BEFORE THE ENVIRONMENTAL APPEALS BOARD
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

In re:	)
Shell Gulf of Mexico, Inc. Permit No. R10OCS/PSD-AK-09-01	)
and	)
Shell Offshore, Inc. Permit No. R10OCS/PSD-AK-2010-01	)

EXHIBITS IN SUPPORT OF PETITION FOR REVIEW

NATURAL RESOURCES DEFENSE COUNCIL, NATIVE VILLAGE OF POINT HOPE, RESISTING ENVIRONMENTAL DESTRUCTION ON INDIGENOUS LANDS (REDOIL), ALASKA WILDERNESS LEAGUE, AUDUBON ALASKA, CENTER FOR BIOLOGICAL DIVERSITY, NORTHERN ALASKA ENVIRONMENTAL CENTER, OCEAN CONSERVANCY, OCEANA, PACIFIC ENVIRONMENT, and SIERRA CLUB

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
SEATTLE, WASHINGTON

STATEMENT OF BASIS
FOR PROPOSED
OUTER CONTINENTAL SHELF
PREVENTION OF SIGNIFICANT DETERIORATION
PERMIT NO. R10OCS/PSD-AK-2010-01

SHELL OFFSHORE INC.
FRONTIER DISCOVERER DRILLSHIP
BEAUFORT SEA EXPLORATION DRILLING PROGRAM

Date of Proposed Permit: February 17, 2010

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3.1 Overview

Shell intends to implement their Beaufort Sea exploration drilling program through the use of the Frontier Discoverer drillship and the Associated Fleet.

As discussed above, determining a project's PTE is essential for determining the applicability of PSD, as well as the scope of PSD review, in particular, the pollutants that are subject to application of BACT, analysis of ambient air quality impacts from the project, analysis of air quality and visibility impact on Class I areas, and analysis of impacts on soils and vegetation. As discussed in Section 2 of this Statement of Basis, PTE reflects a source's maximum emissions of a pollutant from a source operating at its design capacity, including consideration of any physical or operational limitations on design capacity such as air pollution control equipment, emission limitations, and other capacity limiting restrictions that effectively and enforceably limit emissions capacity. See 40 C.F.R. §§ 52.21(b)(4) and 55.2. In the case of OCS sources, emissions from vessels servicing or associated with an OCS source are included in the "potential to emit" for an OCS source while physically attached to the OCS source and while en route to or from the source when within 25 miles of the source.

The detailed emissions calculations for the Beaufort Sea exploration drilling program are contained in the Shell 01/18/10 Permit Application Appendix A and in Environ International Corporation Revised Appendix A Email 01/20/10. In developing the emission inventory, EPA relied extensively on emissions data that were representative of the subject emission unit. For most emission units on board the Discoverer, EPA used emissions data from either the manufacturer or from literature that provided equivalent emissions data, such as data from similar emission units. In a very few instances, where representative data were not available, EPA relied on AP-42 to calculate projected emissions (EPA 1995 AP-42 and updates).

The emission inventory reflects application of emission limitations representing best available control technology or "BACT." As discussed in Section 4.1 of this Statement of Basis, a new major stationary source is required to apply BACT for each pollutant subject to regulation under the CAA that it would have the PTE in significant amounts. 40 C.F.R. § 52.21(j). Based on the emission inventory for the OCS source presented in Table 2-1, the emissions of CO, NO_X, PM, $PM_{2.5}$, PM_{10}, and VOC have a PTE exceeding their respective significant emission rates. Therefore, BACT must be determined for each emission unit on the Discoverer or that is part of the OCS source that emits these pollutants. Section 4 of this Statement of Basis contains a detailed discussion of the BACT determination for each emission unit subject to BACT. The proposed permit contains emission limitations that represent BACT and the emission inventory reflects these BACT-based emission limitations.

The emission inventory also reflects emission limitations and operating restrictions requested by Shell in its permit application as well as emission limitations and operating restrictions based on operating conditions assumed in the air quality impact analysis. The PSD regulations require that a source demonstrate that the allowable emissions increase from the new source, in conjunction with all other applicable increases or reductions (including secondary emissions), would not cause or contribute to a violation of the NAAQS or any applicable maximum allowable increase over the baseline concentration in any area. 40 C.F.R. § 52.21(k). The

"applicable maximum allowable increase over baseline concentration in any area" are referred to as "increments" and are set forth in 40 C.F.R. § 52.21(c). After application of emission limitations that represent BACT, preliminary modeling indicated that additional restrictions on Shell's emissions and mode of operation would be needed to ensure attainment of the NAAQS and compliance with increment for some pollutants. Therefore, to ensure attainment of NAAQS and compliance with increment, the proposed permit imposes restrictions on emission units and Shell's mode of operation that are in addition to the application of BACT and that further limit operation of and emissions from the project.

The air quality impact analysis is discussed in Section 5. Emission limitations and operational restrictions are needed to demonstrate compliance with the annual increment for NO_X, attainment of the 24-hour $PM_{2.5}$ NAAQS, and compliance with the 24-hour PM-10 increment. Therefore, for most emission units, the permit contains an annual limit on NO_X, and 24-hour limits on PM_{10} and $PM_{2.5}$.

The permit contains monitoring, recordkeeping and reporting to monitor and ensure compliance with the emission limitations. This proposed permit requires stack testing of certain sources prior to commencement of each of the first three drilling seasons. Under this approach, not all emission units in a source category will be tested each year, but by the end of the first three drilling seasons, all of them will have been tested. Monitoring for the daily PM_{10} and $PM_{2.5}$ limits and the annual NO_X limit is based on emission factors derived from source tests, load monitoring or fuel usage, and annual fuel usage limits.

The number and range of stack testing of the newer and the smaller internal combustion engines (FD-9 to FD-20) and boilers (FD-21 to FD-22) are contained in Permit Conditions F.6, G.8, H.7, I.8, and J.5. EPA believes that testing at the specified operating loads or operating load ranges will continue to provide a reasonable assurance of compliance and considers operational and logistical concerns regarding stack testing concerns regarding the number of required source tests under the permit generally and the difficulty of stack testing some of these specific units due to their unique operation and function. There are no ambient air standards for VOC and predicted impacts of CO from this project are well below the standards. Therefore, EPA focused the monitoring regime on the BACT emission limits for these pollutants. For VOC and CO, testing at lower loads is expected to provide a higher emission factor than testing at full operating loads (see emissions data for various Caterpillar D343 configurations). The same is true with respect to visible emissions. EPA therefore believes that requiring stack testing for VOC, CO and visible emissions within the expected operating range of each engine will provide a reasonable indication of compliance for the VOC, CO, and visible emission limits for the newer engines, the smaller engines, and the boilers. See Permit Conditions F.6, G.8, H.7, I.7, and J.5. Because the data for NO_X and particulate matter is less conclusive, EPA is requiring stack testing at two load ranges – a high-load operating range and a lower-load operating range. EPA believes it is appropriate to extend this approach to the engines on board the icebreakers for the same reasons and has done so in this proposed permit. See Conditions O.10 and P.12.

While EPA understands that there may be practical challenges to testing the Deck Cranes (Units FD-14 and FD-15) emission units, EPA has insufficient information at this time to eliminate testing for these units. EPA is therefore proposing that, as with the other newer and smaller engines on the Discoverer, that stack testing be required at load ranges between 50 and 70 percent, or 80 and 100 percent. During the public comment period, EPA invites public comment and additional information from Shell and other commenters that further supports or opposes eliminating the stack testing requirement for the deck cranes.

Except for those conditions addressing notification, reporting and testing, the permit conditions contained in Sections B through R of the proposed permit apply only during the time that the Discoverer is an OCS source. Permit conditions addressing notification, reporting and testing apply at all times as specified. When the Discoverer is an "OCS Source" for purposes of the proposed permit is discussed in Section 2.5.1.

3.2 Generally Applicable Requirements

This section describes the permit conditions that apply generally to the Discoverer and the Associated Fleet and generally relate to permit administration or enforcement. These conditions apply in Outer and Inner OCS as specified. Permit Conditions that are included pursuant to COA regulations that have been incorporated in to 40 C.F.R. Part 55 are identified as "COA Regulations". The provisions of this permit apply to both the Inner OCS and Outer OCS unless specified to apply only to the Inner OCS.

Construction and Operation

Condition A.1 requires the permittee to construct and operate the OCS source and the Associated Fleet in accordance with its application and supporting materials and in accordance with the final permit, as provided in 40 C.F.R. §§ 55.6(a)(4)(i) and 52.21(r)(1).

Overlapping Requirements

Condition A.2 requires the permittee to comply both with conditions established in through the PSD permitting process and conditions that are the result of applying the COA regulations. In instances where two different permit conditions apply to the same emission unit or activity, the permittee must comply with both conditions.

Compliance Required

Condition A.3 specifies the enforcement authority for violation of OCS and PSD regulations and this permit, as provided in 40 C.F.R. §§ 55.9(a)-(b) and 52.21. Operation in violation of a permit term or condition is not authorized under this permit.

Compliance with Other Requirements

Condition A.4 makes clear that the permit does not relieve the permittee of the responsibility to comply fully with all other requirements of federal law as provided in 40 C.F.R. §§ 55.6(a)(4)(iii) and 52.21(r)(3). EPA is aware that Shell is required to obtain approval from other agencies before it is authorized to begin exploratory drilling in the Beaufort Sea and that there is pending litigation regarding the leases and exploration plan approval under which Shell proposes to conduct its exploratory drilling. EPA believes it is nonetheless appropriate to proceed with issuance of this OCS/PSD permit so that once Shell has all necessary approvals and authorizations to begin its exploratory drilling program on its leases in Lease Area 195 (March 2005) and 202 (April 2007), Shell can proceed with its exploratory drilling operations in Lease Area lease sales 195 and 202 without further delay consistent with a final OCS/PSD permit and all other necessary federal approvals and requirements. Condition A.4 makes clear Shell's obligation to satisfy all other federal requirements prior to commencing operation under this CAA permit.

repository for these materials. The barge itself would not emit air pollutants but would need to be delivered and removed from the site using a tug. The tug emission units have not been included in the emission inventory or modeling analysis. However, Shell has stated that the barge will be delivered before drilling begins and removed after drilling has ceased. The impacts from this activity should be similar to impacts from the anchor setting and retrieval activities which also occur before an after drilling.

If Shell utilizes a tug/barge combination, the requirements are contained in Condition N which prohibits any emissions from the barge and prohibits the tug from attaching to the Discoverer.

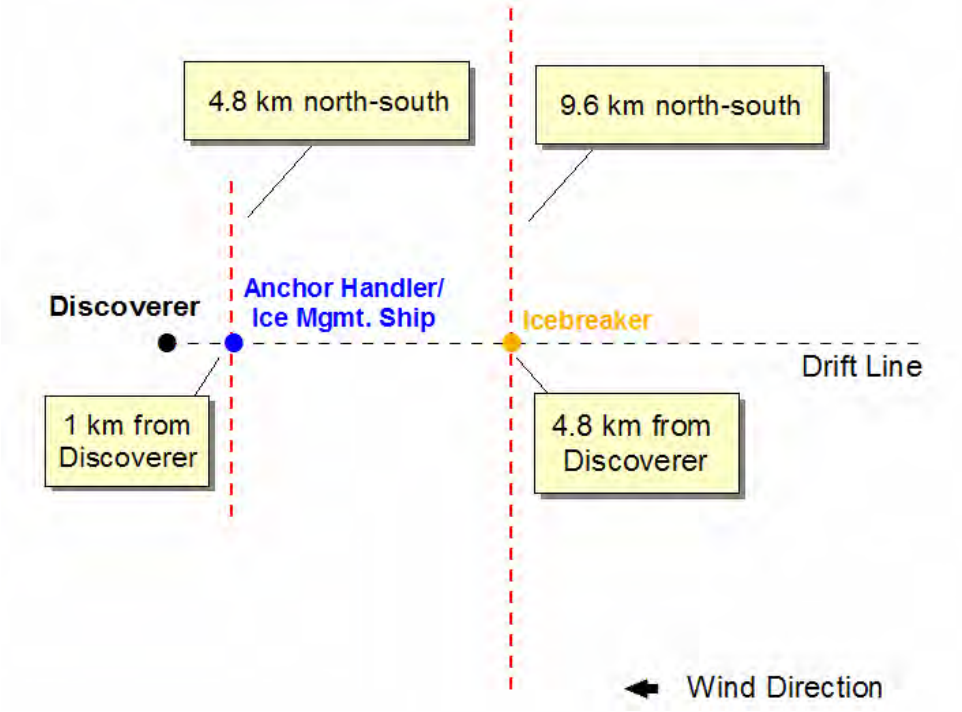
3.5 Ice Management and Anchor Handling Fleet

Shell's ice management and anchor handling fleet is expected to consist of two leased ships: an icebreaker (referred to in the permit as Icebreaker #1) and an anchor handler/icebreaker (referred to in the permit as Icebreaker #2). The purpose of this fleet is to manage the ice in the area of the Discoverer, which involves deflecting or in extreme cases breaking up any ice floes that could impact the ship when it is drilling, and to handle the ship's anchors during connection to and disconnection from the seabed.

The ice floe frequency and intensity is unpredictable and could range from no ice to ice sufficiently dense that the fleet has insufficient capacity and the Discoverer would need to disconnect from its anchors and move off site. Based on statistics on ice at the Sivulliq drill site in the Beaufort Sea, Shell estimates that ice breaking capability in its lease holdings in Lease Area lease sales 195 (March 2005) and 202 (April 2007) in the Beaufort Sea would only be required 38 percent of the time. For the remainder of the time the ice management and anchor handling fleet would be beyond the 25-mile radius from the Discoverer in a warm stack mode (anchored and occupied).

The primary driver of the ice floe is the wind, so the ice management ships are typically upwind of the Discoverer when managing the ice. Figure 3-1 depicts the approximate locations of the primary icebreaker and the anchor handler/ice management vessel when used to break one-year ice.

Figure 3-1: Ice Management and Anchor Handling Ships Locations for Breaking of One Year Ice



For addressing one-year ice, Icebreaker #1 will typically be positioned from 4,800 meters to 19,000 meters upwind on the drift line and Icebreaker #2 will be located from 1,000 meters to 9,600 meters upwind from the Discoverer. In the case of thick ice, the width of the Icebreaker #1 swath will be about 3 miles (4.8 kilometers) to either side of the drift line and Icebreaker #2 will be moving laterally 1.5 miles (2.4 kilometers) to either side of the drift line. The actual vessel distances will be determined by the ice floe speed, size, thickness, and character, and wind forecast. Although 2-meter-thick first-year ice is not expected, it might occur and the ice management fleet would be moving at near full speed to fragment this ice. Occasionally there may be multi-year ice ridges which are expected to be broken at a much slower speed than used for first-year ice. Multi-year ice may be broken by riding up onto the ice so that the weight of the icebreaker on top of the ice breaks it.

Shell will be leasing Icebreaker #1 from year to year. Consequently, the vessel used as Icebreaker #1 may change from year to year. In order to accommodate this uncertainty, Shell has requested that the permit allow for a generic Icebreaker #1. Furthermore, the fleet could consist of either two vessels or only one vessel, depending on availability of ships and ice conditions. At present, there are only a limited number of eligible ships. Murmansk Shipping of Russia operates one vessels – the Vladimir Ignatjuk. Viking leases four vessels – the Odin, the Tor, the Balder and the Vidor. The Talagy is available from Smit, and lastly, the Nordica and Fennica are operated by Finstaship.

The emission sources from all of these icebreaker class vessels consist of diesel engines for propulsion power, general purpose generators, boilers and incinerators. To accommodate the

requested flexibility, Shell has developed a single generic equipment list for Icebreaker #1 that cannot be exceeded for any vessel. Table 3-3 shows the maximum aggregate ratings for each category of equipment for Icebreaker #1.

Table 3-3: Maximum Aggregate Rating of Emission Sources for Icebreaker #1

Description	Make and Model	Maximum Aggregate Rating
Propulsion Engines	Various	28,400 hp
Generator Engine(s)	Various	2,800 hp
Heat Boiler(s)	Various	10 MMBtu/hr
Incinerator	Various	154 lbs/hr

To execute Icebreaker #2 duties, Shell will use one of two vessels – either the Tor Viking or a new icebreaker being built to their specifications by Edison Chouest. Each of these vessels will be equipped with SCR on the main engines, which will result in a substantial reduction of NO_X. (Shell Beaufort Permit Application 01/18/10). The latter vessel has not been named yet but is referred to by the shipbuilder as Hull 247. Throughout this permit documentation, this vessel is also referred to as Hull 247, with the intent that all permit conditions for Icebreaker #2 continue to apply to the vessel, even once it has had its name changed from Hull 247 to its permanent name. Table 3-4 shows the maximum aggregate ratings for each category of equipment for Icebreaker #2.

Table 3-4: Maximum Aggregate Rating of Emission Sources for Icebreaker #2

Description	Make and Model	Maximum Aggregate Rating
Tor Viking		
Propulsion Engines	Various	17,660 hp
Generator Engine(s)	Various	2,336 hp
Heat Boiler(s)	Various	1.37 MMBtu/hr
Incinerator	Various	151 lbs/hr
Hull 247		
Propulsion Engines	Various	24,000 kW
Heat Boiler(s)	Various	4.00 MMBtu/hr
Incinerator	Various	151 lbs/hr

Marine propulsion engines, such as those used on the icebreakers, have a different emission profile than the more common engines found on board the Discoverer. The most cited reference on emissions from marine engines is a document published by Lloyds Register. However, a more recent publication compares emission factors from Lloyds with more recent emissions data from the Swedish Environmental Research Institute (Corbett 11/23/04). To ensure that the emissions factors used in the emission inventory for this project were adequately conservative,

EPA compared these data with emissions data from AP-42 (see Reference Table 3 in Appendix A) and used the highest value for each pollutant.

In addition, Shell has requested limits on $PM_{2.5}$ of 40.2 lbs/hr and on PM_{10} of 45.8 lbs/hr (Shell Beaufort Permit Application 01/18/10) on Icebreaker #1, and 11.4 lbs/hr and 11.7 lbs/hr, respectively, for Icebreaker #2. The proposed permit requires candidate icebreakers to have their emission units tested prior to each drilling season. If a candidate vessel's uncontrolled emissions of $PM_{2.5}$ or PM_{10} are above these values, then the vessel cannot be used as either Icebreaker #1 or Icebreaker #2. Conditions O.1 and P.1 contain these equipment capacity and emission limits for the two icebreakers.

In calculating emissions from the emission sources on board the icebreakers, all sources, except the propulsion engines, were assumed to operate at 100 percent of rated capacity. The propulsion engines were represented at operating at no more than 80 percent of rated capacity. Consequently, these restrictions are imposed in Conditions O.2 and P.2.

Based on the emissions calculations and resultant modeling, Shell has determined a maximum usage for the icebreakers. The emissions, fuel and power output limits associated with this scenario are contained in Conditions O.3, O.4, O.5, O.6, P.3, P.4, P.5 and P.6. The fuel and power output limits in Condition O.5, O.6, P.5 and P.6 will also serve to limit emissions of the other pollutants, such as CO. The fuel limits on the icebreakers are based on Shell's estimate of its need for icebreaking capacity and ensure that emissions from the icebreakers will not exceed the modeled emissions scenarios.

Based on Shell's application, there is no scenario where either of the icebreakers is attached to the drillship, thereby becoming part of the OCS source.[11] Consequently, the permit contains Conditions O.8 and P.10 that prohibit such attachment. The permit does allow each icebreaker to approach near the Discoverer for purposes of transferring equipment and crew to and from the Discoverer. Otherwise, Condition O.7 requires Icebreaker #1 to, consistent with the modeling analysis, operate outside of a 4800 meter long cone centered on the centerline of the Discoverer. Similarly, Condition P.7 requires Icebreaker #2 to operate outside of a 1000 meter long cone centered on the centerline of the Discoverer, except during anchor handling operations (Condition P.8) and bow washing (Condition P.9). The air quality impact analysis was based on these operating scenarios and therefore the permit contains emission limits to impose these restrictions. The icebreakers are allowed to transit through their respective cones as these transit events will be of short duration and at low loads as they will not be conducting icebreaking activities within the cones. Modeled impacts from transit events in the area would therefore be expected to be lower than the worst case scenario.

In order to assure compliance with the emission limits, both icebreakers are required to test their emission sources each drilling season as provided in Conditions O.10 and P.12. Conditions O.11 and P13 require Shell to conduct monitoring, recordkeeping and reporting to assure compliance with the substantive conditions of Sections O and P of the permit.

[11] As discussed in Section 2.5.1 above, EPA does not consider Icebreaker #2 to be physicially attached to the Discoverer within the meaning of the definition of "OCS source" in 40 C.F.R. § 55.2 during the time it is assisting the Discoverer in the anchor setting and retrieval process.

significant impact levels quickly, within a few kilometers of the onshore source, and over 50 kilometers from the Discoverer. See Section 5.2.19.

Table 5-13: PSD Increment Modeling Results

Pollutant	Averaging Period	PSD Class II Increment µg/m^3)	Project Contribution at Peak Receptor (µg/m^3)	Onshore Source Contribution at Peak Receptor (µg/m^3)	Increment Exceeded?
NO_2	Annual	25	19.7	0	No
PM_{10}	24-Hour	30	20.7	NA[a]	No
	Annual	17	1.1	0	No
SO_2	3-Hour	512	25	NA[1]	No
	24-Hour	91	3.2	NA[1]	No
	Annual	20	0.1	0	No

a Short term emissions were not modeled for the onshore sources.

5.2.23 Results of NAAQS Demonstration

All of the modeled operating scenarios for the Discoverer and its Associated Fleet resulted in predicted total concentration impacts, including existing background data, below the level of the NAAQS. Table 5-14 summarizes the maximum predicted total impacts for the base operating scenario. Tables 5-15 to 5-24 show the results for the operating scenarios. The modeling results show that the emissions associated with the proposed permit are not expected to cause or contribute to a violation of the applicable NAAQS.

Table 5-14: NAAQS Modeling Results

Pollutant	Averaging Period	Concentration at Peak Receptor (µg/m^3)				NAAQS (µg/m^3)	Percent NAAQS
		Without Background	Back-ground	Onshore Source Contribution at Peak Receptor	Total with Background		
NO_2	Annual	19.7	11.3	0	31.0	100	31%
$PM_{2.5}$	24-Hour	19.2	10	NA	29.2	35	83%
	Annual	1.1	2	0	3.1	15	20.6%
PM_{10}	24-Hour	20.7	55.1	NA	75.8	150	50.5%
	Annual	1.1	7.5	0	8.6	---	---
SO_2	3-Hour	25.0	41.6	NA	66.6	1,300	5.1%

Air Pollutant	Averaging Period	Peak Predicted Concentration (µg/m^3)	PSD Increment (µg/m^3)	Back-ground (µg/m^3)	Total [a] (µg/m^3)	NAAQS (µg/m^3)	Percent NAAQS
	24-Hour	0.2	91	13	13.2	365	4%
	Annual	0.02	20	2.6	2.6	80	3%
CO	1-Hour	8.3	NA [b]	1749	1757.3	40,000	4%
	8-Hour	7.4	NA [b]	1097	1104.4	10,000	11%

Reference: Shell Beaufort Permit Application 01/18/10

a. The sum of the predicted impact and existing background.
b. There are currently no PSD increments for $PM_{2.5}$ or CO.
c. The annual PM_{10} NAAQS, formerly set at 50 µg/m^3, has been revoked. The tanker peak impact would be 16% of the former PM_{10} NAAQS.

Modeled Results at Local Communities

Tables 5-25, 5-26, and 5-27 show the maximum predicted total impacts at the local communities of Kaktovik, Badami, and Nuiqsut, respectively. Because Kaktovik is over 200 km from the onshore sources, well beyond the extent of the onshore source modeling, the impacts of the onshore sources were not included in the Kaktovik totals. The Kaktovik total concentrations include the contribution from Shell sources at 13,000 meters, the nearest distance between Kaktovik and Shell's Beaufort Sea lease blocks, plus a background concentration. The impacts from the onshore sources at Badami are included in Table 5-26, along with Shell's contribution at 35,500 meters, the nearest distance between Badami and Shell's Beaufort Sea lease blocks, plus a background concentration. Nuiqsut is located well beyond the extent of Shell's 50-kilometer modeling range from the nearest lease block. No concentrations were modeled within Nuiqsut. Table 5-27 gives Shell's predicted concentrations at 50,000 meters from the primary ice breaker's usual location (about 45,000 meters from the Discoverer) as a conservative estimate of the project's potential impact at Nuiqsut and other locations further than 50 kilometers from Shell's drilling sites. Beyond 50 kilometers, the predictions of ISC3-PRIME are generally not used. Air concentrations tend to decrease as the distance from the emission source increases, so the true impact at Nuiqsut from Shell's proposed drilling activities is expected to be less than the values in Table 5-27. Overall, Shell's modeling results show that the emissions associated with the proposed permit are not expected to cause or contribute to a violation of the applicable NAAQS in the local communities.

Table 5-25: Impacts at Local Communities: Kaktovik

Air Pollutant	Averaging Period	Shell Contribution (µg/m^3) [a]	Onshore Source Contribution (µg/m^3) [b]	Back-Ground (µg/m^3)	Total [c] (µg/m^3)	NAAQS (µg/m^3)	Percent of NAAQS
PM_{10}	24-Hour	9.1	NA	55.1	64.2	150	43%
PM_{10}	Annual	0.4	NA	7.5	7.9	NA [d]	(16%) [d]
$PM_{2.5}$	24-Hour	8.3	NA	10	18.3	35	52%

Air Pollutant	Averaging Period	Shell Contribution ($\mu g/m^3$) [a]	Onshore Source Contribution ($\mu g/m^3$) [b]	Back-Ground ($\mu g/m^3$)	Total [c] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
$PM_{2.5}$	Annual	0.4	NA	2.0	2.4	15	16%
NO_2	Annual	8.2	NA	11.3	19.5	100	20%
CO	1-Hour	186.4	NA	1749	1935.4	40000	5%
	8-Hour	134.7	NA	1097	1231.7	10000	12%
SO_2 [b]	3-Hour	1.4	NA	41.6	43.0	1300	3%
	24-Hour	0.3	NA	13	13.3	365	4%
	Annual	0.01	NA	2.6	2.61	80	3%

Reference: Environ 02/05/10

a. Shell's contribution at 13,000 m from drill hole, which is the shortest distance between Kaktovik and the Shell Beaufort Sea lease blocks.
b. The contribution of onshore sources to Kaktovik was not calculated due to their distance from the village, over 200 km.
c. The sum of Shell's contribution, onshore source contribution, and background.
d. The annual PM_{10} NAAQS, formerly set at 50 $\mu g/m^3$, has been revoked.

Table 5-26: Impacts at Local Communities: Badami

Air Pollutant	Averaging Period	Shell Contribution ($\mu g/m^3$) [a]	Onshore Source Contribution ($\mu g/m^3$)	Back-Ground ($\mu g/m^3$)	Total [b] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
PM_{10}	24-Hour	5.4	.99	55.1	61.5	150	41%
PM_{10}	Annual	0.2	.05	7.5	7.8	NA [c]	(16%) [c]
$PM_{2.5}$	24-Hour	4.9	.99	10	15.9	35	45%
$PM_{2.5}$	Annual	0.2	.05	2.0	2.3	15	15%
NO_2	Annual	4.6	1.24	11.3	17.1	100	17%
CO	1-Hour	91.1	NA [d]	1749	1840.1	40000	5%
	8-Hour	73.3	NA [d]	1097	1170.3	10000	12%
SO_2	3-Hour	0.6	24.4	41.6	66.6	1300	5%
	24-Hour	0.2	5.64	13	18.8	365	5%
	Annual	0.01	0.28	2.6	2.9	80	4%

Reference: Environ 02/05/10

a. Shell's contribution at 35,500 m from drill hole, which is the shortest distance between Badami and the Shell Beaufort Sea lease blocks.
b. The sum of Shell's contribution, onshore source contribution, and background.

c. The annual PM_{10} NAAQS, formerly set at 50 $\mu g/m^3$, has been revoked.
d. CO was not included in full PSD/NAAQS analysis; therefore onshore sources' CO emissions were not modeled.

Table 5-27: Impacts at Local Communities: Nuiqsut

Air Pollutant	Averaging Period	Shell Contribution ($\mu g/m^3$) [a]	Back-Ground ($\mu g/m^3$)	Total [b] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
PM_{10}	24-Hour	4.8	55.1	59.9	150	40%
PM_{10}	Annual	0.2	7.5	7.7	NA [c]	(15%) [c]
$PM_{2.5}$	24-Hour	4.4	10	14.4	35	41%
$PM_{2.5}$	Annual	0.2	2.0	2.2	15	15%
NO_2	Annual	3.9	11.3	15.2	100	15%
CO	1-Hour	78.7	1749	1827.7	40000	5%
	8-Hour	64.3	1097	1161.3	10000	12%
SO_2	3-Hour	0.5	41.6	42.1	1300	3%
	24-Hour	0.2	13	13.2	365	4%
	Annual	0.01	2.6	2.6	80	3%

Reference: Environ 02/08/10
a Shell's contribution at 50,000 meters from primary ice breaker; 45,000 meters from the drill hole.
b The sum of Shell's contribution and background.
c The annual PM_{10} NAAQS, formerly set at 50 $\mu g/m^3$, has been revoked.

5.2.24 Ozone

Because NO_X and VOC net emissions exceed 100 tpy, Shell is required under the PSD regulation to perform an ozone ambient air quality impact analysis including gathering ambient air measurements. Ozone is inherently a regional pollutant, the result of chemical reactions between emissions from many sources over a period of hours or days, and over a large area. Ozone is formed in the atmosphere through a chemical reaction that includes NO_X, VOC and CO in the presence of sunlight. The sources of these air pollutants are mainly combustion sources such as power plants, refineries and automobiles.

EPA does not have a recommended modeling approach for assessing the impact of an individual source on ozone. Individual source impacts are generally within the range of "noise" of regional ozone models (i.e., imprecision in predicted concentration due to uncertainty in model inputs for emissions, chemistry, and meteorology). EPA's Guideline on Air Quality Models (40 C.F.R. 51, App. W), which is applicable to PSD permit modeling, reflects this understanding. Guideline § 5.2.1(a) notes that "Simulation of ozone formation and transport is a highly complex and resource intensive exercise," and paragraph (c) states: "Choice of methods used to assess the

APPENDIX A

Shell Offshore Inc.
OCS/PSD Permit for
Frontier Discoverer Beaufort Sea Exploration Drilling Program
Criteria Pollutant Potential to Emit Emission Inventory

Summary of Annual Emissions

Frontier Discoverer Sources

Unit ID	Description	Make/Model	Potential to Emit (tons/year)						
			CO	NO_x	$PM_{2.5}$	PM_{10}	SO_2	VOC	Lead
FD-1	Generator Engine	Caterpillar D399	0.56	1.55	0.40	0.40	2.00E-02	0.08	4.04E-04
FD-2	Generator Engine	Caterpillar D399	0.56	1.55	0.40	0.40	2.00E-02	0.08	4.04E-04
FD-3	Generator Engine	Caterpillar D399	0.56	1.55	0.40	0.40	2.00E-02	0.08	4.04E-04
FD-4	Generator Engine	Caterpillar D399	0.56	1.55	0.40	0.40	2.00E-02	0.08	4.04E-04
FD-5	Generator Engine	Caterpillar D399	0.56	1.55	0.40	0.40	2.00E-02	0.08	4.04E-04
FD-6	Generator Engine	Caterpillar D399	0.56	1.55	0.40	0.40	2.00E-02	0.08	4.04E-04
FD-7[1]	Propulsion Engine	MI / 6UEC65	0.00	0.00	0.00	0.00	0.00E+00	0.00	0.00
FD-8	Emergency Generator	Caterpillar 3304	4.30E-02	7.82E-02	1.54E-02	1.54E-02	3.51E-05	8.16E-03	6.38E-07
FD-9-11[2]	MLC Compressor	Caterpillar C-15	2.50	5.37	0.13	0.13	8.63E-03	5.37	1.57E-04
FD-12-13[3, 4]	HPU Engine	Detroit/8V71	0.25	8.18	0.16	0.16	4.71E-03	0.12	8.56E-05
FD-14-15[5]	Deck Cranes	Caterpillar D343	0.20	9.50	0.07	0.07	6.76E-03	0.06	1.23E-04
FD-16-20[6]	Cementing Units and Logging Winches	Various	0.66	11.84	0.29	0.29	5.71E-03	3.01	1.04E-04
FD-21	Heat Boiler	Clayton 200 Boiler	1.25	3.23	0.38	0.38	2.56E-02	0.02	1.45E-04
FD-22	Heat Boiler	Clayton 200 Boiler	1.25	3.23	0.38	0.38	2.56E-02	0.02	1.45E-04
FD-23	Incinerator	TeamTec GS500C	0.39	0.06	0.09	0.10	3.15E-02	0.04	2.68E-03
FD-24-30[7]	Fuel Tanks	NA						0.01	
FD-31	Supply Ship at Discoverer	NA	0.09	0.43	0.03	0.03	1.56E-04	0.03	2.85E-06
FD-32[8]	Drilling Mud System	NA						0.06	
FD-33[9]	Shallow Gas Diverter System	NA						0.00	
FD-34[10]	Cuttngs/Muds Disposal Barge	NA							
Sub-Total Emissions from Frontier Discoverer			10.00	51.23	3.95	3.96	0.23	9.23	0.01

Associated Fleets

Description	Potential to Emit (tons/year)						
	CO	NO_x	$PM_{2.5}$	PM_{10}	SO_2	VOC	Lead
Ice Management Fleet - Generic							
Ice Breaker # 1	160.50	849.88	33.60	38.43	0.65	35.87	3.74E-02
Ice Breaker #2	237.17	71.19	11.15	11.79	0.68	27.69	3.73E-02
Resupply Ship - Generic	0.56	4.24	0.26	0.32	1.13E-03	0.10	2.06E-05
OSR Fleet - Generic							
Nanuq - Main Ship	39.14	172.35	1.86	2.51	0.39	13.59	2.81E-02
Point Barrow Tug and Arctic Endeavor - Main Ships	14.56	166.88	5.55	6.63	0.06	8.60	1.13E-03
Oil Spill Response, Kvichak No. 1, 2 and 3 Work Boats	2.23	55.72	1.03	1.03	0.06	1.06	1.08E-03
Sub-Total Emissions from Fleets	454.15	1,320.25	53.44	60.70	1.84	86.90	0.10
TOTAL PROJECT EMISSIONS	464.15	1371.48	57.39	64.66	2.07	96.14	0.11

Notes

1 Propulsion engine is not used when Discoverer is an OCS Source.
2 Combined use of all 3 MLC Compressor engines are limited by an aggregate fuel usage limit.
3 Combined use of both HPU are limited by an aggregate fuel usage limit.
4 PTE of HPU Units and Incinerator are based on maximum use of that emission unit in accordance with alternative operating scenarios.
5 Combined use of both deck cranes are limited by an aggregate fuel usage limit.
6 Combined use of all five cementing unit and logging winch engines are limited by an aggregate fuel usage limit.
7 Tanks calculations and software outputs are listed separately but are summarized in this table.
8 Drilling mud system calculations are listed separately but are summarized in this table.
9 Shallow gas diverter system is not expected to be used as part of planned operations.
10 Cuttings/Muds Disposal barge is prohibited from emitting any air pollutants.

	Potential to Emit (lb/hr)						
	CO	NO_x	$PM_{2.5}$	PM_{10}	SO_2	VOC	Lead
FD-1	0.28	0.77	0.20	0.20	1.10E-02	0.04	2.00E-04
FD-2	0.28	0.77	0.20	0.20	1.10E-02	0.04	2.00E-04
FD-3	0.28	0.77	0.20	0.20	1.10E-02	0.04	2.00E-04
FD-4	0.28	0.77	0.20	0.20	1.10E-02	0.04	2.00E-04
FD-5	0.28	0.77	0.20	0.20	1.10E-02	0.04	2.00E-04
FD-6	0.28	0.77	0.20	0.20	1.10E-02	0.04	2.00E-04
FD-7	0.00	0.00	0.00	0.00	0.00E+00	0.00	0.00
FD-8	1.79	3.26	0.64	0.64	1.46E-03	3.40E-01	2.66E-05
FD-9	1.65	3.55	0.10	0.10	5.71E-03	3.55	1.04E-04
FD-10	1.65	3.55	0.10	0.10	5.71E-03	3.55	1.04E-04
FD-11	1.65	3.55	0.10	0.10	5.71E-03	3.55	1.04E-04
FD-12	0.16	5.41	0.10	0.10	3.11E-03	0.08	5.66E-05
FD-13	0.16	5.41	0.10	0.10	3.11E-03	0.08	5.66E-05
FD-14	0.13	6.20	0.04	0.04	4.41E-03	0.04	8.01E-05
FD-15	0.13	6.20	0.04	0.04	4.41E-03	0.04	8.01E-05
FD-16	0.22	7.25	0.14	0.14	4.17E-03	0.11	7.58E-05
FD-17	0.22	7.25	0.14	0.14	4.17E-03	0.11	7.58E-05
FD-18	0.21	3.80	0.09	0.09	1.83E-03	0.07	3.33E-05
FD-19	0.29	1.64	0.01	0.01	2.79E-03	1.64	5.08E-05
FD-20	0.03	0.43	0.01	0.01	3.91E-04	0.04	7.11E-06
FD-21	0.62	1.60	0.19	0.19	1.27E-02	0.01	7.17E-05
FD-22	0.62	1.60	0.19	0.19	1.27E-02	0.01	7.17E-05
FD-23	4.28	0.69	0.97	1.13	3.45E-01	0.41	2.94E-02
FD-31	1.94	9.01	0.63	0.63	3.26E-03	0.00	5.93E-05
	17.43	75.02	4.79	4.96	0.49	13.87	0.03

	Potential to Emit (lb/hr)						
	CO	NO_x	$PM_{2.5}$	PM_{10}	SO_2	VOC	Lead
IB	163.84	1051.42	40.25	45.75	4.93E-01	32.90	2.17E-02
AH	234.48	92.22	11.37	11.69	5.08E-01	23.81	2.14E-02
RS-T	34.89	264.92	16.06	20.02	7.09E-02	6.26	1.29E-03
OSR-MS	28.26	352.96	4.60	5.64	2.88E-01	11.95	1.57E-02
OSR-WB	1.11	27.64	0.51	0.51	2.94E-02	0.53	5.34E-04
	462.57	1,789.16	72.80	83.62	1.39	75.44	0.06
	480.00	1864.18	77.59	88.57	1.88	89.31	0.09

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Criteria Pollutant Potential to Emit Emission Inventory

Emissions Unit:	FD-1-6	Generator Engine
Make/Model[1]:	Caterpillar D399, SCAC, 1200 rpm	
Fuel:	Liquid distillate, #1 or #2	
Rating[2]:	1,325	hp
Maximum Operating Level[5]:	941	hp
Maximum Hourly Fuel Use[3,5]:	367	lbs/hour
Control Equipment:	SCR for NO_X, catalytic oxidation for CO, VOC, PM_{10} and $PM_{2.5}$	

Emissions are on a per-engine basis

Pollutant	Emission Factors[4]	Emission Factor Units	Maximum Hours of Operation		Control Efficiency[6]	Potential to Emit			Potential to Emit in g/sec		
			Daily	Annual		Hourly, lb/hr	Daily, lb/day	Annual, tpy	One-Hour	24-Hour	365-Day
CO	882.7	g/hr	24	4032	0.8	0.28	6.72	0.56	0.035	0.035	0.016
NO_x	0.5	g/kW-h	24	4032		0.77	18.48	1.55	0.097	0.097	0.045
$PM_{2.5}$	251.2	g/hr	24	4032	0.5	0.20	4.8	0.40	0.025	0.025	0.012
PM_{10}	251.2	g/hr	24	4032	0.5	0.20	4.8	0.40	0.025	0.025	0.012
SO_2	0.000030	lb/lb fuel	24	4032		1.10E-02	0.26	2.00E-02	1.39E-03	1.36E-03	5.75E-04
VOC	75.5	g/hr	24	4032	0.7	0.04	0.96	0.08	5.04E-03	5.04E-03	2.30E-03
Lead	0.000029	lb/MMBtu	24	4032		2.00E-04	4.81E-03	4.04E-04	2.52E-05	2.52E-05	1.16E-05

Emissions Factor References

CO	From Caterpillar, See permit application dated 01-18-10, Appendix A, page 1
NO_x	From 10-9-2008 D.E.C. Marine letter to Shell. See permit application dated 01-18-10, Appendix C
$PM_{2.5}$	$PM_{2.5}$ emissions assumed to be same as PM_{10} emissions
PM_{10}	From Caterpillar, See permit application dated 01-18-10, Appendix A, page 1
SO_2	Sulfur content of fuel: 0.000015 by weight
VOC	VOC emissions data from Caterpillar, See permit application dated February 23, 2009, Appendix B, page 28
Lead	Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds, EPA-454/R-98-006, May 1998, page 5-45

Conversions Used

453.59	g/lb
2,000	lbs/ton
745.7	watts/hp
7.076	lbs/gal
133,098	Btu/gal

Footnotes/Assumptions

1 Engine specification per 4/6/2009 and 4/9/2009 e-mails from Air Sciences (Rodger Steen) to EPA (Pat Nair)
2 Engine rating per permit application dated 01-18-10, Appendix A, page 1
3 Fuel usage from Caterpillar, See permit application dated 01-18-10, Appendix A, page 1
237.5 g/kW-hr converted based on engine rating, and watts/hp and g/lb conversions
4 All emission factors are uncontrolled except for NOx, which reflects guaranteed emission rate.
5 Owner requested limit per permit application dated 01-18-10, Appendix A, page 1 71% load
6 Control efficiency is based on use of oxidation catalyst. NOx emission factor already reflects controlled emission rate.

127.005 g/hr	0.135 g/hp-hr	0.18104 g/kW-hr
90.718 g/hr	0.09643 g/hp-hr	0.12932 g/kW-hr
90.718 g/hr	0.09643 g/hp-hr	0.12932 g/kW-hr
18.1436 g/hr	0.01929 g/hp-hr	0.02586 g/kW-hr

Shell Offshore Inc.
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Criteria Pollutant Emission Inventory

Emissions Unit:	FD-8	Emergency Generator Engine
Make/Model[1]:	Caterpillar 3304	
Fuel:	Liquid distillate, #1 or #2	
Rating[2]:	131	hp
Maximum Hourly Fuel Use[3]:	49	lbs/hour
Control Equipment:	None	

Emissions are on a per-engine basis.

Pollutant	Emission Factors	Emission Factor Units	Maximum Hours of Operation[4]		Control Efficiency	Potential to Emit			Potential to Emit in g/sec		
			Daily	Annual		Hourly, lb/hr	Daily, lb/day	Annual, tpy	One-Hour	24-Hour	365-Day
CO	6.2	g/hp-hr	2.00	48		1.79	3.58	4.30E-02	0.226	0.019	1.24E-03
NO_x	11.28	g/hp-hr	2.00	48		3.26	6.52	7.82E-02	0.411	0.034	2.25E-03
$PM_{2.5}$	2.21	g/hp-hr	2.00	48		0.64	1.28	1.54E-02	0.081	0.007	4.42E-04
PM_{10}	2.21	g/hp-hr	2.00	48		0.64	1.28	1.54E-02	0.081	0.007	4.42E-04
SO_2	0.000030	lb/lb fuel	2.00	48		1.46E-03	2.93E-03	3.51E-05	1.84E-04	1.54E-05	1.01E-06
VOC	1.163	g/hp-hr	2.00	48		0.34	0.68	8.16E-03	4.28E-02	3.57E-03	2.35E-04
Lead	0.000029	lb/MMBtu	2.00	48		2.66E-05	5.32E-05	6.38E-07	3.35E-06	2.79E-07	1.84E-08

Emissions Factor References

CO	From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34-36, max of Cat engine tests
NO_x	From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34-36, max of Cat engine tests
$PM_{2.5}$	$PM_{2.5}$ emissions assumed to be same as PM_{10} emissions
PM_{10}	From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34-36, max of Cat engine tests
SO_2	Sulfur content of fuel: 0.000015 by weight
VOC	From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34-36, max of Cat engine tests
Lead	Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds, EPA-454/R-98-006, May 1998, page 5-45

Conversions Used

453.59	g/lb
2,000	lbs/ton
7.076	lbs/gal
133,098	Btu/gal

Footnotes/Assumptions

1 Engine specification per permit application dated 01-18-10, Appendix A, page 2

2 Engine rating per permit application dated 01-18-10, Appendix A, page 2

3 Fuel usage from AP-42, Section 3.3, brake specific fuel consumption from footnote c to Table 3.3.1
7000 Btu/hp-hr converted based on engine rating, fuel density and fuel heat content

4 Operation is restricted to 120 minutes of operation per day and 48 hours per year per permit application dated 01-18-10, Appendix A, page 2

Shell Offshore Inc.
OCS/PSD Permit for
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Criteria Pollutant Emission Inventory

Emissions Unit:	FD-9-11	MLC Compressor
Make/Model[1]:	Caterpillar C-15	
Fuel:	Liquid distillate, #1 or #2	
Rating[2]:	540	hp
Maximum Hourly Fuel Use[3]:	190	lbs/hour
Control Equipment:	Tier 3 engines	

Hourly and daily emissions are on a per-engine basis. Annual emissions are for all three MLC compressor engines in aggregate.

Pollutant	Emission Factors	Emission Factor Units	Maximum Operation[4, 5]		Control Efficiency[6]	Potential to Emit			Potential to Emit in g/sec		
			Daily (hrs)	Annual (gal)		Hourly, lb/hr	Daily, lb/day	Annual, tpy	One-Hour	24-Hour	365-Day
CO	1.86	g/kW-h	24	81,346		1.65	39.6	2.50	0.208	0.208	0.072
NO_x	4.0	g/kW-h	24	81,346		3.55	85.2	5.37	0.447	0.447	0.154
$PM_{2.5}$	0.2	g/kW-h	24	81,346	0.5	0.1	2.4	0.13	0.013	0.013	0.004
PM_{10}	0.2	g/kW-h	24	81,346	0.5	0.1	2.4	0.13	0.013	0.013	0.004
SO_2	0.000030	lb/lb fuel	24	81,346		5.71E-03	0.14	8.63E-03	7.19E-04	7.35E-04	2.48E-04
VOC	4.0	g/kW-h	24	81,346		3.55	85.2	5.37	4.47E-01	4.47E-01	1.54E-01
Lead	0.000029	lb/MMBtu	24	81,346		1.04E-04	2.49E-03	1.57E-04	1.31E-05	1.31E-05	4.52E-06

Emissions Factor References

CO	Controlled emission factor from EPA BACT analysis (OxyCat as BACT).
NO_x	From Tier 3 emission limit in 40 CFR 89.112 (Limit is for NO_X and NMHC, in aggregate)
$PM_{2.5}$	$PM_{2.5}$ emissions assumed to be same as PM_{10} emissions
PM_{10}	Assumed to be the same as PM from Tier 3 emission limit in 40 CFR 89.112 and use of OxyCAT
SO_2	Sulfur content of fuel: 0.000015 by weight
VOC	From Tier 3 emission limit in 40 CFR 89.112 (Limit is for NO_X and NMHC, in aggregate)
Lead	Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds, EPA-454/R-98-006, May 1998, page 5-45

Conversions Used

453.59	g/lb
2,000	lbs/ton
745.7	watts/hp
7.076	lbs/gal
133,098	Btu/gal

Footnotes/Assumptions

1 Engine specification per permit application dated 01-18-10, Appendix A, page 3
2 Engine rating per permit application dated 01-18-10, Appendix A, page 3
3 Fuel usage from Caterpillar LEHW7443-00, 2008
26.9 gal/hr and then converted based on fuel density
4 Daily maximum operation is based on hours of operation
5 Annual maximum operation is based on fuel usage for all three engines: 81,346 gallons
6 Control efficiency is based on use of oxidation catalyst. CO emission factor already reflects controlled emission rate.

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Criteria Pollutant Emission Inventory

Emissions Unit: FD-12-13 HPU Engine
Make/Model[1]: Detroit 8V-71
Fuel: Liquid distillate, #1 or #2
Rating[2]: 250 hp
Maximum Hourly Fuel Use[3]: 104 lbs/hour
Control Equipment: Clean Air Systems PERMIT™ Filter for control of CO, $PM_{2.5}$, PM_{10} and VOC

Hourly emissions are on a per-engine basis. Daily and annual emissions are for both HPU engines in aggregate.

Pollutant	Emission Factors	Emission Factor Units	Maximum Operation[6, 7]		Control Efficiency[4, 5]	Potential to Emit			Potential to Emit in g/sec		
			Daily (gal)	Annual[8] (gal)		Hourly, lb/hr	Daily[7], lb/day	Annual[7], tpy	One-Hour	24-Hour	365-Day
Base Case Scenario									**Base Case Scenario**		
CO	2.99	g/hp-hr	0	44,338	0.9	0	0	0.25	0	0	0.007
NO_x	9.81	g/hp-hr	0	44338		0	0	8.18	0	0	0.235
$PM_{2.5}$	1.26	g/hp-hr	0	44338	0.85	0	0	0.16	0	0	0.005
PM_{10}	1.26	g/hp-hr	0	44338	0.85	0	0	0.16	0	0	0.005
SO_2	0.000030	lb/lb fuel	0	44338		0	0	4.71E-03	0	0	1.354E-04
VOC	1.48	g/hp-hr	0	44338	0.9	0	0	0.12	0	0	3.452E-03
Lead	0.000029	lb/MMBtu	0	44338		0	0	8.56E-05	0	0	2.462E-06
Alternative Scenario #1									**Alternative Scenario #1**		
CO	2.99	g/hp-hr	352	44,338	0.9	0.16	3.96	0.25	0.02	0.021	0.007
NO_x	9.81	g/hp-hr	352	44,338		5.41	129.76	8.18	0.682	0.681	0.235
$PM_{2.5}$	1.26	g/hp-hr	352	44,338	0.85	0.10	2.50	0.16	0.013	0.013	0.005
PM_{10}	1.26	g/hp-hr	352	44,338	0.85	0.10	2.50	0.16	0.013	0.013	0.005
SO_2	0.000030	lb/lb fuel	352	44,338		3.11E-03	7.47E-02	4.71E-03	3.92E-04	3.92E-04	1.35E-04
VOC	1.48	g/hp-hr	352	44,338	0.9	0.08	1.96	0.12	1.01E-02	1.03E-02	3.45E-03
Lead	0.000029	lb/MMBtu	352	44,338		5.66E-05	1.36E-03	8.56E-05	7.13E-06	7.13E-06	2.46E-06
Alternative Scenario #2									**Alternative Scenario #2**		
CO	2.99	g/hp-hr	704	44,338	0.9	0.16	7.91	0.25	0.02	0.042	0.007
NO_x	9.81	g/hp-hr	704	44,338		5.41	259.53	8.18	0.682	1.363	0.235
$PM_{2.5}$	1.26	g/hp-hr	704	44,338	0.85	0.10	5.00	0.16	0.013	0.026	0.005
PM_{10}	1.26	g/hp-hr	704	44,338	0.85	0.10	5.00	0.16	0.013	0.026	0.005
SO_2	0.000030	lb/lb fuel	704	44,338		3.11E-03	0.15	4.71E-03	3.92E-04	7.87E-04	1.35E-04
VOC	1.48	g/hp-hr	704	44,338	0.9	0.08	3.92	0.12	1.01E-02	2.06E-02	3.45E-03
Lead	0.000029	lb/MMBtu	704	44,338		5.66E-05	2.72E-03	8.56E-05	7.13E-06	1.43E-05	2.46E-06

Emissions Factor References

CO From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34 and 2-35, max of 2 tests
NO_x From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34 and 2-35, max of 4 tests
$PM_{2.5}$ $PM_{2.5}$ emissions assumed to be same as PM_{10} emissions
PM_{10} From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, 2-34 and 2-35, max of 4 tests (PM emis.)
SO_2 Sulfur content of fuel: 0.000015 by weight
VOC From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34 and 2-35, max of 2 tests
Lead Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds, EPA-454/R-98-006, May 1998, page 5-45

Conversions Used

453.59 g/lb
2,000 lbs/ton
7.076 lbs/gal
133,098 Btu/gal

Footnotes/Assumptions

1 Engine specification per permit application dated 01-18-10, Appendix A, page 4
2 Engine rating per permit application dated 01-18-10, Appendix A, page 4
3 Fuel usage per permit application dated 01-18-10, Appendix A, page 4
0.415 lb/hp-hr
4 PM_{10} control efficiency based on California Air Resources Board, Verification of Diesel Emission Control Strategies, March 12, 2009 (website), April 24, 2009 letter from CleanAIR Systems and April 20, 2007 quote from CleanAIR Systems, transmitted by April 27, 2009 e-mail from Air Sciences (Rodger Steen) to EPA (Pat Nair)
5 CO and VOC control efficiency from April 24, 2009 letter from CleanAIR Systems and April 20, 2007 quote from CleanAIR Systems, transmitted by April 27, 2009 e-mail from Air Sciences (Rodger Steen) to EPA (Pat Nair)
6 Daily maximum operation and operating scenarios are based on permit application dated 01-18-10, Appendix A, page 4
7 Daily and annual maximum fuel usage is for both engines, in aggregate: 44,338 gallons
8 Annual maximum fuel usage limit is for all operating scenarios in aggregate.

g/kW-hr
0.40096
13.1552
0.25345
0.25345

0.19847
3.9E-05

Shell Offshore Inc.
OCS/PSD Permit for
Frontier Discoverer Beaufort Sea Exploration Drilling Program
Criteria Pollutant Emission Inventory

Emissions Unit: FD-14-15 Deck Cranes
Make/Model[1]: Caterpillar D343
Fuel: Liquid distillate, #1 or #2
Rating[2]: 365 hp
Maximum Hourly Fuel Use[3]: 20.76 gallons/hour
Control Equipment: Clean Air Systems PERMIT™ Filter for control of CO, $PM_{2.5}$, PM_{10} and VOC

Hourly and daily emissions are on a per-engine basis. Annual emissions are for both deck cranes in aggregate.

Pollutant	Emission Factors	Emission Factor Units	Maximum Operation[6, 8]		Control Efficiency[4, 5]	Potential to Emit			Potential to Emit in g/sec		
			Daily (hrs)	Annual (gal)[8]		Hourly, lb/hr	Daily, lb/day	Annual[8], tpy	One-Hour	24-Hour	365-Day
CO	593.6	g/hr	24	63,661	0.9	0.13	3.12	0.20	0.016	0.016	0.006
NO_x	2810.9	g/hr	24	63,661		6.2	148.80	9.50	0.781	0.781	0.273
$PM_{2.5}$	129.8	g/hr	24	63,661	0.85	0.04	0.96	0.07	0.005	0.005	0.002
PM_{10}	129.8	g/hr	24	63,661	0.85	0.04	0.96	0.07	0.005	0.005	0.002
SO_2	0.000030	lb/lb fuel	24	63,661		4.41E-03	0.11	6.76E-03	5.55E-04	5.55E-04	1.94E-04
VOC	172.6	g/hr	24	63,661	0.9	0.04	0.96	0.06	5.04E-03	5.04E-03	1.68E-03
Lead	0.000029	lb/MMBtu	24	63,661		8.01E-05	1.92E-03	1.23E-04	1.01E-05	1.01E-05	3.53E-06

Emissions Factor References

CO From Caterpillar, See attachment to e-mail dated April 6, 2009 from Air Sciences (Rodger Steen) to EPA (Pat Nair)[7]
NO_x From Caterpillar, See attachment to e-mail dated April 6, 2009 from Air Sciences (Rodger Steen) to EPA (Pat Nair)[7]
$PM_{2.5}$ $PM_{2.5}$ emissions assumed to be same as PM_{10} emissions
PM_{10} From Caterpillar, See attachment to e-mail dated April 6, 2009 from Air Sciences (Rodger Steen) to EPA (Pat Nair)[7]
SO_2 Sulfur content of fuel: 0.000015 by weight
VOC From Caterpillar, See attachment to e-mail dated April 6, 2009 from Air Sciences (Rodger Steen) to EPA (Pat Nair)[7]
Lead Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds, EPA-454/R-98-006, May 1998, page 5-45

Conversions Used

453.59 g/lb
2,000 lbs/ton
745.7 watts/hp
7.076 lbs/gal
133,098 Btu/gal

Footnotes/Assumptions

1 Engine specification per permit application dated 01-18-10, Appendix A, page 5
2 Engine rating per permit application dated 01-18-10, Appendix A, page 5
3 From Caterpillar, See attachment to e-mail dated April 6, 2009 from Air Sciences (Rodger Steen) to EPA (Pat Nair)[4]
244.8 g/kW-hr converted based on engine rating, and watts/hp and g/lb conversions
4 PM_{10} control efficiency based on California Air Resources Board, Verification of Diesel Emission Control Strategies, March 12, 2009 (website), April 24, 2009 letter from CleanAIR Systems and April 20, 2007 quote from CleanAIR Systems, transmitted by April 27, 2009 e-mail from Air Sciences (Rodger Steen) to EPA (Pat Nair)
5 CO and VOC control efficiency from April 24, 2009 letter from CleanAIR Systems and April 20, 2007 quote from CleanAIR Systems, transmitted by April 27, 2009 e-mail from Air Sciences (Rodger Steen) to EPA (Pat Nair)
6 Maximum operation per season is based on an owner requested limit of: 63661 gallons
Per permit application dated 01-18-10, Appendix A, page 4
7 As exact engine specification was not available, value used was highest of similarly rated engine configuration
8 Annual fuel usage and annual emissions are for both crane engines aggregated.

g/kW-hr
0.21664
10.3322
0.06666
0.06666
0.06666
0.00013

Shell Offshore Inc.
OCS/PSD Permit for
Frontier Discoverer Beaufort Sea Exploration Drilling Program
Criteria Pollutant Emission Inventory

Emissions Unit: FD-16-17 Cementing Unit
Make/Model[1]: Detroit 8V-71N
Fuel: Liquid distillate, #1 or #2
Rating[2]: 335 hp
Maximum Hourly Fuel Use[3]: 139 lbs/hour
Control Equipment: Clean Air Systems PERMIT™ Filter for control of CO, $PM_{2.5}$, PM_{10} and VOC

Emissions are on a per engine basis at 100% load

Pollutant	Emission Factors	Emission Factor Units	Maximum Hours of Operation[6] Daily	Maximum Hours of Operation[6] Annual	Control Efficiency[4, 5]	Potential to Emit[6] Hourly, lb/hr	Potential to Emit[6] Daily, lb/day	Potential to Emit[6] Annual, tpy	Potential to Emit in g/sec One-Hour	
										g/kW-hr
CO	2.99	g/hp-hr			0.9	0.22			0.028	0.40096
NO_x	9.81	g/hp-hr				7.25			0.913	13.1552
$PM_{2.5}$	1.26	g/hp-hr			0.85	0.14			0.018	0.25345
PM_{10}	1.26	g/hp-hr			0.85	0.14			0.018	0.25345
SO_2	0.000030	lb/lb fuel				4.17E-03			5.26E-04	
VOC	1.48	g/hp-hr			0.9	0.11			1.39E-02	0.19847
Lead	0.000029	lb/MMBtu				7.58E-05			9.56E-06	

Emissions Factor References

CO From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34 and 2-35, max of 2 tests
NO_x From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34 and 2-35, max of 4 tests
$PM_{2.5}$ $PM_{2.5}$ emissions assumed to be same as PM_{10} emissions
PM_{10} From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, 2-34 and 2-35, max of 4 tests (PM emis.)
SO_2 Sulfur content of fuel: 0.000015 by weight
VOC From Health Assessment Document for Diesel Engine Exhaust, EPA/600/8-90/057F, May 2002, pages 2-34 and 2-35, max of 2 tests
Lead Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds, EPA-454/R-98-006, May 1998, page 5-45

Conversions Used

453.59 g/lb
2,000 lbs/ton
7.076 lbs/gal
133,098 Btu/gal

Footnotes/Assumptions

1 Engine specification per permit application dated 01-18-10, Appendix A, page 6
2 Engine rating per permit application dated 01-18-10, Appendix A, page 6
3 Fuel usage permit application dated 01-18-10, Appendix A, page 6
0.415 lb/hp-hr
4 PM_{10} control efficiency based on California Air Resources Board, Verification of Diesel Emission Control Strategies, March 12, 2009 (website), April 24, 2009 letter from CleanAIR Systems and April 20, 2007 quote from CleanAIR Systems, transmitted by April 27, 2009 e-mail from Air Sciences (Rodger Steen) to EPA (Pat Nair)
5 CO and VOC control efficiency from April 24, 2009 letter from CleanAIR Systems and April 20, 2007 quote from CleanAIR Systems, transmitted by April 27, 2009 e-mail from Air Sciences (Rodger Steen) to EPA (Pat Nair)
6 See page 11 for daily and annual emissions