STANDARD RATED POWER:	2763 bhp@1500rpm
SET POINT TIMING:	17	POWER FACTOR:	0.8
		VOLTAGE(V):	480-13800

				MAXIMUM RATING	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE		
RATING		**NOTES**	**LOAD**	**100%**	**100%**	**75%**	**50%**
GENSET POWER	(WITH GEARBOX, WITHOUT FAN)	(1)(2)	ekW	1964	1964	1473	982
GENSET POWER	(WITH GEARBOX, WITHOUT FAN)	(1)(2)	kVA	2455	2455	1841	1227
ENGINE POWER	(WITHOUT GEARBOX, WITHOUT FAN)	(2)	bhp	2762	2762	2072	1390
INLET AIR TEMPERATURE			°F	70	70	70	70
GENERATOR EFFICIENCY		(1)	%	96.3	96.3	96.3	95.7
GENSET EFFICIENCY	(ISO 3046/1)	(3)(4)	%	41.4	41.4	40.3	38.2
THERMAL EFFICIENCY		(3)(5)	%	43.8	43.8	45.4	48.0
TOTAL EFFICIENCY		(3)(6)	%	85.2	85.2	85.7	86.2
ENGINE DATA							
GENSET FUEL CONSUMPTION	(ISO 3046/1)	(7)	Btu/ekW-hr	8245	8245	8456	8942
GENSET FUEL CONSUMPTION	(NOMINAL)	(7)	Btu/ekW-hr	8529	8529	8748	9250
ENGINE FUEL CONSUMPTION	(NOMINAL)	(7)	Btu/bhp-hr	6064	6064	6220	6536
AIR FLOW (@inlet air temp, 14.7 psia)	(WET)	(8)	ft3/min	5220	5222	3949	2712
AIR FLOW	(WET)	(8)	lb/hr	23462	23462	17742	12186
FUEL FLOW (60ºF, 14.7 psia)			scfm	288	288	222	156
INLET MANIFOLD PRESSURE		(9)	in Hg(abs)	141.1	141.1	105.5	72.5
EXHAUST TEMPERATURE - ENGINE OUTLET		(10)	°F	767	767	829	923
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(11)	ft3/min	12998	12998	10338	7629
EXHAUST GAS MASS FLOW	(WET)	(11)	lb/hr	24261	24261	18357	12619
MAX INLET RESTRICTION		(12)	in H2O	10.03	10.03	5.66	2.52
MAX EXHAUST RESTRICTION		(12)	in H2O	20.07	20.07	11.33	5.42
EMISSIONS DATA - ENGINE OUT							
NOx (as NO2)		(13)(14)	g/bhp-hr	0.50	0.50	0.50	0.50
CO		(13)(14)	g/bhp-hr	2.55	2.55	2.40	2.26
THC (mol. wt. of 15.84)		(13)(14)	g/bhp-hr	4.23	4.23	4.44	4.56
NMHC (mol. wt. of 15.84)		(13)(14)	g/bhp-hr	0.72	0.72	0.75	0.77
NMNEHC (VOCs) (mol. wt. of 15.84)		(13)(14)(15)	g/bhp-hr	0.68	0.68	0.71	0.73
HCHO (Formaldehyde)		(13)(14)	g/bhp-hr	0.39	0.39	0.39	0.41
CO2		(13)(14)	g/bhp-hr	414	414	423	452
EXHAUST OXYGEN		(13)(16)	% DRY	10.0	10.0	9.6	9.1
HEAT REJECTION							
LHV INPUT		(17)	Btu/min	279164	279164	214743	151375
HEAT REJ. TO JACKET WATER (JW)		(18)	Btu/min	28138	28138	23492	18426
HEAT REJ. TO ATMOSPHERE		(18)	Btu/min	3814	3814	3178	2551
HEAT REJ. TO LUBE OIL (OC)		(18)	Btu/min	10755	10755	9684	8374
HEAT REJECTION TO EXHAUST (LHV TO 248°F)		(18)	Btu/min	56203	56203	48489	39178
HEAT REJ. TO A/C - STAGE 1 (1AC)		(18)(20)	Btu/min	23827	23827	13119	4830
HEAT REJ. TO A/C - STAGE 2 (2AC)		(18)(20)	Btu/min	13988	13988	9357	5324
HEAT REJECTION FROM GEARBOX (GB)		(18)	Btu/min	1171	1171	878	589
PUMP POWER		(19)	Btu/min	963	963	963	963
COOLING SYSTEM SIZING CRITERIA							
TOTAL JACKET WATER CIRCUIT (JW+OC+1AC)		(21)	Btu/min	68853	68853		
TOTAL STAGE 2 AFTERCOOLER CIRCUIT (2AC+GB)		(21)	Btu/min	15908	15908		
HEAT REJECTION TO EXHAUST (LHV TO 248°F)		(21)	Btu/min	61823	61823		
A cooling system safety factor of 0% has been added to the cooling system sizing criteria.							
MINIMUM HEAT RECOVERY							
TOTAL JACKET WATER CIRCUIT (JW+OC+1AC)		(22)	Btu/min	56564	56564		
TOTAL STAGE 2 AFTERCOOLER CIRCUIT (2AC+GB)		(22)	Btu/min	14401	14401		
HEAT REJECTION TO EXHAUST(LHV TO 248°F)		(22)	Btu/min	50591	50591		

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. Maximum rating is the maximum capability at the specified aftercooler inlet temperature 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.

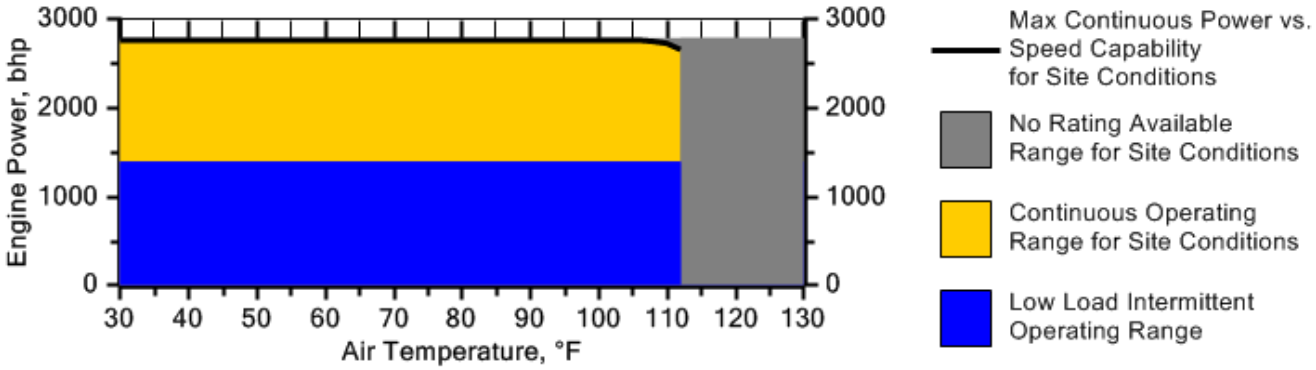
For explanation consult page three.

PREPARED BY:

Data generated by Gas Engine Rating Pro Version 4.07.01
Ref. Data Set EM0515-00-001, Printed 05Sep2014

Engine Power vs. Inlet Air Temperature

Data represents temperature sweep at 500 ft and 1500 rpm



NOTES

1. Generator efficiencies, power factor, and voltage are based on specified generator. [Genset Power (ekW) is calculated as: (Engine Power (bkW) - Gearbox Power (bkW)) x Generator Efficiency], [Genset Power (kVA) is calculated as: (Engine Power (bkW) - Gearbox Power (bkW)) x Generator Efficiency / Power Factor]

2. Rating is with two engine driven water pumps. Tolerance is (+)3, (-)0% of full load. All derates are applied without pumps , then pump power is subtracted to obtain final rating.

3. Efficiency represents a Closed Crankcase Ventilation (CCV) system installed on the engine.

4. ISO 3046/1 Genset efficiency tolerance is (+)0, (-)5% of full load % efficiency value.

5. Thermal Efficiency is calculated based on energy recovery from the jacket water, lube oil, 1st stage aftercooler, and exhaust to 248ºF with engine operation at ISO 3046/1 Genset Efficiency, and assumes unburned fuel is converted in an oxidation catalyst.

6. Total efficiency is calculated as: Genset Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.

7. Fuel consumption tolerance is ± 1.5% of full load data.

8. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.

9. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.

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

11. Exhaust flow value is on a "wet" basis. Flow is a nominal value with a tolerance of ± 6 %.

12. 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.

13. Emissions data is at engine exhaust flange prior to any after treatment.

14. Emission values are based on engine operating at steady state conditions Fuel methane number cannot vary more than ± 3. NOx tolerances are ± 18 % of specified value. All other emission values listed are higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations. They indicate "Not to Exceed" values. THC, NMHC, and NMNEHC do not include aldehydes.

15. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ

16. Exhaust Oxygen level is the result of adjusting the engine to operate at the specified NOx level. Tolerance is ± 0.5.

17. LHV rate tolerance is ± 1.5%.

18. Heat rejection values are representative of site conditions. Tolerances, based on treated water, are ± 10% for jacket water circuit, ± 50% for atmosphere, ± 20% for lube oil circuit, ± 10% for exhaust, ± 5% for aftercooler circuit, and ± 5% for Gearbox.

19. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.

20. Aftercooler heat rejection is nominal for site conditions and does not include an aftercooler heat rejection factor. Aftercooler heat rejection values at part load are for reference only.

21. Cooling system sizing criteria represent the expected maximum circuit heat rejection for the ratings at site, with applied plus tolerances. Total circuit heat rejection is calculated using formulas referenced in the notes on the standard tech data sheet with the following qualifications. Aftercooler heat rejection data (1AC & 2AC) is based on the standard rating. Jacket Water (JW), Oil Cooler (OC), and Gearbox (GB) heat rejection values are based on the respective site or maximum column. Aftercooler heat rejection factors (ACHRF) are specific for the site elevation and inlet air temperature specified in the site or maximum column, referenced from the table on the standard data sheet

22. Minimum heat recovery values represent the expected minimum heat recovery for the site, with applied minus tolerances. Do not use these values for cooling system sizing.

Constituent	Abbrev	Mole %	Norm
Water Vapor	H2O	0.0000	0.0000
Methane	CH4	90.8720	90.8720
Ethane	C2H6	5.8350	5.8350
Propane	C3H8	1.7110	1.7110
Isobutane	iso-C4H1O	0.0770	0.0770
Norbutane	nor-C4H1O	0.0880	0.0880
Isopentane	iso-C5H12	0.0000	0.0000
Norpentane	nor-C5H12	0.0000	0.0000
Hexane	C6H14	0.0000	0.0000
Heptane	C7H16	0.0170	0.0170
Nitrogen	N2	0.7450	0.7450
Carbon Dioxide	CO2	0.6550	0.6550
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

Alpine Gas Sample used from past project.

Fuel Makeup:	Alpine - 11-13-2008
Unit of Measure:	English

Calculated Fuel Properties

Caterpillar Methane Number:	76.9
Lower Heating Value (Btu/scf):	968
Higher Heating Value (Btu/scf):	1073
WOBBE Index (Btu/scf):	1239
THC: Free Inert Ratio:	70.43
Total % Inerts (% N2, CO2, He):	1.4%
RPC (%) (To 905 Btu/scf Fuel):	100%
Compressibility Factor:	0.998
Stoich A/F Ratio (Vol/Vol):	10.10
Stoich A/F Ratio (Mass/Mass):	16.53
Specific Gravity (Relative to Air):	0.611
Specific Heat Constant (K):	1.304

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.

Caterpillar shall have no liability in law or equity, for damages, consequently or otherwise, arising from use of program and related material or any part thereof.

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.

G3516H

GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1500	RATING STRATEGY:	HIGH RESPONSE
COMPRESSION RATIO:	12.1:1	APPLICATION:	GENSET
AFTERCOOLER TYPE:	SCAC	RATING LEVEL:	CONTINUOUS
AFTERCOOLER - STAGE 2 INLET (°F):	118	FUEL:	NAT GAS
AFTERCOOLER - STAGE 1 INLET (°F):	198	FUEL SYSTEM:	CAT LOW PRESSURE
JACKET WATER OUTLET (°F):	210		WITH AIR FUEL RATIO CONTROL
ASPIRATION:	TA	FUEL PRESSURE RANGE(psig):	1.5-5.0
COOLING SYSTEM:	JW+OC+1AC, 2AC+GB	FUEL METHANE NUMBER:	85
CONTROL SYSTEM:	ADEM4 W/ IM	FUEL LHV (Btu/scf):	905
EXHAUST MANIFOLD:	DRY	ALTITUDE CAPABILITY AT 77°F INLET AIR TEMP. (ft):	4593
COMBUSTION:	LOW EMISSION	POWER FACTOR:	0.8
NOx EMISSION LEVEL (g/bhp-hr NOx):	0.5	VOLTAGE(V):	480-13800

RATING		NOTES	LOAD	100%	75%	50%
GENSET POWER	(WITH GEARBOX, WITHOUT FAN)	(1)(2)	ekW	1964	1473	982
GENSET POWER	(WITH GEARBOX, WITHOUT FAN)	(1)(2)	kVA	2455	1841	1227
ENGINE POWER	(WITHOUT GEARBOX, WITHOUT FAN)	(2)	bhp	2762	2072	1390
GENERATOR EFFICIENCY		(1)	%	96.3	96.3	95.7
GENSET EFFICIENCY(@ 1.0 Power Factor)	(ISO 3046/1)	(3)(4)	%	42.4	41.2	39.0
THERMAL EFFICIENCY		(3)(5)	%	43.0	44.6	47.3
TOTAL EFFICIENCY (@ 1.0 Power Factor)		(3)(6)	%	85.4	85.8	86.3
ENGINE DATA						
GENSET FUEL CONSUMPTION	(ISO 3046/1)	(7)	Btu/ekW-hr	8147	8354	8833
GENSET FUEL CONSUMPTION	(NOMINAL)	(7)	Btu/ekW-hr	8428	8642	9138
ENGINE FUEL CONSUMPTION	(NOMINAL)	(7)	Btu/bhp-hr	5992	6144	6457
AIR FLOW (77°F, 14.7 psia)	(WET)	(8)	ft3/min	5347	4042	2776
AIR FLOW	(WET)	(8)	lb/hr	23710	17924	12311
FUEL FLOW (60ºF, 14.7 psia)			scfm	305	234	165
COMPRESSOR OUT PRESSURE			in Hg(abs)	149.9	113.4	79.4
COMPRESSOR OUT TEMPERATURE			°F	479	400	306
AFTERCOOLER AIR OUT TEMPERATURE			°F	125	125	125
INLET MAN. PRESSURE		(9)	in Hg(abs)	142.5	106.5	73.2
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(10)	°F	126	126	127
TIMING		(11)	°BTDC	22	20	16
EXHAUST TEMPERATURE - ENGINE OUTLET		(12)	°F	734	795	886
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(13)	ft3/min	12803	10180	7513
EXHAUST GAS MASS FLOW	(WET)	(13)	lb/hr	24539	18561	12760
MAX INLET RESTRICTION		(14)	in H2O	10.03	5.65	2.50
MAX EXHAUST RESTRICTION		(14)	in H2O	20.07	11.31	5.39
EMISSIONS DATA - ENGINE OUT						
NOx (as NO2)		(15)(16)	g/bhp-hr	0.50	0.50	0.50
CO		(15)(17)	g/bhp-hr	2.28	2.14	2.02
THC (mol. wt. of 15.84)		(15)(17)	g/bhp-hr	5.45	5.70	5.86
NMHC (mol. wt. of 15.84)		(15)(17)	g/bhp-hr	0.93	0.97	1.00
NMNEHC (VOCs) (mol. wt. of 15.84)		(15)(17)(18)	g/bhp-hr	0.87	0.91	0.94
HCHO (Formaldehyde)		(15)(17)	g/bhp-hr	0.39	0.40	0.42
CO2		(15)(17)	g/bhp-hr	401	410	438
EXHAUST OXYGEN		(15)(19)	% DRY	10.2	9.8	9.2
LAMBDA		(15)(19)		1.77	1.74	1.69
ENERGY BALANCE DATA						
LHV INPUT		(20)	Btu/min	275885	212159	149559
HEAT REJECTION TO JACKET WATER (JW)		(21)(30)	Btu/min	28101	23539	18459
HEAT REJECTION TO ATMOSPHERE		(22)	Btu/min	3814	3178	2551
HEAT REJECTION TO LUBE OIL (OC)		(23)(30)	Btu/min	10755	9684	8375
HEAT REJECTION TO EXHAUST (LHV TO 77°F)		(24)(25)	Btu/min	77166	64470	50128
HEAT REJECTION TO EXHAUST (LHV TO 248°F)		(24)	Btu/min	50615	44141	36150
HEAT REJECTION TO A/C - STAGE 1 (1AC)		(26)(30)	Btu/min	23863	13077	4800
HEAT REJECTION TO A/C - STAGE 2 (2AC)		(27)(31)	Btu/min	14080	9390	5344
HEAT REJECTION FROM GEARBOX (GB)		(28)(31)	Btu/min	1171	879	589
PUMP POWER		(29)	Btu/min	963	963	963

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.) 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. 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 °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	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
120	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
110	1	0.97	0.93	0.90	0.86	0.83	0.79	0.75	0.71	0.67	0.63	0.59	0.55
100	1	1	0.98	0.95	0.91	0.88	0.85	0.82	0.78	0.75	0.69	0.63	0.57
90	1	1	1	0.99	0.96	0.93	0.90	0.86	0.83	0.80	0.77	0.70	0.61
80	1	1	1	1	1	0.97	0.94	0.91	0.87	0.84	0.81	0.77	0.70
70	1	1	1	1	1	0.99	0.95	0.92	0.89	0.85	0.82	0.78	0.75
60	1	1	1	1	1	0.99	0.95	0.92	0.89	0.85	0.82	0.78	0.75
50	1	1	1	1	1	0.99	0.95	0.92	0.89	0.85	0.82	0.78	0.75

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	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
120	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
110	1.15	1.18	1.21	1.25	1.29	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
100	1.10	1.13	1.16	1.20	1.23	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
90	1.05	1.08	1.11	1.15	1.18	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
80	1	1.03	1.06	1.10	1.13	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
70	1	1	1.01	1.05	1.08	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
60	1	1	1	1	1.03	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
50	1	1	1	1	1	1	1	1	1	1	1	1	1

ALTITUDE (FEET 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 reduction 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 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):
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 30 and 31 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. Generator efficiencies, power factor, and voltage are based on standard generator. [Genset Power (ekW) is calculated as: (Engine Power (bkW) - Gearbox Power (bkW)) x Generator Efficiency], [Genset Power (kVA) is calculated as: (Engine Power (bkW) - Gearbox Power (bkW)) x Generator Efficiency / Power Factor]
2. Rating is with two engine driven water pumps. Tolerance is (+)3, (-)0% of full load.
3. Efficiency represents a Closed Crankcase Ventilation (CCV) system installed on the engine.
4. ISO 3046/1 Genset efficiency tolerance is (+)0, (-)5% of full load % efficiency value based on a 1.0 power factor.
5. Thermal Efficiency is calculated based on energy recovery from the jacket water, lube oil, 1st stage aftercooler, and exhaust to 248ºF with engine operation at ISO 3046/1 Genset Efficiency, and assumes unburned fuel is converted in an oxidation catalyst.
6. Total efficiency is calculated as: Genset Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.
7. ISO 3046/1 Genset fuel consumption tolerance is (+)5, (-)0% of full load data. Nominal genset and engine fuel consumption tolerance is ± 1.5% of full load data.
8. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.
9. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.
10. Inlet manifold temperature is a nominal value with a tolerance of ± 9°F.
11. Timing indicated is for use with the minimum fuel methane number specified. Consult the appropriate fuel usage guide for timing at other methane numbers.
12. Exhaust temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.
13. Exhaust flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 6 %.
14. 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.
15. Emissions data is at engine exhaust flange prior to any after treatment.
16. NOx tolerances are ± 18% of specified value.
17. CO, CO2, THC, NMHC, NMNEHC, and HCHO values are "Not to Exceed" levels. THC, NMHC, and NMNEHC do not include aldehydes. An oxidation catalyst may be required to meet Federal, State or local CO or HC requirements.
18. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
19. 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.
20. LHV rate tolerance is ± 1.5%.
21. 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.
22. Heat rejection to atmosphere based on treated water. Tolerance is ± 50% of full load data.
23. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
24. Exhaust heat rate based on treated water. Tolerance is ± 10% of full load data.
25. Heat rejection to exhaust (LHV to 77°F) value shown includes unburned fuel and is not intended to be used for sizing or recovery calculations.
26. Heat rejection to A/C - Stage 1 based on treated water. Tolerance is ±5% of full load data.
27. Heat rejection to A/C - Stage 2 based on treated water. Tolerance is ±5% of full load data.
28. Heat rejection to Gearbox based on treated water. Tolerance is ±5% of full load data.
29. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.
30. Total Jacket Water Circuit heat rejection is calculated as: (JW x 1.1) + (OC x 1.2) + (1AC x 1.05) + [0.792 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.
31. Total Second Stage Aftercooler Circuit heat rejection is calculated as: (2AC x 1.05) + [(1AC + 2AC) x 0.208 x (ACHRF - 1) x 1.05] + (GB 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	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1964	100	2762	122.8	89.1	88.5	93.6	94.9	95.7	99.9	100.2	102.8	103.3	104.0
1473	75	2072	118.4	87.5	85.2	92.3	91.6	93.8	97.6	97.5	100.7	102.3	103.5
982	50	1390	115.4	85.9	82.0	89.1	89.9	92.8	96.8	95.3	100.3	100.9	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	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1964	100	2762	102.5	104.3	105.3	104.7	105.0	105.2	105.5	110.1	121.5	103.9	99.6
1473	75	2072	101.4	103.1	104.0	103.6	104.8	106.1	107.3	115.5	107.3	103.2	102.3
982	50	1390	100.8	101.5	102.2	102.5	103.9	105.4	109.0	106.7	103.0	102.5	96.9

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	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1964	100	2762	125.5	98.9	102.2	108.0	109.8	106.2	109.2	110.4	112.2	113.5	112.4
1473	75	2072	121.4	98.4	102.7	107.7	107.8	101.1	100.6	99.7	103.2	105.3	102.9
982	50	1390	119.3	98.9	100.4	102.5	106.7	97.4	95.3	95.2	102.8	100.4	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	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1964	100	2762	112.9	113.7	113.8	115.0	115.9	115.6	114.1	111.4	115.6	109.0	105.4
1473	75	2072	105.2	107.3	109.3	110.8	112.7	113.0	111.6	112.1	108.9	105.7	103.4
982	50	1390	103.2	104.9	108.4	109.0	110.1	110.9	110.7	109.6	106.0	104.4	101.2

SOUND PARAMETER DEFINITION:

Sound Power Level Data - DM8702-02

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 6798. 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 6798 for engine and exhaust sound level only. 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.

Appendix B

Electronic Copy of Modeling Files and Modeling Report