Shell Exploration & Production

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May 1, 2014

United States Department of the Interior
Bureau of Ocean Energy Management
Attn: David Johnston
Regional Supervisor Leasing and Plans
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

Re: Requests for Additional Information – Chukchi Sea Exploration Plan, Revision 2

Dear Mr. Johnston:

Shell Gulf of Mexico Inc. (Shell) provides the attached information in response to the requests for additional information from the Bureau of Ocean Energy Management dated January 14, 2014 on the above-referenced document.

Please contact me at (907) 646-7112 or via e-mail at Susan.Childs@Shell.com for further information.
Thank you,

Susan Childs
Alaska Venture Support Integrator, Manager

Attachments:

- Bureau of Ocean Energy Management January 14, 2014 RFAI Responses; Shell Gulf of Mexico Inc. Chukchi Sea Exploration Plan, Revision 2

Table of Contents

OPERATIONAL

RFAI No. 1 (Section 1.0, Page 1-1, Paragraph 1)

November 29, 2013 Comment

Provide information on any modifications that Shell performed to the Noble Discoverer to make it Arctic-ready, and provide documentation that Shell has addressed and corrected all non-compliance deficiencies cited by the U.S. Coast Guard and EPA following exploration drilling by the Noble Discoverer in 2012.

Section 2.2 of the IOP, pages (15-18) detailed the preparation of the *Discoverer* for Arctic service in 2014.

Marine vessels chartered by Shell are subject to stringent U.S. Coast Guard inspection requirements contained in the Code of Federal Regulations. Various certificates and documents are issued by the Coast Guard to the vessel owner/operator to demonstrate compliance with the regulations. Shell will request these certifications and documents from the appropriate vessel operator so Shell can provide to BSEE any such certifications and documents required by their regulations (subject to appropriate confidentiality limitations, if any). Shell will provide copies of any such certifications and documents to BOEM.

January 14, 2014 Comment

BOEM will accept the U.S. Coast Guard (USCG) Certification of Compliance as demonstration of Shell's correction of the deficiencies cited by the USCG in 2012.

U.S. Environmental Protection Agency (EPA) verified that it terminated Shell's Air Quality permit on December 26, 2013 (letter to Susan Childs from Kate Kelly, Director at EPA Office of Air, Waste, and Toxics). Accordingly, any Air Quality permit deficiencies cited by the EPA remain with the EPA.

During our meeting December 13, 2013, BOEM clarified its expectation concerning the information it was seeking under RFAI No. 1. BOEM is seeking assurance from Shell that not only have the physical deficiencies been resolved, but also if Shell's management/oversight deficiencies that allowed the physical deficiencies to remain undedicated or unresolved throughout the course of operations have been fixed. What adjustments or changes has Shell made to its project management/ implementation /assurance plans to ensure that operational deficiencies, should they occur in the future, will be quickly detected and fixed?

Prior to the start of the 2014 exploration drilling season, Shell will present to BOEM in-person how guidance, management and oversight have been improved since following the 2012 exploration season. This presentation will be before the start of exploration drilling activities in 2014.

RFAI No. 2 (Section 1.0)

November 29, 2013 Comment

Provide confirmation of the completion of the third party management system review (as required by the 60-Day Report) or, if not yet complete, Shell's plans and schedule for completing the third party review.

On December 9, 2013 Shell submitted a Safety and Environmental Management Systems (SEMS) and Shell Alaska Management System Audit document to the Bureau of Safety and Environmental Enforcement. This document outlines Shell's plans and schedule for completing the third party review as recommended in the Department of the Interior report. This document is under review by BSEE. A final version will be submitted to BOEM when available.

January 14, 2014 Comment

BOEM received a copy of Shell's SEMS Audit Plan on January 7, 2014. The purpose of the plan is to define the audit program and procedures for the periodic audit of Shell Alaska Venture's Safety and Environmental Management System (SEMS) and the additional one time audit (i.e., 3rd Party Audit) required by DOI's 60-Day Report. Shell must complete the 3rd Party audit before recommencing drilling in the Chukchi Sea. Shell's submittal of the audit plan on January 7, 2014 and a copy of the audit report when the audit is complete will satisfy this RFAI item.

A Third-party party audit will begin during February 2014. The scope of the audit includes two stages: Stage 1 in the Shell Anchorage office; and Stage 2 on the drillship Noble *Discoverer* once the *Discoverer* is operating in the Outer Continental Shelf (OCS) waters of Alaska. Once the Stage I audit report is final, a copy of the report will be submitted to BSEE and a copy will be provided to BOEM. Once the Stage II audit of the *Discoverer* is final, a copy of the report will be submitted to BSEE. A copy of this Stage II audit report will also be provided to BOEM.

RFAI No. 3 (Section 1.0, Page 1-1)

November 29, 2013 Comment

EP Rev 2 proposes adjusting the BOP test frequency from once every 7 days to once every 14 days. In its 2012 Chukchi Sea EP, Shell stated "[t]he blowout prevention program will be enhanced through ...increased frequency of BOP performance tests from 14 to 7 days ..." Provide the rationale behind Shell's decision now to reduce the frequency of BOP tests to 14 days. Also, provide clarification for the doubling of the barrels of well fluids to be discharged because of BOP re-testing, if the BOP system is now proposed to be tested half as often (i.e., every 14 days as opposed to 7 days).

Shell has adopted the current industry practice from the Gulf of Mexico: a pressure test every 14 days and a function test every 7 days, so the control systems would still be tested every 7 days. Standardizing the frequency of the pressure test to concur with the Gulf of Mexico will reduce wear on the BOP sealing elements, enhancing rather than degrading BOP reliability. Fluids discharged will not be reduced, since the function test is still being conducted every 7 days. The BOP discharge fluid was doubled to allow contingency for re-test.

Section 12 of EP Revision 2 will be modified to include the preceding explanation.

January 14, 2014 Comment

Shell indicated it would reduce BOP pressure testing frequency from every seven days to every 14 days, but would continue to conduct BOP function tests every 7 days. The pressure testing frequency is in alignment with BSEE regulations at 30 CFR 250.447. Shell will modify Section 12 of EP Revision 2 to include the explanation of doubling fluid discharge volumes; the inclusion of this explanation in EP Revision 2 will satisfy this RFAI item.

EP Revision 2, Section 12, under the heading Exploration Drilling Operations, has been modified with the revised BOP testing frequency language.

RFAI No. 4 (Section 1.0, Page 1-1, Footnote)

November 29, 2013 Comment

Correction: BOEM was enjoined from taking action on the May document. Once the injunction was lifted, Shell submitted its Revised draft EP, dated October11, 2011.

Comment noted.

January 14, 2014 Comment

Shell noted the comment and this RFAI item is satisfied.

RFAI is satisfied.

RFAI No. 5 (Section 1.0, Page 1-7, Figure 1.b-7)

November 29, 2013 Comment

The anchor radius of the Burger S well is projected to extend outside of lease block 6762 and would require a right of use easement per 30 CFR 550.160. This should be reflected within the EP narrative, within Table 1-1, and other applicable sections of the EP Rev 2.

Under 30 CFR 550.160 Shell will apply for a right-of-use and easement authorization to place one or more anchors on an adjacent lease when Shell submits an Application for Permit to Drill to BSEE. Text addressing this request has been included in the EP Revision 2 on page 12-1.

January 14, 2014 Comment

Shell has agreed that it will apply for a right-of-use and easement authorization to place one or more anchors on the adjacent block lease when Shell submits an Application for Permit to Drill (APD) to BSEE. Shell's modifications to EP Revision 2, Section 1.0, will satisfy this RFAI item.

EP Revision 2, Section 1a) has been modified to include the application for right-of-use and easement authorization language.

RFAI No. 6 (Section 2.0, Page 2-1, Table 2.a-1)

November 29, 2013 Comment

Permits and certifications associated with the relief drilling rig operations in the Chukchi Sea need to be identified in this table. Submittal of copies of the permits listed in this table would be helpful.

Shell does not plan to have the *Polar Pioneer* enter the Chukchi Sea as a primary drilling vessel. The *Polar Pioneer* will remain in Dutch Harbor on standby while the Discoverer is drilling in the Chukchi Sea. Therefore, there are no permits or authorizations under 30 CFR 550.213(a) for the *Polar Pioneer* as a drilling vessel in the Chukchi Sea, and Table 2.a-1 of the EP Revision 2 will not be modified.

January 14, 2014 Comment

BOEM understands that the State of Alaska will require permits for mooring the Polar Pioneer in Dutch Harbor; Shell modifications of Table 2.a-1 by inclusion of permits and certifications (including local permits and certifications) will satisfy this RFAI item.

EP Revision 2, Table 2.a-1 includes the State of Alaska Land Use Permit required to moor the *Polar Pioneer* in the vicinity of Dutch Harbor.

RFAI No. 7 (Section 2.0 & 6.0, Tables 2.b-1, 6.1-1, 6.a-2, 6.a-3, 6.a-4, 6.a-5)

November 29, 2013 Comment

Provide clarification of the differences between volumes provided in Table 2.b-1 and the well specific tables within Section 6.0 regarding estimated discharge volumes once the riser is set. Provide example of calculations.

Using the Burger F drill site as an example, it is estimated that 7,188 bbl of drilling fluid will be used to drill the well to total depth (Table 2.b-1). The corresponding discharge volume in Table 6.a-2 (WBM drilling fluids and cuttings with adhered WBM) is 6,731 bbl. 6,731 bbl includes 5,688 bbl of drilling fluids and 1,043 bbl of cuttings. 5,688 bbl of drilling fluid added to 1,500 bbl of reserve pit WBM totals 7,188 bbl. A clarifying footnote has been added to Table 2.b-1 on page 2-2 of the EP Revision 2 and text has been added to Tables 6.a-1 through -6 clarifying the drilling fluid and cuttings volumes for each planned well.

January 14, 2014 Comment

Shell stated it would add a clarifying footnote to EP Revision 2, Table 2.b-1 and add text to Tables 6.a-1 through 6.a-6 clarifying the drilling fluid and cuttings volumes for each planned well. Shell's response, with additional information and modifications to the EP Revision 2, will satisfy this RFAI item.

A clarifying footnote has been added to EP Revision 2, Table 2.b-1 and additional text has been added to Tables 6.a-1 through 6.a-6 to clarify the specific amounts of drilling fluids and cuttings for the portion of the well after the riser is set.

RFAI No. 8 (Section 2.0, Page 2-2)

November 29, 2013 Comment

Provide information and documentation (i.e. certification and approvals) to verify that the well capping stack and containment system are ready and available for Arctic OCS conditions.

Section 2.12 (Surface Intervention Capping and Containment (If Necessary)) and 2.13 (ACS Dome Component Improvements) of the IOP provides information that the capping stack and containment system are ready and available for Arctic OCS conditions.

Marine vessels chartered by Shell are subject to stringent U.S. Coast Guard inspection requirements contained in the Code of Federal Regulations. Various certificates and documents are issued by the Coast Guard to the vessel owner/operator to demonstrate compliance with the regulations. Shell will request these certifications and documents from the appropriate vessel operator so Shell can provide to BSEE any such certifications and documents required by their regulations (subject to appropriate confidentiality limitations, if any). Shell will provide copies of any such certifications and documents to BOEM.

January 14, 2014 Comment

Certifications and/or approvals (USCG and BSEE) of the capping stack, containment dome, and associated vessels are needed before drilling may commence. Shell has agreed to provide copies of any such certifications and documents to BOEM. Shell's modification will satisfy this RFAI item.

RFAI has been satisfied.

RFAI No. 9 (Section 2.0, Page 2-2)

November 29, 2013 Comment

For drilling a relief well, provide for the Polar Pioneer:

- ***mobilization time (supported by speed of towing vessel, distance, weather factors, time to anchor, etc.), and proposed drilling schedule; • notifications that Shell will issue before moving the Polar Pioneer; and***
- ***assets (availability and logistics of support vessels/equipment) moving with the Polar Pioneer***

The following table outlines the schedule for the *Polar Pioneer* and her support vessels to mobilize to the Burger Prospect and drill a relief well.

Activity	Unmooring at Dutch	Tow from Dutch to Burger	Mooring at Burger	Drilling to intercept point
Timing	1.0 days	7.5 days	1.5 days	28 days
Comments	Based on pulling and racking anchors and commencing tow. Rig will be fully crewed with TransOcean staff keeping equipment in a state of readiness	Built around 6 knots travel speed based on previous average tows with *Polar Pioneer* incorporating a variety of weather conditions and one active tug. In this case two tugs and a contingency anchor handle are available.	Based on 2 anchor handlers and past anchoring times.	Base time of 23 days from original estimate with logging, MLC and P&A operations removed. Adds in ranging runs. Nominal estimate of NPT at 20% takes estimate to 28 days. Additional information will be provided in the APD as required.

January 14, 2014 Comment

Shell submitted a table that outlines the schedule for the Polar Pioneer and her support vessels to mobilize to the Burger Prospect and drill a relief well. This table shows 1 day for unmooring at Dutch, 7.5 days travel time from Dutch to Burger, 1.5 days for mooring at Burger, and 28 days to drill a relief well. Shell's inclusion of this table into EP Revision 2, Section 2.0 will satisfy this RFAI item.

The Regional Supervisor, Office of Leasing and Plans, will require Shell to notify BOEM if the* Polar Pioneer *is mobilized.

Shell has included a relief well drilling unit mobilization schedule for the *Polar Pioneer* and her support vessels to the Burger Prospect in Section 2.0 of EP Revision 2.

RFAI No. 10 (Section 3.0)

November 29, 2013 Comment

The EP Rev 1 proprietary Section 3.0 was written prior to the drilling program in 2012. The drilling program at the Burger Site A included the excavation of a mudline cellar approximately 21 feet in diameter by 40 feet deep and drilling a pilot hole to approximately 1,500 feet below the sea level that was continuously logged while drilling. Shell interpreted the proprietary well log data, concluding that no permafrost is present in the subsurface at Burger Site A and that cooled muds would not be required when drilling to TD. These conclusions are asserted on pages 12-1 and xiv (App. E) in EP Rev 2, but the logs nor their analysis are not included. Provide an updated proprietary Section 3.0 with geological descriptions and associated data (specifically log data) obtained from the 2012 drilling field season, and Shell's analysis to support changes in the exploration drilling program.

The response to this request contains proprietary information and is attached as a separate document under separate cover labeled RFAI 10 Proprietary Section 3. Changes to this section are noted with red font.

January 14, 2014 Comment

To satisfy this RFAI item, BOEM requires the submission of the Logging While Drilling (LWD) logs, as well as an explanation of how Shell reached the conclusion that permafrost is not present based on these logs (pursuant to 30 CFR 550.214 and 30 CFR 550.227 (b)(i)) within EP Revision 2, Section 3.0.

Shell presented to BOEM geologists/geophysicists its rationale behind determinations that permafrost is absent at the Burger A location. Shell provides a discussion of this rationale drawn from the LWD logs in the Proprietary and Confidential Section 3 of EP Revision 2. This satisfies the requirement of 30 CFR §550.214 and 30 CFR §550.227.

RFAI No. 11 (Section 4.0)

November 29, 2013 Comment

Submit the recent H2S Contingency Plan that was submitted to BSEE on July 18, 2013. The revised H2S plan should be referenced in the EP Rev. 2 and changes are needed to Section 4.0 to reflect this new plan. Also, confirm that all emergency contact phone numbers are valid. Provide information on how any changes will be provided to relevant agencies.

The most recent H_2S plan was submitted to BSEE on July 18, 2012. The changes included minor administrative changes such as naming the attending vessel and updating the contact list. A copy of the H_2S is attached as the RFAI 11 document.

The H_2S plan has only been provided to BOEM and BSEE; each agency now has an updated copy.

January 14, 2014 Comment

Shell provided a copy of its most recently updated H2S plan. Shell must update EP Revision 2, Section 4.0, with these changes to satisfy this RFAI item.

EP Revision 2, Section 4 has been modified to reflect the updated H_2S plan.

RFAI No. 12 (Section 6.0)

November 29, 2013 Comment

Within Table 1-1 Shell has indicated that drilling fluids will not be cooled. Provide the rationale for the change, with supporting documentation, including any associated changes this will have on permitted actions and environmental impacts.

The purpose of cooling drilling fluids is to prevent the melting and subsequent washout of permafrost/hydrate zones in shallow hole sections. The LWD logs from our pilot hole, which were provided to BSEE, did not show any evidence of permafrost, hydrates, shallow hydrocarbons or any other shallow hazard. This is consistent with our expectations and well-site clearance letters. BSEE also concurred with our assessment of the absence of shallow hazards by allowing us to open the hole for 20" casing. Absent permafrost or hydrates, there is no reason to cool drilling fluids during operations.

Section 12 of EP Revision 2 will be modified to note why Shell deems it is not necessary to cool drilling fluids.

January 14, 2014 Comment

As stated previously, BOEM will require submittal of the LWD logs to support Shell's determination that permafrost or hydrates are absent, and that there is no reason to cool drilling fluids. To satisfy this RFAI item, Shell may modify EP Revision 2, Section 12.0, to note why Shell deems it unnecessary to cool drilling fluids; or this information may be included in EP Revision 2, Section 3.0, if Shell determines that it is proprietary

Shell presented to BOEM geologists/geophysicists its rationale behind determinations that permafrost or hydrates are absent at the Burger A location. As such, given the absence of permafrost there is no need to cool drilling muds and no change to permitting actions or environmental impacts. Shell provides a discussion of this rationale drawn from the LWD logs in the Proprietary and Confidential Section 3 of EP Revision 2.

RFAI No. 13 (Section 9.0)

November 29, 2013 Comment

The Well Control Plan in the EP Rev 1 included two topics that are not addressed in Appendix L, EP Rev 2, specifically: Blowout Well Ignition and Blowout Well Intervention. Identify and discuss any changes of assets and/or procedures to the referenced methods/practices for these two topics.

Blowout Well Ignition and Blowout Well Intervention remain options available during blowout response which could be executed with the named support fleet. Placing human safety as the highest priority, Shell would consider the feasibility of igniting the blowout and the benefits this may bring to personnel and assets supporting capping and containment work. Any action taken to ignite the blowout would be a product of careful planning, repositioning of the fleet, and concurrence from the Unified Command. Blowout Well Intervention is considered an opportunity which would always be evaluated dependent on the wellbore condition and blowout scenario. Either rig is capable of intervening back into a blowout well either after successful activation of the BOP, wellbore depletion, or the well bridging over. Wells commonly do bridge over sometimes within 24-48 hours of first blowing out.

Appendix L was revised in Revision 2 of the EP to focus on the elements of the Well Control Plan which requires the most comprehensive planning to execute: Well Planning, Secondary Well Control, and Well Containment and Response. Several contingent operations, such as Blowout Well Ignition and Blowout Well Intervention, exist and would be evaluated during a response.

January 14, 2014 Comment

Shell responded with an explanation that those well control options (i.e., Blowout Well Ignition and Blowout Well Intervention) remain available even though they were not specifically addressed in the EP Revision 2, Appendix L. As these well control options remain available, BOEM requests that the options be included in EP Revision 2, Appendix L, to satisfy this RFAI item.

Shell has included the well control options (Blowout Well Ignition and Blowout Well Intervention) in Appendix L of EP Revision 2.

RFAI No. 14 (Section 10.0, Page 10-1)

November 29, 2013 Comment

Discuss the Hanna Shoal Walrus Use Area (HSWUA) and Shell's proposed mitigations, specifically for the months of June through September since Figure 13.e-1 and Figure 13.e-2 and identify operational/logistical activities (i.e. ice management, vessel, aircraft travel, etc.) within the HSWUA.

Shell is currently in discussion with US Fish & Wildlife Service (USFWS) with respect to the approach to operations that may occur in and around the HSWUA during and related to drilling activities in 2014. The details of the monitoring and mitigation measures that are to be utilized in relation to the HSWUA will be fully documented in the Letter of Authorization (LOA) and any variances under the HSWUA that Shell receives from the USFWS. The Bureau of Ocean Energy Management will be copied on these requests, when made, and any variances, when they are received.

Section 10 of EP Revision 2 will be modified to note Shell's plans regarding operations in the HSWUA.

January 14, 2014 Comment

Shell responded that it will modify EP Revision 2, Section 10, regarding operations in the HSWUA. Shell is currently discussing the details of monitoring and mitigation measures with US Fish & Wildlife Service (USFWS). Shell will provide BOEM a copy of any Letter of Authorization (LOA) and any variances that it receives from USFWS. Shell's commitment to providing the LOA, with the additional information and modifications to EP Revision 2, Section 10.0, will satisfy this RFAI item.

EP Revision 2 Section 12 has been modified to include language regarding operations in the HSWUA. Shell will provide a copy of the LOA request to BOEM after it has been submitted to the USFWS.

RFAI No. 15 (Section 11.0, Page 11-1)

November 29, 2013 Comment

Provide decision criteria for when a sound source verification of the drillship and support vessels would not be necessary.

Shell plans to conduct sound source verification (SSV) on the vessels which did not have a SSV during the 2012 exploration drilling season. Since sound levels generated by drilling operations do not exceed sound levels where mitigation measures are required, the utility of SSVs, which are normally used to verify and adjust mitigation distances, is limited. Shell is also utilizing distributed arrays around the drilling location to measure cumulative sound impacts throughout the drilling process. These arrays are generating more useful information than individual SSVs.

Section 11 of EP Revision 2 will be modified to note Shell's plans regarding SSVs.

January 14, 2014 Comment

Shell stated it will conduct sound source verifications (SSV) on vessels which did not have a SSV during the 2012 program. Shell will modify EP Revision 2, Section 11.0, to note Shell's plans regarding SSVs; Shell's modifications will satisfy this RFAI item.

In EP Revision 2, Section 11.0 language under Stipulation #4 has been modified to note Shell's plans regarding SSVs.

RFAI No. 16 (Section 12.0, Page 12-1)

November 29, 2013 Comment

Provide performance and capability information (i.e., drill unit specifications) for the Polar Pioneer. BOEM expects information similar to what is provided for the primary drilling unit within EP Rev 1. At minimum, include: station keeping capabilities; drilling capabilities; and, Arctic-readiness modifications and capabilities. Also revise Table 2.a-1 to include any permits or certifications associated with the Polar Pioneer's ability to operate in the Chukchi Sea under Alaska OCS conditions.

The *Polar Pioneer* is specially designed and constructed to operate in cold, harsh, sub-zero environments. All structural components have a design temperature of -20 degrees Celsius as defined by DNV for unrestricted service. All areas other than the pipe deck and riser deck are fully enclosed from the environment. There is heat tracing on all the deck and walkways as well as all the piping. See the following table for the *Polar Pioneer* specifications. Shell does not plan to have the *Polar Pioneer* enter the Chukchi Sea as a primary drilling vessel. The *Polar Pioneer* will remain in Dutch Harbor on standby while the Discoverer is drilling in the Chukchi Sea. Therefore, there are no permits or authorizations under 30 CFR 550.213(a) for the *Polar Pioneer* as a drilling vessel in the Chukchi Sea, and Table 2.a-1 of the EP Revision 2 will not be modified.

POLAR PIONEER SPECIFICATIONS	
TYPE-DESIGN	Sonar Polar / Hitachi design
SHAPE	Harsh Environment Semi-Submersible
SHIP BUILDERS & YEAR	Hitachi Zosen, Ariake, Japan
YEAR OF HULL CONSTRUCTION	1985/1994/1999
DATE OF LAST DRY-DOCKING	No Dry dock since Hitachi Zosen shipyard 1983-1985
POLAR PIONEER DIMENSIONS	
MIN HULL LENGTH X WIDTH	Upper hull length x width: 85 x 71 m
LENGTH OF PONTOONS	116 m
MAX HEIGHT (ABOVE THRUSTERS)	102.15 m
HEIGHT OF DERRICK ABOVE RIG FLOOR	51.80 m
POLAR PIONEER MOORING EQUIPMENT	
MOORING CLASS	Posmoor-ATA
ANCHOR WINCHES	8 x Maritime Pusnes Model 750 double winches
ANCHORS	8 x 15 MT Stevpris anchors
ANCHOR LINES	Combined line and chain
SIZE/GRADE	K-4, 84 mm chain
LENGTH OF USABLE WIRE AND CHAIN PER ANCHOR	1969 - 2035 m per line
THRUSTER ASSIST	Both manual and automatic. APM 3000 installed.

POLAR PIONEER OPERATING WATER DEPTH	
MAX WATER DEPTH	450 m
MAX DRILLING DEPTH	6500 m
POLAR PIONEER DRILLING PACKAGE	
DRAW WORKS	Continental Emsco C3; 3,000 hp
ROTARY	Continental Emsco T4950-65 with 49½in opening
MUD PUMPS	3 x Continental Emsco FB 1600, triplex pumps
DERRICK	Maritime Hydraulics 50 x 12 x 12m;
PIPE RACKING	MH type NH 1147-50
DRILL STRING COMPENSATOR	Maritime Hydraulics (Aker Kvae) - Model AHC 25-270
RISER TENSIONERS	8 x 44 mt tensioners, 7.62 m stroke - Wicham A/S Model 100k
CROWN BLOCK	Maritime Hydraulics (Aker Kvae) - Model MH 1068-20
TRAVELING BLOCK	Maritime Hydraulics (Aker Kvae) - Model MH 1142 650 st
BOP	2 x Hydril 18¾in 15,000 psi double rams / 1 x10,000 psi GX Hydril annular
RISER	Hughes 21" riser - Model HMF
TOP DRIVE	Maritime Hydraulics DDM-650-HY
BOP HANDLING	BOP crane: Kita overhead crane 2 x 110 mt main hoists. Trolley 1 x BOP maritime Hydraulic 220 mt, 1 x 220 mt BOP.
POLAR PIONEER DISPLACEMENT	
SURVIVAL	43312 mt
DRILLING	46440 mt
POLAR PIONEER DRAFT	
DRAFT AT LOAD LINE	23 m
TRANSIT	9.15 m
DRILLING	23 m
POLAR PIONEER HELIDECK	
MAXIMUM HELICOPTER SIZE	Sikorsky S61N, Super Puma or similar helicopter
FUEL STORAGE ON HELIDECK	10 m3
POLAR PIONEER ACCOMODATIONS	
NUMBER OF BEDS	110
SEWAGE TREATMENT UNIT	Fredrikstad Sewage treatment plant Model CP 65

POLAR PIONEER PROPULSION EQUIPMENT	
THRUSTERS	4 each Rolls-Royce, Liaaen with adju azimuth and pitch
POWER CONSUMPTION EACH [kW]	thruster power consumption: 2400 kW each
TRANSIT SPEED	N/A, NON-SELF PROPELLED - Historically towed at 4-6 knots
GENERAL STORAGE CAPACITIES	
SACK STORAGE AREA	145 m^2
BULK STORAGE	
Bulk Bentonite (column/surface)	98 / 14 m^3
Bulk Barite (column/surface)	389 / 58 m^3
Bulk Cement (column/surface)	300 / 59 m^3
LIQUID MUD	
Active	199 m3 (active), 228 m3(reserve main deck)
Reserve	365 m3
Total Mud storage	792 m3
POTABLE WATER	4843 bbl
DRILL WATER	11140 bbl
FUEL OIL	11290 bbl
ARCTIC READINESS MODIFICATIONS	
RIG FLOOR	Fully enclosed
DERRICK	Fully enclosed
CEMENT AND FLUID SYSTEMS	Heat Traced
PIPEWORK	Heat Traced
CRANES	
DRILLING SYSTEMS	Heat Traced
ADDITIONAL INFORMATION	The installation is specially designed and constructed to operate in cold, harsh, sub-zero environments. All structural components have a design temperature of -20 degrees Celsius as defined by DNV for unrestricted service. All areas other than the pipe deck and riser deck are fully enclosed from the environment. There is heat tracing on all the deck and walkways as well as all the piping.

January 14, 2014 Comment

Shell submitted specifications for the* Polar Pioneer. *BOEM requests that Shell include this information in EP Revision 2, Section 12.0, to satisfy this RFAI item.

BOEM will require a copy of the U.S. Coast Guard (USCG) Certification of Compliance for the Polar Pioneer when available.

In EP revision 2, Section 13, Table 13.a-4 has been added listing the specification of the *Polar Pioneer*. A copy of the Certificate of Compliance to be issued by the USCG will be sent to BOEM when available.

RFAI No. 17 (Section 13.0, Page 13-1)

November 29, 2013 Comment

Identify and incorporate the relief drilling rig and support vessel(s) within this section.

30 CFR 550.224(a) requires the listing of vessels "… you will use to support your exploration activities." The *Polar Pioneer* and support vessels will be stationed in Dutch Harbor and are not part of the exploration drilling support fleet so Shell has determined that these vessels do not belong in Table 13.a-1.

	Polar Pioneer	Tugs (X2)[1]	Anchor Handler[2]	Barge and Tug	
				Barge[3]	Tug[4]
Length	279ft (85m)	146ft (44.4m)	274ft (83.7m)	400ft (122m)	150ft (45.7m)
Width	233ft (71m)	46ft (14m)	59.0ft (18.0m)	99.5ft (30.3m)	40ft (12.2m)
Draft	30ft (9m)	25ft (7.6m)	19.7ft (6.0m)	19.3ft (5.9m)	18.5ft (5.6m)
Accommodations	100	13	64		11
Maximum Speed		16kts (30kph)	16kts (30kph)		12kts (22kph)
Fuel Storage	11290bbl (1794m3)	5585bbl (888m3)	1190m3	390bbl (62m3)	1786bbl (284m3)
Liquid Storage	6180bbl (982m3)			76900bbl (1226m3)	

[1] specifications based on Crowley Ocean Class tug
[2] specifications based on the Tor Viking
[3] specifications based on the Tuuq
[4] specifications based on the Lauren Foss

January 14, 2014 Comment

Shell's IOP identifies* Polar Pioneer *as a support vessel (Table 1), in accordance with 30 CFR 550.220. Shell has linked the* Polar Pioneer *to the emergency plan, and therefore by extension, the* Polar Pioneer *supports the overall operation.

BOEM requires that EP Revision 2, Table 13.a-1 be modified to include the information to satisfy this RFAI item.

In EP Revision 2, Section 13, Table 13.a-3 has been added listing the *Polar Pioneer* and her support vessels stationed in Dutch Harbor.

RFAI No. 18 (Section 13.0, Page 13-1)

November 29, 2013 Comment

Provide a description of how the assets in Section 13-1 are designed and built or modified for the Alaska OCS Conditions (i.e., extreme cold, freezing spray, snow, extended periods of low light, strong winds, dense fog, sea ice, strong currents, and dangerous sea states). Explain how Shell will manage all assets within the EP drilling program. If Shell believes all or some of this information is included in the Integrated Operations Plan, submitted November 26, Shell may respond by citing the IOP page number referencing the responsive information.

The explanation must address:

- ***how contractor safety practices are aligned with Shell safety principles and standards;***

Shell Management of Contractors is defined in Section 5.0, of the IOP, pages 37-45.

- ***documentation of your integrated risk management approach for contractor management and oversight from mobilization through to demobilization;***

Shell Management of Contractors is defined in Section 5.0, of the IOP, pages 37-45.

- ***a schedule of your exploration program, including contractor work on critical components, and plans to tailor your management and oversight programs to Alaska OCS Conditions;***

The exploration program summary is outlined in the IOP Section1, pages 3 - 14. Information regarding contractor work on critical components and plans to tailor management and oversight programs to Alaska OCS conditions are found in Section 2, pages 15 – 23.

- ***documentation of Health, Safety, Security, and Environmental (HSSE) elements and risk management capabilities tailored for the risks and challenges of operating in the Alaska OCS;***

HSSE Risk Management approach is outlined in Section 5.2 of the IOP page 38.

- ***documentation about how vessels and equipment will be (or have been) designed, built, and/or modified to handle the Alaska OCS Conditions;***

Section 1.1 of the IOP, Vessel Operation, page 4, and Section 5.6 Alaska Maritime Assurance Process pages 42-44 defines the requirements for Winterization and Ice classification of assets working in the OCS

- ***drilling program objectives and timelines for each objective, including contingency plans for temporary abandonment of its well(s);***

Drilling Program Objectives and season timelines can be referenced in the IOP Section 1.0. Temporary abandonment of a wellbore for any reason will be done via the BSEE APM process and satisfy the requirements of 30 CFR 250.1721.

- ***documentation of mobilization and demobilization operations, including tow plans applicable within Alaska OCS Conditions, as well as anticipated maintenance plans;***

Asset Maritime Assurance processes, including mobilization and towing requirements are included Section 5.6 of the IOP pages 42-44.

- ***documentation of any resource sharing agreements for assets or mutual aid in the event of an emergency;***

Reference Shell's *Chukchi Sea Regional Exploration Program Oil Spill Response Plan* (OSRP) to identify additional Tier III resources, or those that go beyond that scaled to meet the WCD. Please reference the OSRP Appendix C, Out-of-Region Resources for a discussion of Shell's plans for accessing these resources. The OSRP Appendix B may also be referenced for Shell's Certification of Memberships and Contractual Agreements which includes OSRO memberships (Alaska Clean Seas and Marine Spill Response Corporation) and response contracts (ASRC Energy Services Response Operations and UIC Arctic Response Services). Part 2 of the OSRP provides a comprehensive description of Shell's Emergency Action Plan.

Tier III resources may be accessed through multiple venues, inclusive of:

1. OSRO memberships (e.g., ACS) ACS as a member of the Association of Petroleum Industry Co-op Managers (APICOM) (Reference Appendix C, Figure C-4, ACS Tactic L-10, Accessing Non-Obligated Resources)
2. direct contract with vendors and logistical support / supply contractors (Appendix G)
3. Shell Americas Response Team

- ***information regarding Shell's preparation and plans for staging spill response and cleanup assets;***

Reference Shell's Chukchi Sea Regional Exploration Program Oil Spill Response Plan (OSRP) for information regarding Shell's staged spill response and cleanup assets. Appendix C identifies those resources scaled to meet the WCD with specific discussion of recovery capacity. Offshore and nearshore oil spill response assets are scaled to demonstrate sufficient EDRC to meet the WCD. Based upon a conservative transit speed, these vessel-based assets are positioned and staged to respond within a specific time frame (as opposed to assignment to a specific location). Shore-based assets are also identified within Appendix C with further discussion of the scaled response provided in Part 2 (Specifically, Sections 2.4 and 2.7). OSR equipment will be staged based upon a defined transit speed and associated transit time as identified within Table C-3.

Appendix A, Table A-2 of the OSRP provides a summary of the major Shell-chartered and contracted equipment that is scaled to meet the WCD. This summary also identifies the equipment assigned to each Task Force and the distance to the projected response location.

- ***weather and ice forecasting capability for all phase of the exploration program, including transportation to and from the Alaska OCS, and plan for managing ice hazards and responding to extreme weather events;***

Weather and Ice forecasting capability is outlined in Section 1.4 of the IOP, page 9-11.

- ***accountability and auditing of the implementation of plans and oversight of contractors; and, benchmarks for determining successful implementation***

Oversight of contractors is outlined in Section 5 of the IOP pages 37-45.

<u>January 14, 2014 Comment</u>

Shell clarified or provided additional information in their responses and referenced useful information and page numbers within the IOP. See Items 1 - 14 in the RFAI - IOP for comments and requests pertaining to this RFAI item.

Shell accepts BOEM's response and notes that RFAIs on the Integrated Operations Plan (IOP) will be addressed by Shell in a submittal to BOEM on the IOP RFAIs separate from the EP Revision 2 RFAIs.

RFAI No. 19 (Section 13.0, Page 13-1 & 13-2)

November 29, 2013 Comment

The following vessels are identified as available when needed: an ice management vessel, M/V Nordica; an anchor handling vessel, M/V Aiviq; a resupply tug and barge, such as M/V Lauren Foss and/or Tuuq; an additional tug, similar to the M/V Ocean Wave; a science research vessel; an additional third offshore supply vessel; and an oil storage tanker, Affinity. Some of these vessels were listed in the Shell Camden Bay Exploration Plan. To ensure that the Chukchi Sea EP Rev 2 will be a stand-alone document, provide the same detail for each of these vessels as was provided for the Camden Bay EP: information where the support vessels are to be stationed when they are not in direct support of the drilling activities; and provide clarification of when and how these assets will be utilized and managed on a daily basis.

The M/V Nordica (or similar) is listed in the Camden Bay EP as the primary ice management vessel. For this Chukchi Sea EP Revision 2 it will be used on an occasional or as needed basis to help with ice management or other duties. It is likely that the Nordica will be in the lease sale area during the drilling season in case it is needed. Specifications for the Nordica that were provided for the Camden Bay EP are now provided for the "Ice Management Vessel" listed in Table 13.a-1 of the EP Revision 2.

The M/V Aiviq (or similar) is listed in the Camden Bay as an anchor handler. (At that time, the Aiviq was not yet named and was listed as Hull 247 in the Camden Bay EP). For this Chukchi Sea EP Revision 2, it will be used on an occasional or as needed basis to help with anchor handling duties with either the drilling vessel and/or the containment barge. The Aiviq (or similar) will be located near the drilling vessel, or near the containment barge outside the lease sale area in Kotzebue Sound depending on where it is needed. The Aiviq will be utilized as a vessel of opportunity skimming system in the event of a well control incident. Specifications for the Aiviq are provided for the "Anchor Handler" listed in Table 13.a-1 of the EP Revision 2.

The tug M/V Lauren Foss and Tuuq barge (or similar vessels) were not listed in either the Camden Bay EP or Chukchi Sea EP Revision 1. The tug and barge will provide general resupply support for the exploration drilling operations. It will remain in the Chukchi Sea most of the time, but may make trips to Dutch Harbor. When not in use, the tug and barge may be moored outside the lease sale area in Kotzebue Sound. Specifications for the Lauren Foss and Tuuq are provided for the "Tug and Barge" listed in Table 13.a-1 of the EP Revision 2.

An additional tug, the M/V Ocean Wave (or similar) was not listed in either the Camden Bay EP or the Chukchi Sea EP Revision 1. It will be available for use when needed. It will remain outside the Lease sale area, possibly moored in Kotzebue Sound, when not in use. Specifications for the Ocean Wave are provided for the "Tug" listed in Table 13.a-1 of the EP Revision 2.

The science (oceanographic research) vessel was not listed in either the Camden Bay EP or the Chukchi Sea EP Revision 1. It is planned that the science (oceanographic research) vessel will remain near the drilling unit throughout the drilling season to monitor waste stream discharges for compliance with the NPDES General Permit AKG-28-8100. Specifications for the science (oceanographic research) vessel are available in Table 13.a-1 of the EP Revision 2.

An additional OSV will be added to the existing two OSVs in order to bolster resupply to and from the drilling vessel. The OSVs will make several trips between the drilling unit and Dutch Harbor. Specifications for the OSV are available in Table 13.a-1 of the EP Revision 2.

The OST Affinity (or similar) is mentioned as an OST in the Camden Bay EP and the Chukchi Sea EP Revision 1. Rather than being centrally located between the Chukchi and Beaufort Sea as was described in the EP Revision 1, it will now be positioned closer to the drilling unit. The OST is not an added vessel, but is mentioned because of change of location during drilling.

January 14, 2014 Comment

Shell provided clarification regarding the named vessels and how they are referred in EP Revision 2, Table 13.a-1; Shell's modification to include this information in EP Revision 2, Section 13.0, will satisfy this RFAI item.

The vessel clarifications have been added to Section 13a) of the EP Revision 2.

RFAI No. 20 (Section 13.0, Page 13-1)

November 29, 2013 Comment

The Aiviq suffered four engine failures during the towing of the Kulluk in 2012. Provide information about the cause of the failure of the four engines on the Aiviq in 2012 and what steps or procedures has Shell adopted to prevent a reoccurrence.

Marine vessels chartered by Shell are subject to stringent U.S. Coast Guard inspection requirements contained in the Code of Federal Regulations. Various certificates and documents are issued by the Coast Guard to the vessel owner/operator to demonstrate compliance with the regulations. Shell will request these certifications and documents from the appropriate vessel operator so Shell can provide to BSEE any such certifications and documents required by their regulations (subject to appropriate confidentiality limitations, if any). Shell will provide copies of any such certifications and documents to BOEM.

January 14, 2014 Comment

BOEM will accept the USCG Certification of Inspection as demonstration of Shell's resolution of any issues associated with* Aiviq *in 2012. BOEM, however, still requires information about what steps or procedures Shell has adopted to ensure that similar problems will not be repeated in the future. Shell's response to Operation Item # 1 concerning changes Shell has made, or plans to make, to its project management / implementation /assurance plans will likely satisfy this RFAI item.

Prior to the start of the 2014 exploration drilling season, Shell will present to BOEM in-person how guidance, management and oversight have been improved since following the 2012 exploration season. This presentation will be before the start of exploration drilling activities in 2014.

RFAI No. 21 (Section 13.0, Page 13-2)

November 29, 2013 Comment

Provide additional information and clarification of assets and activities associated with the Goodhope Bay in Kotzebue Sound. Clarify what operational activities are planned; and if there will be any on-shore based activities/facilities associated with exploration drilling activities.

Shell plans limited support operations at Goodhope Bay in Kotzebue Sound. Up to three temporary mooring buoys may be established proximate to the DI-04-01 site identified in the Northwest Arctic Subarea Contingency Plan Potential Places of Refuge (PPOR) supplements the Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Release (Unified Plan). These temporary moorings may support the seasonal location of up to three tug/barge combinations. Moored activity would be minimal and consisting of routine machinery and equipment readiness checks and exercises, routine logistics support and other ancillary activities. Seasonal location of the tug/barge combinations in the vicinity of exploration activity, but not at the exploration site described elsewhere in this EP is thought to be safer for tug crews, as well as be more efficient and minimize risk exposures

operationally and logistically. Support for the moored barges is expected via a support landing craft (or similar) staging from a dock or terminal in the City of Kotzebue.

Section 13 a) of EP Revision 2 will be modified to reflect Shell's support operations in Goodhope Bay, Kotzebue Sound.

January 14, 2014 Comment

Shell responded with information describing limited support operations at Goodhope Bay in Kotzebue Sound. Shell's modifications to the EP Revision 2, Section 13.0, to reflect support operations in Goodhope Bay, will satisfy this RFAI item.

EP Revision 2, Section 13 a) has been modified with the above language regarding support operations in Goodhope Bay, Kotzebue Sound.

RFAI No. 22 (Section 13.0, Page 13-2)

November 29, 2013 Comment

Provide more information on activities (staging, fueling, duration, etc.) associated with landing craft operations.

The landing craft is intended to be used for primarily for crew transfers for vessels located in Kotzebue Sound. A secondary mission is transport of materials within the fleet if required. The vessel will transit with the fleet from Dutch Harbor at commencement of the season and will be refueled as required at Kotzebue marine terminal or at sea in accordance with the fuel transfer plan. The vessel will return to Dutch Harbor with the rest of the fleet on completion of the drilling season.

Section 13 a) of EP Revision 2 will be modified to include additional information on the landing craft operations.

January 14, 2014 Comment

Shell responded with additional information regarding planned landing craft activities. Shell's modifications to EP Revision 2, Section 13.0, to include this information will satisfy this RFAI item.

EP Revision 2, Section 13 a) has been modified with the above language regarding landing craft operations in Goodhope Bay, Kotzebue Sound.

RFAI No. 23 (Section 14.0, Page 14-1)

November 29, 2013 Comment

Shell proposes to increase its man camp capacity in Barrow from 75 beds to approximately 200 beds. Provide the information required by 30 CFR 550.225(a)(2); as well as any changes in existing permits that will be required for the expansion and operations of the camp. Any changes in permits and/or authorization should also be identified within Table 2.a-1; and identified and discussed within other applicable sections of EP Rev 2.

EP Revision 2 states that Shell would, move the existing Barrow man camp from its current location near NARL to a location near the airport, expand these facilities to accommodate 200 persons, and add a kitchen dining area. This plan has been modified. Shell now plans to: 1) maintain the existing 75-person man camp; 2) add a kitchen/dining/recreation (K/D/R) area to this existing 75-person man camp – the KDR unit would adjoin the existing facilities and be located on the same pad; and 3) lease / utilize additional accommodations at the existing 40-person Ukpeaġvik Iñupiat Corporation (UIC) modular

construction camp which is at the UIC storage location in Barrow and will relocated to its new location on the existing UIC pad (see the location figure under RFAI No.1 EIA 2.3, Page 2.9).

30 CFR 550.225(a)(2) requires the following information be provided with regard to onshore support facilities:

"(2) If the onshore support facilities are, or will be, located in areas not adjacent to the Western GOM, provide a timetable for acquiring lands (including rights-of-way and easements) and constructing or expanding the facilities. Describe any State or Federal permits or approvals (dredging, filling, etc.) that would be required for constructing or expanding them."

An Administrative Approval (development permit) was obtained the North Slope Borough (NSB) by UIC for the development of the existing 75-person man camp. The K/D/R will be permitted by the SOA Fire Marshall and the existing development permit with the NSB will be revised to show the addition of the K/D/R unit to the pad with the 75-person man camp. No State or Federal permits were required so no additional information is required for Table 2.a-1.

The planned 40-person construction camp will be installed on a similar sand pad constructed by the U.S. Navy in 1940's. These existing modular accommodations, owned by UIC, currently reside in Barrow and will be moved to the pad and installed on through pad pilings. Permitting of this facility is the owner's responsibility; the facilities are not Shell's. Shell will only be leasing the use of these facilities which are being constructed regardless of Shell's intentions.

Section 14 a) of EP revision 2 will be modified to reflect the added information regarding the Barrow man camp.

January 14, 2014 Comment

Shell has substantially modified the plans originally provided in EP Revision 2. Shell responded with information detailing the new plans for the Barrow man camp and the leasing of certain facilities. Shell's modifications to the EP Revision 2, Section 14.0, will satisfy this RFAI item.

EP revision 2, Section 14 a) has been modified to reflect the change in the man camp facilities.

RFAI No. 24 (Appendix A, Rev. 1)

November 29, 2013 Comment

With changes to proposed anchor radii, updated OCS Plan Information forms should be submitted with the EP Rev 2 (see section of form entitled "Anchor Locations for Drilling Rig or Construction Barge").

See the attached RFAI 24 document for the revised page 2 from form BOEM-137 for drill sites Burger F, J, R, S and V. Note of Clarification: Required well location coordinates include Lambert X-Y coordinates, but currently there is no standard used for Lambert projection in the Alaska OCS. In place of the Lambert coordinates, Universal Transverse Mercator (UTM) coordinates have been substituted.

January 14, 2014 Comment

Shell provided revised* OCS Plan Information *forms for proposed wells and has replaced Lambert X-Y coordinates with Universal Transverse Mercator (UTM) coordinates for each well's location. Shell's inclusion of these forms in EP Revision 2, Appendix A, will satisfy this RFAI item.

EP Revision 2, Appendix A includes the modified pages from form BOEM-137 for Burger drill sites F, J, R, S and V.

RFAI No. 25 (Appendix L)

November 29, 2013 Comment

Provide specifics regarding blowout well ignition and blowout well intervention. BOEM expects that safety principles and standards; accountability for implementations and auditing; and, benchmarks for determining successful implementation, etc. will be fully incorporated into the discussions regarding:

- ***the schedule of blowout well intervention (including contractor work on critical program components);***
- ***discrete and amalgamated timeline(s);***
- ***descriptions of mobilization and demobilization operations;***
- ***general maintenance schedule for vessels and equipment;***
- ***description of the primary and secondary (if applicable) mission and corresponding work designated for each vessel (including all contracted operations and contractors)***

The following table is also included in the response to the preceding RFAI #9. The table lists the schedule and timeline regarding mobilization to the Burger Prospect and finishing a relief well and provides a description of the duties of those vessels supporting the *Polar Pioneer*.

Activity	Unmooring at Dutch	Tow from Dutch to Burger	Mooring at Burger	Drilling to intercept point
Timing	1.0 days	7.5 days	1.5 days	28 days
Comments	Based on pulling and racking anchors and commencing tow. Rig will be fully crewed with TransOcean staff keeping equipment in a state of readiness	Built around 6 knots travel speed based on previous average tows with *Polar Pioneer* incorporating a variety of weather conditions and one active tug. In this case two tugs and a contingency anchor handle are available.	Based on 2 anchor handlers and past anchoring times.	Base time of 23 days from original estimate with logging, MLC and P&A operations removed. Adds in ranging runs. Nominal estimate of NPT at 20% takes estimate to 28 days. Additional information will be provided in the APD as required.

January 14, 2014 Comment

Shell provided a table listing a schedule for drilling a relief well. Shell addressed additional aspects of the well control plan within the response to Operations Item # 13. Shell's modifications to the EP Revision 2, Appendix L, to include a schedule for drilling a relief well will satisfy this RFAI item.

Shell has included a relief well drilling unit mobilization schedule for the *Polar Pioneer* and her support vessels to the Burger Prospect in Appendix L of EP Revision 2.

ENVIRONMENTAL

EFH

RFAI No. 1 (Section: EIA Fish and EFH, Page 4-5)

November 29, 2013 Comment

Seafloor Disturbance is addressed for the drilling sites in the EIA, Table 4.5-4. Provide similar information (e.g. the number of anchors, the surface area disturbed per anchor, the volume displaced per anchor, and the total seafloor area disturbed) for vessels moored in Kotzebue Sound--Opilio crab EFH will now be part of the analysis.

The EIA stated that Shell may install 2-4 mooring buoys in the Goodhope Bay area of Kotzebue Sound. At this time it appears most likely that three will be installed; therefore, this analysis is based on installation of three buoys. These buoys would be installed annually. The mooring buoys will be of two different designs; both types will be moored with conventional drag embedment anchors at this time we believe they will be 20,000 lb stockless anchors. One design (A) requires three such anchors; the other design (B) utilizes a single anchor (Table 4.1.5-1). Utilizing the anchor dimensions and drag lengths we estimate that the setting of the anchors during installation of the mooring buoys may disturb about 0.4 ac (1,449 m^2) of seafloor and displace about 1,049 cu yd (802 m^3) annually (Tables 4.1.5-1, 4.1.5-2, and 4.1.5-3).

Table 4.1.5-1: Estimated Area of Seafloor Disturbed Annually by Installation of a Mooring Buoy

Buoy Type	Anchors [1]	Anchor Scar Area [2]		Anchor Cable [3]		Total Disturbance Area / Buoy	
		ft^2	m^2	ft^2	m^2	ft^2	m^2
A	3	725	67	1,324	123	6,157	572
B	1	725	67	2,562	238	3,283	305

[1] Number of anchors associated with the buoy type
[2] Seafloor area disturbed by single anchor only during setting; based on a drag length 5x anchor length includes a 1.0 m area around scar where sediment would be bermed
[3] Assumes 1,620 ft anchor cable or chain on the seafloor with 0.8 ft wide disturbance; includes 1,500 ft caternary tow line for Type B

Table 4.1.5-2: Estimated Volumes of Seafloor Sediments Displaced by Installation of a Mooring Buoy

Buoy Type	Anchors	Anchor Scar Volume [1]		Anchor Cable Volume [2]		Total Volume of Seafloor Sediment Displaced / Buoy	
		ft^3	m^3	ft^3	m^3	ft^3	m^3
A	3	2,815	80	1,088	572	11,724	332
B	1	2,815	80	2,097	572	4,909	139

[1] Sediments disturbed by anchor only; based on a drag length 5x anchor length, anchor width, and anchor depth; does not include the 1.0 m area around scar where sediment would be bermed
[2] Assumes a 1,620 ft anchor cable or chain on the seafloor with 0.8 ft wide x 0.8 ft deep disturbance; includes 1,500 ft caternary tow line for Type B

Table 4.1.5-3: Estimated Annual Seafloor Disturbance and Sediment Displacement by Installation of All Mooring Buoys

Buoy	Anchors	Total Annual Seafloor Disturbance		Total Seafloor Sediments Displaced Annually	
		ft^2	m^2	yd^3	m^3
1	3	2,052	572	434	332
2	3	2,052	572	434	332
3	1	3,282	305	182	139
All	7	15,595	1,449	1,049	802

The seafloor disturbance associated with the moorings in Kotzebue Sound will occur within areas designated as essential fish habitat (EFH) for the snow or opilio crab. These impacts will be negligible given that the impacts would be temporary and would be limited to a very small portion of the opilio crab EFH in the Chukchi Sea. Generally, all waters less than 328 ft (100 m) in the Chukchi Sea south of Cape Lisburne are designated as opilio crab EFH.

Section 4.1.5 of the EIA for EP Revision 2 will be modified by adding the above information and tables. Section 4.1.6, Impact of Vessel Traffic on Fish and EFH will be modified to provide an analysis of the effects of the moorings on opilio crab EFH.

January 14, 2014 Comment

Shell indicated that the impacts to the Opilio crab EFH will be negligible given that the impacts would be temporary and would be limited to a very small portion of the Opilio crab EFH in the Chukchi Sea. Shell's modifications to EP Revision 2, Environmental Impact Analysis, Sections 4.1.5 and 4.1.6 with these tables and explanations will satisfy this RFAI item.

Shell has added the above text and tables (Tables 4.1.5-1, 4.1.5-2, and 4.1.5-3) quantifying potential seafloor impacts from the planned mooring in Kotzebue Sound, to Section 4.1.5 of the EIA for EP Revision 2. The analysis of potential effects on Opilio crab has been added to Section 4.1.6 (Impact of Vessel Traffic on Fish and EFH) of the EIA.

Sociocultural/Subsistence

RFAI No. 1 (Section: EIA 2.3, Page 2-9)

November 29, 2013 Comment

Provide full details regarding man-camps in Barrow and Wainwright. Provide maps and a detailed description to fully address the expansion (and new location) of the man camp from 75 to 200 persons in Barrow, to include precise location of the camp and changes in footprint to accommodate expansion. Also, describe the disposal of wastes (wastewater and solid waste handling) in terms of amounts and methods of disposal (impacts on NSB services) and provide associated permits.

EP Revision 2 states that Shell would, move the existing Barrow man camp from its current location near NARL to a location near the airport, expand these facilities to accommodate 200 persons, and add a kitchen dining area. This plan has been modified. Shell now plans to: 1) maintain the existing 75-person man camp; 2) add a kitchen/dining/recreation (K/D/R) area to this existing 75-person man camp the KDR unit would adjoin the existing facilities and be located on the same pad; and 3) lease / utilize additional accommodations at the existing 40-person Ukpeaġvik Iñupiat Corporation (UIC) construction camp. Passenger processing facility expansion and hangar repairs are planned for the Barrow airport area at this time. Additional blocks of hotel rooms may also be reserved at either the new Top of the World Hotel, or the old Top of the World Hotel if refurbished since the fire in the adjacent restaurant. The two pads where the 75-person and 40-person camps are/will be located are in the NARL area approximately 4.0 mi from the center of Barrow, and are located approximately 0.75 mi from each other. The pad locations are indicated in the attached Figure 2.3-2.

Shell's existing 75-person man camp consists of skid-mounted modular buildings. The planned K/D/R unit is approximately 166 ft long by 64 ft wide and will be installed on the existing pad at the southwest corner of the existing accommodations. The K/D/R unit will be placed on mats and dunnage on the existing pad material (sand/gravel). After the K/D/R unit is set, gravel will be hauled in and mixed with the beach sand in the driveway area of the pad along the back and end of the K/D/R over 14,375 sq ft (0.33 ac) of the existing pad to stabilize the new driving area (Figure 2.3-3). The K/D/R would service both man camps and overflow facilities.

The existing camp has been permitted with the North Slope Borough (NSB) with a Development Permit and a fill permit. The K/D/R will be permitted by the SOA Fire Marshall and the existing Development Permit with the NSB will be revised to show the addition of the K/D/R to the pad with the 75-person man camp. No State or Federal permits were required.

The UIC 40-person construction camp will be relocated from its existing location in Barrow to a similar sand pad constructed by the U.S. Navy in 1940's as indicated in Figure 2.3-2. The modular accommodations owned by UIC are currently unused and reside in Barrow. They would be moved to the pad and installed on through pad pilings. Permitting of this facility is not Shell's responsibility as the facilities are not Shell's; Shell will only lease the facilities once installed at the new location.

Blackwater (sewage) and graywater (showers, kitchen) from the two camps will be held in holding tanks at each site. Based on an average camp occupancy of 50 percent of capacity, and average per capita waste generation factors provided by the local utility, Shell expects to generate about 1,000 gal of combined blackwater and graywater wastes per day. These wastes will be picked up by the NSB with their routine service and treated in their waste water plant. These wastes generated by camps with temporary population of 40-115 persons, will not tax Barrow's municipal wastewater treatment system, which accommodates a population of over 4,000 people, and consists of a series of large water treatment lagoons.

Household trash from the camps will be stored in bear proof containers for all locations. These household wastes will be set up for collection by NSB's regular dumpster service, and will be disposed of at the NSB Landfill. Shell estimates, based on 2012 Barrow operations and accounting for the additional planned camp accommodations, that the two man camps may generate up to 200 cu yd of household trash per season, which represents less than 0.75 percent of the average annual volumes disposed of at the landfill.

Non-household waste generated at the camps will be stored in a 20-ft shipping container set up as a waste accumulation area located behind the primary camp. The accumulation area will hold any hazardous, non-hazardous and liquid wastes. All of Shell's Barrow facilities are operated as a Conditionally Exempt Small Quantity Generators of Hazardous waste by the EPA, and therefore a permit is not required and hold times do not apply. These wastes will be transported out of the Arctic and disposed of at licensed facilities as indicated in the EP Revision 1.

Expansion of the existing passenger processing facility (Figure 2.3-4) utilized by Shell in 2012 at the Barrow airport is also planned. The expansion would consist of four buildings totaling approximately 2,200 sq ft (204 m^2). The expansion would adjoin the existing passenger processing facility (Figure 2.3-5) and would occur on previously developed lands adjacent to the airport and controlled by the FAA. The facilities will be constructed and operated by UIC and leased by Shell. No State or Federal permits are required. The expansion will be permitted with the NSB.

Shell reserves rooms at the existing Olgoonik Oil Field Services Camp in Wainwright. Shell's oil spill response group will be housed and fed at these facilities. EP Revision 2 states that Shell may utilize a larger camp of up to 55 accommodations to accommodate certain contingencies such as Shell conducting crew changes through Wainwright, or onshore environmental studies in the area. At this time this would involve only the potential reservation of additional rooms. Construction of new facilities or expansion of existing facilities is not planned at this time.

With the exception of food waste from the camp kitchen, all wastes generated at the Wainwright camp (Figure 2.3-6) will be containerized and transported to either Oxbow Landfill in Deadhorse or the Anchorage Landfill in Anchorage, depending on the availability of barges. Food wastes from the kitchen will be disposed in the Wainwright landfill. These actions taken by Shell with respect to waste handling will minimize the impact to the community, including the landfill. Based on water usage information provided by the ADEC website, it is estimated that the response group will generate less than 200 gallons of black and gray water per day on average. This equates to approximately 2% of the estimated average generation rate for the entire village, based on a 2012 population of 575.

Section 2.3 of the EIA for EP revision 2 will be modified to include the above information and the following figures.

Figure 2.3-2 Barrow Man Camp Locations

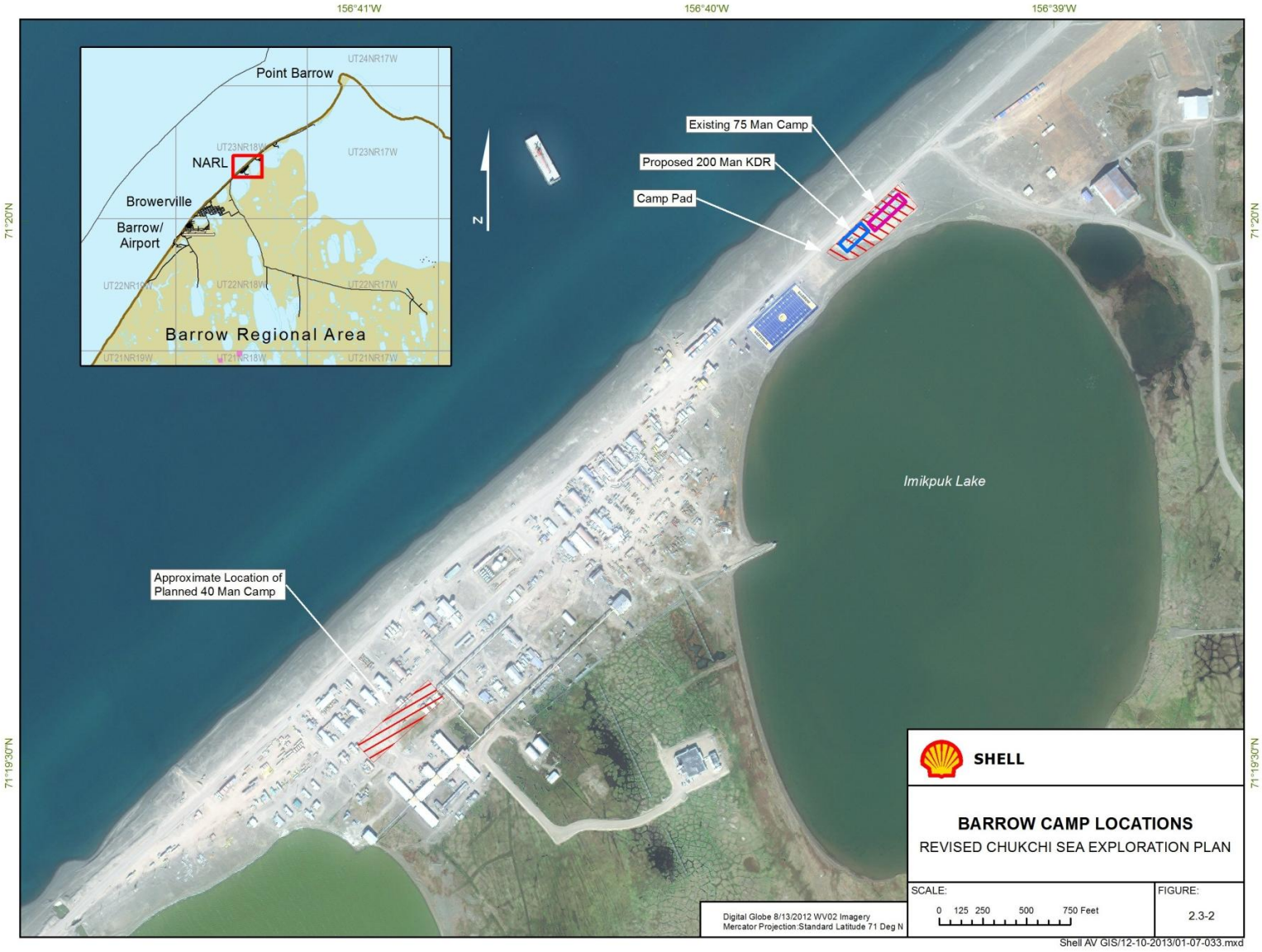


Figure 2.3-3 Layout and Planned Expansion of Shell's Existing 75-Person Man Camp

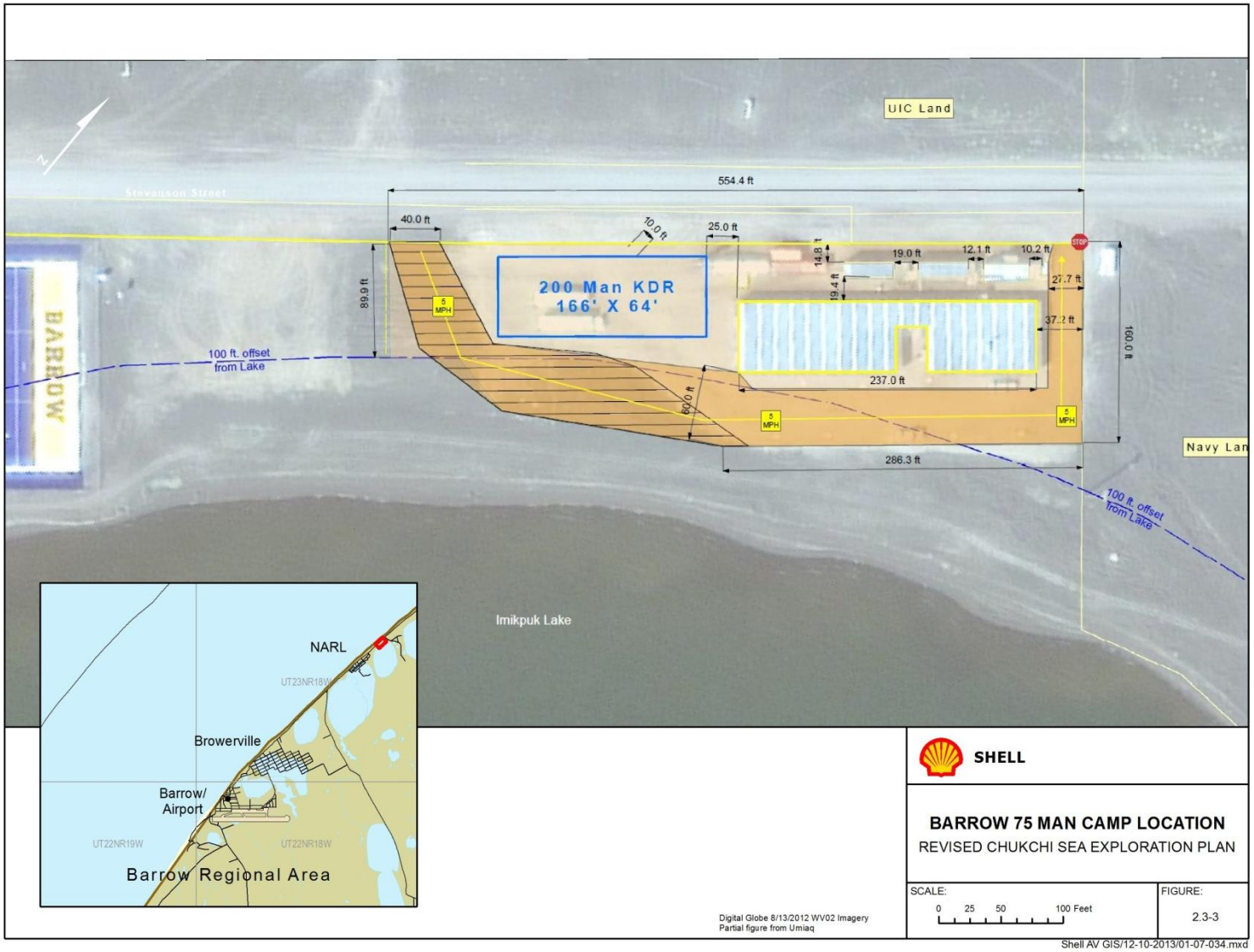


Figure 2.3-4 Passenger Facility Location

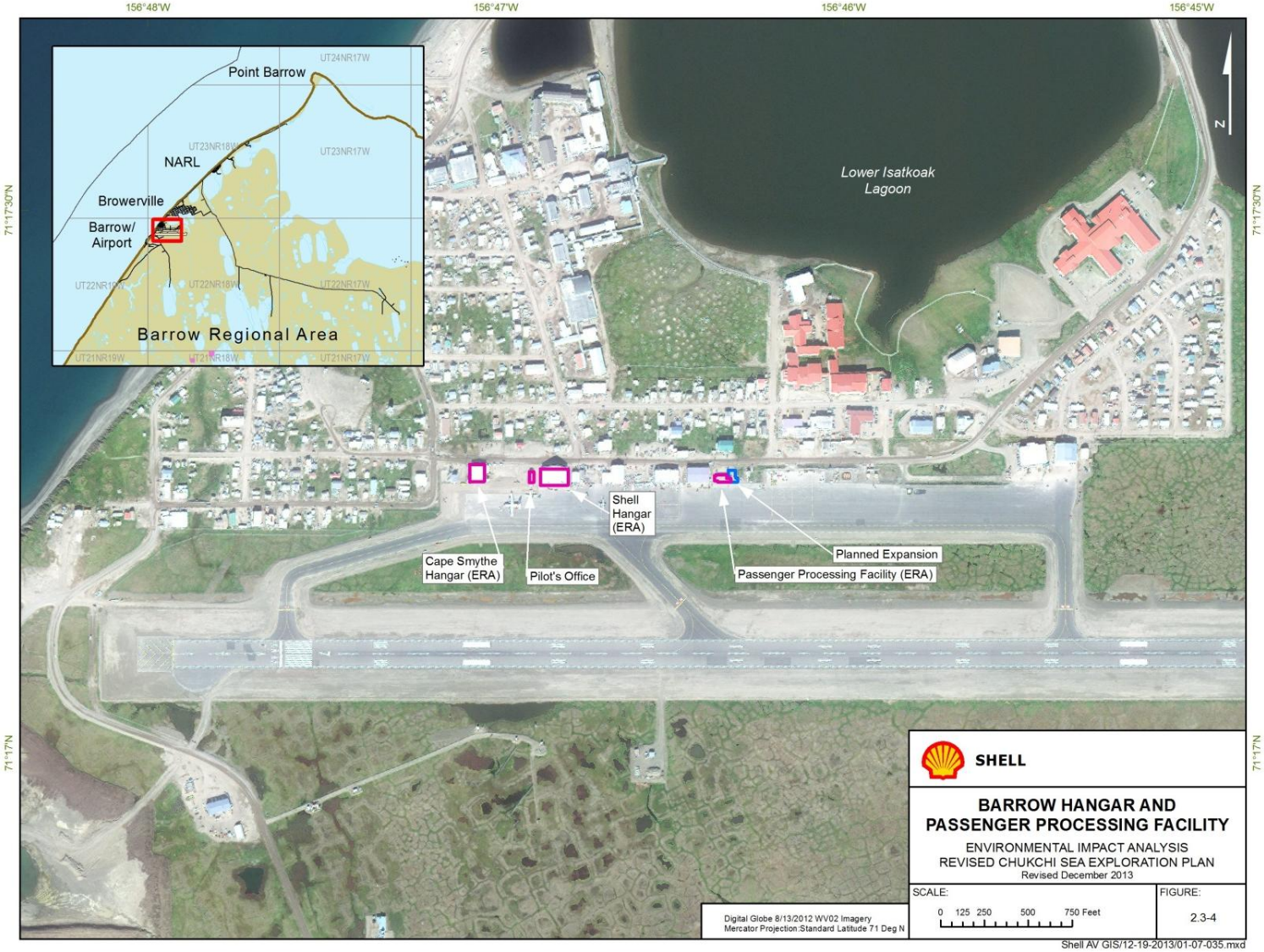


Figure 2.3-5 Passenger Facility Expansion Diagram

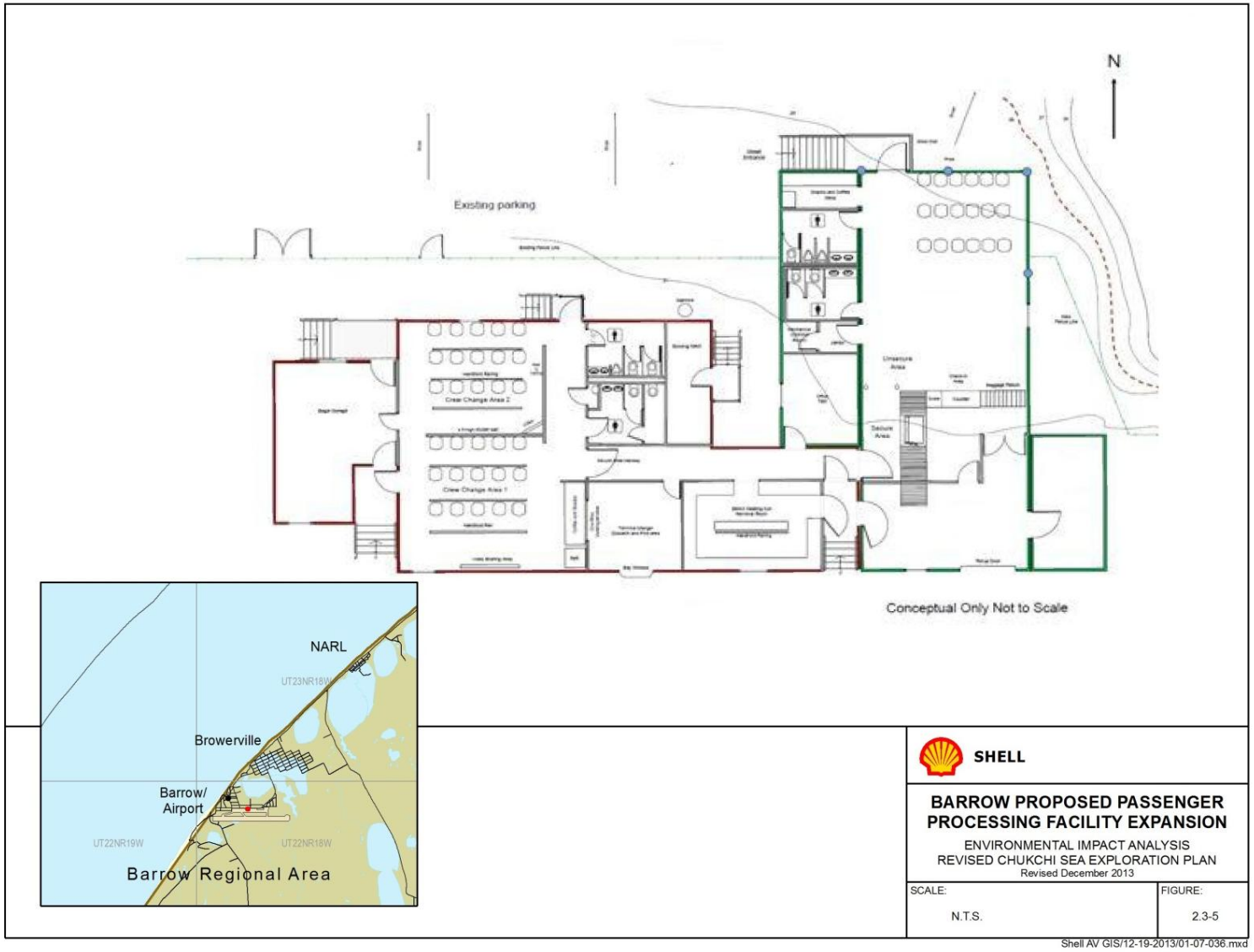
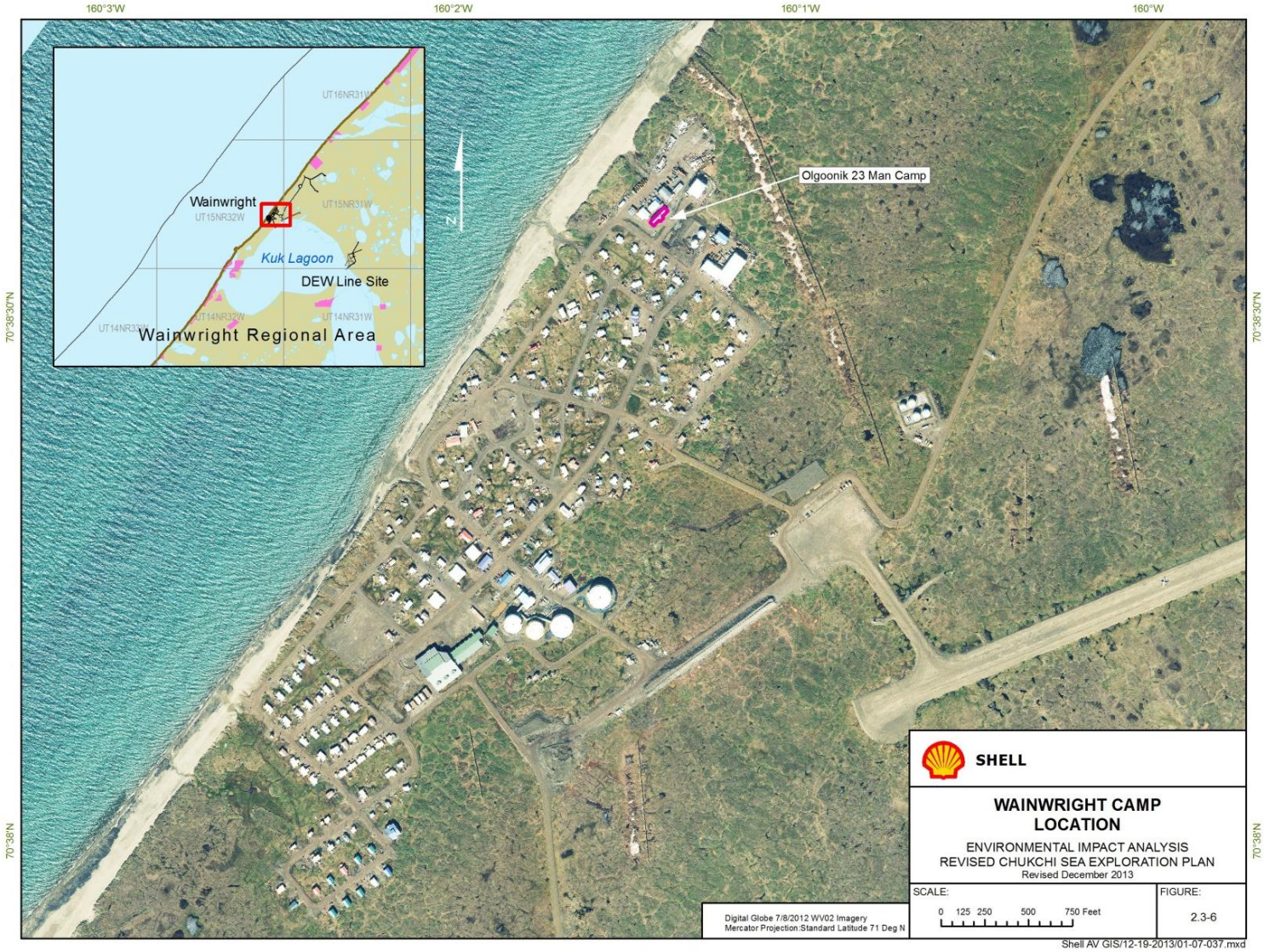


Figure 2.3-6 Wainwright Camp Location



January 14, 2014 Comment

Shell indicated that it plans to expand its existing man camp, add a kitchen/dining/recreational area, lease additional accommodations, complete a hanger expansion and repairs, and possibly rent additional rooms for its employees as necessary. Shell's modifications EP Revision 2, Environmental Impact Analysis, Section 2.3, with these tables and additional information will satisfy this RFAI item.

Section 2.3 of the EIA for EP Revision 2 has been modified with the addition of the above text and figures, which provide details on Shell's planned changes to shorebase facilities.

RFAI No. 2 (Section: EP 5.0, Page 5.1)

November 29, 2013 Comment

Provide the most recent UMIAQ reports: UMIAQ 2012 and UMIAQ 2013.

See the attached RFAI Socio 2 response documents.

January 14, 2014 Comment

The provided UMIAQ 2012 and UMIAQ 2013 reports satisfy this RFAI item.

RFAI is satisfied.

RFAI No. 3 (Section: EIA 4.1.12 & 4.1.13, Page 4-26)

November 29, 2013 Comment

Provide detailed information regarding numbers of transits, crew changes, and estimated treated sanitary waste quantities to be discharged from vessels.

The expected frequency of transit (trips) for each vessel directly associated with the exploration drilling program are provided in Table 2.1-3 on page 2-4 of the EIA for the submitted EP Revision 2.

Crew rotations vary depending on the specific job responsibilities the crew member has, and the vessel, aircraft, or terminal at which the crew member is stationed. Crew rotation on the drillship is expected to be 21 days for most personnel as indicated in EP Revision 1. Crew changes are planned to be carried out primarily by helicopter. The frequency of crew change helicopter flights may be up to 40/week as indicated on page 13-2 of the EP Revision 2 and page 2-5 of the EIA for EP Revision 2 as submitted. Also as indicated on page 2-1 of the EIA for EP Revision 2, Shell may as a contingency conduct crew changes using a vessel to transport crew members from the drillship or offshore vessels to the beach at Barrow. As described in the submittal, this is a contingency if the crew changes cannot be effected by helicopter. Because the crew changes by vessel are only a contingency, we cannot estimate the frequency or number of such vessel trips.

Estimates of the volumes of treated sanitary wastes that may be discharged from vessels associated with the exploration drilling program are provided Table 4.1.2-1 on page 4-11 of the EIA for EP Revision 2.

January 14, 2014 Comment

Shell indicated that crew changes by vessel will only be necessary during contingency events; it cannot estimate the frequency or number of such vessel trips. This response satisfies this RFAI item.

RFAI is satisfied.

RFAI No. 4 (Section: EIA Page 4-30)

November 29, 2013 Comment

Provide SA Beluga Whale harvest reports for the communities of Wainwright and Point Lay through 2012.

Beluga harvests reported to Shell Subsistence Advisors (SAs) for the 2010-2012 from the villages of Wainwright and Point Lay are provided below in Table 4.1.13-3.

The above information was provided as requested. A table will be added to the EIA for EP Revision 2 that provides annual beluga harvests for Barrow, Wainwright, Point Lay, and Point Hope for 1990-2012; however the harvest data are from the Alaska Beluga Whale Committee.

Table 4.1.13-3: Reported Beluga Harvests for Wainwright and Point Lay in 2010-2012

Village	Number of Belugas Reported as Harvested		
	2010	2011	2012
Wainwright	0	1	33
Point Lay	0	0	14

January 14, 2014 Comment

Shell indicated that a table will be added to the EP Revision 2, Environmental Impact Analysis, Section 4, that provides annual beluga harvests for Barrow, Wainwright, Point Lay, and Point Hope for 1990-2012; however the harvest data are from the Alaska Beluga Whale Committee instead of Shell's subsistence advisors. Shell's modifications to EP Revision 2, Environmental Impact Analysis, Section 4.0, with this additional table will satisfy this RFAI item.

A new Table 4.1.14-3 has been added to the EIA for EP Revision 2, which provides beluga harvests by year from 1990 through 2012 for Barrow, Wainwright, Point Lay, and Point Hope.

RFAI No. 5 (Section: Attachement C, 2.0 Page 2-1)

November 29, 2013 Comment

Provide a map showing the locations of the maximum pollutant concentrations occurring offshore within the subsistence areas.

Figure 1 has been prepared and shows locations of peak model-predicted offshore concentrations by receptor and averaging time based on the results in Table 2. For the offshore concentrations, BOEM also requested that drawings with isopleths be provided for the peak 1-hour concentrations within the offshore subsistence area. Figures 2 through Figure 6 provide those isopleths for NO_X, PM_{10}, $PM_{2.5}$, CO and SO_2, respectively.

This information also incorporates changes to the dispersion modeling results since submittal of Shell's Chukchi Sea Exploration Plan Revision 2 on November 6, 2013 (see response to Air Quality, RFAI No. 1). Table 1 (Case 1) and Table 2 (Case 2) provide the dispersion modeling results for the offshore locations based on the logic pattern described under response to Air Quality, RFAI No. 5.

Table 1. Summary of Maximum Offshore Concentration Locations (Case 1)

Offshore Peak Impacts		Peak Conc.	Background	Total	Criteria	Receptor	X Coord	Y Coord
Pollutant	Av. Time	in µg/m^3	in µg/m^3	in µg/m^3	in µg/m^3	No.	(km)	(km)
NOx	1-hour	18.5	53	71	3760	631	-230	94
PM10	1-hour	7.7	143	151	500	631	-230	94
PM2.5	1-hour	7.7	143	151	500	N/A	-230	94
CO	1-hour	12.6	1145	1158	55000	631	-230	94
SO2	1-hour	0.2	16	16	5200	577	-242	78

Table 2. Summary of Maximum Offshore Concentration Locations (Case 2)

Offshore Peak Conc.		Peak Conc.	Background	Total	Criteria	Receptor	X Coord	Y Coord
Pollutant	Av. Time	in µg/m^3	in µg/m^3	in µg/m^3	in µg/m^3	No.	(km)	(km)
NOx	1-hour	28.0	53	81	3760	631	-230	94
PM10	1-hour	11.6	143	155	500	631	-230	94
PM2.5	1-hour	11.6	143	155	500	631	-230	94
CO	1-hour	12.6	1145	1158	55000	631	-230	94
SO2	1-hour	0.2	16	16	5200	577	-242	78

Figure 1: Location of Maximum Offshore Concentrations (Case 2)

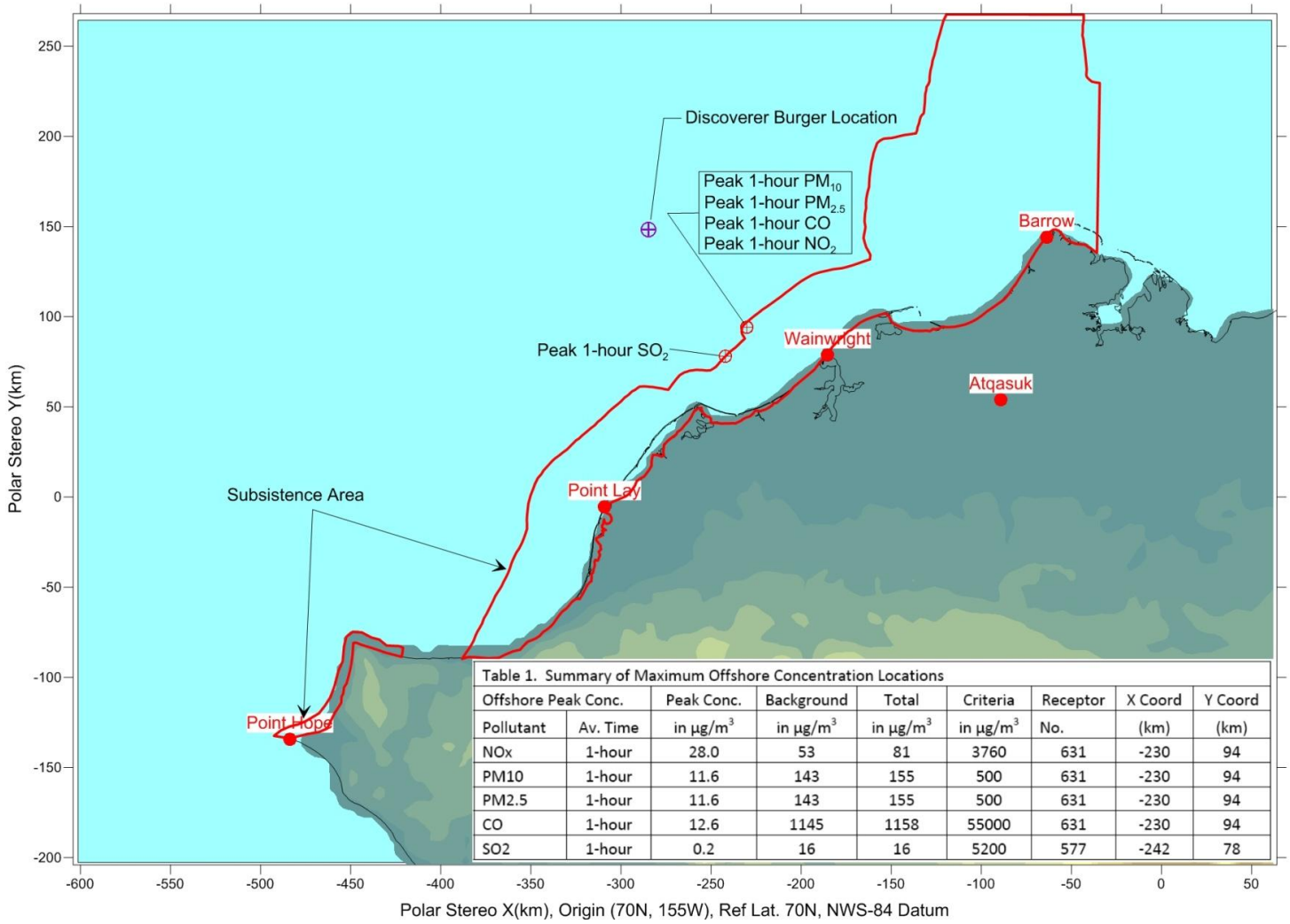


Table 1. Summary of Maximum Offshore Concentration Locations

Offshore Peak Conc.		Peak Conc.	Background	Total	Criteria	Receptor	X Coord	Y Coord
Pollutant	Av. Time	in µg/m³	in µg/m³	in µg/m³	in µg/m³	No.	(km)	(km)
NOx	1-hour	28.0	53	81	3760	631	-230	94
PM10	1-hour	11.6	143	155	500	631	-230	94
PM2.5	1-hour	11.6	143	155	500	631	-230	94
CO	1-hour	12.6	1145	1158	55000	631	-230	94
SO2	1-hour	0.2	16	16	5200	577	-242	78

Figure 2: Isopleths of peak 1-hour NO_2 Concentration in Offshore Subsistence Use Area in micrograms per cubic meter (µg/m3)

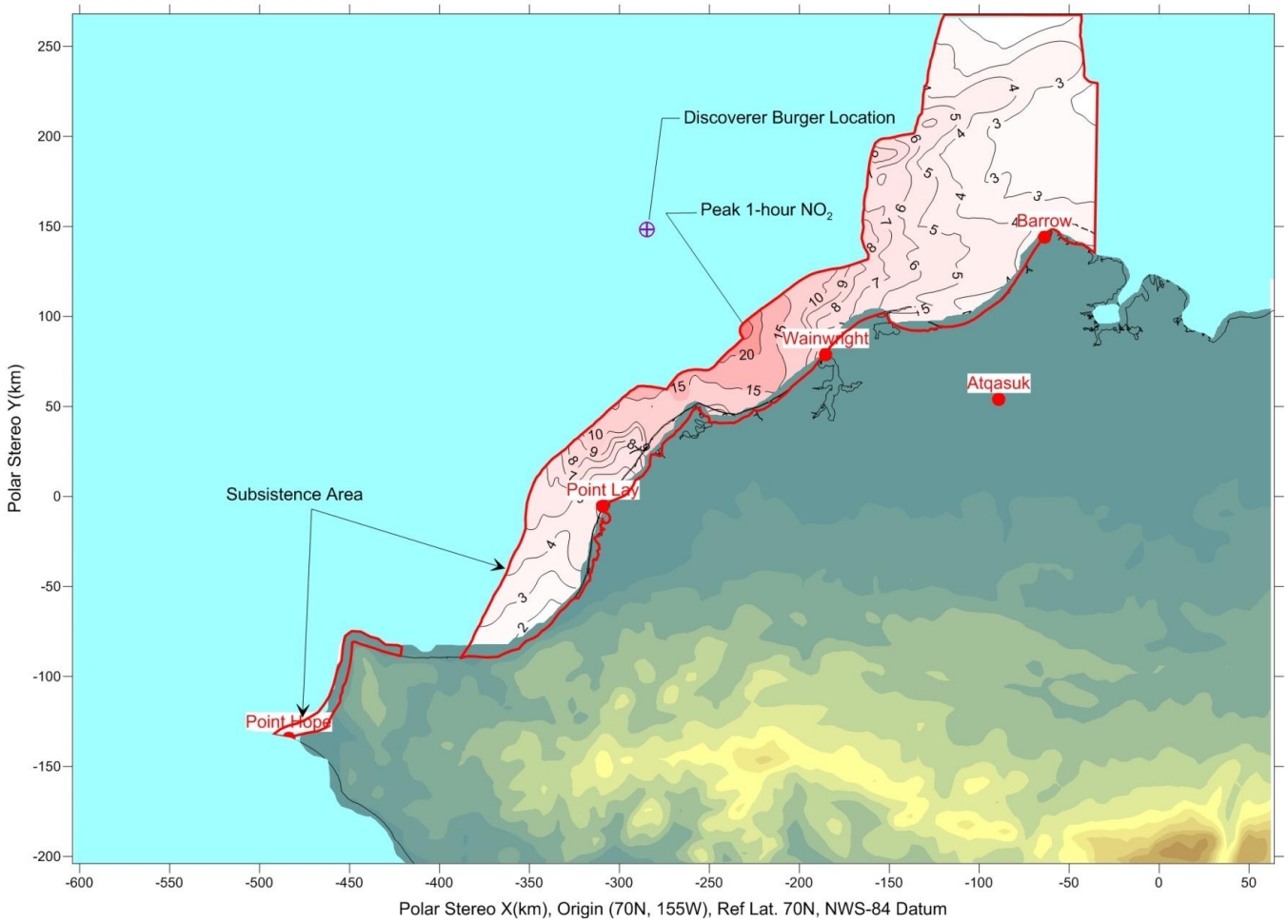


Figure 3: Isopleths of peak 1-hour PM_{10} Concentration in Offshore Subsistence Use Area in micrograms per cubic meter (µg/m3)

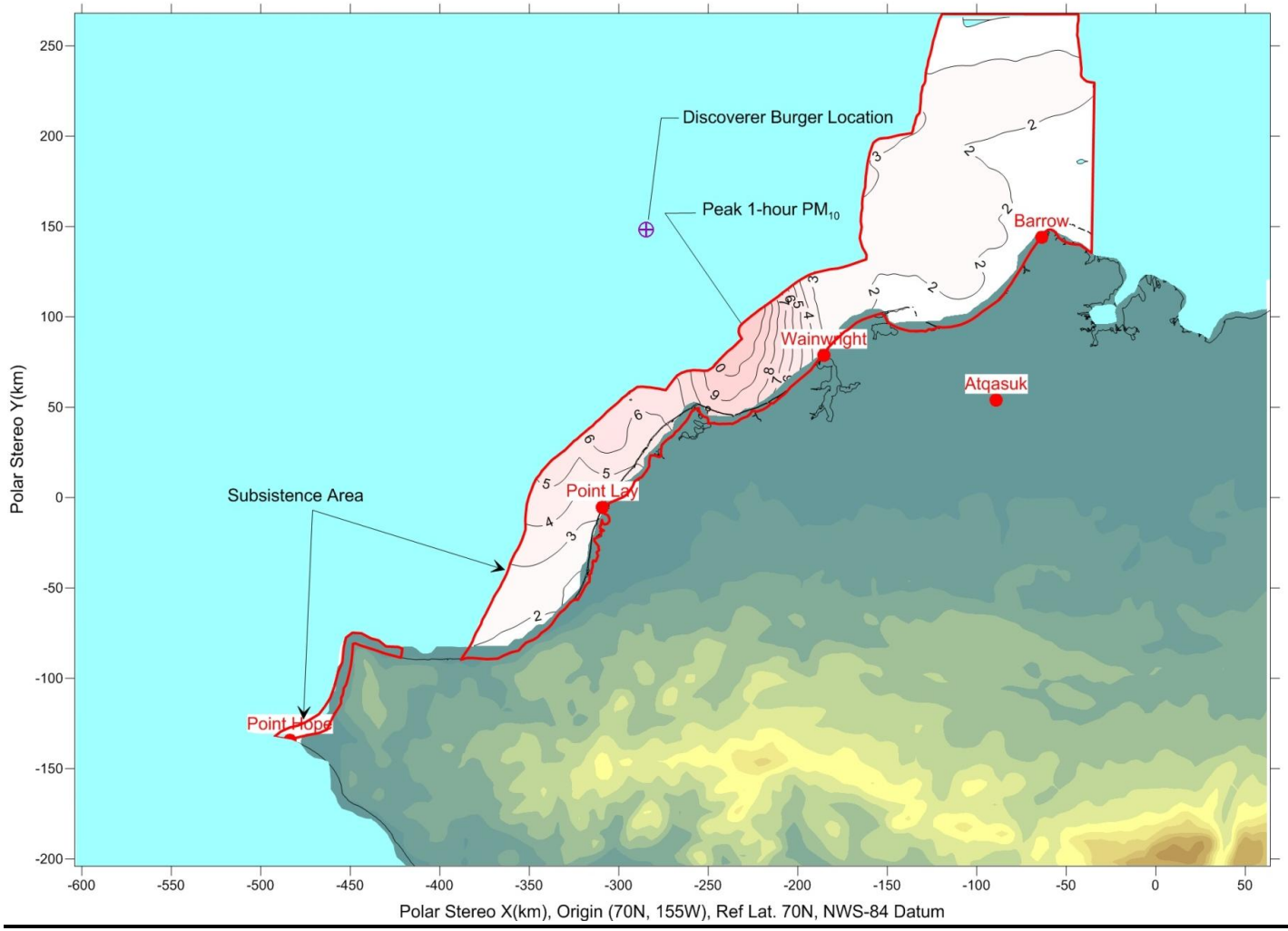


Figure 4: Isopleths of Peak 1-hour $PM_{2.5}$ Concentration in Offshore Subsistence Use Area in micrograms per cubic meter (µg/m3)

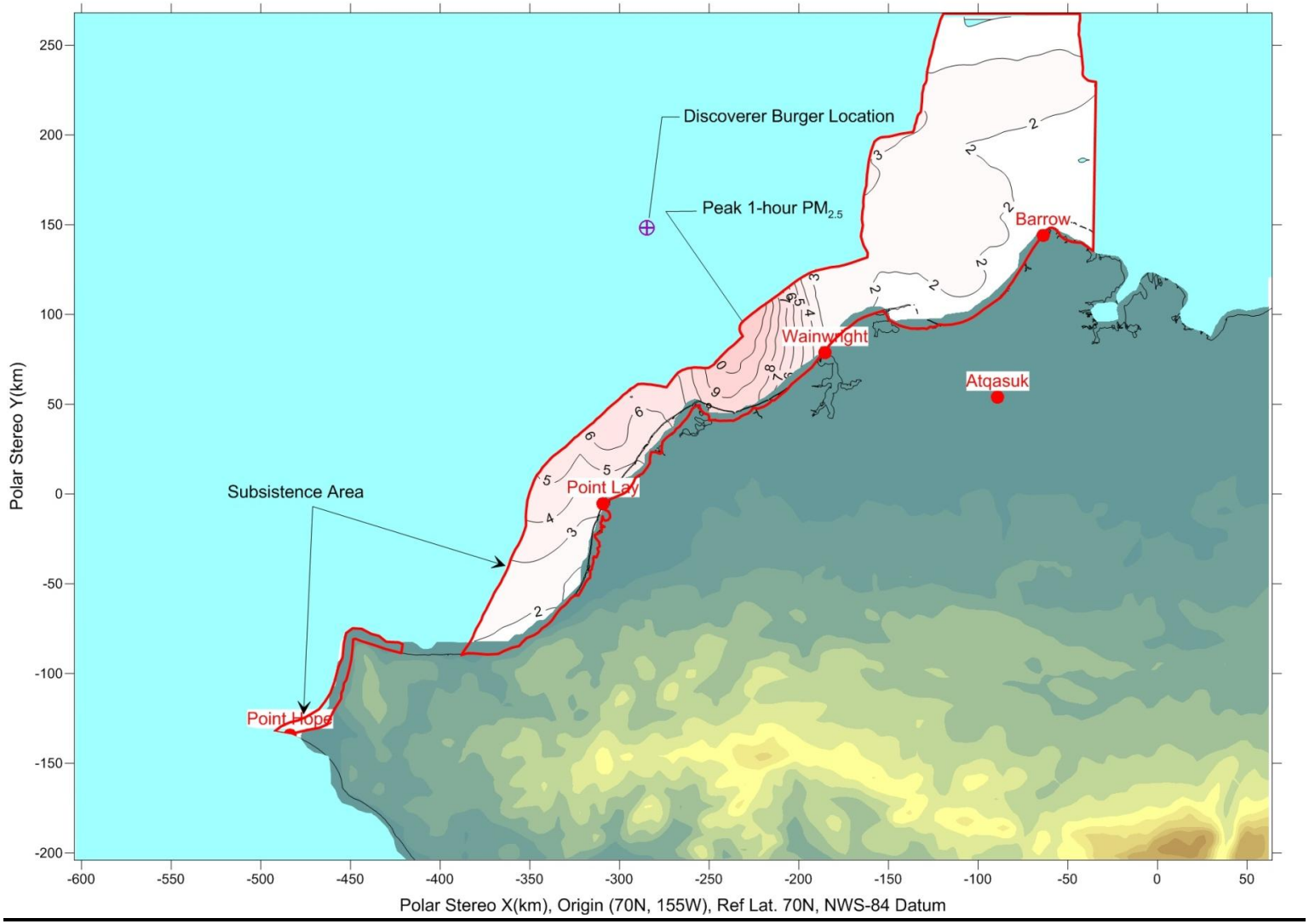


Figure 5: Isopleths of Peak 1-hour CO Concentration in Offshore Subsistence Use Area in micrograms per cubic meter (µg/m3)

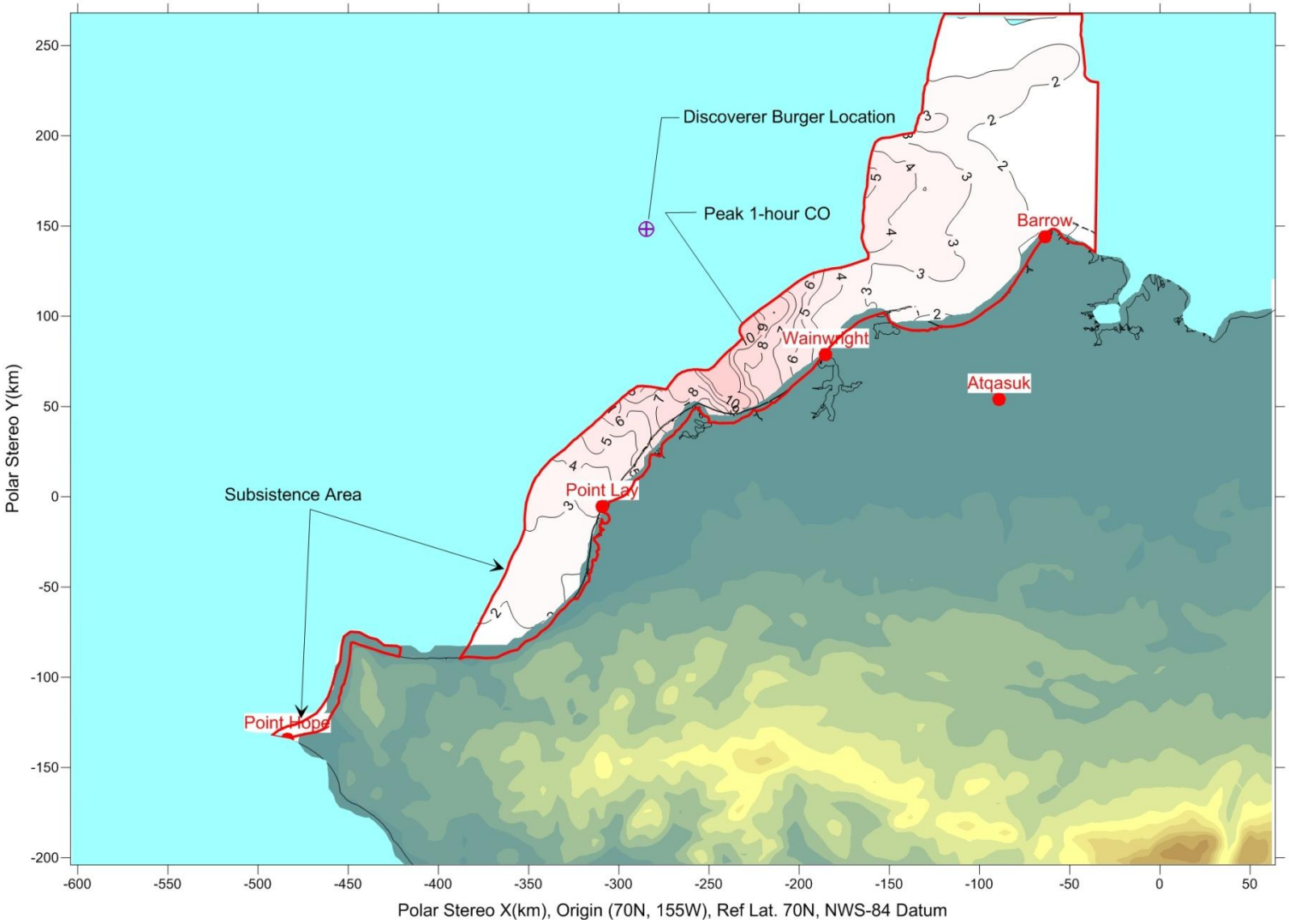
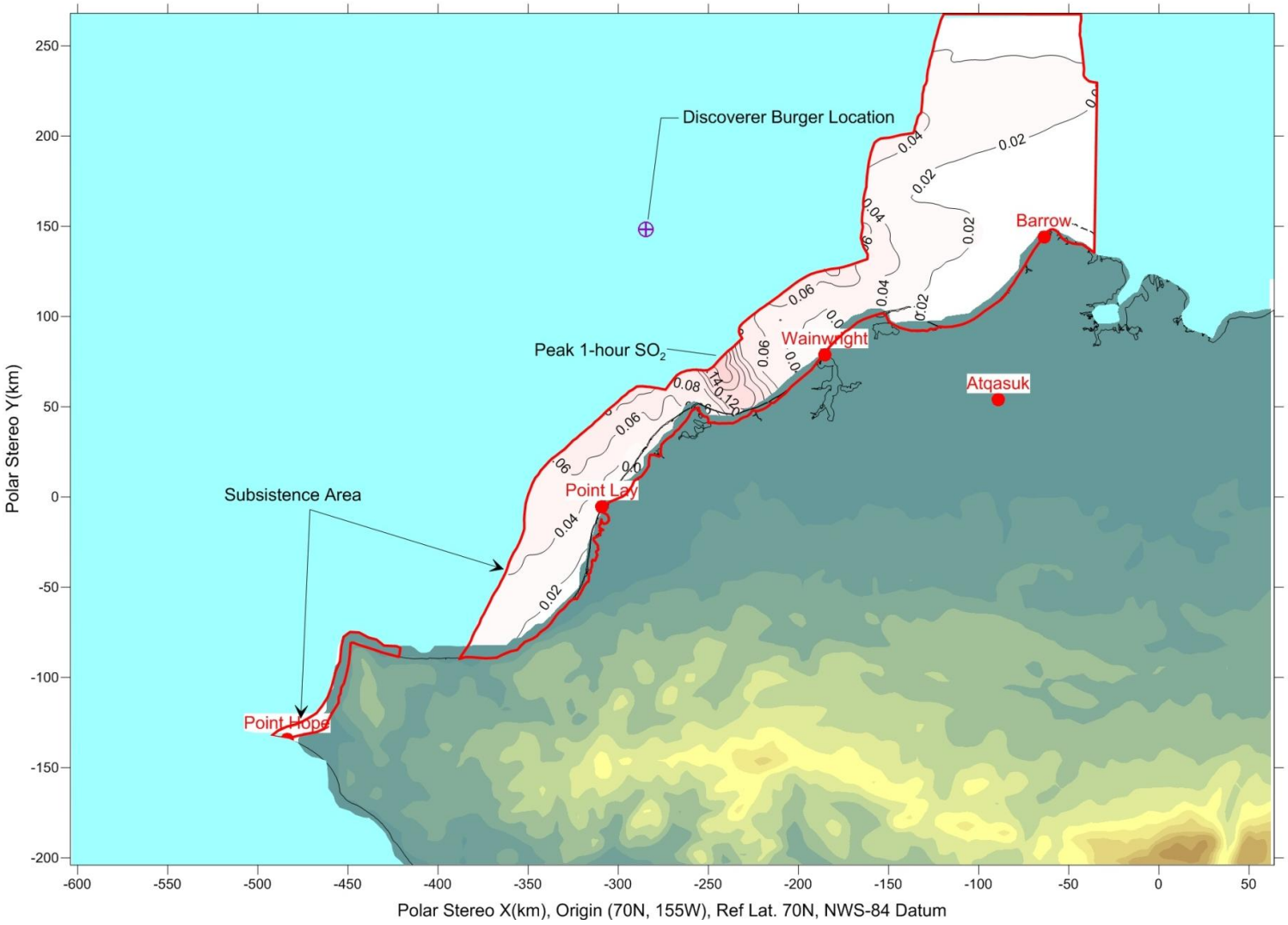


Figure 6: Isopleths of Peak 1-hour SO2 Concentration in Offshore Subsistence Use Area in micrograms per cubic meter (µg/m3)



January 14, 2014 Comment

Shell provided figures and tables illustrating the maximum pollutant concentrations occurring offshore within the subsistence areas. Shell's modifications to include these additional tables and figures in EP Revision 2, Section 2.0 will satisfy this RFAI item.

Shell includes the following new figures and tables in Attachment C of the EIA for EP Revision 2 to include this information for the offshore subsistence use area.

- New Figure 6 includes the locations of maximum predicted concentrations.
- New Figure 7 through Figure 11 includes the isopleths maps for NOX, PM10, PM2.5, CO, and SO2, respectively.
- Revised Table 5 includes new maximum predicted concentrations.
- New Table 6 includes coordinates of maximum predicted concentrations.

Please note, as described under responses to RFAIs regarding Air Quality, Shell is now providing a revised emission unit inventory and related dispersion modeling results. These revisions impact the original response provided under the November 29, 2013 to this RFAI.

Archaeology

RFAI No. 1 (Section: EP 13.0(a) Page 13-2)

November 29, 2013 Comment

Provide full details regarding the staging of near shore tug and barge in Goodhope Bay: precise location, moorings, depth, distance from shore, any other seabed disturbance, discharges, staffing, etc. If the seabed will be disturbed, provide an archaeological report or information sufficient for BOEM to determine that no historic properties will be affected.

The precise location of mooring is yet to be determined; however it will be in the vicinity of 66° 13' N 163° 28' W, which is approximately 7.0 nmi from land on the 5.0 fathom contour. Setting of three mooring buoys is anticipated with each buoy having up to three anchors.

Setting and retrieval of the anchors will result in some disturbance of the seafloor, but the extent of the disturbance will be small. Shell selected the area in large part because it has been selected and approved as a potential place of refuge (PPOR) in the Northwest Alaska Subarea Plan. The review process for selecting PPORs considers the existence of sensitive resources such as historic properties. Subsea surveys have not been conducted at the location, but it is the conclusion of an archaeological review requested by Shell (RFAI Arch 1 attachment) that there is low potential for any effects to historic resources from the planned moorings and staging in Goodhope Bay.

Vessels will remain compliant with the existing waste management plan, MARPOL regulations, and Vessel General Permit for any discharge of gray water or treated effluent. Crew changes will occur throughout the season using a landing craft vessel (yet to be contracted) transiting out from Kotzebue to the vessel locations in Kotzebue Sound. Vessels may also receive resupply of food stores via this landing craft.

Section 13 a) of the EP revision 2 will be modified to include this additional mooring information. Shell will modify the text in Section 2.1 of the EIA for EP Revision 2 to reflect the information provided above. A new section (Section 4.1.12 Impact of Vessel Traffic (Mooring) on Cultural Resources) containing some of this analysis will be added to the impact analysis in the EIA.

A technical memorandum on the archaeological resources of the area is attached - RFAI Arch 1 document.

January 14, 2014 Comment

Shell provided a technical memorandum on the archaeological resources of the mooring area. Shell's modifications to EP Revision 2, Section 13.0, and Environmental Impact Analysis, Section 2.1 and Section 4.1.12, to include additional mooring information will satisfy this RFAI item.

EP Revision 2, Section 13 a) has been modified to include the additional language regarding mooring in Goodhope Bay, Kotzebue Sound.

Details on the water depth at the mooring location in Kotzebue Sound and discharge management have been added to the EIA for EP Revision 2 in Section 2.1 and 4.1.5. Section 4.1.5 of the EIA has been modified with a quantitative description of the potential seafloor impact of the mooring, including the addition of three new Table 4.1.5-1, 4.1.5-2, and 4.1.5-3. A new Section 4.1.12 Impact of Vessel Traffic (Mooring) on Cultural Resources, containing the above-referenced analysis of potential affects archaeological resources, has been added to the EIA.

RFAI No. 2 (Section: EIA 4.3.2 Page 4-47)

November 29, 2013 Comment

Provide an archaeological report on the proposed camp in Barrow or information sufficient for BOEM to ensure that no historic properties will be affected.

Shell's existing 75-person man camp will be expanded by adding a Kitchen / Dining / Recreation (K/D/R) unit. The primary camp is on a pad constructed by UIC in 2012; the facilities on the pad, including the planned K/D/R expansion, are Shell facilities. No State or Federal permits were required of UIC for construction. Construction was permitted with the North Slope Borough and no archaeological reports were required or prepared. A review of the AHRS database indicates there are historic properties in the area including the NARL facilities themselves the NARL Historic District (BAR-00075), which has been determined eligible for National Register of Historic Places listing by the Alaska State Historic Preservation Officer, but not been nominated to the Register. Any effects to BAR-00075 from the installation and expansion of Shell's 75-person man camp with a K/D/R unit will be temporary and reversible. Thus these effects should not affect the historic integrity of the NARL Historic District. The existing accommodations and the planned K/D/R unit are modular, portable, facilities that will only be there as long as Shell's exploration drilling program requires them. The facilities are located on mats and skids and are self contained, not connected with municipal utilities.

Shell now plans to also use a 40-person man camp in the same area. This man camp is being relocated by UIC. Shell plans to lease / reserve the accommodations for up to 40 persons at this site.

A new section (Section 4.3.3 Impact of Shorebase Increases on Cultural resources and Historic Properties) containing the above information and analysis will be added to the EIA for EP Revision 2.

January 14, 2014 Comment

Shell indicated that a new section, EP Revision 2, Environmental Impact Analysis, Section 4.3.3 Impact of Shorebase Increases on Cultural Resources and Historic Properties, will be added to provide additional information and analyses describing how Shell's camp should not affect the historic integrity of the NARL Historic District. This additional information and modifications to EP Revision 2 will satisfy this RFAI item.

A new Section 4.3.3 Impact of Shorebase Expansion on Cultural Resources has been added to the EIA for EP Revision 2. The new section contains the above-referenced analysis of potential effects on the NARL Historic District.

Birds

RFAI No. 1 (Section: EIA Preface, Page xviii)

November 29, 2013 Comment

Provide report in electronic format: "Distribution and abundance of seabirds in the northeastern Chukchi Sea, 2008 – 2012" (Gall and Day 2013).

Shell has attached an electronic copy of the report Distribution and abundance of seabirds in the northeastern Chukchi Sea, 2008 – 2012" (Gall, Day, and Morgan 2013). The report was in a draft form (Gall and Day 2013) at the time EP Revision 2 was prepared. The attached file (RFAI Birds 1) is for the final report.

January 14, 2014 Comment

Shell provided Distribution and abundance of seabirds in the northeastern Chukchi Sea, 2008 – 2012 (Gall, Day, and Morgan 2013) report. This RFAI item is satisfied.

RFAI is satisfied.

RFAI No. 2 (Section: EP Appendix I, Page i)

November 29, 2013 Comment

Provide a description of the measures Shell took, or will take, to satisfy the conditions of Lease Stipulation 7 regarding bird collisions for the Polar Pioneer.

Stipulation number 7 does not apply to the *Polar Pioneer* when it is moored in Dutch Harbor.

January 14, 2014 Comment

BOEM concurs with Shell that Lease Stipulation 7 does not apply to the Polar Pioneer when it is moored in Dutch Harbor; however, BOEM requests verification that the Polar Pioneer is prepared to comply with Lighting Protocols required in Lease Stipulation 7, in case it is necessary for the vessel to move northward.

Shell will not verify that an emergency-only vessel, the *Polar Pioneer* which is the relief well drilling unit staged in Dutch Harbor for the next drilling season, need be compliant with lighting protocols in Lease Stipulation 7 in the event the vessel moves northward.

RFAI No. 3 (Section: EP 13.0, Page 13-1)

November 29, 2013 Comment

Provide IHA and LOA applications.

According to 30 CFR 550.213(a) Shell is only required to list the federal, state and local application approvals or permits Shell must obtain to conduct the proposed exploration activities.

The IHA application was submitted to NMFS on December 3, 2013 and is attached. The LOA application has not yet been submitted to the USFWS. When it is submitted to the USFWS a copy will be sent to BOEM.

January 14, 2014 Comment

To satisfy this RFAI item, confirm whether or not Shell's contractor will be entering the Ledyard Bay Critical Habitat Unit (LBCHU). Figure 8 in the Marine Mammal Monitoring and Mitigation Plan submitted with Shell's IHA Application appears to indicate that the acoustic recorders previously deployed in the LBCHU have been removed.

If Shell's contractor will be entering the LBCHU, please confirm that Shell will continue to follow the conditions specified in the July 25, 2013 letter from David Johnston (BOEM) to Susan Childs (Shell) regarding Shell's request for approval to deploy and recover acoustic recorders within the LBCHU.

As indicated in Figure 8 of the Shell's Marine Mammal Monitoring and Mitigation Plan, no acoustic recorders will be deployed in the LBCHU to monitor activities covered in EP Revision 2.

RFAI No. 4 (Section: EP Attachment A, Page A-3)

November 29, 2013 Comment

Correct the title to remove the parenthetical "(Stipulation Area)." Stipulation 7 applies to the Chukchi Sea, not only to the listed blocks.

Shell has removed the language (Stipulation Area) from the title.

January 14, 2014 Comment

Shell indicated that it has removed the language (Stipulation Area) from the title within the modified EP Revision 2; the modification will satisfy this RFAI item.

EP Revision 2, Appendix I, Attachment A has been modified. *(Stipulation Area)* has been removed from the title on page A-3 of Appendix I and is attached to this submittal.

Oil Spill

RFAI No. 1 (Section: EP 13.0, Page 13-2)

November 29, 2013 Comment

Provide information regarding whether fuel transfers will occur within Kotzebue Sound/Goodhope Bay for tugs, capping stack barge, or near shore barge. If fuel transfers will occur provide the following:

1) ***how many times might refueling occur during the season of operation;***
2) ***an estimate of fuel spill volume (if a hose ruptures, for example);***
3) ***type of fuel that would be transferred;***
4) ***minimum distance to shoreline;***
5) ***verification that the "Shell Fuel Transfer Plan" is in effect and applicable to these operations; and***
6) ***any mitigation measures in place to address fuel transfer spills, if they occur***

The only vessels requiring refuel whilst moored in Kotzebue sound are the Arctic Challenger (ACS Barge) and CORBIN FOSS (Tug for ACS). These are expected to be refueled with approx 100,000 gallons ULSD (ultra-low sulfur diesel) once each during the operating season. The mooring location is in excess of 6nm from land, in vicinity of 66 13N 163 28W. If required, Shell intends to refuel via a commercial fuel barge performing regularly scheduled fueling operations along the coastal communities of Alaska. The Fuel Transfer plan will be in effect for any fuel transfer operations.

January 14, 2014 Comment

Shell provided information regarding the refueling of the* Arctic Challenger *and* CORBIN FOSS *in Kotzebue Sound/Goodhope Bay. Shell's modification to include this information within EP Revision 2, Section 13.0, will satisfy this RFAI item.

EP Revision 2, Section 13 a) has been modified to include the refueling information for the ACS.

General

RFAI No. 1 (Section: Appendix O, EP 5.6, Page 23)

November 29, 2013 Comment

Clarify "as-yet undefined ports" and the vessels that will be using these ports.

Vessel staging and anchor locations outside the area used for the NEPA air quality analysis include Dutch Harbor and Goodhope Bay in the western part of Kotzebue Sound.

Section 5.6 of Appendix O will be clarified as indicated in the response above.

January 14, 2014 Comment

Shell indicated that vessel staging and anchor locations outside the area used for the NEPA air quality analysis include Dutch Harbor and Kotzebue Sound/Goodhope Bay. Shell's modification to include this information in EP Revision 2, Appendix O, Section 5.6, will satisfy this RFAI item.

Shell includes this information in EP Revision 2, Appendix O, Section 5.6.

RFAI No. 2 (Section: EP Table 6.c-2, Page 6-5)

November 29, 2013 Comment

Provide an explanation for the inclusion of the additive "biocide" in the drilling fluid components. What are its effects to wildlife and how long does it remain active? If this material is to be released into the ocean, provide detailed information about its potential effects.

Micro-organisms, primarily bacteria, buildup naturally in untreated mud systems; these bacteria break down various components of the drilling fluids degrading the drilling fluids. The biocide Busan 1060 was added as a contingency drilling fluid component that may be used to prevent this bacterial growth.

EPA (2008) has concluded that the biocide is practically non-toxic to birds, slightly to moderately toxic to laboratory mammals, and practically non-toxic to moderately toxic to marine species (fish and invertebrates). A maximum of 0.4 pounds per barrel of Busan 1060 is planned for any water based fluid formulation. Shell's current drilling fluid plan (MI-SWACO 2013) contains the results of toxicity tests on 17 different water based drilling fluid formulations, all of which contain 0.4 pounds per barrel of the biocide Busan 1060. Of the 17 tests, six of the fluids had LC50 values >500,000 ppm with the remaining 11 tests ranging between 91,800 ppm and 365,000 ppm.

EPA's NPDES General Permit AKG-28-8100 requires operators to use drilling fluids have an LC50 value greater than 30,000 ppm and this must be verified and documented by laboratory testing. EPA (2012) concluded in their Ocean Discharge Criteria Evaluation prepared for General Permit AKG-28-8100, that such drilling fluids will not result in unreasonable degradation of marine waters, and this included an assessment of persistence and bioaccumulation of the drilling fluids and their components in the Chukchi Sea. The EPA further concluded that the discharges are not likely to affect species protected under the Endangered Species Act (ESA) which includes most of the marine mammal species in the area and several bird species of seabirds.

It should be noted that the toxicity tests referenced above are conducted on the types of organisms (adult and larval crustaceans, fish) that are generally considered to be most sensitive to potentially toxic chemicals, and are conducted with very low dilutions of the drilling fluids. Additionally, as described in Section 4.5.3 of EP Revision 2, both modeling and discharge monitoring studies have shown that discharged drilling fluids are diluted by magnitudes of 1,000 or more within a very short distance from

the outlet and within a couple minutes when discharged at open ocean water environments within the range of water depths found at Shell's drill sites. At these dilutions there will be no effect on fish and wildlife.

The biocide degrades due to abiotic and biotic processes in the environment. Persistence in water depends on the pH, with the chemical degrading more quickly at lower pH's (EPA 2008). Testing abiotic hydrolysis, half-lives of 3.4 hr, 16 min, and 32 sec for pH's of 10.9, 9.5, and 9.0 respectively at temperatures of 22 °C have been reported (Bakke et al. 2001 in EPA 2008), but other studies have found half-lives of 3.2 days, 5.0 days, and 302 days at a pH of 5, 7, and 9 respectively. The biocide is also readily bio-degradable (EPA 2008 citing Voerts et al. 1975) as 100 percent of the biocide was degraded by direct metabolism under both aerobic an anaerobic conditions at 28 °C. Formaldehyde is one degradate, but formaldehyde is itself short-lived in the marine environment. Bio-concentration by fish or other aquatic organism is unlikely (EPA 2008).

Section 6c) of EP Revision 2 will be modified to show that the biocide is a contingency product, to be used only as needed. Section 2.4 of the EIA for EP Revision 2 will be modified to reflect the information provided above. Tables 2.4-1 and 2.4-2 in Section 2.4 will be modified to indicate that the biocide is a contingency product, to be used only as needed.

Bakke, J.M., J. Buhaung, and J. Riha. 2001. Hydrolysis of 1,3,5-Tris(2-hydroxyethyl) hexahydro-s-triazine and its reaction with H_2S. Department of Chemistry, Norwegian University of Science and Technology. Ind. Eng. Chem. Res. 40:6051-6054.

EPA. 2008. Hexahydro-1,3,5 tris (2-hydroxyethyl)-s-triazine (HHT). P.C. Code 083301. Human health and ecological risk assessments for the re-registration eligibility decision (RED) document. Cace 3074. CAS Registry No. 4719-04-4. Memorandum from William J. Hazel, Ph.D., Chemist, Risk Assessor; Jenny Tao, Toxicologist; Jonathan Chen, Ph.D., Incident Report; Cassi Walls, Ph.D., Occupational/Residential Assessor; Najm Shamim, Ph.D., Dietary Assessor, Product Chemist; William Erickson, Ecological Effects; James Breithaupt, Environmental Fate to Risk Assessment and Science Support Branch (RASSB) Antimicrobials Division (7510P) to Norm Cook, Branch Chief, Risk Assessment and Science Support Branch (RASSB), Antimicrobials Division (7510P). Office of Prevention, Pesticides, and Toxic Substances, United States Environmental Protection Agency, Washington, D.C.

Voets, J.P., P. Pipyn, P. Van Lancker, and W. Verstraete. 1975. Degradation of microbiocides under Different Environmental Conditions. J. appl. Bact. 40:67-72.

January 14, 2014 Comment

Shell elaborated that the EPA (2008) has concluded that the biocide is practically non-toxic to birds, slightly to moderately toxic to laboratory mammals, and practically non-toxic to moderately toxic to marine species (fish and invertebrates); and provided additional information and analyses of how this biocide will be utilized within their drilling program. Shell's modification to EP Revision 2, Section 6, Environmental Impact Analysis, Section 2.4 and Environmental Impact Analysis, Tables 2.4-1 and 2.4-2 to include additional information will satisfy this RFAI item.

EP Revision 2, Section 6, Table 6.c-2 has been modified by moving the biocide from the additive portion of the table to the contingency portion of the table. The above-referenced information on the toxicity, persistence, and ecological effects of the biocide were added to Section 2.4 of the EIA for EP Revision 2. Tables 2.4-1 through 2.4-3 in the EIA were modified to indicate that the biocide Busan 1060 is a contingency component of the KLA-SHIELD inhibited drilling fluids. Cited references were added to the reference list in Section 6.

AIR

RFAI No. 1

November 29, 2013 Comment

Active spreadsheets that were used for the calculations to allow verification of data provided in Appendix O include each emission unit by make and model. The spreadsheets must not contain any locked cells, hidden rows or columns or text (i.e. white text on a white background), and the workbooks and spreadsheets must not be password protected, unless the password is provided to the Regional Supervisor.

On December 12, 2013, Shell provided a diskette with the Excel workbook file titled "Discoverer_BOEM_EI_20131011_final_D.xlsx" to Mr. David Johnston with Alaska BOEM that includes the original spreadsheets for the November 6, 2013 Chukchi Sea EP Revision 2. In addition, the pdf file "Discoverer_BOEM_EI_20131011_final_D.pdf" was provided at that time that included a printer friendly version of the Excel workbook.

Since the November 6, 2013 submittal of Shell's Chukchi Sea EP Revision 2, necessary updates to the emission unit inventory are recognized. These updates include the following:

- Update to the rating for the Caterpillar D3512C generator engines for the *Discoverer* "Generation" category (see response to Air Quality, RFAI No. 2).
- Updates to emission factor selection (see response to Air Quality, RFAI No. 5).
- Update to vessel selection for the Anchor Handler 2. The *Tor Viking* is now replaced with the *Ross Chouest* as the candidate vessel for future drilling seasons. This update requires changes to the Ice Management & Anchor Handling "Propulsion & Generation" and "Boilers" categories.
- Update to correct the volatile organic compounds (VOC) emission factor for the *Discoverer* "Boilers" category. Actual source test data is applied for these units.
- Update to correct the VOC emission factor for the *Discoverer* "Incinerator" category. Actual source test data is applied for this unit.
- Update to correct the VOC emission factor for the Ice Management & Anchor Handling "Incinerator" category. A more appropriate emission factor for the expected type of incinerators to be used has been identified for these units.
- Update to correct the SO_2 emission factor for all combustion sources that burn ultra low sulfur diesel (ULSD). An error was recognized in the stoichiometric calculation. Upon further review, it was discovered that the combustion sources SO_2 emission factor was in pounds per million British thermal units (lb/MMBtu) instead of pounds per gallon (lb/gallon).

Based on these described changes, Shell submits an update to the spreadsheets in Appendix O and is providing the Excel workbook titled "Discoverer_BOEM_EI_20131219_final_D.xlsx". In addition, the pdf file "Discoverer_BOEM_EI_20131219_final_D.pdf" is provided in Attachment A of this response that includes a printer friendly version of the Excel workbook.

January 14, 2014 Comment

Provide the updated spreadsheet with the changes requested under Air Quality Items #22, #23, and #25 to satisfy this RFAI item.

Attachment A of this response provides updates to these inventories that reflect other changes described in subsequent responses. Shell submits an update to the spreadsheets in Appendix O with the changes requested under Air Quality Items #22, #23, and #25.

RFAI No. 2

November 29, 2013 Comment

Documentation or clarification concerning the capacity of the 3512C generator sets. Shell states that the generation units on the Noble Discoverer are Caterpillar 3512C generator sets. Shell lists the capacity of the 6 Caterpillar 3512C generators at 6000KW (Attachment A, Appendix O). Caterpillar's specification for the 3512C generator shows a minimum rating of 1250 ekW and a maximum rating of 1500 ekW.

Attachment B of this response includes the engine certificates for the six Caterpillar D3512C generator engines to be installed on the Noble Discoverer by the end of 2013. These certificates document the capacity of each of the D3512C engines for the Noble Discoverer as 1,476 horsepower (1,101 kilowatts), each.

January 14, 2014 Comment

Shell's response satisfies this RFAI item.

Shell provides the engine certificates under Appendix O (Emissions Inventory) of EP Revision 2.

RFAI No. 3

November 29, 2013 Comment

Documentation concerning the estimated control efficiency of 50% per pollutant (Section 5.4, Appendix O).

The controlled emission factors for nitrogen oxides (NOX), carbon monoxide (CO), particulate matter (PM), and VOC for the Discoverer main generator engines (Caterpillar D3512C) are derived using an estimated control efficiency of 50 percent. These engines are fitted with Selective Catalytic Reduction (SCR) and Catalytic Diesel Particulate Filter (CDPF) controls, the same emission controls used in the 2012 drill season on the previous main generator engines (Caterpillar D399). According to vendor specification sheets (see Attachment C of this response) and an April 2012 table of preliminary results of a source test completed for a Caterpillar 3512C engine equipped with the same SCR and CDPF controls installed on the Discoverer (see Attachment D of this response), control efficiencies are documented to range from 60 to 95 percent. In order to be conservative in our estimated projected maximum emissions, the use of an estimated control efficiency of 50 percent was applied to the emission factors.

January 14, 2014 Comment

Shell's response does not satisfy this RFAI item - insufficient documentation provided.

The RFAI response references the "April 2012 table of preliminary results" from source testing the Caterpillar 3512C engine equipped with the same SCR and CDPF controls installed on the Discoverer. Provide the data of preliminary results as a computer spreadsheet for BOEM review of the methods and calculations. Explain why the results of source testing, which are used in the air quality analysis, are preliminary results and why the final results are not used.

Shell's EP Revision 2 stated that the AQRP emission inventory would not reflect emission reduction controls, such as SCR and CDPF. Verify that the controls that allow a 50% reduction in emissions, or any measures to reduce emissions, are not used in the calculation of the emission inventory prepared

for comparison to the emission exemption thresholds as required under 30 CFR 550.303(d), the Air Quality Regulatory Program (AQRP).

Although Shell was not required to test the Caterpillar 3512C engines, Shell elected to conduct engineering tests at NC Machinery in Tukwila, Washington in the spring of 2012. Because the 3512C engine tests were conducted solely to evaluate their potential emissions (rather than for any compliance demonstrations), Shell did not ask the test company to formally document the tests in a final report. Therefore our response identified them as preliminary results rather than final results. However, there was no further reporting of these test results. We also confirm that the emissions reduction calculation provided in Attachment D of the December 20, 2013 response to BOEM's initial RFAI were conducted by the Avogadro Group (source testers), not by Shell.

The AQRP emission inventory does not use any emission reduction controls when calculating emissions for the exemption threshold from the facility only. The Discoverer Generation emission factors are uncontrolled factors converted to g/kW-hr from the Caterpillar 3512C vendor data received from Louisiana CAT. The Excel workbook (Shell Noble Discoverer 3512C Engine Performance Data.xlsx) has been provided with this submittal and a printer friendly version in Attachment C. In addition, Attachment A contains the revised AQRP inventory with emission factors.

This information is also represented in the "EI_AQRP" tab of the Excel workbook (Discoverer_BOEM_EI_20140124_FinalRevised_D.xlsx) also provided with this submittal. None of the Discoverer engine emission factors used in the AQRP exemption assessment applies any emission reduction efficiencies.

Shell has updated Section 5.4 of Appendix O (Emissions Inventory) of EP Revision 2 to include this information.

RFAI No. 4

November 29, 2013 Comment

Information describing what constitutes "good engine operating practices" to lower emissions by reducing all diesel engine load factors by 20% in Section 2.0 of Appendix O.

As stated in the September 29, 2012 Noble Discoverer Application to Revise PSD Permit, during operation, maximum continuous power ratings of marine engines are typically 10 to 20 percent below "name-plate" power ratings. These types of "good engine operating practices" are performed in order to extend the equipment life because, unlike power plants and on-road diesel vehicles, engines in vessels tend to be built into the hull and cannot be economically replaced in total. For example, Noble has installed an electrical distribution system with controls that limit the engines' operating rate on several groups of engines. Documentation of this practice is further explained in the January 11, 2012 letter from Susan Childs to EPA's Natasha Greaves (see Attachment E of this response). This practice was applied during the actual source testing required under the EPA air permit and was described under the Discoverer Drillship Test Protocol submitted to EPA's Natasha Greaves on February 22, 2012.

January 14, 2014 Comment

Shell's response does not satisfy this RFAI item.

The explanation provided in response to the RFAI states that "good engine operating practices" of limiting the diesel engines by imposing a 20% reduction in power is necessary for marine engines that are "built into the hull and cannot be economically replaced in total." This is contrary to BOEM's understanding that the power reduction is applied because of "standard industry practice" for good maintenance and efficient operation of diesel engines. Shell's explanation implies that non-road diesel engines at power plants, which Shell uses as an example, would not require this operational limitation

for efficient operation. Provide the vendor information recommending 80% maximum power for all diesel engines as good operating practice.

Further, the response references documentation that exists in the form of a letter from Ms. Susan Childs to EPA's Natasha Greaves on January 11, 2011, which requests concurrence with the practice of reducing engine power by 20%. Provide EPA's response from Ms. Greaves.

BOEM correctly understands that the power reduction is applied because of "standard industry practice" for good maintenance and efficient operation of diesel engines. Shell stated that these types of "good engine practices" are performed to extend the equipment life." The intent of the statement that the engines are "built into the hull" was to clearly identify that there is a greater need to perform these "standard industry practices" for some marine engines because of the huge cost of replacing engines that are built into the hulls of vessels; this usually includes propulsion and generator engines. As such, limiting the maximum operating power load is standard industry practice for marine engines.

Shell did not receive a formal written response from Natasha Greaves as requested in the January 11, 2012 letter. However, EPA demonstrated concurrence with the 80 percent limit by issuing permits and consent orders based on applications that included emissions inventories and modeling performed using the 80 percent maximum power limit. The permits included fuel limits and emissions limits that were calculated based on the 80 percent limit.

Shell has updated Section 2.0 of Appendix O (Emissions Inventory) of EP Revision 2 to include this information. In addition, the letter from Ms. Childs to Ms. Greaves is included under Attachment C of Appendix O of EP Revision 2.

RFAI No. 5

November 29, 2013 Comment

Documentation of MARPOL Annex VI compliance for each engine claiming the lower MARPOL emissions standards. Documentation of EPA marine engine tier standards for each engine claiming the lower EPA emissions standards. Using emission factors simply described as "a mixture of other generic emission factors" is not sufficient.

Within the Chukchi Sea Exploration Plan Revision 2 submitted on November 6, 2013, Shell provided an assessment of air quality impacts expected to occur for a future exploration drilling season. As described in Appendix O, this assessment includes equipment categories of emission unit types (e.g. propulsion, heaters, etc.) that are expected to be operated during the season with an associated emission rate for the group. In an effort to maintain operational flexibility, categories of units have been listed rather than individual emission units.

This approach provides flexibility to operate various engines within a group that meet the criteria listed for a particular group. For each category of emission units, an associated emission factor (e.g., source test, Tier standard, AP-42) has been selected that represents an achievable emission rate for the units in the group. Under this plan, Shell may retain the ability to switch out certain equipment within a group as necessary without deviating from a particular premise of the EP.

Emission factors used in the air quality analysis provided under the response to Air Quality, RFAI No. 1 are primarily of three types:

- Results of emission source tests on the actual unit to be used;
- Marine Category 1 – Tier 2 emission factors (40 CFR 94.8 Table A-1); or
- EPA AP-42 emission factors from Table 3.4-1.

Actual emission source test results are used in cases where the actual unit tested is likely to be the same in an upcoming drilling season. As described above, some equipment may not be identified at this time for use or there may be a need to switch equipment prior to the next drilling season. In these cases, a published emission factor was used that is appropriate for the category group.

Tier 2 published emission factors were generally used in the inventory because they are the highest Tier Level emission rates for most marine engines. However, some engines in the inventory date to a time before the Tier Levels were established, so a logic pattern was established which determined the emission factors to use. The logic pattern is as follows:

Option 1. If the engines have been source tested and it is certain that the engines will be used in the upcoming drill season, then the source test values are used.

Option 2. If the engines have been source tested but it is uncertain the engines will be used in an upcoming drill season, the decision on which emission factor to use is based on the results of the source test:

- Option 2a. If the source test resulted in emission rates less than the Tier 2 level, the Tier 2 level is used, whether or not documentation can be provided that the engine is in fact a Tier 2 engine. The source test itself is assumed to be justification that this engine can meet the Tier 2 levels.
- Option 2b. If the source test resulted in emission rates higher than the Tier 2 level, both the Tier 2 emission factor (Case 1) and the AP-42 emission factor (Case 2, if AP-42 is higher) are analyzed in separate model runs to "bracket" the range of possible values. (see response to Environmental, Sociocultural/Subsistence, RFAI No. 5; and response to Air Quality, RFAI No. 16).

Option 3. If the engine has not been source tested but documentation can be provided that the engine is in fact a Tier 2 engine, the Tier 2 emission factors are used.

Option 4. If the engine has not been source tested and no documentation can be provided on the Tier Level of the engine, both the Tier 2 emission factor (Case 1) and the AP-42 emission factor (Case 2, if AP-42 is higher) are analyzed in separate model runs to bracket the range of possible values.

The Case 1 dispersion modeling analysis applies the Tier standards listed in the inventory (see response to Air Quality, RFAI No. 16). The Case 2 dispersion modeling analysis applies more conservative emission rate values to demonstrate that the Tier 2 standards identified in Appendix O are more conservative for the applicable categories. Table 1 provides a summary of the emission factor selection used for the Case 2 dispersion modeling where Tier 2 standards are identified in Appendix O.

Table 1. Summary of Emission Factor Selection for Dispersion Modeling Analysis (Case 2)

Emission Rates Listed in Appendix O with Tier 2 Ratings			
	NO_X	CO*	PM
Discoverer			
Propulsion	Option 4, AP-42	Option 2b, Tier 2	Option 4, AP-42
Small IC Engines	Not Applicable	Option 2b, Tier 2	Option 2a
Seldom –Used IC Engines	Option 4, AP-42	Option 2b, Tier 2	Option 4, AP-42
OSR Propulsion & Generation	Option 2b, AP-42	Option 2b, Tier 2	Option 2b, AP-42
Offshore Supply Propulsion & Generation	Option 2b, AP-42	Option 2b, Tier 2	Option 2b, AP-42
Science Vessel Propulsion & Generation	Option 2b, AP-42	Option 2b, Tier 2	Option 2b, AP-42
Arctic Oil Storage Tanker	Option 3	Option 2b, Tier 2	Option 3

*No Tier 1 or Tier 0 CO emission standards do not exist for marine engines and AP-42 applicable emission standards are less than the Tier 2 standards used.

Since 40 CFR 94.8 Table A-1 does not provide a VOC emission factor, an emission factor from EPA's non-road compression ignition engines (Tier 1), 40 CFR 89.112 Table 1 was selected.

Finally, as described in Appendix O, Section 5.4 "For the onshore emission units, the emission factors are a mixture of other generic emission factors." These emission factors are from 40 CFR 89.112, Nonroad and EPA AP-42, Section 1.4, Natural Gas Combustion. These emission factors are representative of the proposed man camp engines and hangar/storage building heat boiler planned for use at this time.

MARPOL Annex VI emission standards were not used in the emission inventories.

January 14, 2014 Comment

Shell's response does not satisfy this RFAI item.

The source of emission factors listed in the RFAI response includes Marine Category 1-Tier 2 emission factors obtained from 40 CFR 98.4, Table A-1. To confirm use of the proper emission factors from Table A-1, Shell must provide the model year and engine size (displacement) that corresponds to the emission factors used in the calculation of emissions.

In response to BOEM's January 14, 2014 comment and after discussions with BOEM staff, Shell now provides a revised inventory that applies the most conservative emission factors for the category of emission units listed above in Table 1. When determining these emission factors for the various emission unit groups, the specific model year and engine size (displacement) that corresponds to the emission factors was not used. Instead, to maintain flexibility to operate various engines within a group, the following emission factor resources were primarily used to determine the most conservative emission factors for the representative groups.

- 40 CFR 94.8, marine engine exhaust emission standards; and
- EPA's AP-42, emission factors from Table 3.4-1.

In the case where a VOC representative emission factor was unavailable from 40 CFR 94.8 or EPA AP-42, the following resource was used to obtain an appropriate emission factor.

- 40 CFR 89.112, EPA's non-road compression ignition engines emission standards.

Table 2 provides a summary of the emission factors from the various resources described above. These factors have been applied under Appendix O and the modeling analyses of the EIA and represent the most conservative emission rates used for each pollutant.

Table 2. Conservative Emission Factors

Pollutant	Emission Factor	Reference
NO_X g/kW-hr	14.59	EPA AP-42, Table 3.4-1
CO g/kW-hr	5.0	40 CFR 94.8 Table A-1
PM g/kW-hr	0.43	EPA AP-42, Table 3.4-1
VOC g/kW-hr	1.3	40 CFR 89.112, Table 1

The Marine Category 1 - Tier 2 emission factors obtained from 40 CFR 94.8, Table A-1 (Primary Tier 2 Exhaust Emission Standards) are provided below in Table 3. Table 4 provides emission factors from AP-42, Table 3.4-1.

Table 3. Applicable Emission Rates from 40 CFR 94.8 Table A-1

Engine Size liters/cylinder, rated power	Category	Model year	THC+NO_X g/kW-hr	CO g/kW-hr	PM g/kW-hr
1.2 ≤ disp. <2.5 all power levels	Category 1, Commercial	2004	7.2	5.0	0.20
2.5 ≤ disp. <5.0 all power levels	Category 1, Commercial	2007	7.2	5.0	0.20

Table 4. Applicable Emission Rates from EPA AP-42, Table 3.4-1

Units	NO_X	CO	PM	TOC*
lb/hp-hr	0.024	5.5E-3	0.0007	0.000705
g/kW-hr	14.59	3.34	0.43	0.43

*TOC means Total Organic Compounds.

In the case of CO, the Marine Category 1 - Tier 2 emission standard is used because the Tier 2 CO emission factor is greater and more conservative than the CO emission factor from AP-42, Table 3.4-1. In addition, the Discoverer Small IC engines were source tested in 2012 and the PM source test resulted in emission rates less than the Marine Category 1 - Tier 2 standard. Therefore, the Tier 2 PM standard that is applied is a conservative emission rate that is used in the emissions inventory.

40 CFR 94.8, Table A-1 does not provide a VOC emission factor. EPA AP-42 only provides a TOC factor and not VOC, which is a subset of TOC. 40 CFR 89.112, Table 1, was reviewed and the hydrocarbon (HC) emission factor from this section was ultimately selected because it is more conservative that EPA AP-42. Table 5 provides the HC emission factors listed in 40 CFR 89.112, Table 1.

Table 5. Applicable Emission Rates from 40 CFR 89.112, Table 1 (Hydrocarbon Only)

Rated Power	Tier	Model Year	HC g/kW-hr
130≤kW≤225	Tier 1	1996	1.3
225≤kW≤450	Tier 1	1996	1.3
450≤kW≤560	Tier 1	1996	1.3
kW>560	Tier 1	2000	1.3

Within the spreadsheet provided in response to Air Quality Item #1, the generator sets have emission factors, such as 1.3 g/kW-hr for CO, which cannot be traced to any published table or list. Shell's Table 1 provides a summary of sources from which emission factors were obtained. However, the Discoverer generator sets are not listed within Table 1. Provide the emissions factors and source references, and include them within modified Table 1.

The Discoverer Generation category emission factors listed in the spreadsheet provided in response to Air Quality Item No. 1 are from the Caterpillar 3512C vendor data received from Louisiana Caterpillar. These factors have been converted to g/kW-hr using the "Emissions Data for Rated Speed Nominal Data". The Excel workbook (Shell Noble Discoverer 3512C Engine Performance Data.xlsx) has been provided with this submittal on diskette and a printer friendly version in Attachment C. Shell's Table 1 of the December 20, 2013 BOEM RFAI Air Quality response to RFAI No. 5 did not contain the Discoverer Generation engines because emissions calculations for these engines are not derived using MARPOL Annex VI compliance or EPA marine engine tier standards as was requested in the November 26, 2013 RFAI No. 5.

In addition, when Tier emission factors are used for NOx or for VOC, where the published emission factors provide one value for "NOx+VOC," explain how the proportional emission factors were calculated separately for NOx and VOC emissions.

The Tier emission standard used for NOX (7.2 g/kW-hr), comes from 40 CFR 94.8 Table A-1 - Primary Tier 2 Exhaust Emission Standards and is the standard for THC+NOX (refer to Table 3 above). The published emission factor has not been modified or proportioned out for NOX and VOC. Therefore, the NOX emission factor used is conservative assuming the full emission rate of 7.2 g/kW-hr is NOX.

Shell has updated Attachment A and B of Appendix O of EP Revision 2 to include this information. In addition, Shell provides the Shell Noble Discoverer 3512C Engine Performance Data on a printer friendly version under Appendix O (Emissions Inventory) of EP Revision 2. Electronic versions are provided on diskette.

RFAI No. 6

November 29, 2013 Comment

Documentation of the "safety policy" referenced in Table 6 of Section 5.2 of Appendix O to reduce engine power level by 50%.

Dynamic Positioning (DP) vessels are equipped with computer-controlled systems that automatically maintain the vessel's position and heading. Because DP vessels must operate in close proximity to other vessels or structures, DP systems have been developed to require redundant components and systems that, in the case of a failure, must be immediately available and must have sufficient capacity that the DP operation can continue until work in progress can be finished safely. As such, vessels operating in normal DP mode must limit the load on the power system so that the vessel will be left with adequate power and thrusters to maintain position after a failure. A more accurate term for this operational consideration is "safety factor" to describe the measures used to ensure adequate control and to prevent potential vessel collisions.

The 50 percent limit for DP operations is based on observation of several DP vessels in normal operation in the Gulf of Mexico. This was confirmed by reviewing actual power demands during heavy sea conditions of several Gulf of Mexico Platform Supply Vessels, both totally diesel electric (e.g., Sisuaq) and some that were mechanical (e.g. Harvey Explorer). In addition, Shell reviewed resupply events from the 2012 Beaufort Sea Drilling Program for the Sisuaq to better characterize resupply events in the Arctic. During the 2012 drill season, Shell recorded 5-minute electrical output data while the Sisuaq operated within 25 miles of the Kulluk drilling unit. Using this 5-minute data, total hourly average

electrical output for the combined four main generator engines was calculated. Shell reviewed approximately 380 hours of data. Over the course of the 2012 season, the maximum hourly power capacity from all four engines was 34.4 percent and the seasonal average power capacity was 9.4 percent.

January 14, 2014 Comment

Shell's modification to include this information within EP Revision 2, Appendix O will satisfy this RFAI item.

Shell has updated Section 5.2 and Table 5 of Appendix O (Emissions Inventory) of EP Revision 2 to include this information.

RFAI No. 7

November 29, 2013 Comment

Documentation or other supporting justification that short-term use limitation in equations (1) through (5) in Section 5.2 of Appendix O are established practices.

Under equations (1) through (5), Shell has calculated the short-term utilizations for various equipments that are based on operator knowledge and represent the best professional judgment for anticipated operation. These estimations were developed after consultation with Shell staff and contractors and represent reasonable, typical scenarios for how these types of equipment are run under normal and expected use.

Equation (1) is based on the total aggregate rating of the non-cementing IC engines (1,263 kW) within the "Small IC Engines" category (1,763 kW). The non-cementing IC engines are the maximum group of small IC engines, which can't be utilized at the same time as the cementing engines. In order to determine a final maximum power level for the small IC engines (57 percent), a maximum power level of 80 percent was utilized (see response to Air Quality, RFAI No. 4).

$$\frac{1{,}263\ kW}{1{,}763\ kW} \times 80\% = 57\%$$

Equation (2) is based on the maximum capacity of the largest engine (679 hp) within the "Seldom-Used Engines" category and the total aggregate rating for the "Seldom-Used Engines" category (595 kW). The "Seldom Used Engines" category includes the emergency generator and lifeboats. Due to the nominal use of engines in this category, it is assumed that the engines from the Discoverer "Seldom-Used" group will not operate at the same time. Therefore, in order to calculate the highest hourly emission factor for the "Seldom-Used" engines, the maximum capacity of the largest engine from this group is used. The maximum power level of 63 percent was determined for this group by incorporating the maximum power level of 80 percent (see response to Air Quality, RFAI No. 4).

$$679\ hp\ \div 1.34\ {}^{hp}/_{kW}\ \div 595\ kW\ \times 80\% = 68\%$$

Equation (3) is based on an average of the output for different operational activities for the offshore supply vessels (OSV). In order to calculate the average use for an hour, DP mode is estimated at 50 percent capacity (see response to Air Quality, RFAI No. 6) for one OSV and 65 percent for the other OSV that will be in transit to or from the Chukchi Sea. Based on discussions with Shell Marine staff, an OSV is estimated to most efficiently operate while cruising at a power use of approximately 65 percent. The final average power level for this group is 58 percent.

$$(50\% + 65\%) \div 2 = 58\%$$

Equation (4) is based on the aggregate rating for the Arctic Oil Storage Tanker (20, 611 kW), the maximum rating for the propulsion engines (15,820 kW), and the three generators (3,360 kW) that exist on this vessel. Based on discussion with Shell staff and contractors, during the drill season the propulsion engines are estimated to operate at 30 percent power in addition to 2 of the 3 generators (one generator engine is kept offline to be used as backup) will operate at 80 percent power (see response to Air Quality, RFAI No. 4). The final maximum power level for this group is estimated at 32 percent.

$$30\% \times \frac{15{,}820\ kW}{20{,}611\ kW} + 80\% \times \frac{3{,}360\ kW\ (^2/_3)}{20{,}611\ kW} = 32\%$$

Equation (5) includes the maximum rating for the man camp generators (1,396 kW). The man camp contains two primary generators (448 kW) and one 500 kW emergency backup generator. The emergency backup is the largest generator of the man camp group. This generator is operated for 15 minutes per week as a regular performance check. In order to determine a final maximum hourly power level for this group (59 percent), the 80 percent limit was utilized (see response to Air Quality, RFAI No. 4).

$$80\% \times \frac{448\ \times 2\ kW}{1{,}396\ kW} + 80\% \times \frac{15\ minutes}{60\ minutes} \times \frac{500\ kW}{1{,}396\ kW} = 59\%$$

For the power use utilizations, fuel use is directly related to power consumption and may be an acceptable surrogate for confirming the utilizations. Annual (i.e., seasonal) fuel consumption may be recorded as a tool for confirming these values and for continually improving these planning assumptions.

January 14, 2014 Comment

Shell's modification to include this information within EP Revision 2, Appendix O will satisfy this RFAI item.

Shell has updated Section 5.2 of Appendix O (Emissions Inventory) of EP Revision 2 to include this information.

RFAI No. 8

November 29, 2013 Comment

Documentation or clarification for using the 15% power to lift the drill stem in equations (6) through (15) in Section 5.2 for Appendix O.

Under equations (6) through (15), Shell has calculated short-term utilizations for reasons similarly as described under response to Air Quality, RFAI No. 7 above. Based on engineering knowledge and normal drilling experience, an estimated utilization of power needs during drilling activities is provided in Section 5.2. In equation (6) maximum power on a seasonal average from the generator engines is anticipated to be needed for only ¾ of an hour to conduct actual drilling to turn the bit and drill deeper. For the remainder of an hour, power needs are substantially reduced to conduct other activities such as lifting drill stem pipe. As described above, these estimations were developed after consultation with Shell staff and contractors and represent typical scenarios for how these types of equipment are run under normal and expected use. Equations (7) through (15) do not incorporate the assumption for 15% power to lift the drill stem.

January 14, 2014 Comment

Shell's modification to include this information within EP Revision 2, Appendix O will satisfy this RFAI item.

Shell has updated Section 5.2 of Appendix O (Emissions Inventory) of EP Revision 2 to include this information.

RFAI No. 9

November 29, 2013 Comment

Clarification of the column heading "Aggregate Nameplate Rating" and justification of the method used to aggregate the rating in Table 2-4 of Section 5.1 of Appendix O.

"Aggregate Nameplate Rating" in Table 2 through Table 3 indicates the combined rating/output for the category of emissions in the unit group type, vessel type, or support equipment type. Table 2 through Table 3 includes the sums of ratings as an aggregate per source group category. Table 4 does not include a similar column heading.

January 14, 2014 Comment

Shell's modification to include this information within EP Revision 2, Appendix O will satisfy this RFAI item.

Shell has updated Table 2 and Table 3 of Appendix O *(Emissions Inventory)* of EP Revision 2 to include this information.

RFAI No. 10

November 29, 2013 Comment

Clarification of the column heading "policy limits on emissions units/group" in Table 5 of Section 5.1 of Appendix O.

The heading "Policy Limits on Emission Units/Groups" is an inaccurate description of the column of data represented. This column of data listed under Table 5 describes the category of emission units, vessel types, or fuel types for which there is an associated short-term limitation applied in the emissions inventory. There is no specific written policy per se associated with these data.

January 14, 2014 Comment

Shell must modify Table 5 within EP Revision 2, Appendix O, Section 5.1 to satisfy this RFAI item.

Shell has updated Table 5 of Appendix O *(Emissions Inventory)* of EP Revision 2 to update this information.

RFAI No. 11

November 29, 2013 Comment

Documentation that propulsion engine emissions were used in the projected emissions inventory for purposes of 30 CFR 550.303(d).

Propulsion engine emissions for the Noble Discoverer are included under Page 2 of Attachment A of Appendix O and under Attachment A of this response (see response to Air Quality, RFAI No. 1). The propulsion engine for the Noble Discoverer is estimated to operate for two days per drilling season.

January 14, 2014 Comment

Shell's response satisfies this RFAI item.

RFAI No. 12

November 26, 2013 Comment

Clarification of the row heading "Project Duration Total" in Table 7 of Section 5.5 of Appendix O, and an explanation of the values under this heading.

The information provided under "Project Duration Total" in Table 7 of Section 5.5 of Appendix O fulfills the regulatory requirements. Under 30 CFR 550.218(a)(1)(iii), the "emissions over the duration of the proposed exploration activities" are required to be included under the EP. As described under the Chukchi Sea EP Revision 2, three years are estimated to complete the six wells described and the annual/seasonal emissions provided in Table 7 are scaled appropriately (three times increase) to reflect the project duration total emissions.

January 14, 2014 Comment

Shell's response does not satisfy this RFAI item.

The RFAI response states that Table 7 in Appendix O provides a line item, "Project Duration Total," to represent the total emissions multiplied by 3, as the revised EP is a multi-year plan. The emission inventory presented in Table 7 is the inventory used to compare to the emission exemption thresholds as required under 30 CFR part 550 subpart C. Thus, pursuant to 30 CFR 550.303(d), which requires use of the "highest annual total amount of emissions from the facility," and pursuant to 30 CFR 550.218 (a)(1)(iii), either clarify that the inventory provided is the highest annual inventory of the three seasons, and thus the "Project Duration Total" is worst-case scenario, or provide all three annual projected emission tables and the total over the duration of the proposed exploration activities.

For the revised Table 7, provide the inventory in a simple computer spreadsheet table showing the calculations of emissions by source aboard the facility only, the maximum engine rating of each source, if applicable, the operational limitation applied to the maximum engine rating, if applicable, the hours of use for each source, and the emission factors used, along with documentation of the source of the emission factors. Emission factors should be obtained from the final results of source testing; manufacturer data; a published source (non-road diesel Tier factors or marine engine Tier factors); or AP-42 tables. Include a column in the table that totals the emissions by pollutant and by source, as appropriate. Include projected emissions of NOx, SO2, VOC, CO, PM10 and PM2.5. Do not combine PM10 and PM2.5 emissions under a heading of "particulate matter." Provide all three seasonal inventories and a total of emissions over the duration of the three seasons; or provide the highest annual emission inventory and multiply the total by three, and state definitively that the one emission inventory provided is the highest annual emission inventory.

The emissions inventory detailed in Appendix O represents a conservative assessment of Discoverer and associated fleet emissions in any year. Shell believes this annual (seasonal) emissions estimate reflects a worst case scenario (from an air emissions perspective). At this time, Shell cannot distinguish between activities (and air emissions) in 2014 versus those in 2015 and 2016. Consequently, Shell believes it is appropriate to estimate "Project Duration Total" emissions by assuming a conservative representation of emissions for each of the three seasons, utilizing the current equipment configuration. Shell has updated Chapter 7 of EP Revision 2 (rather than Appendix O) to include this information.

Per BOEM request, Shell provides within Appendix O of EP Revision 2 new computer spreadsheets for the emissions inventory as proposed. These spreadsheets apply AP-42 emission factors when detailed engine information is not available and identifies PM10 and PM2.5 emissions in separate columns. The basis for each emission factor is identified in the emissions inventory.

In addition, all emission tables within Chapter 7, Appendix O (Emissions Inventory), and the EIA of EP Revision 2 have been updated to include this information.

RFAI No. 13

November 29, 2013 Comment

Data or other information to clarify the characterizations of emissions from equipment and surface vehicles for construction as "minor" and "small" in Section 4.10.3 of Appendix O.

Under the responses to these RFAIs (Operational, RFAI No. 23; and Environmental, Sociocultural/Subsistence, RFAI No. 1), Shell has provided an update to modify the plan for the Barrow man camp and facilities at the airport. For the Barrow man camp, Shell now plans to: 1) maintain the existing 75-person man camp near NARL; 2) add a kitchen/dining/recreation (K/D/R) area to this existing 75-person man camp, the KDR unit would adjoin the existing facilities and be located on the same pad; and 3) lease/utilize additional accommodations at the existing 40-person Ukpeaġvik Iñupiat Corporation (UIC) modular construction camp which is at the UIC storage location in Barrow and will be relocated to its new location on the existing UIC pad. Passenger processing facility expansion and hangar repairs are planned for the Barrow airport area at this time.

The planned K/D/R unit will consist of 14 skid-mounted modular buildings delivered by rolligon within Barrow over the 2013/14 winter season and will be installed on the existing pad at NARL. The K/D/R unit will be placed on mats and dunnage on the existing pad material (sand/gravel). After the K/D/R unit is set, gravel will be hauled in by approximately 15 to 20 truck loads and mixed with the beach sand in the driveway area of the pad along the back and end of the K/D/R over the existing pad to stabilize the new driving area. As similar to the emission unit inventory for the camp described in Appendix O of the Chukchi Sea EP Revision 2, power from the two existing generators at NARL and a third backup engine will be used to support the K/D/R unit and the 75-person camp near NARL.

The UIC 40-person camp is planned to be relocated from its existing location in Barrow to a similar pad near the existing NARL camp. These facilities are not Shell's and Shell will only lease the facilities at the new location. This camp will be relocated regardless of Shell's activities associated with this project.

Passenger processing facility expansion near the airport will involve the construction of buildings but no major site preparation is required. The expansion will consist of four buildings. It will adjoin the existing passenger processing facility and would occur on previously developed lands adjacent to the airport and controlled by the FAA. Hangar repairs will include repair and replacement of a new hangar door for aircraft.

The majority of emissions associated with the construction activities are expected to be associated with transport of the skid-mounted modular buildings and placement of the limited amount of new gravel. Vehicle activity will include delivery of the manufactured buildings to their locations and cranes to load and/or unload the buildings for each delivery. Because the modular buildings are expected to be transported over frozen ground, road dust emissions are minimal. Fugitive dust emissions may occur from importing gravel and minor grading at the NARL camp. This type of activity is considered normal pad maintenance and the associated dust emissions are also small and minimal. Any fugitive dust will be mitigated through watering of dusty surfaces and roadways and covering gravel trucks.

January 14, 2014 Comment

Shell's response does not satisfy this RFAI item.

The response to this RFAI does not clarify how the emissions from construction constitutes the characterization of construction emissions as "minor" and "small" in the EP Revision 2.

While the RFAI response claims minimal fugitive dust due to transport over frozen ground, there is no accounting for the emissions of the criteria pollutants from operating the construction equipment, particularly the 15-20 truckloads hauling gravel, emissions from vehicles used to relocate the 40-person camp, and expansion of the passenger processing facility.

Provide the inventory of emissions resulting from the use of equipment expected to accomplish the construction described in the EP Revision 2 in the same manner and form described under Air Quality Item #12.

In order to show that the construction emission are "minor" and "small" as compared to the total emissions in the NEPA inventory, Attachment F provides the detailed emission calculations from the addition of a kitchen/dining/recreation (K/D/R) area to this existing 75-person man camp. As described in the December 20, 2013 RFAI response, the planned K/D/R unit will consist of 14 skid-mounted modular buildings delivered by rolligon within Barrow over the 2013/14 winter season and will be installed on the existing pad at NARL. The K/D/R unit will be placed on mats and dunnage on the existing pad material (sand/gravel). After the K/D/R unit is set, gravel will be hauled in by approximately 15 to 20 truck loads and mixed with the beach sand in the driveway area of the pad along the back and end of the K/D/R over the existing pad to stabilize the new driving area. Table 6 presents the total emissions calculated, described in detail along with their assumptions in Attachment F.

Table 6. Barrow Camp K/D/R Emissions Summary

	NO_X ton	PM ton	PM_{10} ton	$PM_{2.5}$ ton	CO ton	NMHC ton
Gravel Truck Tailpipe	3.4E-3	7.9E-6	7.9E-6	7.9E-6	7.9E-3	1.8E-4
Gravel Truck Unpaved Roads	---	7.1E-1	1.5E-1	1.5E-2	---	---
Gravel Dump - Material Transfer	---	1.2E-6	1.2E-6	1.2E-6	---	---
Material Mixing (Dozing)	---	1.6E-1	2.5E-2	1.7E-2	---	---
Dozer Tailpipe	2.7E-2	1.3E-3	1.3E-3	1.3E-3	2.4E-2	8.8E-3
Modular Building Delivery Truck Tailpipe	2.4E-3	5.6E-6	5.6E-6	5.6E-6	5.5E-3	1.3E-4
Modular Building Delivery Truck Unpaved Roads	---	4.9E-1	1.0E-1	1.0E-1	---	---
Modular Building Placement - Crane Tailpipe	8.5E-3	2.6E-2	2.6E-2	2.6E-2	1.2E-1	9.5E-3
Crane Unpaved Roads	---	8.2E-2	1.7E-2	1.7E-3	---	---
Total (ton)	0.04	1.47	0.32	0.07	0.16	0.02

Shell has updated the EIA and Appendix O (Emissions Inventory) of EP Revision 2 to include this information.

RFAI No. 14

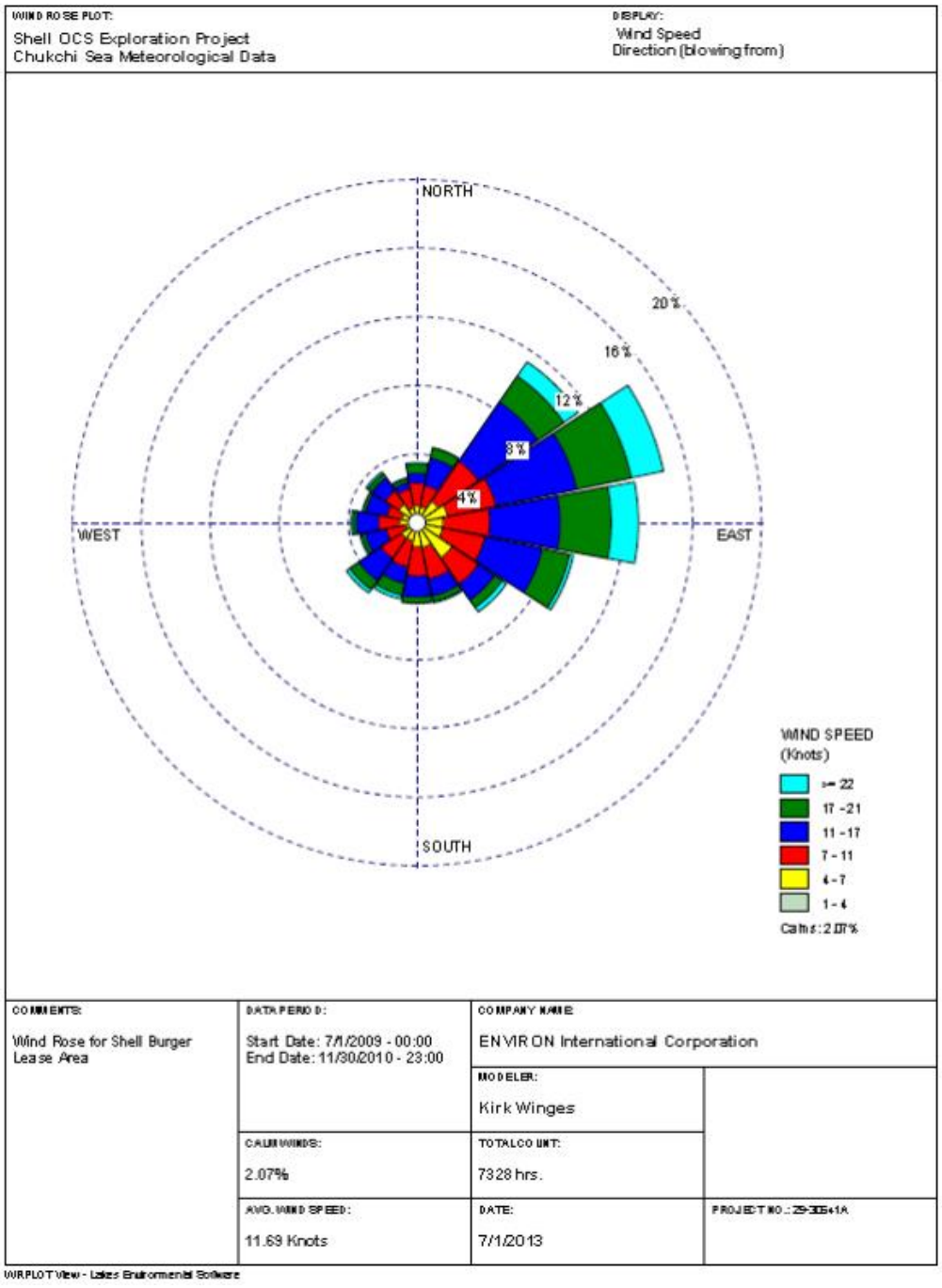
November 29, 2013 Comment

Diagrams, figures, and text missing from Appendix C of the EIA.

The text missing at the end of Section 5.1.1 of Attachment C (page 14) is a reference to Table 4. The sentence is revised as "Emission rates for project emissions units are summarized in Table 4."

In addition, Figure 3 was missing on page 24 of Attachment C. Please see Figure 3 below.

Figure 3. Wind Rose for Shell Burger Lease Area



January 14, 2014 Comment

Shell's modification to include this information within EP Revision 2, Environmental Impact Analysis, Appendix C will satisfy this RFAI item.

Shell has updated Attachment C of the EIA of EP Revision 2 to include this information.

RFAI No. 15

November 29, 2013 Comment

Provide documentation that aggregate or averaged methods are not applied to nonlinear functions.

In all cases, emissions are based on engine or boiler firing operating rates (or incinerator throughput) and a fixed emission factor. In every case, we assumed a linear relationship between the activity level and emissions. For example, a small compression ignition engine with a NOX emission factor of 5.5 grams per kilowatt hour would emit 550 grams (1.2 pounds) per hour operating at 100 kW and three times that (1,650 grams or 3.6 pounds per hour) operating at 300 kW.

This information is provided in Section 5.2.5 of Attachment B and Attachment C of the EIA of EP Revision 2.

January 14, 2014 Comment

Shell's response satisfies this RFAI item.

RFAI is satisfied

RFAI No. 16

November 29, 2013 Comment

Provide a map showing the locations of the maximum pollutant concentrations occurring onshore.

Figure 8 has been prepared and shows the locations of peak model-predicted onshore concentrations by receptor and averaging time based on the results in Table 3.

This information also incorporates changes to the dispersion modeling since submittal of Shell's Chukchi Sea Exploration Plan Revision 2 on November 6, 2013 (see response to Air Quality, RFAI No. 1). Table 2 (Case 1) and Table 3 (Case 2) provide the dispersion modeling results for the onshore locations based on the logic pattern described under response to Air Quality, RFAI No. 5.

Table 2. Summary of Maximum Onshore Concentration Locations (Case 1)

Onshore Peak Impacts		Peak Conc.	Background	Total	Criteria	Receptor	X Coord	Y Coord
Pollutant	Av. Time	in µg/m^3	in µg/m^3	in µg/m^3	in µg/m^3	No.	(km)	(km)
NOx	1-hour	9	53	62	188	6237	-278	18
NOx	Annual	0.009	2	2	100	6920	-258	50
PM10	24-hour	1.9	57	59	150	6498	-282	30
PM2.5	24-hour	1.9	18	20	35	6498	-282	30
PM2.5	Annual	0.006	2	2	12	6920	-258	50
CO	1-hour	9	1145	1154	40000	6846	-230	46
CO	8-hour	5	1145	1150	10000	7064	-206	58
SO2	1-hour	0.1	16	16	196	6846	-230	46
SO2	3-hour	0.1	13	13	1300	6922	-222	50
SO2	24-hour	0.03	5	5	365	6923	-218	50
SO2	Annual	0.0001	2	2	80	6920	-258	50

Table 3. Summary of Maximum Onshore Concentration Locations (Case 2)

Onshore Peak Impacts		Peak Conc.	Background	Total	Criteria	Receptor	X Coord	Y Coord
Pollutant	Av. Time	in µg/m^3	in µg/m^3	in µg/m^3	in µg/m^3	No.	(km)	(km)
NOx	1-hour	14	53	67	188	6237	-278	18
NOx	Annual	0.014	2	2	100	6920	-258	50
PM10	24-hour	2.8	57	60	150	6498	-282	30
PM2.5	24-hour	2.8	18	21	35	6498	-282	30
PM2.5	Annual	0.008	2	2	12	6920	-258	50
CO	1-hour	9	1145	1154	40000	6846	-230	46
CO	8-hour	5	1145	1150	10000	7064	-206	58
SO2	1-hour	0.1	16	16	196	6846	-230	46
SO2	3-hour	0.1	13	13	1300	6922	-222	50
SO2	24-hour	0.03	5	5	365	6923	-218	50
SO2	Annual	0.0001	2	2	80	6920	-258	50

Figure 2. Locations of Maximum Onshore Concentrations (Case 2 Results)

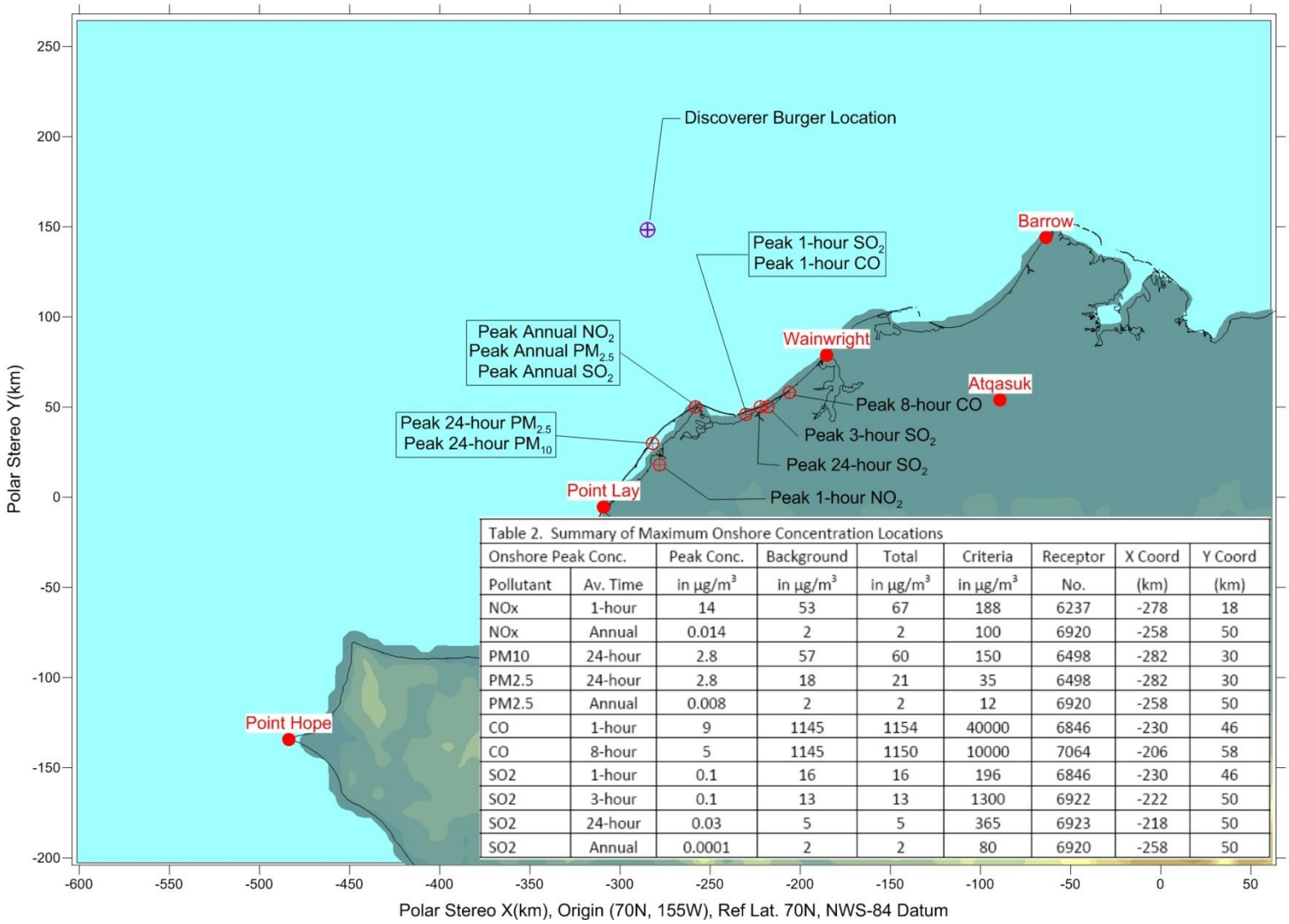


Table 2. Summary of Maximum Onshore Concentration Locations

Onshore Peak Conc.		Peak Conc.	Background	Total	Criteria	Receptor	X Coord	Y Coord
Pollutant	Av. Time	in µg/m³	in µg/m³	in µg/m³	in µg/m³	No.	(km)	(km)
NOx	1-hour	14	53	67	188	6237	-278	18
NOx	Annual	0.014	2	2	100	6920	-258	50
PM10	24-hour	2.8	57	60	150	6498	-282	30
PM2.5	24-hour	2.8	18	21	35	6498	-282	30
PM2.5	Annual	0.008	2	2	12	6920	-258	50
CO	1-hour	9	1145	1154	40000	6846	-230	46
CO	8-hour	5	1145	1150	10000	7064	-206	58
SO2	1-hour	0.1	16	16	196	6846	-230	46
SO2	3-hour	0.1	13	13	1300	6922	-222	50
SO2	24-hour	0.03	5	5	365	6923	-218	50
SO2	Annual	0.0001	2	2	80	6920	-258	50

January 14, 2014 Comment

Shell's modification to include these maps and information within EP Revision 2, Appendix O, will satisfy this RFAI item. However, see Air Quality Item #27.

Shell updates Table 4 and provides a new Table 7 of Attachment B of the EIA of EP Revision 2 to include these modeling results. In addition, Shell has included the figure as Figure 6 of Attachment B of the EIA of EP Revision 2. Please note that the results provided in the November 29, 2013 response to this comment have been updated to reflect changes provided elsewhere under these responses to the January 14, 2014 comments.

RFAI No. 17

January 14, 2014 Comment

Pursuant to 30 CFR 550.218(a), ensure the data reported in Tables 7, 8, and 9 will be provided when the revised Appendix O is updated to reflect the data provided on the revised EXCEL workbook dated 12/20/2013. In the tables, provide projected emissions of particulate matter in the form of PM10 and PM2.5; do not combine PM10 and PM2.5 as "particulate matter" as shown in Table 7 of Appendix O.

Shell has updated Table 7 through Table 9 of Appendix O (Emissions Inventory) of EP Revision 2 to include this information.

RFAI No. 18

January 14, 2014 Comment

While projected maximum hourly (short-term) emissions are provided in Table 8 of Appendix O, provide confirmation that these are peak hourly rates when all years of operations have been considered for the multi-year plan.

Pursuant to 30 CFR 550.218 (a)(1)(i), provide an explanation of how the peak hour rates are calculated and provide the results in a simple table, together with the supporting computer spreadsheet similar to that described in Air Quality Item #12.

As discussed in the response to January 14, 2014 RFAI No. 12, Shell cannot distinguish between activities (and air emissions) in 2014 versus those in 2015 and 2016. Shell believes the peak hourly emissions presented in Table 8 are equally representative of peak emissions in all three years of the Project as it is currently configured. The condensed emissions spreadsheet discussed in response to RFAI No. 12 identifies how short term emissions are calculated.

Shell has updated Chapter 7 of EP Revision 2 to include this information.

RFAI No. 19

January 14, 2014 Comment

Data in Table 7 of Appendix O is provided only as "seasonal" values. The AQRP requires an inventory of the highest annual total amount of emissions for a multiyear plan.

Pursuant to 30 CFR 550.218 (a)(1)(ii) and 30 CFR 550.303(d), provide data for each season for the multi-year plan or confirm that the information provided in the revised Table 7 represents the highest value for any season, and not an average. If one particular year of activities shows a higher rate of emissions, provide and explain the assumptions upon which the inventory is based and why one year's emissions might be higher than another.

Please see the response to RFAI No. 12. As described under Response to RFAI No. 18, Shell has updated Chapter 7 of EP Revision 2 to include this information.

RFAI No. 20

January 14, 2014 Comment

An annual emission inventory for the AQRP was provided only for "a" season. Pursuant to 30 CFR 550.218 (a)(1)(iv) and 30 CFR 550.303(d), either provide data for each season, or confirm that information that will be provided in EP Revision 2 will represent the highest value of annual emissions for any season.

Please see the response to RFAI No. 12. As described under Response to RFAI No. 18, Shell has updated Chapter 7 of EP Revision 2 to include this information.

RFAI No. 21

January 14, 2014 Comment

Pursuant to 30 CFR 550.218 (a)(1)(v), providing data requested above in Air Quality Items #17 - #20 will satisfy this requirement.

Please see the response to RFAI No. 12. As described under Responses to RFAI No. 17 through 20, Shell has updated Chapter 7 of EP Revision 2 to include this information.

RFAI No. 22

January 14, 2014 Comment

To fully comply with 30 CFR 550.218 (a)(2):

- ***Provide a copy of the email that is referenced to support the SO2 emissions factor (Tesoro Nikiski, Email Royal Harris 4/20/11).***
- ***Verify the diesel density of 7.00 lb/gal is valid for ULSD fuel Shell intends to purchase.***
- ***Verify and document use of 100 ppm S for the SO2 emission factor for combustion sources by providing the Material Safety Data Sheet (MSDS) for the fuel Shell intends to purchase.***

Attachment G of this response provides a copy of the email from Royal Harris dated April 20, 2011 providing details on the diesel produced by Tesoro Nikiski. The email states the specific gravity of ULSD as 0.8398 using "ASTM D4052 - Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter". This specific gravity along with the density of water was used to calculate the density of diesel as follows:

$$Diesel\ Density = 0.8398 \times 8.34 \frac{lb}{gallon} (density\ of\ water) = 7.0\ lb/gallon \qquad (1)$$

In addition, the email states a net diesel heat content value of 131,180 Btu/gallon that was utilized in the NEPA and AQRP emission inventories for conversion of the emission factors from g/kW-hr to lb/gallon.

Attachment G of this response provides a MSDS for the fuel Shell intends to purchase from Tesoro, listing ULSD with a Sulfur content of 15 ppm maximum. Because most of the candidate vessels Shell will lease do not utilize ULSD year round, the NEPA and AQRP emissions are calculated assuming a conservative 100 ppm sulfur content to account for the potential for higher sulfur content based on residual non-ULSD fuel left after fuel tanks are pumped out mixing with the ULSD that Shell purchases. Because, there is this potential for traces of sulfur from residual diesel fuel in the tanks and fuel lines, the 100 ppm assumption accounts for contamination by fuel.

Shell provides a copy of the email under Appendix O (Emissions Inventory) of EP Revision 2. In addition, Shell provides the MSDS for the fuel under Appendix O (Emissions Inventory) of EP Revision 2.

RFAI No. 23

January 14, 2014 Comment

Refer to Air Quality Item #1 above. Data provided in the RFAI Response computer workbook, spreadsheet [Discoverer Engines], is insufficient for "seldom used" engines. Pursuant to 30 CFR 550.224(b), provide the actual engine type, with maximum rating capacity expected for use, or provide a reasonable substitute citing the engine type. Providing documentation of "no spec sheet" and "Sabb" is not sufficient documentation.

The Discoverer Seldom-used engines group category consists of the Discoverer Emergency Generator, a Caterpillar 3412 679-hp engine, and four Discoverer lifeboats each equipped with a Sabb 29.5 hp engine. It was recently discovered that the two diver engines originally listed in the Appendix O of the Exploration Plan submitted on November 6, 2013 are no longer needed onboard the Discoverer for the project. Therefore, we have removed the two diver engines from the Discoverer Seldom-used engines group in the emissions inventory. The current Discoverer Seldom-used engines include the following:

Unit ID	Description	Make/Model	Engine Rating
D-8	Emergency Generator	Caterpillar 3412	679 hp
D-LB-1	Lifeboat #1 Engine	Sabb	29.5 hp
D-LB-2	Lifeboat #2 Engine	Sabb	29.5 hp
D-LB-3	Lifeboat #3 Engine	Sabb	29.5 hp
D-LB-4	Lifeboat #4 Engine	Sabb	29.5 hp
	Seldom-Used IC Engines		*595 kW*

Conversion: 1.34 hp/kW

Attachment H contains a copy of the Sabb Motor A/S Test Department Works Test Certification engine specification sheet. The NEPA and AQRP inventories have been updated accordingly. Shell provides this information under Appendix O (Emissions Inventory) of EP Revision 2.

RFAI No. 24

January 14, 2014 Comment

Pursuant to 30 CFR 550.227(a)(3) and (b)(2), providing the data requested above in Air Quality Items #6 - #23, and Air Quality Items #26 - #27 will satisfy this requirement.

As described under Responses to RFAI No. 6 through 23, 26 and 27, Shell provides this information under EP Revision 2.

RFAI No. 25

January 14, 2014 Comment

Refer to Air Quality Item #1. The emission exemption threshold formulas are applied incorrectly:

- ***Rule specifically requires formula of E=33.3D for most of the criteria pollutants, including VOC, and the formula of E=3400(Dexp2/3) for CO. E is defined as the calculated emissions threshold and D is the distance from shore to the proposed facility. Providing a formula of D=E/33.3, where E represents projected annual emissions, and D is some other distance is incorrect.***
- ***Provide solutions to the exemption threshold calculations using emissions from the facility (i.e. drillship) only and provide solutions for each pollutant, as applicable.***
- ***Use the highest projected annual emissions for the multi-year plan for these calculations.***

The emission exemption threshold formulas are as follows:

Distance, D (statute miles)=	64			
For CO	E=3400*D^(2/3)	=	54,400	tons per year
For TSP, SO_2, NO_X, and VOC:	E=33.3*D	=	2,131	tons per year

Annual Emissions	NOx ton/season	PM_{10} ton/season	$PM_{2.5}$ ton/season	CO ton/season	VOC ton/season	SO_2 ton/season
Drill Rig Only	191	7	7	69	20	2
Drill Rig & Auxiliary Support	2,118	65	65	587	211	11
Exemption emissions	2,131	2,131	2,131	54,400	2,131	2,131
	Below	Below	Below	Below	Below	Below

Emissions from the facility (i.e. drillship) only and the drillship plus auxiliary support are provided for each pollutant. The emissions from the drillship plus auxiliary support are presented to show that at utilizations greater than their projected maximum use, emissions are still below the exemptions threshold.

The AQRP emissions are from the highest projected annual emissions for the multi-year plan as currently configured and discussed in the response to RFAI No. 12.

Shell has updated Chapter 7 of EP Revision 2 to include this information.

RFAI No. 26

January 14, 2014 Comment

Explain the basis for the use of surface roughness of 0.025 in computer modeling of the emission inventory.

A single value of 0.025 was not used for the surface roughness in the dispersion modeling analysis. The air quality modeling was performed with CALPUFF, a three-dimensional puff model. Surface roughness is provided to the model for a two-dimensional grid representing the surface. The surface in the CALPUFF modeling was represented by a rectangular 167-by-118 grid. So, in effect there were 19,706 values of the surface roughness entered in the model. But, these values can change from hour to hour. The ultimate source of the surface roughness values used in this analysis was the WRF solutions. Over the water, in particular, WRF has a wind-water routine that will calculate a different value of the surface roughness for every water grid cell for every hour. Over land, roughness is not affected by wind as much as over water, but roughness does change seasonally. In summary, the surface roughness is not a user input in the current analysis.

This information is provided in Section 5.2.4 of Attachment B and Section 5.2.5 of Attachment C of the EIA of EP Revision 2.

RFAI No. 27

January 14, 2014 Comment

Explain why dispersion of the emissions from the facility shows impacts (refer to the isopleth plots) on the shoreline along a line of transport from the northwest, given that the windrose shows prevailing winds from the northeast; or provide the contours of the entire grid so the pollutant transport can be readily understood.

For comparison with hourly impact criteria, the isopleths provided were for 1-hour averages of NO2, CO, SO2, PM10, and PM2.5 concentration. The wind rose referred to in BOEM's RFAI reflects the frequency of wind directions over the year. In dispersion modeling, it is common that peak short-term impacts are often not in the same direction as the predominant wind direction. Peak 1-hour concentrations occur during the most adverse meteorological conditions, not the most frequent wind direction.

Shell has updated Section 6.1 of Attachment C of the EIA of EP Revision 2 to include this information.

RFAI No. 28

January 14, 2014 Comment

The spreadsheet provided in response to Air Quality Item #1 is difficult to interpret and verification of the data is problematic. BOEM requests that all emission inventory tables submitted to satisfy 30 CFR 550, Subpart C and the informational requirements of 30 CFR 550.218, .224, and .227, be provided as described in Air Quality Item #12.

Shell submits a condensed emission inventory electronically and in a printer friendly version as Attachment C of Appendix O (Emissions Inventory) of EP Revision 2.

Air RFAI: Attachment A

Emission Inventory Tables

Air Sciences Inc.	PROJECT TITLE: Shell OCS Alaska	BY: S. Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 180-23-1	PAGE: 1	OF: 2	SHEET: 1
	SUBJECT: AQRP Mass Emission Summary	DATE: January 24, 2013		

Discoverer OCS Source - Seasonal AQRP Emissions for each source group

		NOx_tps	PM10_tps	PM2.5_tps	CO_tps	VOC_tps	SO2_tps
		NO_X ton/season	PM_{10} ton/season	$PM_{2.5}$ ton/season	CO ton/season	VOC ton/season	SO_2 ton/season
	Discoverer						
D_GEN	Generation	123.79	3.36	3.36	27.28	9.44	0.95
D_P	Propulsion	5.01	0.15	0.15	1.71	0.45	0.02
D_SE	Small IC engines	30.78	1.12	1.12	27.98	7.27	0.25
D_SU	Seldom-Used IC engines	27.57	0.81	0.81	9.44	2.45	0.09
D_B	Boilers	3.64	0.05	0.05	0.42	0.01	0.24
D_I	Incinerator	0.64	1.37	1.37	2.15	0.08	0.69
	SUBTOTAL	*191.42*	*6.86*	*6.86*	*68.98*	*19.71*	*2.24*
	Ice Management & Anchor Handling (4 vessels)						
IB_P&G	Propulsion & Generation	880.03	22.47	22.47	155.03	97.36	3.40
IB_H&B	Boilers	4.60	0.12	0.12	0.06	0.09	0.35
IB_I	Incinerator	1.81	5.21	5.21	6.27	1.26	1.45
	SUBTOTAL	*886.43*	*27.80*	*27.80*	*161.36*	*98.71*	*5.21*
	Oil Spill Response (Vessel, Tug & Barge, 3 WB)						
OSR_P&G	All IC Engines (non-emergency)	340.56	10.03	10.03	116.63	30.32	1.06
	SUBTOTAL	*340.56*	*10.03*	*10.03*	*116.63*	*30.32*	*1.06*
	Offshore Supply (2 vessels)						
OSV_P&G	All IC Engines (non-emergency)	334.59	9.85	9.85	114.59	29.79	1.04
	SUBTOTAL	*334.59*	*9.85*	*9.85*	*114.59*	*29.79*	*1.04*
	Science Vessel						
RV_P&G	All IC Engines (non-emergency)	174.30	5.13	5.13	59.69	15.52	0.54
	SUBTOTAL	*174.30*	*5.13*	*5.13*	*59.69*	*15.52*	*0.54*
	Arctic Oil Storage Tanker						
FT_P&G	All IC Engines (non-emergency)	191.06	5.63	5.63	65.43	17.01	0.59
	SUBTOTAL	*191.06*	*5.63*	*5.63*	*65.43*	*17.01*	*0.59*
	TOTAL	**2,118**	**65**	**65**	**587**	**211**	**11**

Discoverer OCS Source - Project Total AQRP Emissions for each source group

Project Duration: 3 years

NOx_tpp PM10_tpp PM2.5_tpp CO_tpp VOC_tpp SO2_tpp

	NO_X ton/project	PM_{10} ton/project	$PM_{2.5}$ ton/project	CO ton/project	VOC ton/project	SO_2 ton/project
Discoverer						
Generation	371.37	10.07	10.07	81.83	28.32	2.86
Propulsion	15.02	0.44	0.44	5.14	1.34	0.05
Small IC engines	92.33	3.36	3.36	83.94	21.82	0.76
Seldom-Used IC engines	82.70	2.44	2.44	28.32	7.36	0.26
Boilers	10.92	0.15	0.15	1.26	0.04	0.73
Incinerator	1.91	4.11	4.11	6.44	0.24	2.06
SUBTOTAL	*574.25*	*20.57*	*20.57*	*206.93*	*59.13*	*6.72*
Ice Management & Anchor Handling (4 vessels)						
Propulsion & Generation	2,640.09	67.41	67.41	465.10	292.09	10.20
Boilers	13.79	0.35	0.35	0.17	0.26	1.06
Incinerator	5.42	15.64	15.64	18.80	3.78	4.36
SUBTOTAL	*2,659.30*	*83.40*	*83.40*	*484.07*	*296.14*	*15.62*
Oil Spill Response (Vessel, Tug & Barge, 3 WB)						
All IC Engines (non-emergency)	1,021.68	30.09	30.09	349.89	90.97	3.18
SUBTOTAL	*1,021.68*	*30.09*	*30.09*	*349.89*	*90.97*	*3.18*
Offshore Supply (2 vessels)						
All IC Engines (non-emergency)	1,003.78	29.56	29.56	343.76	89.38	3.12
SUBTOTAL	*1,003.78*	*29.56*	*29.56*	*343.76*	*89.38*	*3.12*
Science Vessel						
All IC Engines (non-emergency)	522.90	15.40	15.40	179.08	46.56	1.63
SUBTOTAL	*522.90*	*15.40*	*15.40*	*179.08*	*46.56*	*1.63*
Arctic Oil Storage Tanker						
All IC Engines (non-emergency)	573.19	16.88	16.88	196.30	51.04	1.78
SUBTOTAL	*573.19*	*16.88*	*16.88*	*196.30*	*51.04*	*1.78*
TOTAL	**6,355**	**196**	**196**	**1,760**	**633**	**32**

Air Sciences Inc.	PROJECT TITLE: Shell OCS Alaska	BY: S. Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 180-23-1	PAGE: 1	OF: 5	SHEET: 2
	SUBJECT: Discoverer Chukchi Project-AQRP Inventory	DATE: January 24, 2013		

FOR AQRP ANALYSIS ONLY

OPERATING ASSUMPTIONS

ACTIVITY LEVELS

	Emission Units to permit	capacity		per season max load % of capacity	days/season	Load Comments
	Discoverer					
D_GE	Generation	6,609	kW	100%	120	
D_P	Propulsion	6,480	kW	100%	2	Season: max use of Propulsion is estimated for 2 days
D_SE	Small IC engines	1,763	kW	100%	120	
D_SU	Seldom-Used IC engines	595	kW	100%	120	
D_B	Boilers	16	MMBtu/hr	100%	120	
D_I	Incinerator	276	lb/hr	100%	120	
	Auxiliary Support - within 25 nm					
	Ice Management & Anchor Handling (4 vessels)					
IB_P&	Propulsion & Generation	78,640	kW	30%	120	
IB_H&	Boilers	23	MMBtu/hr	100%	120	
IB_I	Incinerator	584	lb/hr	100%	120	
	Oil Spill Response (Vessel, Tug & Barge, 3 WB)					
OSR_I	All IC Engines (non-emergency)	18,369	kW	40%	120	
	Offshore Supply (2 vessels)					
OSV_I	All IC Engines (non-emergency)	16,042	kW	45%	120	
	Science Vessel					
RV_P(	All IC Engines (non-emergency)	8,357	kW	45%	120	
	Arctic Oil Storage Tanker					
FT_P&	All IC Engines (non-emergency)	20,611	kW	20%	120	

ASSUMED AUXILIARY SUPPORT CANDIDATE VESSELS FOR EI

Ice Management 1	Fennica
Ice Management 2	Nordica
Anchor Handler 1	Aiviq
Anchor Handler 2	Ross Chouest
Oil Spill Response Vessel	Nanuq
Oil Spill Response - Tug/Barge	Ocean Wave/Arctic Endeavour
Offshore Supply Vessel 1	Sisuaq
Offshore Supply Vessel 2	Supporter
Science vessel	Sisuaq or similar
Arctic Oil Storage Tanker	Affinity

ASSUMPTIONS			**Reference**
Diesel engine thermal efficiency	7,000	Btu/hp-hr	AP42 Table 3.3-1, 10/96
Diesel heating value	0.1312	MMBtu/gallon	Tesoro Nikiski, Email Royal Harris 4/20/11
Diesel density	7.00	lb/gal	Tesoro Nikiski, Email Royal Harris 4/20/11
Municipal solid waste HHV	9.95	MMBtu/short ton	Table C-1 to Subpart C of 40 CFR Part 98
Emission factors represent over 90% of the capacity power			

CONVERSIONS

1.34	hp/kW	2,000	lb/ton	32.07	wt S
0.7457	kW / hp	24	hr/day	64.06	wt. SO2
1,000,000	Btu/MMBtu	168	hr/wk	2.00	wt. conversion of S to SO2
453.592	g/lb	2.2	lb/kg	0.608	lb/hp-hr to kg/kW-hr
17.1	wk/season	1000	g/kg		

blue values are input, black values are calculated or linked

MAXIMUM ANNUAL EMISSIONS

NOx_tps PM10_tps PM2.5_tps CO_tps VOC_tps SO2_tps

EMISSIONS

	Emission Units	NOx ton/season	PM_{10} ton/season	$PM_{2.5}$ ton/season	CO ton/season	VOC ton/season	SO_2 ton/season
	Discoverer						
D_GI	Generation	124	3	3	27	9	1E+0
D_P	Propulsion	5	1E-1	1E-1	2	4E-1	2E-2
D_SI	Small IC engines	31	1	1	28	7	3E-1
D_SU	Seldom-Used IC engines	28	8E-1	8E-1	9	2	9E-2
D_B	Boilers	4	5E-2	5E-2	4E-1	1E-2	2E-1
D_I	Incinerator	6E-1	1	1	2	8E-2	7E-1
	SUBTOTAL	191	7	7	69	20	2
	Auxiliary Support - within 25 nm						
	Ice Management & Anchor Handling (4 vessels)						
IB_P	Propulsion & Generation	880	22	22	155	97	3
IB_H	Boilers	5	1E-1	1E-1	6E-2	9E-2	4E-1
IB_I	Incinerator	2	5	5	6	1	1
	Oil Spill Response (Vessel, Tug & Barge, 3 WB)						
OSR	All IC Engines (non-emergency)	341	10	10	117	30	1
	Offshore Supply (2 vessels)						
OSV	All IC Engines (non-emergency)	335	10	10	115	30	1
	Science Vessel						
RV_I	All IC Engines (non-emergency)	174	5	5	60	16	5E-1
	Arctic Oil Storage Tanker						
FT_P	All IC Engines (non-emergency)	191	6	6	65	17	6E-1
	SUBTOTAL	1,927	58	58	518	191	8
	TOTAL	2,118	65	65	587	211	11

PROJECT DURATION EMISSIONS

Project duration 3 years

NOx_tpp PM10_tpp PM2.5_tpp CO_tpp VOC_tpp SO2_tpp

EMISSIONS

	Emission Units	NOx ton/project	PM_{10} ton/project	$PM_{2.5}$ ton/project	CO ton/project	VOC ton/project	SO_2 ton/project
	Discoverer						
D_GI	Generation	371	10	10	82	28	3
D_P	Propulsion	15	4E-1	4E-1	5	1	5E-2
D_SI	Small IC engines	92	3	3	84	22	8E-1
D_SU	Seldom-Used IC engines	83	2	2	28	7	3E-1
D_B	Boilers	11	1E-1	1E-1	1	4E-2	7E-1
D_I	Incinerator	2	4	4	6	2E-1	2
	SUBTOTAL	574	21	21	207	59	7
	Ice Management & Anchor Handling (4 vessels)						
IB_P	Propulsion & Generation	2,640	67	67	465	292	10
IB_H	Boilers	14	3E-1	3E-1	2E-1	3E-1	1
IB_I	Incinerator	5	16	16	19	4	4
0	*Oil Spill Response (Vessel, Tug & Barge, 3 WB)*						
OSR	All IC Engines (non-emergency)	1,022	30	30	350	91	3
0	*Offshore Supply (2 vessels)*						
OSV	All IC Engines (non-emergency)	1,004	30	30	344	89	3
0	*Science Vessel*						
RV_I	All IC Engines (non-emergency)	523	15	15	179	47	2
0	*Arctic Oil Storage Tanker*						
FT_P	All IC Engines (non-emergency)	573	17	17	196	51	2
	SUBTOTAL	5,781	175	175	1,553	574	25
	TOTAL	6,355	196	196	1,760	633	32

FUEL & WASTE CONSUMPTION

	Emission Units	Capacity Values		MMBtu/hr	FUEL gal/season	WASTE lb/season
	Discoverer					
D_GE	Generation	6,609	kW	62	1,361,007	
D_P	Propulsion	6,480	kW	61	22,241	
D_SE	Small IC engines	1,763	kW	17	362,997	
D_SU	Seldom-Used IC engines	595	kW	6	122,485	
D_B	Boilers	16	MMBtu/hr	16	349,956	
D_I	Incinerator	276	lb/hr			794,880
		SUBTOTAL			2,218,685	794,880
	Auxiliary Support - within 25 nm					
	Ice Management & Anchor Handling (4 vessels)					
IB_P&	Propulsion & Generation	78,640	kW	738	4,858,363	
IB_H&	Boilers	23	MMBtu/hr	23	505,113	
IB_I	Incinerator	584	lb/hr			1,681,920
	Oil Spill Response (Vessel, Tug & Barge, 3 WB)					
OSR_I	All IC Engines (non-emergency)	18,369	kW	172	1,513,111	
	Offshore Supply (2 vessels)					
OSV_I	All IC Engines (non-emergency)	16,042	kW	150	1,486,605	
	Science Vessel					
RV_P(	All IC Engines (non-emergency)	8,357	kW	78	774,423	
	Arctic Oil Storage Tanker					
FT_P&	All IC Engines (non-emergency)	20,611	kW	193	848,900	
		SUBTOTAL			9,986,515	1,681,920
		TOTAL			12,205,201	2,476,800

NO_X EMISSION FACTORS

id	Source	Pollutant	EF	unit	EF	unit	Reference
D_	Discoverer Generation	NO_X	5.9	g/kW-hr	0.18	lb/gal	Caterpillar 3512 Vendor Data
D_	Discoverer Propulsion	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
D_	Discoverer Small IC engines	NO_X	5.5	g/kW-hr	0.17	lb/gal	Average value from source testing, performed 3/28/2012-5/14/2012
D_	Discoverer Seldom-Used IC engines	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
D_	Discoverer Boilers	NO_X	20.8	lbs/k-gal	2.1E-2	lb/gal	Average value from source testing, performed 6/10/2012-6/11/2012
D_	Discoverer Incinerator	NO_X	3.2	lb/ton	1.6E-3	lb/lb	Average value from source testing, performed 6/11/2012
IB	IM/AH Propulsion & Generation	NO_X	11.75	g/kW-hr	0.36	lb/gal	Weighted based on vessel capacities, IMO Tier 2, EPA Marine Tier 2 and AP-42[a]
IB	IM/AH Boiler	NO_X	18.2	lbs/k-gal	1.8E-2	lb/gal	Average value from source testing, performed 4/14/2012 - 4/21/2012 (2 vessels)
IB	IM/AH Incineration	NO_X	4.3	lb/ton	2.2E-3	lb/lb	Average value from source testing, performed 4/16/2012 - 5/10/2012 (3 vessels)
OS	OSR Propulsion & Generation	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
OS	Offshore Supply P & G	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
RV	Science Vessel Propulsion & Generation	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
FT	Arctic Oil Storage Tanker	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
[a]	IM/AH Propulsion & Generation				P&G Capacity		
	Fennica	NO_X	12.0	g/kW-hr	21,530	kW	IMO Tier I at 750 rpm
	Nordica	NO_X	12.0	g/kW-hr	21,530	kW	IMO Tier I at 750 rpm
	Aiviq	NO_X	9.8	g/kW-hr	23,051	kW	EPA 40 CFR 94.8 Marine Category 2, Tier 2, 15 ≤ displacement < 20
	Ross Chouest	NO_X	14.59	g/kW-hr	12,529	kW	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
					78,640	kW	

PM EMISSION FACTORS [b]

id	Source	Pollutant	EF	unit	EF	unit	Reference
D_	Discoverer Generation	PM	0.16	g/kW-hr	0.00	lb/gal	Caterpillar 3512 Vendor Data
D_	Discoverer Propulsion	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
D_	Discoverer Small IC engines	PM	0.20	g/kW-hr	6.2E-3	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
D_	Discoverer Seldom-Used IC engines	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
D_	Discoverer Boilers	PM	0.28	lbs/k-gal	2.8E-4	lb/gal	Average value from source testing, performed 6/10/2012-6/11/2012
D_	Discoverer Incinerator	PM	6.90	lb/ton	3.5E-3	lb/lb	Average value from source testing, performed 6/11/2012
IB	IM/AH Propulsion & Generation	PM	0.30	g/kW-hr	0.01	lb/gal	Weighted based on vessel capacities, source test data, EPA Marine Tier 2 and AP-42[a]
IB	IM/AH Boiler	PM	0.46	lbs/k-gal	4.6E-4	lb/gal	Average value from source testing, performed 4/14/2012 - 4/21/2012 (2 vessels)
IB	IM/AH Incineration	PM	12.40	lb/ton	6.2E-3	lb/lb	Average value from source testing, performed 4/16/2012 - 5/10/2012 (3 vessels)
OS	OSR Propulsion & Generation	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
OS	Offshore Supply P & G	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
RV	Science Vessel Propulsion & Generation	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
FT	Arctic Oil Storage Tanker	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
[a]	IM/AH Propulsion & Generation				P&G Capacity		
	Fennica	PM	0.18	g/kW-hr	21,530	kW	Uncontrolled - assumed 50% control form OxyCat controlled EF
	Nordica	PM	0.15	g/kW-hr	21,530	kW	Uncontrolled - assumed 50% control form OxyCat controlled EF
	Aiviq	PM	0.50	g/kW-hr	23,051	kW	EPA 40 CFR 94.8 Marine Category 2, Tier 2, 15 ≤ displacement < 20
	Ross Chouest	PM	0.43	g/kW-hr	12,529	kW	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
					78,640	kW	
	CDPF PM reduction efficiency	50%					Estimate

[b] $PM=PM_{10}=PM_{2.5}$, the same emission factors are used for all particulate matter emissions.

CO EMISSION FACTORS

id	Source	Pollutant	EF	unit	EF	unit	Reference
D_	Discoverer Generation	CO	1.3	g/kW-hr	0.04	lb/gal	Caterpillar 3512 Vendor Data
D_	Discoverer Propulsion	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
D_	Discoverer Small IC engines	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
D_	Discoverer Seldom-Used IC engines	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
D_	Discoverer Boilers	CO	2.4	lbs/k-gal	2.4E-3	lb/gal	Average value from source testing, performed 6/10/2012-6/11/2012
D_	Discoverer Incinerator	CO	10.8	lb/ton	5.4E-3	lb/lb	Average value from source testing, performed 6/11/2012
IB	IM/AH Propulsion & Generation	CO	2.07	g/kW-hr	0.06	lb/gal	Weighted based on vessel capacities, source test data, EPA Marine Tier 2 and AP-42[a]
IB	IM/AH Boiler	CO	0.23	lbs/k-gal	2.3E-4	lb/gal	Average value from source testing, performed 4/14/2012 - 4/21/2012 (2 vessels)
IB	IM/AH Incineration	CO	14.9	lb/ton	7.5E-3	lb/lb	Average value from source testing, performed 4/16/2012 - 5/10/2012 (3 vessels)
OS	OSR Propulsion & Generation	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
OS	Offshore Supply P & G	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
RV	Science Vessel Propulsion & Generation	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
FT	Arctic Oil Storage Tanker	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
[a]	IM/AH Propulsion & Generation				P&G Capacity		
	Fennica	CO	0.16	g/kW-hr	21,530	kW	Uncontrolled - assumed 50% control form OxyCat controlled EF
	Nordica	CO	0.10	g/kW-hr	21,530	kW	Uncontrolled - assumed 50% control form OxyCat controlled EF
	Aiviq	CO	5.0	g/kW-hr	23,051	kW	EPA 40 CFR 94.8 Marine Category 2, Tier II, 15 ≤ displacement < 20
	Ross Chouest	CO	3.34	g/kW-hr	12,529	kW	EPA, AP-42, Table 3.4-1, CO, diesel fuel, 10/96
					78,640	kW	
	CDPF CO reduction efficiency	50%					Estimate

VOC EMISSION FACTORS

id	Source	Pollutant	EF	unit	EF	unit	Reference
D_	Discoverer Generation	VOC	0.45	g/kW-hr	0.01	lb/gal	Caterpillar 3512 Vendor Data
D_	Discoverer Propulsion	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
D_	Discoverer Small IC engines	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
D_	Discoverer Seldom-Used IC engines	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
D_	Discoverer Boilers	VOC	0.085	lbs/k-gal	8.5E-5	lb/gal	Average value from source testing, performed 6/10/2012-6/11/2012
D_	Discoverer Incinerator	VOC	0.4	lb/ton	2.0E-4	lb/lb	Average value from source testing, performed 6/11/2012
IB	IM/AH Propulsion & Generation	VOC	1.3	g/kW-hr	0.04	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
IB	IM/AH Boiler	VOC	0.34	lbs/k-gal	3.4E-4	lb/gal	EPA AP-42, Table 1.3-3 ver. 5-10, Commercial Boilers - Distillate Oil.
IB	IM/AH Incineration	VOC	3	lb/ton	1.5E-3	lb/lb	EPA AP-42, Table 2.1-12, Refuse Combustor, Industrial/commercial, multiple chamber
OS	OSR Propulsion & Generation	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
OS	Offshore Supply P & G	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
RV	Science Vessel Propulsion & Generation	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
FT	Arctic Oil Storage Tanker	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)

SO_2 EMISSION FACTORS

Source	Pollutant	EF	unit	EF	unit	Reference
Combustion Sources	SO_2	100	ppm S	1.4E-3	lb/gal	Stoichiometric Calculation
Incineration	SO_2	3.46	lb/ton	1.7E-3	lb/lb	EPA, AP42, Table 2.1-2, EF for Modular Excess Air Combustors, uncontrolled, 10/96

Air Sciences Inc.	PROJECT TITLE: Shell OCS Alaska	BY: S. Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 180-23-1	PAGE: 1	OF: 2	SHEET: 1
	SUBJECT: NEPA Mass Emission Summary	DATE: January 24, 2014		

Discoverer OCS Source - Hourly Maximum NEPA Emissions for each source group

		NOx_pph	PM_pph	CO_pph	VOC_pph	Pb_pph	SO2_pph
		NO_X lb/hr	$PM/PM_{10}/PM_{2.5}$ lb/hr	CO lb/hr	VOC lb/hr	Pb lb/hr	SO_2 lb/hr
Discoverer							
D_GEN	Generation	39.63	1.17	9.32	3.50	1.4E-3	0.53
D_P	Propulsion	166.86	4.91	57.14	14.86	1.4E-3	0.52
D_SE	Small IC engines	12.25	0.45	11.13	2.90	2.7E-4	0.10
D_SU	Seldom-Used IC engines	13.05	0.38	4.47	1.16	1.1E-4	0.04
D_B	Boilers	2.53	0.03	0.29	0.01	1.4E-4	0.17
D_I	Incinerator	0.44	0.95	1.49	0.06	2.9E-2	0.48
	SUBTOTAL	*234.76*	*7.90*	*83.85*	*22.48*	*3.3E-2*	*1.84*
Ice Management & Anchor Handling (4 vessels)							
IB_P&G	Propulsion & Generation	384.19	22.19	83.22	180.31	1.7E-2	6.29
IB_H&B	Boilers	3.19	0.08	0.04	0.06	2.1E-4	0.25
IB_I	Incinerator	1.26	3.62	4.35	0.88	6.2E-2	1.01
	SUBTOTAL	*388.64*	*25.89*	*87.61*	*181.24*	*8.0E-2*	*7.55*
Oil Spill Response (Vessel, Tug & Barge, 3 WB)							
OSR_P&G	All IC Engines (non-emergency)	473.00	13.93	161.99	42.12	4.0E-3	1.47
	SUBTOTAL	*473.00*	*13.93*	*161.99*	*42.12*	*4.0E-3*	*1.47*
Offshore Supply (2 vessels)							
OSV_P&G	All IC Engines (non-emergency)	296.90	8.74	101.68	26.44	2.5E-3	0.92
	SUBTOTAL	*296.90*	*8.74*	*101.68*	*26.44*	*2.5E-3*	*0.92*
Science Vessel							
RV_P&G	All IC Engines (non-emergency)	134.49	3.96	46.06	11.98	1.1E-3	0.42
	SUBTOTAL	*134.49*	*3.96*	*46.06*	*11.98*	*1.1E-3*	*0.42*
Arctic Oil Storage Tanker							
ST_P&G	All IC Engines (non-emergency)	210.44	6.20	72.07	18.74	1.8E-3	0.65
	SUBTOTAL	*210.44*	*6.20*	*72.07*	*18.74*	*1.8E-3*	*0.65*
On-shore Support							
Heli	Helicopter	0.20	0.04	1.25	1.50	-	0.06
ManCamp_G	Man Camp Generators	7.73	0.36	6.30	2.34	-	0.08
Bldg	Hangar/Storage Building Boiler	0.49	0.04	0.41	0.02	2.5E-6	0.05
Veh	Vehicles	7.9E-3	7.9E-4	0.29	7.7E-3	-	1.6E-3
	SUBTOTAL	*8.43*	*0.43*	*8.25*	*3.86*	*2.5E-6*	*0.19*
	TOTAL	**1,747**	**67**	**562**	**307**	**1.2E-1**	**13**

Discoverer OCS Source - Seasonal Maximum NEPA Emissions for each source group

NOx_tps PM_tps CO_tps VOC_tps Pb_tps SO2_tps

	NO_X ton/season	$PM/PM_{10}/PM_{2.5}$ ton/season	CO ton/season	VOC ton/season	Pb ton/season	SO_2 ton/season
Discoverer						
Generation	45.66	1.34	10.74	4.03	1.7E-3	0.61
Propulsion	4.00	0.12	1.37	0.36	3.4E-5	0.01
Small IC engines	17.64	0.64	16.03	4.17	4.0E-4	0.15
Seldom-Used IC engines	0.11	3.3E-3	0.04	0.01	9.5E-7	3.5E-4
Boilers	1.82	0.02	0.21	0.01	1.0E-4	0.12
Incinerator	0.64	1.37	2.15	0.08	4.2E-2	0.69
SUBTOTAL	*69.87*	*3.50*	*30.54*	*8.65*	*4.5E-2*	*1.58*
Ice Management & Anchor Handling (4 vessels)						
Propulsion & Generation	154.88	8.95	33.55	72.69	6.9E-3	2.54
Boilers	1.60	0.04	0.02	0.03	1.0E-4	0.12
Incinerator	1.26	3.62	4.35	0.88	6.2E-2	1.01
SUBTOTAL	*157.73*	*12.61*	*37.92*	*73.59*	*6.9E-2*	*3.67*
Oil Spill Response (Vessel, Tug & Barge, 3 WB)						
All IC Engines (non-emergency)	217.22	6.40	74.39	19.34	1.8E-3	0.68
SUBTOTAL	*217.22*	*6.40*	*74.39*	*19.34*	*1.8E-3*	*0.68*
Offshore Supply (2 vessels)						
All IC Engines (non-emergency)	266.44	7.85	91.25	23.72	2.3E-3	0.83
SUBTOTAL	*266.44*	*7.85*	*91.25*	*23.72*	*2.3E-3*	*0.83*
Science Vessel						
All IC Engines (non-emergency)	135.57	3.99	46.43	12.07	1.1E-3	0.42
SUBTOTAL	*135.57*	*3.99*	*46.43*	*12.07*	*1.1E-3*	*0.42*
Arctic Oil Storage Tanker						
All IC Engines (non-emergency)	94.06	2.77	32.21	8.38	7.9E-4	0.29
SUBTOTAL	*94.06*	*2.77*	*32.21*	*8.38*	*7.9E-4*	*0.29*
On-shore Support						
Helicopter	0.28	0.05	1.80	2.16	-	0.08
Man Camp Generators	12.76	0.64	11.16	4.15	-	0.14
Hangar/Storage Building Boiler	0.35	0.03	4.88	0.01	1.8E-6	0.04
Vehicles	1.2E-2	1.2E-3	0.42	1.1E-2	-	0.00
SUBTOTAL	*13.41*	*0.72*	*18.27*	*6.33*	*1.8E-6*	*0.27*
TOTAL	**954**	**38**	**331**	**152**	**1.2E-1**	**8**

Seasonal Pollutant Total

NO_X ton/season	PM ton/season	CO ton/season	VOC ton/season	Pb ton/season	SO_2 ton/season	CO_2e ton/season
591	27	331	152	1.2E-1	8	93,346

Air Sciences Inc.	PROJECT TITLE: Shell OCS Alaska	BY: S. Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 180-23-1	PAGE: 1	OF: 6	SHEET: 2
	SUBJECT: Discoverer Chukchi Project-NEPA Inventory	DATE: January 24, 2014		

OPERATING ASSUMPTIONS

ACTIVITY LEVELS

	Emission Units	capacity		hourly max load % of capacity	per season max load % of capacity	days/season	Load Comments
	Discoverer						
D_GE	Generation	6,609	kW	80%	64%	120	Season: 15% use for 1/4 and 80% for 3/4 = 64%
D_P	Propulsion	6,480	kW	80%	80%	2	Season: max use of Propulsion is estimated for 2 days
D_SE	Small IC engines	1,763	kW	57%	57%	120	Season: emissions represented by generation (no Cementing)
D_SU	Seldom-Used IC engines	595	kW	68%	68%	0.7	Hour: eGen only operating at 80% capacity, Season: 1 hr/wk
D_B	Boilers	16	MMBtu/hr	100%	50%	120	Season: expected max use of Boilers is 50%
D_I	Incinerator	276	lb/hr	100%	100%	120	no operational restrictions preventing 100% use
	Auxiliary Support - within 25 nm						
	Ice Management & Anchor Handling (4 vessels)						
IB_P&	Propulsion & Generation	78,640	kW	80%	22%	120	Season: calculations and assumptions available on Support Vessels Sheet
IB_H&	Boilers	23	MMBtu/hr	100%	35%	120	Season: calculations and assumptions available on Support Vessels Sheet
IB_I	Incinerator	584	lb/hr	100%	69%	120	Season: calculations and assumptions available on Support Vessels Sheet
	Oil Spill Response (Vessel, Tug & Barge, 3 WB)						
OSR_I	All IC Engines (non-emergency)	18,369	kW	80%	26%	120	Season: calculations and assumptions available on Support Vessels Sheet
	Offshore Supply (2 vessels)						
OSV_I	All IC Engines (non-emergency)	16,042	kW	58%	36%	120	Season: calculations and assumptions available on Support Vessels Sheet
	Science Vessel						
RV_P	All IC Engines (non-emergency)	8,357	kW	50%	35%	120	Season: calculations and assumptions available on Support Vessels Shee
	Arctic Oil Storage Tanker						
FT_P&	All IC Engines (non-emergency)	20,611	kW	32%	10%	120	Season: calculations and assumptions available on Support Vessels Sheet
	On-shore Support						
Heli	Helicopter	40	roundtrips per week			120	See Helicopter Sheet
ManC	Man Camp Generators	1,396	kW	59%	51%	168	See Onshore Sheet, 2 Diesel fired Gens at 80%, 1 as back up operated 15 min/wk
Bldg	Hangar/Storage Building Boiler	5	MMBtu/hr	100%	50%	120	See Onshore Sheet, Natural Gas fired Boiler - heat input
Veh	Vehicles	200	gal/wk			123	Based on 3/4 ton diesel on-road truck, see Vehicle Sheet

ASSUMED AUXILIARY SUPPORT CANDIDATE VESSELS FOR EI

Ice Management 1	Fennica
Ice Management 2	Nordica
Anchor Handler 1	Aiviq
Anchor Handler 2	Ross Chouest
Oil Spill Response Vessel	Nanuq
Oil Spill Response - Tug/Barge	Ocean Wave/Arctic Endeavour
Offshore Supply Vessel 1	Sisuaq
Offshore Supply Vessel 2	Supporter
Science vessel	Sisuaq or similar
Arctic Oil Storage Tanker	Affinity

ASSUMPTIONS			Reference
Diesel engine thermal efficiency	7,000	Btu/hp-hr	AP42 Table 3.3-1, 10/96
Diesel heating value	0.1312	MMBtu/gallon	Tesoro Nikiski, Email Royal Harris 4/20/11
Diesel density	7.00	lb/gal	Tesoro Nikiski, Email Royal Harris 4/20/11
Municipal solid waste HHV	9.95	MMBtu/short ton	Table C-1 to Subpart C of 40 CFR Part 98
Emission factors represent over 90% of the capacity power			

CONVERSIONS

1.34	hp/kW	2,000	lb/ton	32.07	wt S
0.7457	kW / hp	24	hr/day	64.06	wt. SO2
1,000,000	Btu/MMBtu	168	hr/wk	2.00	wt. conversion of S to SO2
453.592	g/lb	2.2	lb/kg	0.608	lb/hp-hr to kg/kW-hr
17.1	wk/season	1000	g/kg		

blue values are input, black values are calculated or linked

NOx_pph NOx_tps PM_pph PM_tps CO_pph CO_tps VOC_pph VOC_tps Pb_pph Pb_tps

EMISSIONS

		NOx		$PM/PM_{10}/PM_{2.5}$		CO		VOC		Pb	
	Emission Units	**lb/hr**	**ton/season**	**lb/hr**	**ton/season**	**lb/hr**	**ton/season**	**lb/hr**	**ton/season**	**lb/hr**	**ton/season**
	Discoverer										
D_GI	Generation	40	46	1	1	9	11	3	4	1E-3	2E-3
D_P	Propulsion	167	4	5	1E-1	57	1	15	4E-1	1E-3	3E-5
D_SI	Small IC engines	12	18	4E-1	6E-1	11	16	3	4	3E-4	4E-4
D_SU	Seldom-Used IC engines	13	1E-1	4E-1	3E-3	4	4E-2	1	1E-2	1E-4	9E-7
D_B	Boilers	3	2	3E-2	2E-2	3E-1	2E-1	1E-2	7E-3	1E-4	1E-4
D_I	Incinerator	4E-1	6E-1	1E+0	1	1	2	6E-2	8E-2	3E-2	4E-2
	SUBTOTAL	235	70	8	4	84	31	22	9	3E-2	4E-2
	Auxiliary Support - within 25 nm										
	Ice Management & Anchor Handling (4 vessels)										
IB_P	Propulsion & Generation	384	155	22	9	83	34	180	73	2E-2	7E-3
IB_H	Boilers	3	2	8E-2	4E-2	4E-2	2E-2	6E-2	3E-2	2E-4	1E-4
IB_I	Incinerator	1	1	4	4	4	4	9E-1	9E-1	6E-2	6E-2
	Oil Spill Response (Vessel, Tug & Barge, 3 WB)										
OSR	All IC Engines (non-emergency)	473	217	14	6	162	74	42	19	4E-3	2E-3
	Offshore Supply (2 vessels)										
OSV	All IC Engines (non-emergency)	297	266	9	8	102	91	26	24	3E-3	2E-3
	Science Vessel										
RV_I	All IC Engines (non-emergency)	134	136	4	4	46	46	12	12	1E-3	1E-3
	Arctic Oil Storage Tanker										
FT_P	All IC Engines (non-emergency)	210	94	6	3	72	32	19	8	2E-3	8E-4
	SUBTOTAL	1,503	871	59	34	469	282	281	137	9E-2	8E-2
	On-shore Support										
Heli	Helicopter	2E-1	3E-1	4E-2	5E-2	1	2	1	2	-	-
Man(	Man Camp Generators	8	13	4E-1	6E-1	6	11	2	4	-	-
Bldg	Hangar/Storage Building Boiler	5E-1	4E-1	4E-2	3E-2	4E-1	5	2E-2	1E-2	2E-6	2E-6
Veh	Vehicles	8E-3	1E-2	8E-4	1E-3	3E-1	4E-1	8E-3	1E-2	-	-
	SUBTOTAL	8	13	4E-1	7E-1	8	18	4	6	2E-6	2E-6
	TOTAL	1,747	954	67	38	562	331	307	152	1E-1	1E-1
	TOTAL Discoverer + Auxiliary Support	1,738	941	67	37	553	313	303	146	1E-1	1E-1

SO2_pph SO2_tps GHG_pph GHG_tps

EMISSIONS continued

	Emission Units	SO_2 lb/hr	SO_2 ton/season	GHG lb/hr	GHG ton/season
	Discoverer				
D_GEN	Generation	5E-1	6E-1	8,097	9,327
D_P	Propulsion	5E-1	1E-2	7,939	191
D_SE	Small IC engines	1E-1	1E-1	1,547	2,228
D_SU	Seldom-Used IC engines	4E-2	3E-4	621	5
D_B	Boilers	2E-1	1E-1	2,602	1,874
D_I	Incinerator	5E-1	7E-1	280	403
	SUBTOTAL	2	2	21,085	14,028
	Auxiliary Support - within 25 nm				
	Ice Management & Anchor Handling (4 vessels)				
IB_P&G	Propulsion & Generation	6	3	96,341	38,838
IB_H&B	Boilers	2E-1	1E-1	3,756	1,878
IB_I	Incinerator	1	1	592	592
	Oil Spill Response (Vessel, Tug & Barge, 3 WB)				
OSR_P&	All IC Engines (non-emergency)	1	7E-1	22,504	10,334
	Offshore Supply (2 vessels)				
OSV_P&	All IC Engines (non-emergency)	9E-1	8E-1	14,126	12,676
	Science Vessel				
RV_P&G	All IC Engines (non-emergency)	4E-1	4E-1	6,399	6,450
	Arctic Oil Storage Tanker				
FT_P&G	All IC Engines (non-emergency)	7E-1	3E-1	10,012	4,475
	SUBTOTAL	11	6	153,730	75,243
	On-shore Support*				
Heli	Helicopter	6E-2	8E-2	858	1,236
ManCam	Man Camp Generators	8E-2	1E-1	1,251	2,214
Bldg	Hangar/Storage Building Boiler	5E-2	4E-2	816	588
Veh	Vehicles	2E-3	2E-3	25	37
	SUBTOTAL	2E-1	3E-1	2,950	4,075
	TOTAL	13	8	177,765	93,346
	TOTAL Discoverer + Auxiliary Support	13	7	174,815	89,271

SO_2 EMISSIONS

		ton/season
Combustion Sources	SO_2	6
Incineration	SO_2	2
TOTAL		8

GHG EMISSIONS

		ton/season
Combustion Sources	CO_2	92,040
Combustion Sources	CH_4	4
Combustion Sources	N_2O	7E-1
Incineration	CO_2	974
Incineration	CH_4	3E-1
Incineration	N_2O	5E-2
All Sources	CO_2e	93,346

1 Fuel_gph Fuel_gpd Fuel_gps Waste_pph Waste_ppd Waste_pps

FUEL & WASTE CONSUMPTION

	Emission Units	Capacity Values	MMBtu/hr	FUEL gal/hr	FUEL gal/day	FUEL gal/season	WASTE lb/hr	WASTE lb/day	WASTE lb/season
	Discoverer								
D_GE	Generation	6,609 kW	62	378	9,073	871,045			
D_P	Propulsion	6,480 kW	61	371	8,896	17,793			
D_SE	Small IC engines	1,763 kW	17	72	1,734	208,024			
D_SU	Seldom-Used IC engines	595 kW	6	29	696	497			
D_B	Boilers	16 MMBtu/hr	16	122	2,916	174,978			
D_I	Incinerator	276 lb/hr					276	6,624	794,880
	SUBTOTAL			971	23,315	1,272,336	276	6,624	794,880
	Auxiliary Support - within 25 nm								
	Ice Management & Anchor Handling (4 vessels)								
IB_P&	Propulsion & Generation	78,640 kW	738	4,498	107,964	3,626,903			
IB_H&	Boilers	23 MMBtu/hr	23	175	4,209	175,386			
IB_I	Incinerator	584 lb/hr					584	14,016	1,168,000
	Oil Spill Response (Vessel, Tug & Barge, 3 WB)								
OSR_I	All IC Engines (non-emergency)	18,369 kW	172	1,051	25,219	965,090			
	Offshore Supply (2 vessels)								
OSV_I	All IC Engines (non-emergency)	16,042 kW	150	660	15,830	1,183,778			
	Science Vessel								
RV_P&	All IC Engines (non-emergency)	8,357 kW	78	299	7,171	602,329			
	Arctic Oil Storage Tanker								
FT_P&	All IC Engines (non-emergency)	20,611 kW	193	467	11,220	417,902			
	SUBTOTAL			7,150	171,612	6,971,388	584	14,016	1,168,000
	On-shore Support*								
Heli	Helicopter		5	40	962	115,404			
ManC&	Man Camp Generators	1,396 kW	7	58	1,231	206,799			
Bldg	Hangar/Storage Building Boiler		5	38	915	54,886			
Veh	Vehicles		0.2	1	28	3,429			
	SUBTOTAL			138	3,135	380,518			
	TOTAL			8,260	198,062	8,624,242	860	20,640	1,962,880

*gallon measurements are in diesel equivalen

EMISSION FACTORS

NO_X EMISSION FACTORS

id	Source	Pollutant	EF	unit	EF	unit	Reference
D_	Discoverer Generation	NO_X	3.4	g/kW-hr	0.10	lb/gal	5 engines SCR controlled, 1 engine uncontrolled due to start-up/variable loads[a]
D_	Discoverer Propulsion	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
D_	Discoverer Small IC engines	NO_X	5.5	g/kW-hr	0.17	lb/gal	Average value from source testing, performed 3/28/2012-5/14/2012
D_	Discoverer Seldom-Used IC engines	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
D_	Discoverer Boilers	NO_X	20.80	lbs/k-gal	2.1E-2	lb/gal	Average value from source testing, performed 6/10/2012-6/11/2012
D_	Discoverer Incinerator	NO_X	3.20	lb/ton	1.6E-3	lb/lb	Average value from source testing, performed 6/11/2012
IB	IM/AH Propulsion & Generation	NO_X	2.77	g/kW-hr	8.5E-2	lb/gal	Weighted based on vessel capacities, source test data and AP-42[b]
IB	IM/AH Boiler	NO_X	18.2	lbs/k-gal	1.8E-2	lb/gal	Average value from source testing, performed 4/14/2012 - 4/21/2012 (2 vessels)
IB	IM/AH Incineration	NO_X	4.3	lb/ton	2.2E-3	lb/lb	Average value from source testing, performed 4/16/2012 - 5/10/2012 (3 vessels)
OS	OSR Propulsion & Generation	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
OS	Offshore Supply P & G	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
RV	Science Vessel Propulsion & Generation	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
FT	Arctic Oil Storage Tanker	NO_X	14.6	g/kW-hr	0.45	lb/gal	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/97
	[a] Discoverer Generation	NO_X					
			1 engine uncontrolled at		5.9	g/kW-hr	Caterpillar 3512 Vendor Data
			5 engines controlled at		3.0	g/kW-hr	SCR Controlled with 50% reduction efficiency
	SCR NOx reduction efficiency	50%					Estimate
	[b] IM/AH Propulsion & Generation				P&G Capacity		
	Fennica	NO_X	0.57	g/kW-hr	21,530	kW	SCR controlled source test value, performed 4/13-4/27/2012
	Nordica	NO_X	0.45	g/kW-hr	21,530	kW	SCR controlled source test value, performed 4/23-4/26/2012
	Aiviq	NO_X	0.57	g/kW-hr	23,051	kW	SCR controlled source test value, performed 4/25-5/9/2012
	Ross Chouest	NO_X	14.59	g/kW-hr	12,529	kW	EPA, AP-42, Table 3.4-1, NOx Uncontrolled, diesel fuel 10/96
					78,640	kW	

PM EMISSION FACTORS [c]

id	Source	Pollutant	EF	unit	EF	unit	Reference
D_	Discoverer Generation	PM	0.10	g/kW-hr	3.1E-3	lb/gal	5 engines CDPF controlled, 1 engine uncontrolled due to start-up/variable loads[a]
D_	Discoverer Propulsion	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
D_	Discoverer Small IC engines	PM	0.20	g/kW-hr	6.2E-3	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
D_	Discoverer Seldom-Used IC engines	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
D_	Discoverer Boilers	PM	0.28	lbs/k-gal	2.8E-4	lb/gal	Average value from source testing, performed 6/10/2012-6/11/2012
D_	Discoverer Incinerator	PM	6.90	lb/ton	3.5E-3	lb/lb	Average value from source testing, performed 6/11/2012
IB	IM/AH Propulsion & Generation	PM	0.16	g/kW-hr	4.9E-3	lb/gal	Weighted based on vessel capacities, source test data and AP-42[b]
IB	IM/AH Boiler	PM	0.46	lbs/k-gal	4.6E-4	lb/gal	Average value from source testing, performed 4/14/2012 - 4/21/2012 (2 vessels)
IB	IM/AH Incineration	PM	12.4	lb/ton	6.2E-3	lb/lb	Average value from source testing, performed 4/16/2012 - 5/10/2012 (3 vessels)
OS	OSR Propulsion & Generation	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
OS	Offshore Supply P & G	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
RV	Science Vessel Propulsion & Generation	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
FT	Arctic Oil Storage Tanker	PM	0.43	g/kW-hr	1.3E-2	lb/gal	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
	[a] Discoverer Generation	PM					
			1 engine uncontrolled at		0.16	g/kW-hr	Caterpillar 3512 Vendor Data
			5 engines controlled at		0.08	g/kW-hr	CDPF Controlled with 50% reduction efficiency
	CDPF PM reduction efficiency	50%					Estimate
	[b] IM/AH Propulsion & Generation				P&G Capacity		
	Fennica	PM	0.09	g/kW-hr	21,530	kW	OxyCat controlled source test value, performed 4/13-4/27/2012
	Nordica	PM	0.07	g/kW-hr	21,530	kW	OxyCat controlled source test value, performed 4/23-4/26/2012
	Aiviq	PM	0.16	g/kW-hr	23,051	kW	OxyCat controlled source test value, performed 4/25-5/9/2012
	Ross Chouest	PM	0.43	g/kW-hr	12,529	kW	EPA, AP-42, Table 3.4-1, PM, diesel fuel, 10/96
					78,640	kW	

[c] $PM=PM_{10}=PM_{2.5}$, the same emission factors are used for all particulate matter emissions.

EMISSION FACTORS, cont'd

CO EMISSION FACTORS

id	Source	Pollutant	EF	unit	EF	unit	Reference
D_	Discoverer Generation	CO	0.80	g/kW-hr	2.5E-2	lb/gal	5 engines CDPF controlled, 1 engine uncontrolled due to start-up/variable loads[a]
D_	Discoverer Propulsion	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
D_	Discoverer Small IC engines	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
D_	Discoverer Seldom-Used IC engines	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
D_	Discoverer Boilers	CO	2.4	lbs/k-gal	2.4E-3	lb/gal	Average value from source testing, performed 6/10/2012-6/11/2012
D_	Discoverer Incinerator	CO	10.80	lb/ton	5.4E-3	lb/lb	Average value from source testing, performed 6/11/2012
IB	IM/AH Propulsion & Generation	CO	0.60	g/kW-hr	1.8E-2	lb/gal	Weighted based on vessel capacities, source test data and AP-42[b]
IB	IM/AH Boiler	CO	0.23	lbs/k-gal	2.3E-4	lb/gal	Average value from source testing, performed 4/14/2012 - 4/21/2012 (2 vessels)
IB	IM/AH Incineration	CO	14.9	lb/ton	7.5E-3	lb/lb	Average value from source testing, performed 4/16/2012 - 5/10/2012 (3 vessels)
OS	OSR Propulsion & Generation	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
OS	Offshore Supply P & G	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
RV	Science Vessel Propulsion & Generation	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
FT	Arctic Oil Storage Tanker	CO	5.0	g/kW-hr	0.15	lb/gal	40 CFR 94.8 Table A-1. Marine Category 1 - Tier 2
	[a] Discoverer Generation	CO					
			1 engine uncontrolled at		1.30	g/kW-hr	Caterpillar 3512 Vendor Data
			5 engines controlled at		0.65	g/kW-hr	CDPF Controlled with 50% reduction efficiency
	CDPF CO reduction efficiency	50%					Estimate
	[b] IM/AH Propulsion & Generation				P&G Capacity		
	Fennica	CO	0.08	g/kW-hr	21,530	kW	OxyCat controlled source test value, performed 4/13-4/27/2012
	Nordica	CO	0.05	g/kW-hr	21,530	kW	OxyCat controlled source test value, performed 4/23-4/26/2012
	Aiviq	CO	0.12	g/kW-hr	23,051	kW	OxyCat controlled source test value, performed 4/25-5/9/2012
	Ross Chouest	CO	3.34	g/kW-hr	12,529	kW	EPA, AP-42, Table 3.4-1, CO, diesel fuel, 10/96
					78,640	kW	

VOC EMISSION FACTORS

id	Source	Pollutant	EF	unit	EF	unit	Reference
D_	Discoverer Generation	VOC	0.30	g/kW-hr	9.2E-3	lb/gal	5 engines CDPF controlled, 1 engine uncontrolled due to start-up/variable loads[a]
D_	Discoverer Propulsion	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
D_	Discoverer Small IC engines	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
D_	Discoverer Seldom-Used IC engines	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
D_	Discoverer Boilers	VOC	8.5E-2	lbs/k-gal	8.5E-5	lb/gal	Average value from source testing, performed 6/10/2012-6/11/2012
D_	Discoverer Incinerator	VOC	0.4	lb/ton	2.0E-4	lb/lb	Average value from source testing, performed 6/11/2012
IB	**IM/AH Propulsion & Generation**	**VOC**	**1.3**	**g/kW-hr**	**4.0E-2**	**lb/gal**	**40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)**
IB	IM/AH Boiler	VOC	0.34	lbs/k-gal	3.4E-4	lb/gal	EPA AP-42, Table 1.3-3 ver. 5-10, Commercial Boilers - Distillate Oil.
IB	IM/AH Incineration	VOC	3	lb/ton	1.5E-3	lb/lb	EPA AP-42, Table 2.1-12, Refuse Combustor, Industrial/commercial, multiple chamber
OS	OSR Propulsion & Generation	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
OS	Offshore Supply P & G	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
RV	Science Vessel Propulsion & Generation	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
FT	Arctic Oil Storage Tanker	VOC	1.3	g/kW-hr	4.0E-2	lb/gal	40 CFR 89.112 Table 1. EPA Nonroad CI engines (Tier 1)
	[a] Discoverer Generation	VOC					
			1 engine uncontrolled at		0.45	g/kW-hr	Caterpillar 3512 Vendor Data
			5 engines controlled at		0.23	g/kW-hr	CDPF Controlled with 50% reduction efficiency
	CDPF VOC reduction efficiency	50%					Estimate

GHG EMISSION FACTORS

Source	Pollutant	EF	unit	EF	unit	Reference	Multiplier
Combustion Sources	CO_2	73.96	kg/MMBtu	21.3	lb/gal	40 CFR Part 98, Subpart C, Table C-1 (Distillate Fuel Oil No. 2)	1
Combustion Sources	CH_4	3.0E-3	kg/MMBtu	8.7E-4	lb/gal	40 CFR Part 98, Subpart C, Table C-2 (Fuel Type: Petroleum)	21
Combustion Sources	N_2O	6.0E-4	kg/MMBtu	1.7E-4	lb/gal	40 CFR Part 98, Subpart C, Table C-2 (Fuel Type: Petroleum)	310
Incineration	CO_2	90.7	kg/MMBtu	1.0	lb/lb	40 CFR Part 98, Subpart C, Table C-1 (Municipal Solid Waste)	1
Incineration	CH_4	3.2E-2	kg/MMBtu	3.5E-4	lb/lb	40 CFR Part 98, Subpart C, Table C-2 (Fuel Type: Municipal Solid Wa	21
Incineration	N_2O	4.2E-3	kg/MMBtu	4.6E-5	lb/lb	40 CFR Part 98, Subpart C, Table C-2 (Fuel Type: Municipal Solid Wa	310

SO_2 EMISSION FACTORS

Source	Pollutant	EF	unit	EF	unit	Reference
Combustion Sources	SO_2	100	ppm S	1.4E-3	lb/gal	Stoichiometric Calculation
Incineration	SO_2	3.46	lb/ton	1.7E-3	lb/lb	EPA, AP42, Table 2.1-2, EF for Modular Excess Air Combustors, uncontrolled, 10/96

Pb EMISSION FACTORS

Source	Pollutant	EF	unit	EF	unit
Internal Combustion Engines	Pb	2.9E-5	lb/MMBtu	3.8E-6	lb/gal
Heaters & Boilers	Pb	9	$lb/10^{12}$ Btu	1.2E-6	lb/gal
Incineration	Pb	0.213	lb/ton	1.1E-4	lb/lb

Source	Reference
Internal Combustion Engines	L & E Air Emissions from Sources of Lead and Lead Compounds, EPA 454/R-98-006, May 1998, Section 5.2.2, Distillate oil-fired gas turbines.
Heaters & Boilers	AP42, Table 1.3-10. Emission Factors For Trace Elements From Distillate Fuel Oil Combustion Sources.
Incineration	EPA, AP42, Table 2.1-2, EF for Modular Excess Air Combustors, uncontrolled

Air RFAI: Attachment B

Engine Certificates

Technical File
for 3500 Marine Engines

(Engine Family 3500PA10001)

Engine Model	**3512**
Engine Serial No.	**LLB00137**
Performance Spec.	**0K7405**
GL Family Approval No.	**97436-10 HH**

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GL EMISSION CERTIFICATION
H.-J. Rein B. Witt
Hamburg 2013-09-12 Approval No.: 85941-13 HH

3500 Engine Part Number Table*

Performance Specification		0K7379	0K7023	0K7396	0K7391	0K7405	0K7850	0K8054	0K8055
Engine Ratings (Advertised)	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1101	2225	1628	1785
	bhp	*2250*	*2250*	*2150*	*2150*	*1476*	*2984*	*2183*	*2394*
	Cycle	C1	C1	C1	C1	D2 E2	D2 E2	D2 E2	D2 E2
Engine Ratings (Overload)	rpm	1900	1900	1900	1900	1200	1800	1800	1800
NOTE: Applies to Marine	BkW	1678	1678	1603	1603	1235	2450	1825	2000
Auxiliary Engines Only	*bhp*	*2250*	*2250*	*2150*	*2150*	*1656*	*3285*	*2447*	*2682*
Engine Model	Part Number	3512	3512	3512	3512	3512	3516	3512	3512
Compression Ratio		14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
Static Timing[1]	Deg.	NA	NA	NA	NA	NA	NA	NA	NA
Piston	Part Number	2494512 3393027	2494512 3393027	2494512 3393027	2494512 3393027	2816140 3145006 3742082	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357
Cylinder Head	Part Number	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351
Camshaft	Part Number	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2837631 2837633 2837635 2837637	2835739 2835741 2835743 2835786	2835731 2835737 3085352 3085354	2835731 2835737 3085352 3085354
Aftercooler	Part Number	NA*	NA*	NA*	NA*	2454622	2454621	2454622	2454622
Turbocharger Basic Group	Part Number	3016873	2963616	2877215	2877215	2506110	3284277	3219033 3219028 3043748 3284268	3219033 3043748 3284268
Injector	Part Number	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2461854 3861771 3920219	2501368 3760511 3920221	2501368 3760511 3920221	2501368 3760511 3920221
Personality Module Software	Part Number	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	3471251	3203324 3489873 3505880 3623092	3035955 3175988 3420501 3919018	3035955 3175988 3420501

Note [1]: Engine timing is electronically controlled by the engine Electronic Control Module (ECM). There are no adjustments that can be made to change engine timing.

*Air to air charge air cooler provided by customer. Max allowable inlet manifold temp according to page 12 is to be observed.

Technical File
for 3500 Marine Engines

(Engine Family 3500PA10001)

Engine Model	**3512**
Engine Serial No.	**LLB00138**
Performance Spec.	**0K7405**
GL Family Approval No.	**97436-10 HH**

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GL EMISSION CERTIFICATION
H. J. Rein B. Witt
Hamburg 2013-09-12 Approval No.: 85942-13 HH

3500 Engine Part Number Table*

Performance Specification		0K7379	0K7023	0K7396	0K7391	0K7405	0K7850	0K8054	0K8055
Engine Ratings (Advertised)	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1101	2225	1628	1785
	bhp	*2250*	*2250*	*2150*	*2150*	*1476*	*2984*	*2183*	*2394*
	Cycle	C1	C1	C1	C1	D2 E2	D2 E2	D2 E2	D2 E2
Engine Ratings (Overload) NOTE: Applies to Marine Auxiliary Engines Only	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1235	2450	1825	2000
	bhp	*2250*	*2250*	*2150*	*2150*	*1656*	*3285*	*2447*	*2682*
Engine Model	Part Number	3512	3512	3512	3512	3512	3516	3512	3512
Compression Ratio		14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
Static Timing[1]	Deg.	NA	NA	NA	NA	NA	NA	NA	NA
Piston	Part Number	2494512 3393027	2494512 3393027	2494512 3393027	2494512 3393027	2816140 3145006 3742082	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357
Cylinder Head	Part Number	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351
Camshaft	Part Number	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2837631 2837633 2837635 2837637	2835739 2835741 2835743 2835786	2835731 2835737 3085352 3085354	2835731 2835737 3085352 3085354
Aftercooler	Part Number	NA*	NA*	NA*	NA*	2454622	2454621	2454622	2454622
Turbocharger Basic Group	Part Number	3016873	2963616	2877215	2877215	2506110	3284277	3219033 3219028 3043748 3284268	3219033 3043748 3284268
Injector	Part Number	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2461854 3861771 3920219	2501368 3760511 3920221	2501368 3760511 3920221	2501368 3760511 3920221
Personality Module Software	Part Number	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	3471251	3203324 3489873 3505880 3623092	3035955 3175988 3420501 3919018	3035955 3175988 3420501

Note [1]: Engine timing is electronically controlled by the engine Electronic Control Module (ECM). There are no adjustments that can be made to change engine timing.

*Air to air charge air cooler provided by customer. Max allowable inlet manifold temp according to page 12 is to be observed.

Technical File
for 3500 Marine Engines

(Engine Family 3500PA10001)

Engine Model	**3512**
Engine Serial No.	**LLB00139**
Performance Spec.	**0K7405**
GL Family Approval No.	**97436-10 HH**

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GL EMISSION CERTIFICATION
H.-J. Rein B. Witt
Hamburg 2013-09-12 Approval No.: 85943-13 HH

3500 Engine Part Number Table*

Performance Specification		0K7379	0K7023	0K7396	0K7391	0K7405	0K7850	0K8054	0K8055
Engine Ratings (Advertised)	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1101	2225	1628	1785
	bhp	*2250*	*2250*	*2150*	*2150*	*1476*	*2984*	*2183*	*2394*
	Cycle	C1	C1	C1	C1	D2 E2	D2 E2	D2 E2	D2 E2
Engine Ratings (Overload) NOTE: Applies to Marine Auxiliary Engines Only	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1235	2450	1825	2000
	bhp	*2250*	*2250*	*2150*	*2150*	*1656*	*3285*	*2447*	*2682*
Engine Model	Part Number	3512	3512	3512	3512	3512	3516	3512	3512
Compression Ratio		14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
Static Timing[1]	Deg.	NA	NA	NA	NA	NA	NA	NA	NA
Piston	Part Number	2494512 3393027	2494512 3393027	2494512 3393027	2494512 3393027	2816140 3145006 3742082	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357
Cylinder Head	Part Number	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351
Camshaft	Part Number	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2837631 2837633 2837635 2837637	2835739 2835741 2835743 2835786	2835731 2835737 3085352 3085354	2835731 2835737 3085352 3085354
Aftercooler	Part Number	NA*	NA*	NA*	NA*	2454622	2454621	2454622	2454622
Turbocharger Basic Group	Part Number	3016873	2963616	2877215	2877215	2506110	3284277	3219033 3219028 3043748 3284268	3219033 3043748 3284268
Injector	Part Number	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2461854 3861771 3920219	2501368 3760511 3920221	2501368 3760511 3920221	2501368 3760511 3920221
Personality Module Software	Part Number	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	3471251	3203324 3489873 3505880 3623092	3035955 3175988 3420501 3919018	3035955 3175988 3420501

Note [1]: Engine timing is electronically controlled by the engine Electronic Control Module (ECM). There are no adjustments that can be made to change engine timing.

*Air to air charge air cooler provided by customer. Max allowable inlet manifold temp according to page 12 is to be observed.

Technical File
for 3500 Marine Engines

(Engine Family 3500PA10001)

Engine Model	**3512**
Engine Serial No.	**LLB00140**
Performance Spec.	**0K7405**
GL Family Approval No.	**97436-10 HH**

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GL EMISSION CERTIFICATION
H. v. Rein B. Witt
Hamburg 2013-09-12 Approval No.: 85944-13 HH

3500 Engine Part Number Table*

Performance Specification		0K7379	0K7023	0K7396	0K7391	0K7405	0K7850	0K8054	0K8055
Engine Ratings (Advertised)	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1101	2225	1628	1785
	bhp	*2250*	*2250*	*2150*	*2150*	*1476*	*2984*	*2183*	*2394*
	Cycle	C1	C1	C1	C1	D2 E2	D2 E2	D2 E2	D2 E2
Engine Ratings (Overload) NOTE: Applies to Marine Auxiliary Engines Only	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1235	2450	1825	2000
	bhp	*2250*	*2250*	*2150*	*2150*	*1656*	*3285*	*2447*	*2682*
Engine Model	Part Number	3512	3512	3512	3512	3512	3516	3512	3512
Compression Ratio		14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
Static Timing[1]	Deg.	NA	NA	NA	NA	NA	NA	NA	NA
Piston	Part Number	2494512 3393027	2494512 3393027	2494512 3393027	2494512 3393027	2816140 3145006 3742082	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357
Cylinder Head	Part Number	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351
Camshaft	Part Number	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2837631 2837633 2837635 2837637	2835739 2835741 2835743 2835786	2835731 2835737 3085352 3085354	2835731 2835737 3085352 3085354
Aftercooler	Part Number	NA*	NA*	NA*	NA*	2454622	2454621	2454622	2454622
Turbocharger Basic Group	Part Number	3016873	2963616	2877215	2877215	2506110	3284277	3219033 3219028 3043748 3284268	3219033 3043748 3284268
Injector	Part Number	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2461854 3861771 3920219	2501368 3760511 3920221	2501368 3760511 3920221	2501368 3760511 3920221
Personality Module Software	Part Number	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	3471251	3203324 3489873 3505880 3623092	3035955 3175988 3420501 3919018	3035955 3175988 3420501

Note [1]: Engine timing is electronically controlled by the engine Electronic Control Module (ECM). There are no adjustments that can be made to change engine timing.

*Air to air charge air cooler provided by customer. Max allowable inlet manifold temp according to page 12 is to be observed.

Technical File
for 3500 Marine Engines

(Engine Family 3500PA10001)

Engine Model	**3512**
Engine Serial No.	**LLB00141**
Performance Spec.	**0K7405**
GL Family Approval No.	**97436-10 HH**

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GL EMISSION CERTIFICATION
H. J. Rein
i.A. B. Witt
Hamburg 2013-09-12 Approval No.: 85945-13 HH

3500 Engine Part Number Table*

Performance Specification		0K7379	0K7023	0K7396	0K7391	0K7405	0K7850	0K8054	0K8055
Engine Ratings (Advertised)	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1101	2225	1628	1785
	bhp	*2250*	*2250*	*2150*	*2150*	*1476*	*2984*	*2183*	*2394*
	Cycle	C1	C1	C1	C1	D2 E2	D2 E2	D2 E2	D2 E2
Engine Ratings (Overload) NOTE: Applies to Marine Auxiliary Engines Only	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1235	2450	1825	2000
	bhp	*2250*	*2250*	*2150*	*2150*	*1656*	*3285*	*2447*	*2682*
Engine Model	Part Number	3512	3512	3512	3512	3512	3516	3512	3512
Compression Ratio		14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
Static Timing[1]	Deg.	NA	NA	NA	NA	NA	NA	NA	NA
Piston	Part Number	2494512 3393027	2494512 3393027	2494512 3393027	2494512 3393027	2816140 3145006 3742082	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357
Cylinder Head	Part Number	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351
Camshaft	Part Number	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2837631 2837633 2837635 2837637	2835739 2835741 2835743 2835786	2835731 2835737 3085352 3085354	2835731 2835737 3085352 3085354
Aftercooler	Part Number	NA*	NA*	NA*	NA*	2454622	2454621	2454622	2454622
Turbocharger Basic Group	Part Number	3016873	2963616	2877215	2877215	2506110	3284277	3219033 3219028 3043748 3284268	3219033 3043748 3284268
Injector	Part Number	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2461854 3861771 3920219	2501368 3760511 3920221	2501368 3760511 3920221	2501368 3760511 3920221
Personality Module Software	Part Number	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	3471251	3203324 3489873 3505880 3623092	3035955 3175988 3420501 3919018	3035955 3175988 3420501

Note [1]: Engine timing is electronically controlled by the engine Electronic Control Module (ECM). There are no adjustments that can be made to change engine timing.

*Air to air charge air cooler provided by customer. Max allowable inlet manifold temp according to page 12 is to be observed.

Technical File
for 3500 Marine Engines

(Engine Family 3500PA10001)

Engine Model	**3512**
Engine Serial No.	**LLB00142**
Performance Spec.	**0K7405**
GL Family Approval No.	**97436-10 HH**

Do Not Discard
This Document is to be kept on board.

GL EMISSION CERTIFICATION
H.-J. Rein
B. Witt
Hamburg 2013-09-12 Approval No.: 85946-13 HH

3500 Engine Part Number Table*

Performance Specification		0K7379	0K7023	0K7396	0K7391	0K7405	0K7850	0K8054	0K8055
Engine Ratings (Advertised)	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1101	2225	1628	1785
	bhp	*2250*	*2250*	*2150*	*2150*	*1476*	*2984*	*2183*	*2394*
	Cycle	C1	C1	C1	C1	D2 E2	D2 E2	D2 E2	D2 E2
Engine Ratings (Overload) NOTE: Applies to Marine Auxiliary Engines Only	rpm	1900	1900	1900	1900	1200	1800	1800	1800
	BkW	1678	1678	1603	1603	1235	2450	1825	2000
	bhp	*2250*	*2250*	*2150*	*2150*	*1656*	*3285*	*2447*	*2682*
Engine Model	Part Number	3512	3512	3512	3512	3512	3516	3512	3512
Compression Ratio		14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
Static Timing[1]	Deg.	NA	NA	NA	NA	NA	NA	NA	NA
Piston	Part Number	2494512 3393027	2494512 3393027	2494512 3393027	2494512 3393027	2816140 3145006 3742082	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357	2796770 2935428 3393028 3485357
Cylinder Head	Part Number	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351	1011176 2901351
Camshaft	Part Number	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2835731 2835733 2835735 2835737	2837631 2837633 2837635 2837637	2835739 2835741 2835743 2835786	2835731 2835737 3085352 3085354	2835731 2835737 3085352 3085354
Aftercooler	Part Number	NA*	NA*	NA*	NA*	2454622	2454621	2454622	2454622
Turbocharger Basic Group	Part Number	3016873	2963616	2877215	2877215	2506110	3284277	3219033 3219028 3043748 3284268	3219033 3043748 3284268
Injector	Part Number	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2481079 3861768 3920216	2461854 3861771 3920219	2501368 3760511 3920221	2501368 3760511 3920221	2501368 3760511 3920221
Personality Module Software	Part Number	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	2843092 2844807 2949325 3105962 3286950 3529325 3818953 4152421 4213142	2843091 2844806 2949599 3042340 3105961 3286949 3529324 3687620	3471251	3203324 3489873 3505880 3623092	3035955 3175988 3420501 3919018	3035955 3175988 3420501

Note [1]: Engine timing is electronically controlled by the engine Electronic Control Module (ECM). There are no adjustments that can be made to change engine timing.

*Air to air charge air cooler provided by customer. Max allowable inlet manifold temp according to page 12 is to be observed.

Air RFAI: Attachment C

Vendor Specification Sheets

Discoverer Main Engines
Caterpillar 3512 Emission Factors

Table 1 - Engine Specific Emissions Data - Provided by Engine Supplier (Vendor Data)

Speed RPM	Percent Load	Engine Power BHP	Engine Power kW	Uncontrolled Total NO_X (AS NO2) g/kW-hr	Controlled* Total NO_X (AS NO2) g/kW-hr	Uncontrolled Total CO g/kW-hr	Controlled* Total CO g/kW-hr	Uncontrolled Total HC g/kW-hr	Controlled Total HC g/kW-hr	Uncontrolled PM g/kW-hr	Controlled PM g/kW-hr	Uncontrolled Total CO2 g/kW-hr
1,200	100	1,476	1,101	6.92	3.46	0.14	0.07	0.10	0.05	0.02	0.01	624.51
1,200	75	1,107	825	5.71	2.86	0.26	0.13	0.16	0.08	0.02	0.01	638.28
1,200	50	738	550	4.99	2.50	1.18	0.59	0.24	0.12	0.08	0.04	668.53
1,200	25	369	275	4.78	2.39	1.40	0.70	0.45	0.22	0.20	0.10	740.15
1,200	10	148	110	6.95	3.47	3.33	1.66	1.32	0.66	0.49	0.25	914.47
Average	**52**	**768**	**572**	**5.87**	**2.94**	**1.26**	**0.63**	**0.45**	**0.23**	**0.16**	**0.08**	**717.19**
Max	**100**	**1,476**	**1,101**	**6.95**	**3.47**	**3.33**	**1.66**	**1.32**	**0.66**	**0.49**	**0.25**	**914.47**
*Using average control efficiency of:					50%		50%		50%		50%	

Table 2 - Summary

Control	Average NO_X g/kW-hr	Average CO g/kW-hr	Average VOC g/kW-hr	Average PM g/kW-hr
Uncontrolled	5.87	1.26	0.45	0.16
Controlled	2.94	0.63	0.23	0.08
Weighted [a]	3.43	0.74	0.26	0.10

[a] 5 engines controlled & 1 engine uncontrolled due to start-up/variable loads
1 engine uncontrolled
5 engines controlled

Conversions	
453.592	g/lb
1.34102	hp/kW

3512C Engine Serial Numbers:

Serial #	Arrangement #	LMC ID#	CAT ESO #
LLB00137	2617308	12190	FPMQR
LLB00138	2617308	12189	FPMQQ
LLB00139	2617308	12188	FPMQP
LLB00140	2617308	12187	FPMQN
LLB00141	2617308	12192	FPMRG
LLB00142	2617308	12191	FPMRF

Engine Data - Serial # LLB

Sales Model:	**3512CDITA**
Engine Power:	**1,476 HP**
Manifold Type:	**DRY**
Turbo Quantity:	**2**
Application Type:	**OIL FLD-DIE**
Rating Type:	**P/DRIL-ELECT**
Combustion:	**Direct Injected**
Speed:	**1,200 RPM**
Governor Type:	**ADEM3**
Engine App:	**Offshore**
Engine Rating:	**Offshore**
Certification:	**EPA TIER-2 2006 -**
Aspr:	**Turbocharged Aftercooled**
After Cooler:	**SCAC**
After Cooler Temp(F):	**122 F**
Turbo Arrangement:	**Parallel**
Performance #:	**DM8321**
Serial # Prefix:	**LLB**
Engine Test Spec:	**0K7405**
Compression Ratio:	**14.7:1**
Crankcase Blowby Rat (CFH)	**1476.2 cfh**
Fuel Injector	**2461854**
Unit Injector Timing	**64.3 mm**
Piston Speed @ rated engine speed	**1496.1 ft/min**
Fuel rate (rated RPM) no load (gal/hr)	**5.2 gal/hr**

EMISSIONS DATA

EPA TIER-2 2006 - ********** B5

Gaseous emissions data measurements are consistent with those described in
EPA 40 CFR PART 89 SUBPART D and ISO 8178 for measuring HC, CO, PM, and NOx

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance
with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kW-hr
U.S. (incl Calif)	EPA/TIER-2	CO:3.5 NOx + HC:6.4 PM:0.2

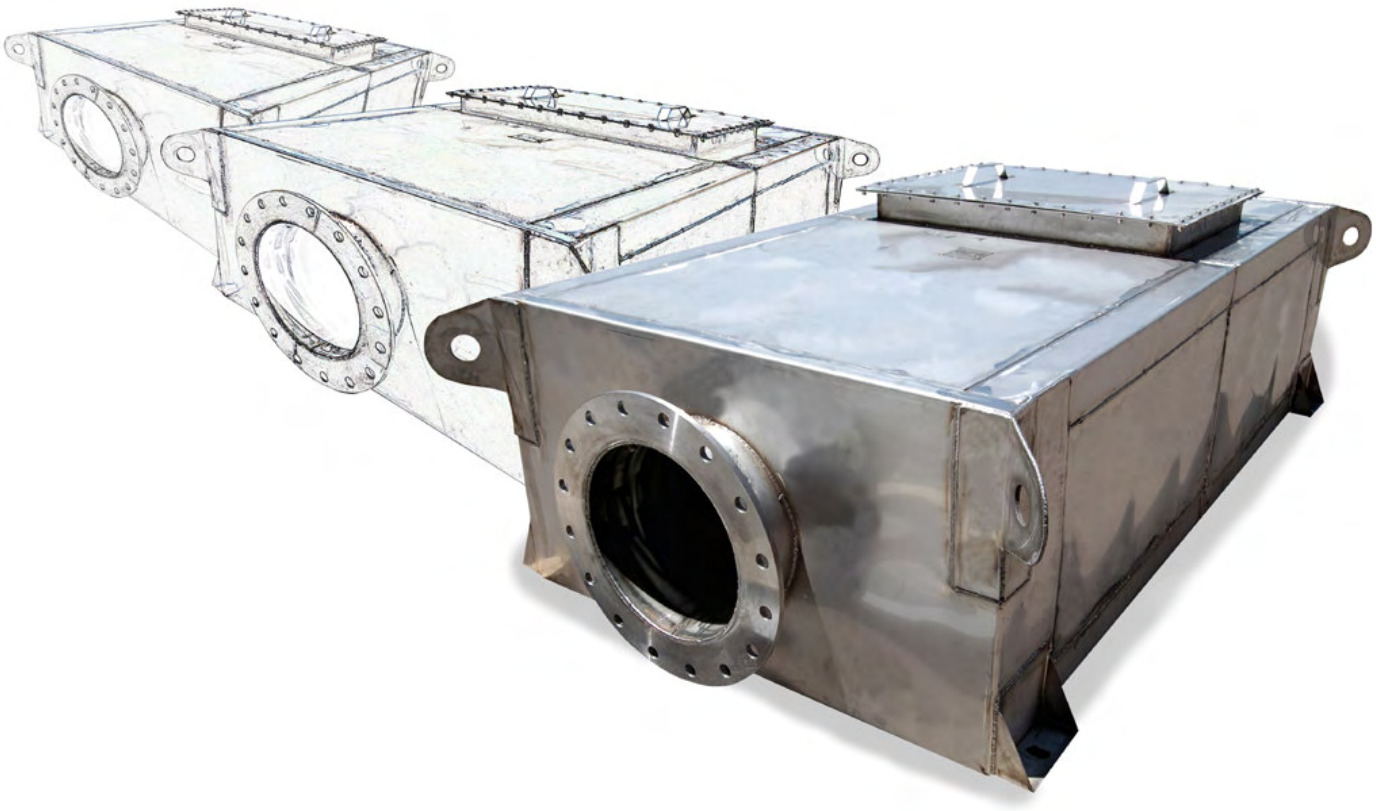
REFERENCE EXHAUST STACK DIAMETER	10 IN
WET EXHAUST MASS	14,984.8 LB/HR
WET EXHAUST FLOW (746.60 F STACK TEMP)	7,702.14 CFM
WET EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	3,157.00 STD CFM
DRY EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	2,892.27 STD CFM
FUEL FLOW RATE	69 GAL/HR

RATED SPEED "Potential site variation"

ENGINE SPEED RPM	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,200	100	1476	20.17	0.61	0.33	0.09	11.1	0.3	1.28
1,200	75	1107	12.48	0.87	0.39	0.05	11.6	0.5	1.28
1,200	50	738	7.27	2.58	0.39	0.13	11.9	2.1	1.28
1,200	25	369	3.48	1.52	0.35	0.17	13.6	3.4	1.28
1,200	10	148	2.02	1.46	0.43	0.17	16.4	2.2	1.28

RATED SPEED "Nominal Data"

ENGINE SPEED RPM	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR	TOTAL CO2 LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,200	100	1476	16.8	0.34	0.24	1,515.40	0.06	11.1	0.3	1.28
1,200	75	1107	10.4	0.48	0.3	1,161.60	0.03	11.6	0.5	1.28
1,200	50	738	6.06	1.43	0.29	811.1	0.1	11.9	2.1	1.28
1,200	25	369	2.9	0.85	0.27	449	0.12	13.6	3.4	1.28
1,200	10	148	1.69	0.81	0.32	222.5	0.12	16.4	2.2	1.28



The CleanAIR PERMIT™ Filter System

Reduces PM, CO and HC

The CARB verified PERMIT™ Filter for diesel engines is designed to reduce diesel particulate matter (PM), carbon monoxide (CO) and hydrocarbons (HC). Applications for the passively-regenerating PERMIT™ Filter system include stationary diesel engines used for power generation and pumps.

The wall-flow filter is coated with a unique, high performance catalyst and housed within a stainless steel canister. The PERMIT™ Filter is available in standard add-on designs, muffler combination, and silencer configurations. In many large diesel engine applications, multiple PERMIT™ Filters are integrated into a silencer design, taking the place of a standard exhaust silencer. Filter/Silencer designs are available with critical and super-critical sound attenuation.

The PERMIT Filter (non-verified) is also available for some on- and off-road mobile applications, such as mining and construction equipment.

Reduces:
- PM greater than 85%
- HC up to 95%
- CO up to 95%

CARB Verified Level 3+
for Prime and Emergency Generators

505-474-4120 800-355-5513 information@cleanairsys.com

CleanAIR SYSTEMS

CARB Level 3+ Verified

- Verified for prime and emergency stationary engines
- PM reductions greater than 85%
- HC and CO reductions up to 95%
- Meets regulation compliance levels for PM reduction on stationary engines
- Passive regeneration with wall-flow ceramic filter
- Low regeneration temperature of 300°C
- Works with diesel engines: generators and pumps
    - Available for some on- and off-road applications that meet regeneration requirements

Customized to Client's Specifications

- Technical product and engineering assistance to determine the correct size and design to fit the application
- Custom engineering to fit space availability or enclosure dimensions
- Compact packaging – filters and silencing in one unit
- Available as standard add-on filter, filter/muffler or filter/silencer design
- Designed to customer inlet/outlet specs
- Choice of Industrial, Critical or Super-Critical Grade Sound Attenuation

Guaranteed Long-Life Construction

- All components produced by CleanAIR
- All stainless steel body using corrosion-resistant 304L steel inside and outside
- Double-walled, insulated construction
- Precious metal-based non-washcoat catalyst

No Health Risk

- Uses non-toxic, non-vanadium particulate filters

How the PERMIT™ Filter Works

The wall-flow design of the CleanAIR PERMIT™ Filter captures diesel PM as soon as the engine is started and continues through operation, dramatically reducing PM and visible black smoke.

Due to the PERMIT™ Filter's unique non-washcoat catalyst incorporated within the wall-flow filter, the captured PM is then oxidized into CO_2 while the engine is operating. This results in a passive, self-cleaning (or regenerating) filter without the need for manual intervention.

Emissions of carbon monoxide and hydrocarbons are also eliminated when exhaust gases interact with the filter's unique catalyst. Regeneration is dependent upon exhaust temperature, fuel sulfur level, duty cycle and engine load.

The easy-to-install, CARB verified CleanAIR PERMIT™ Filter works with all diesel stationary engines for compliance with air quality regulations and is available in many design configurations to meet customer needs and space availability.

Meet CARB Level 3+ Standards

with the

CleanAIR PERMIT Filter

Reduces:

- PM greater than 85%
- HC up to 95%
- CO up to 95%

CleanAIR SYSTEMS

505-474-4120 800-355-5513 information@cleanairsys.com
www.cleanairsys.com

PERMIT™ Filter Emissions Reduction Summary

Control Technology	Fuel	PM	HC	CO
PERMIT™ Filter System for Stationary Engines	ULSD (<15 ppm S)	Greater than 85%	90-95%	90-95%
	Biodiesel (<15 ppm S)	Greater than 85%	90-95%	90-95%

Results are fuel dependent and may vary with application.
Operating the filter using high sulfur fuels may have varying results.

Guidelines for PERMIT™ Filter Passive Regeneration

The following guidelines ensure engine operation adheres to verification parameters specified by ARB for passive regeneration of the PERMIT™ Filter:

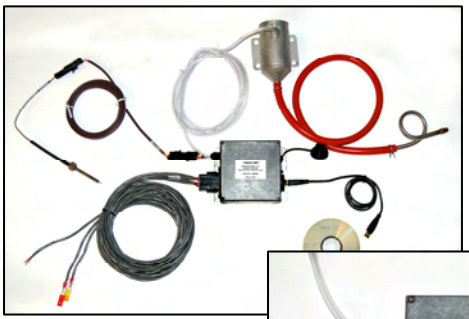
- At least 30% of the operating time the exhaust temperature is above 300°C and the engine load is above 40%
- Fuel sulfur content <15 ppm, ULSD
- Engine PM output of < 0.2 g/bhp-hr

How Sulfur in Fuel Affects the PERMIT™ Filter Performance

The PERMIT™ Filter can operate using high sulfur fuel. However, lower regeneration temperatures and maximum performance are achieved when low sulfur fuels (<15 ppm S) are used. ARB verifications specify the use of ultra-low sulfur fuel with all verified filters.

CleanAIR HiBACK USB™ Data Logging and Alarm System

The HiBACK USB™ is a microprocessor-based data logger and alarm system used in conjunction with the CleanAIR PERMIT™ Filter System as both an alarm and a data logger to record time, backpressure and temperature data. It is the key component to ensuring the PERMIT™ Filter unit is working as intended and that the filter is not plugging up with particulate matter. The HiBACK USB™ unit can warn the operator of possible problems with excessive backpressure, can track the duty cycle of the engine and allow analysis for operation time, exhaust temperature and backpressure profiles. Data collected by the HiBACK USB™ can be downloaded to an Excel spread sheet on a computer for detailed analysis using optional software. *(Optional software sold separately. The HiBACK USB™ is required for warranty and verification of the PERMIT™ Filter.)*



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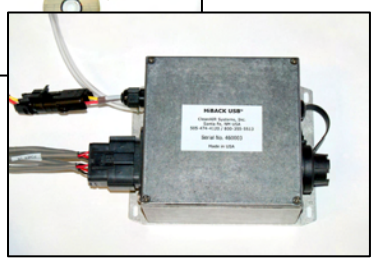


HiBACK™ USB Data logger and alarm system with software

System Components:

1. PERMIT™ Filter Silencer: double-walled, fully insulated stainless steel silencer body
   1a. - includes diesel particulate filters packaged inside of unit
2. HiBACK™ USB Data logger and alarm system with software
3. *Optional:* Custom-designed insulated blanket to reduce heat loss and optimize regeneration performance; available for exhaust piping, filter body and engine housing

1a. *PERMIT Filters inside of silencer unit*

3. *Optional insulated blanket*

1.

CleanAIR SYSTEMS

505-474-4120 800-355-5513

PERMIT™ Filter Package Designs for Stationary Engines

The CleanAIR Systems' PERMIT™ Filter is packaged in a 304L stainless steel shell and finished by bead blasting to give a highly corrosion-resistant product that will last for years. The packaged filter can be incorporated into many different configurations depending upon the application requirements. The most basic configuration is a packaged filter with cones on both inlet and outlet ends. Typical sound attenuation for this design is 12 dBA.

Replacement muffler designs are used for applications where space is too tight to add the filter separate from the existing muffler. Special inlet or outlet configurations and brackets can be used on the PERMIT™ Filter/Muffler combination that will allow the filter to replace an existing muffler. Typical sound attenuation for this design is 15-20 dBA.

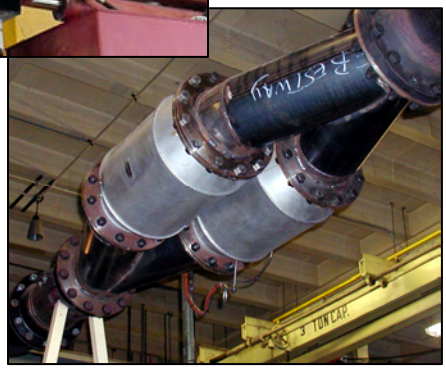
A filter/silencer replacement design is available for applications that require higher levels of sound attenuation or that require multiple PERMIT™ Filters. The corrosion-resistant stainless steel shell has a removable panel allowing complete access to the filters mounted inside. The fully-insulated, double-walled body also helps keeps surface temperature lower. The PERMIT™ Filter/Silencer is available in three sound reduction levels.

Silencer Type	Typical Attenuation
Industrial Grade	22 – 29 dBA
Critical Grade	27 – 35 dBA
Super Critical Grade	30 – 38 dBA

Optional Equipment for System:

- AeroCLEAN™ Filter Cleaning System for built up non-combustable ash
- Load Bank - increases engine load, optimizes filter performance
- Custom-designed insulating blankets – reduces heat loss, optimizes filter performance
- Extra filter unit – minimizes system down-time

To submit an online Request for Pricing, go to:
www.cleanairsys.com/rfp.asp



505-474-4120 800-355-5513 information@cleanairsys.com
www.cleanairsys.com

Air RFAI: Attachment D

Preliminary Source Test Data

EPOD REMOVAL EFFICIENCY SUMMARY

Unit..... **3512C** *All loads remained steady, compared to previous testing days and configurations.*

Date..... 4/24/2012

Inlet Stack Area, ft^2..... 1.187

Outlet Stack Area, ft2..... 0.442

T_{ref} (reference temperature), °F..... 68

Urea Monitoring

	Test condition	985	Test condition	875	Test condition	825	Test condition	775	Test condition	700	Test condition	492	Test condition	775	Test condition	492
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
T_s (stack temperature), °F.....	736.5	691.5	735.0	680.0	727.5	685.0	724.3	683.1	720.3	682.1	701.8	656.8	724.3	683.1	701.8	656.8
GASEOUS SAMPLE DATA																
$\%O_2$ (oxygen stack gas), % volume dry.....	11.400	11.300	11.700	11.500	11.800	11.670	12.000	11.800	12.140	11.980	12.700	12.500	11.800	11.600	12.500	12.300
$\%CO_2$ (carbon dioxide stack gas), % volume dry...	6.89	7.22	6.70	6.99	6.60	6.94	6.50	6.85	6.35	6.72	5.90	6.30	6.60	6.90	6.00	6.40
CO (carbon monoxide stack gas), ppm volume dry	25.20	2.33	30.00	2.21	34.30	2.30	42.20	2.29	58.00	2.30	153.70	2.20	50.20	2.20	150.30	2.30
NO (nitrogen oxide stack gas), ppm volume dry.....		105.00		107.00		108.00		113.30		115.60		117.98		119.10		116.90
NO_2 (nitrogen dioxide stack gas), ppm volume dry.....		25.20		27.00		29.70		30.40		32.33		38.85		33.20		43.40
NO_X (nitrogen oxides stack gas), ppm volume dry.	649.20	130.20	578.00	134.00	546.00	137.70	520.00	143.70	487.30	147.93	396.40	156.83	539.20	152.30	398.50	160.30
VOC (or NMHC, stack gas), ppm volume wet.....		0.13		0.05		0.06		0.06		0.09		0.13		0.05		0.05
NH3 (ammonia, stack gas), ppm volume wet.....		22.00		28.00		32.00		33.00		34.00		40.00		33.00		--
NH3 (ammonia, stack gas), ppm volume dry.....		24.48		31.04		34.53		35.61		36.69		41.94		35.61		--
SAMPLE TRAIN CALCULATIONS																
1j Q_{ds} (stack flow rate), dscfm.....	3,124	2,821	2,990	2,674	2,896	2,609	2,774	2,499	2,560	2,358	2,001	1,905	2,774	2,499	2,000	1,906
UNIT DATA																
Mechanical power output, kW.....	1036.8	1036.8	921.1	921.1	868.4	868.4	815.8	815.8	736.8	736.8	517.9	517.9	815.8	815.8	517.9	517.9
Electrical power produced, kWe.....	985.0	985.0	875.0	875.0	825.0	825.0	775.0	775.0	700.0	700.0	492.0	492.0	775.0	775.0	492.0	492.0
FUEL DATA																
Quantity of fuel used, gallons/hour.....	67.9	67.9	61.6	61.6	58.3	58.3	54.2	54.2	48.6	48.6	43.6	43.6	66.1	66.1		
GASEOUS EMISSIONS																
2e CO (carbon monoxide, stack gas), g/kW-hr.....	0.1502	0.0125	0.1926	0.0127	0.2263	0.0137	0.2839	0.0139	0.3986	0.0146	1.1746	0.0160	0.3377	0.0133	1.1484	0.0167
2s CO (carbon monoxide, stack gas), g/kWe-hr.....	0.1581	0.0132	0.2028	0.0134	0.2382	0.0144	0.2988	0.0146	0.4196	0.0153	1.2364	0.0169	0.3554	0.0140	1.2089	0.0176
2e NO_X (nitrogen oxides, stack gas), g/kW-hr.....	6.3561	1.1510	6.0967	1.2641	5.9174	1.3442	5.7464	1.4304	5.5008	1.5384	4.9760	1.8750	5.9578	1.5160	5.0017	1.9167
2s NO_X (nitrogen oxides, stack gas), g/kWe-hr.....	6.6907	1.2116	6.4176	1.3306	6.2289	1.4150	6.0488	1.5057	5.7903	1.6193	5.2379	1.9737	6.2713	1.5958	5.2650	2.0175
2e VOC (or NMHC, stack gas), g/kW-hr.....		0.0004		0.0002		0.0002		0.0002		0.0004		0.0006		0.0002		0.0002
2s VOC (or NMHC, stack gas), g/kWe-hr.....		0.0005		0.0002		0.0002		0.0002		0.0004		0.0006		0.0002		0.0002
2e NOX and NMHC (nitrogen oxides and NMHC, sta	6.3561	1.1515	6.0967	1.2643	5.9174	1.3444	5.7464	1.4307	5.5008	1.5387	4.9760	1.8756	5.9578	1.5162	5.0017	1.9169
2a NH_3 (ammonia, stack gas), ppm volume dry.....		24.48		31.04		34.53		35.61		36.69		41.94		35.61		--

Load	985.00	875.00	825.00	775.00	700.00	492.00	775.00	492.00
	Removal Eff, % Based on kW	Removal Eff, % Based on kW	Removal Eff, % Based on kW	Removal Eff, % Based on kW	Removal Eff, % Based on kW	Removal Eff, % Based on kW	Removal Eff, % Based on kW	Removal Eff, % Based on kW
CO	91.65	93.41	93.96	95.11	96.35	98.64	96.05	98.54
NO	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
NO2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
NOX	81.89	79.27	77.28	75.11	72.03	62.32	74.55	61.68
VOC	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Removal Eff, % Based on kWe	Removal Eff, % Based on kWe	Removal Eff, % Based on kWe	Removal Eff, % Based on kWe	Removal Eff, % Based on kWe	Removal Eff, % Based on kWe	Removal Eff, % Based on kWe	Removal Eff, % Based on kWe
CO	91.65	93.41	93.96	95.11	96.35	98.64	96.05	98.54
NO	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
NO2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
NOX	81.89	79.27	77.28	75.11	72.03	62.32	74.55	61.68
VOC	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Air RFAI: Attachment E

January 11, 2012 Letter from Shell to EPA

Shell Exploration & Production

Shell
3601 C Street, Suite 1000
Anchorage, AK 99503
Tel. (907) 646-7112
Email Susan.Childs@Shell.com
Internet http://www.Shell.com/

Natasha Greaves
OCS/PSD Air Quality Permits
U.S. EPA - Region 10, AWT-107
1200 Sixth Avenue, Suite 900
Seattle, Washington, 98101

January 11, 2012

Re: *Frontier Discoverer* Source Tests
Shell OCS Exploration Program

On September 19, 2011, EPA issued Shell Gulf of Mexico Inc. (Shell) Prevention of Significant Deterioration Permits to Construct for the Noble Discoverer drill ship operations in the Chukchi and Beaufort seas. The PSD permits require measurement of emissions from most of the emission units on the Discoverer and on the Discoverer's associated fleet via source testing.

The purpose of this letter is two-fold. First, we request EPA concurrence with Shell's intent to measure at on-shore facilities emissions from certain engines not now on the Discoverer. Secondly, we request EPA concurrence that physical or contractual limitations imposed on engine operating capacity can be considered when defining 100 percent load (and, correspondingly, fractions of that 100 percent load). As explained below, we believe Shell's approach meets the intent of the permit while ensuring a safer and equally realistic testing process.

On-shore testing

Shell intends to test the main generator engines, the port crane engine, the boilers, and the incinerator on the Discoverer because these emission units are permanently installed. However, none of the other engines that require testing are currently onboard the drill ship; in fact, most of the other engines are portable and routinely removed from the drill rig at the end of each drill season.

The PSD permits require Shell to test certain engines prior to the beginning of the drill season. Because of other construction activities that will be undertaken at the same time on the Discoverer, and the limited deck space available for those activities as well as source test equipment, testing certain engines at an on shore site will simply allow for a higher level of safety for testing, and personnel during testing. Shell would maintain that the physical location of the equipment during testing should not be an issue here, as the operating range necessary to be maintained to confirm accurate testing will need to be maintained whether the engine is physically located on the Discoverer at the time of testing or not.

Shell therefore proposes to test the starboard crane engine, the Mud Line Cellar Hydraulic Power Unit engines, the Mud Line Cellar Air Compressor engines, the cementing engines and the C7 logging winch engine at an on-shore facility. It is likely that testing will take place at NC Machinery, south of Tukwila, Washington. Although engine-specific information will be included in test protocols, dynamometers or hydraulic flow restrictors are likely to be used to load these engines to the operating rates required by the permits.

Definition of engine load

The Discoverer PSD permits require Shell to measure emissions from the engines powering the main generators, mud line cellar compressor engines, hydraulic pressure unit engines, crane engines, and cementing and logging engines at multiple loads. However, a number of these engines power equipment that, for various reasons, preclude operating, and as an extension testing, the engine to its full rated capacity. In some other cases, where the emissions units are owned by others, there are contractual restrictions on the maximum allowable engine operating loads.

In both cases, Shell proposes to redefine the maximum operating rate of the engine (100 percent load) to reflect those restrictions. Partial load testing (e.g., 50% load or 80% load) would also be correspondingly adjusted relative to this redefined maximum load condition. Below please find explanations of why, and examples of how, this would work for the subject engines.

FD 1-6. Main Generators

Noble, the owner of the Discoverer, has established 800 kW as the maximum operating rate for the generators, and has installed an electrical distribution system with controls that limit the engines' operating rate accordingly. This operating rate is nearly 20 percent lower than the 988 kW nameplate rating on the engine. With this contractual and operational restriction in place, Shell submits that an engine operating rate that results in 800 kW output reflects the true 100 percent engine load to be encountered during our OCS drilling operations, and that the "100% load" source tests should take place at this restricted engine operating rate. Similarly, source tests at 75% and 50% load should be conducted at engine operating rates that generate 600 and 400 kW, respectively.

FD 14-15. Deck Cranes

Each of the deck cranes engines are rated at 365 HP. The PSD permit requires testing at 60-80% and 80-100% loads.

Crane engine testing is challenging, as the engine is only one part of the crane hoisting system. The maximum load on the system is defined by the boom capacity, which for the cranes on the Discoverer is much less than the hoisting capacity of the corresponding engine and winch. One hundred percent boom capacity for the cranes to be used on the Discoverer translates to about 310-320 HP of engine/winch capacity, which is below their nameplate capacity. Because the

cranes cannot physically exceed the boom capacity, the engines are functionally limited to a lower load than their name plate rating. There is a boom radius-load indicator and alarm in the crane cabs that indicates when the load is approaching 100 percent of boom capacity. In this case, then, it is appropriate to consider the maximum load the engines will operate to be 320 HP. Thus, Shell proposes to define 100 percent load for these engines as 320 HP.

FD 12-13. Mud Line Cellar Hydraulic Power Unit Engines.

The MLC HPU engines are rated at 322 HP. The PSD permit requires testing at 50-70% and 80-100% loads.

These engines power hydraulic pumps that operate hydraulic motors on the MLC bit. The hydraulic motor capacity is limited to 150 gallons per minute at 2500 PSI, which translates to an engine load of about 218 HP. The energy load into the hydraulic motor cannot exceed this value. Given this physical limitation, Shell believes the functional maximum load the engine can operate is at 218 HP, and that we should consider this to be 100% load for testing.

We request EPA's written concurrence that testing the starboard crane engine, the Mud Line Cellar Hydraulic Power Unit engines, the Mud Line Cellar Air Compressor engines, the cementing engines and the C7 logging winch engine at an on-shore facility is consistent with the requirements of the Noble Discoverer PSD permits. We also request EPA's written concurrence that we can redefine 100 percent load for the main generators, the crane engines, and the Mud Line Cellar Hydraulic Power Unit engines as proposed above. Please contact Pauline Ruddy (907.771.7243) if you have questions or require additional information regarding these proposals.

Thank you,

Susan Childs

Susan Childs
AK Venture Support Integrator, Manager

Cc: Pauline Ruddy, Shell
Lance Tolson, Shell
Keith Craik, Shell
Eric Hansen, ENVIRON

Air RFAI: Attachment F

Kitchen/Dining/Recreation Area Emission Calculations

Air Sciences Inc.	PROJECT TITLE: Shell OCS Alaska	BY: N. Tipple		
	PROJECT NO: 180-23-2	PAGE: 1	OF: 5	SHEET: KDR
ENGINEERING CALCULATIONS	SUBJECT: KDR Construction Emissions	DATE: January 30, 2014		

Kitchen/Dining/Recreation (KDR) Emissions Summary (Short Term)

	NO_X	$PM_{2.5}$	PM_{10}	PM	CO	NMHC
	lb/hr	*lb/hr*	*lb/hr*	*lb/hr*	*lb/hr*	*lb/hr*
Gravel Truck Tailpipe	0.28	0.001	0.001	0.001	0.65	0.02
Gravel Truck Unpaved Roads		1.23	12.33	58.85		
Gravel Dump - Material Transfer		0.0001	0.0001	0.0001		
Material Mixing (Dozing)		1.67	11.95	15.93		
Dozer Tailpipe	2.70	0.13	0.13	0.13	2.36	0.88
Modular Building Delivery Truck Tailpipe	0.28	0.001	0.001	0.001	0.65	0.02
Modular Building Delivery Truck Unpaved Roads		1.23	12.33	58.85		
Modular Building Placement - Crane Tailpipe	8.32	0.49	0.49	0.49	10.31	1.18
Crane Unpaved Roads		0.25	2.47	11.77		
Total *(lb/hr)*	**11.58**	**5.01**	**39.69**	**146.01**	**13.98**	**2.08**

Kitchen/Dining/Recreation (KDR) Emissions Summary (total)

	NO_X	$PM_{2.5}$	PM_{10}	PM	CO	NMHC
	ton	*ton*	*ton*	*ton*	*ton*	*ton*
Gravel Truck Tailpipe	3.4E-3	7.9E-6	7.9E-6	7.9E-6	7.9E-3	1.8E-4
Gravel Truck Unpaved Roads		1.5E-2	1.5E-1	7.1E-1		
Gravel Dump - Material Transfer		1.2E-6	1.2E-6	1.2E-6		
Material Mixing (Dozing)		1.7E-2	1.2E-1	1.6E-1		
Dozer Tailpipe	2.7E-2	1.3E-3	1.3E-3	1.3E-3	2.4E-2	8.8E-3
Modular Building Delivery Truck Tailpipe	2.4E-3	5.6E-6	5.6E-6	5.6E-6	5.5E-3	1.3E-4
Modular Building Delivery Truck Unpaved Roads		1.0E-2	1.0E-1	4.9E-1		
Modular Building Placement - Crane Tailpipe	5.8E-2	3.4E-3	3.4E-3	3.4E-3	7.2E-2	8.2E-3
Crane Unpaved Roads		1.7E-3	1.7E-2	8.2E-2		
Total *(ton)*	**0.09**	**0.05**	**0.39**	**1.45**	**0.11**	**0.02**

Conversions	
453.6	*g/lb*
2,000	*lb/ton*
1.34	*hp/kW*

Gravel Truck Assumptions	
20	*Quantity of Round Trips*
15	*One Way Route Distance (miles)*
30	*Round Trip Route Distance (miles)*
600	*Total Vehicle Miles Traveled (VMT)*
25	*Average Speed (mph)*
1.2	*Average Time for 1 Round Trip (hr)*
15,000*	*Approximate Payload Capacity (lb)*
30,000*	*Approximate GVW (lb)*
300*	*Approximate Engine Rating (hp)*
24	*Maximum Time of Gravel Truck Transit (hr)*

**Phone conversation with International sales representative, Ken Conway, 01/20/2014*

Gravel Truck Tailpipe

Tailpipe Emission Factors		
NO_X	0.426	*g/hp-hr*
PM, PM_{10}, $PM_{2.5}$	0.001	*g/hp-hr*
CO	0.99	*g/hp-hr*
NMHC	0.023	*g/hp-hr*

2013 On-Highway Heavy Duty: www.epa.gov/otaq/certdata.htm#largeng

Tailpipe Emissions		
Pollutant	*lb/hr*	*ton (total)*
NO_X	2.8E-1	3.4E-3
PM, PM_{10}, $PM_{2.5}$	6.6E-4	7.9E-6
CO	6.5E-1	7.9E-3
NMHC	1.5E-2	1.8E-4

Gravel Truck Unpaved Roads

Surface material silt content (s)	1.8	%	*Assuming lowest silt content given for equation due to the fact that*
Mean Vehicle Weight (W)	11.25	*ton*	*the roads are primarily ice.*

Emission Factor Equation

$E = k\,(s/12)^a\,(W/3)^{0.45}$ *lb/VMT* — *AP-42, 13.2.2-4, Equation (1a), Rev 11/06.*

EF Equation Constants	$PM_{2.5}$	PM_{10}	PM
k (lb/VMT)	0.15	1.5	4.9
a	0.9	0.9	0.7
b	0.45	0.45	0.45

Fugitive Dust Emissions	$PM_{2.5}$	PM_{10}	PM
E (lb/VMT)	0.05	0.49	2.35
lb/hr	1.23	12.33	58.85
ton (total)	0.01	0.15	0.71

Gravel Dump - Material Transfer

Emission Factor	1.6E-05	*lb PM/ton*	*AP-42, 11.19.2- 8, Table 11.19.2-2 Rev 8/04, Truck Unloading*
Max Dumping Rate	7.5	*ton/hr*	
Dumping Duration	1	*hr per delivery*	
Total Duration	20	*hr*	

Fugitive Dust Emissions		
PM, PM_{10}, $PM_{2.5}$	1.2E-4	*lb/hr*
	1.2E-6	*ton(total)*

Material Mixing (Dozing)

Dozer use	1	*hours of dozer operation per gravel delivery*	
Total dozer use	20	*hr*	
Surface material silt content (s)	1.6	%	*AP-42, 13.2.4-2, Rev 1/06, Crushed Limestone*
Material moisture content (M)	0.7	%	*AP-42, 13.2.4-2, Rev 1/06, Crushed Limestone*

Emission Factor Equation

$E = 5.7\ (s)^{1.2} / (M)^{1.3}$ *lb/hr* — *AP-42, Table 11.9-1, overburden dozing (07/98)*

Fugitive Dust Emissions	$PM_{2.5}$	PM_{10}	PM
*Scaling Factor**	0.105	0.75	1
lb/hr	1.7	11.9	15.9
ton (total)	0.02	0.12	0.16

**AP-42, Table 11.9-1, overburden dozing (07/98)*

Dozer Tailpipe

Dozer Assumptions		
Dozer Engine	410 hp	*Assuming CAT D9T, Tier 3*

Tailpipe Emission Factors		
NO_X	4.00 *g/kW-hr*	2.98 *g/hp-hr*
PM, PM_{10}, $PM_{2.5}$	0.20 *g/kW-hr*	0.15 *g/hp-hr*
CO	3.50 *g/kW-hr*	2.61 *g/hp-hr*
VOC	1.30 *g/kW-hr*	0.97 *g/hp-hr*

§ 89.112 Oxides of nitrogen, carbon monoxide, hydrocarbon, and particulate matter exhaust emission standards.

Tailpipe Emissions		
Pollutant	*lb/hr*	*ton (total)*
NO_X	2.7E+0	2.7E-2
PM, PM_{10}, $PM_{2.5}$	1.3E-1	1.3E-3
CO	2.4E+0	2.4E-2
NMHC	8.8E-1	8.8E-3

Delivery Truck Assumptions	
14	*Quantity of Round Trips*
15	*One Way Route Distance (miles)*
30	*Round Trip Route Distance (miles)*
420	*Total Vehicle Miles Traveled (VMT)*
25	*Average Speed (mph)*
1.2	*Average Time for 1 Round Trip (hr)*
15,000*	*Approximate Payload Capacity (lb)*
30,000*	*Approximate GVW (lb)*
300*	*hp*
16.8	*Maximum Time of Delivery Truck Transit (hr)*

**Phone conversation with International sales representative, Ken Conway*

Modular Building Delivery Truck Tailpipe

Tailpipe Emission Factors		
NO_X	0.426	*g/hp-hr*
PM, PM_{10}, $PM_{2.5}$	0.001	*g/hp-hr*
CO	0.99	*g/hp-hr*
NMHC	0.023	*g/hp-hr*

2013 On-Highway Heavy Duty: www.epa.gov/otaq/certdata.htm#largeng

Tailpipe Emissions		
Pollutant	*lb/hr*	*ton (total)*
NO_X	2.8E-1	2.4E-3
PM, PM_{10}, $PM_{2.5}$	6.6E-4	5.6E-6
CO	6.5E-1	5.5E-3
NMHC	1.5E-2	1.3E-4

Modular Building Delivery Truck Unpaved Roads

Surface material silt content (s)	1.8	%	*Assuming lowest silt content given for equation due to the fact that*
Mean Vehicle Weight (W)	11.25	*ton*	*the roads are primarily ice.*

Emission Factor Equation

$E = k\,(s/12)^a\,(W/3)^b$ *lb/VMT* — *AP-42, 13.2.2-4, Equation (1a), Rev 11/06.*

Fugitive Dust Emissions	$PM_{2.5}$	PM_{10}	PM
E (lb/VMT)	0.05	0.49	2.35
lb/hr	1.23	12.33	58.85
ton (total)	0.01	0.10	0.49

Modular Building Placement - Crane Tailpipe

Crane Assumptions	
550	*hp*
1	*EPA Nonroad Tier Rating*
1	*hours of crane operation per placement*
14	modular buildings
14	*Maximum Time of Crane Operation (hr)*
1	*Distance Travelled Per Delivery (miles)*
5	*Average Speed (mph)*
0.2	*Average Crane Transit Time for 1 Delivery (hr)*

Tailpipe Emission Factors				
NO_X	9.2	*g/kW-hr*	6.86	*g/hp-hr*
PM, PM_{10}, $PM_{2.5}$	0.54	*g/kW-hr*	0.40	*g/hp-hr*
CO	11.4	*g/kW-hr*	8.50	*g/hp-hr*
VOC	1.3	*g/kW-hr*	0.97	*g/hp-hr*

§ 89.112 Oxides of nitrogen, carbon monoxide, hydrocarbon, and particulate matter exhaust emission standards, 225 ≤kW≤450, Tier 1

Tailpipe Emissions		
Pollutant	*lb/hr*	*ton (total)*
NO_X	8.32	5.8E-2
PM, PM_{10}, $PM_{2.5}$	0.49	3.4E-3
CO	10.31	7.2E-2
NMHC	1.18	8.2E-3

Crane Unpaved Roads

Surface material silt content (s)	1.8	%	*Assuming lowest silt content given for equation due to the fact that*
Mean Vehicle Weight (W)	11.25	*ton*	*the roads are primarily ice.*

Emission Factor Equation

$E = k\,(s/12)^a\,(W/3)^b$ *lb/VMT* — *AP-42, 13.2.2-4, Equation (1a), Rev 11/06.*

Fugitive Dust Emissions	$PM_{2.5}$	PM_{10}	PM
E (lb/VMT)	0.05	0.49	2.35
lb/hr	0.25	2.47	11.77
ton (total)	0.002	0.02	0.08

Air RFAI: Attachment G

ULSD Specifications

Sabrina Pryor

From: Nicole.StAmand@shell.com
Sent: Wednesday, April 20, 2011 12:32 PM
To: rgsteen@airsci.com
Cc: spryor@airsci.com
Subject: FW: Diesel Question

Importance: High

Follow Up Flag: Follow up
Flag Status: Completed

Rodger

Below is some data from Crowley. Please let me know if you need more.

Nicole

From: Spring, Karen SEPCO-UAX/A/R
Sent: Wednesday, April 20, 2011 10:31 AM
To: St Amand, Nicole M SEPCO-UAX/A/SD
Cc: Yampolsky, Lev M SEPCO-UAX/A/R
Subject: Fw: Diesel Question

Fyi

From: Bruce.Harland@crowley.com <Bruce.Harland@crowley.com>
To: Spring, Karen SEPCO-UAX/A/R
Sent: Wed Apr 20 13:08:09 2011
Subject: FW: Diesel Question

Karen
The values below are for the diesel produced by tesoro in Nikiski. Other sources could differ.
Regards
Bruce

Sent from my GoodLink synchronized handheld (www.good.com)

-----Original Message-----
From: Harris, Royal
Sent: Wednesday, April 20, 2011 01:34 PM Eastern Standard Time
To: Harland, Bruce
Subject: RE: Diesel Question

Oh yes:

The maximum sulfur content of marine diesel is available in Alaska? 15 PPM (D5453)

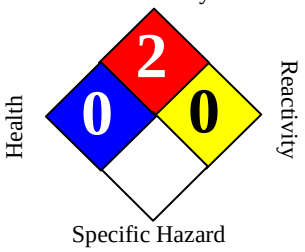
These two questions would be specific to each refiner. Petro Star not back up and running yet. Tesoro, Nikiski, is producing. We also mobilize in products from US West Coast, and also from Korea depending on the relative values.

Based upon Tesoro Nikiski production:
Then what the density: ULS2 Density at 15C is 0.8393 (D4052 Specific Gravity is 0.8398)

heat content (BTU/gal) is? ULS2 D4809 1) gross 139,450 2) net 131,180

Safety Data Sheet
Diesel Low Sulfur (LSD) and Ultra Low Sulfur Diesel (ULSD)

NFPA:



SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Diesel Low Sulfur (LSD) and Ultra Low Sulfur Diesel (ULSD)		
Synonyms	:	CARB Diesel, 888100004478		
MSDS Number		888100004478	**Version**	2.31
Product Use Description				
Company		For: Tesoro Refining & Marketing Co. 19100 Ridgewood Parkway, San Antonio, TX 78259		
Tesoro Call Center		(877) 783-7676	**Chemtrec (Emergency Contact)**	(800) 424-9300

SECTION 2. HAZARDS IDENTIFICATION

Classifications

Flammable Liquid – Category 3
Skin Irritation – Category 2
Eye Irritation – Category 2B
Aspiration Hazard – Category 1
Carcinogenicity – Category 2
Acute Toxicity - Inhalation – Category 4
Chronic Aquatic Toxicity – Category 2

Pictograms

Signal Word

Danger

Hazard Statements

Flammable liquid and vapor.
May be fatal if swallowed and enters airways – do not siphon diesel by mouth.
Causes skin irritation.
Causes eye irritation.
Suspected of causing skin cancer if repeated and prolonged skin contact occurs.
Suspected of causing cancer in the respiratory system if repeated and prolonged over-exposure by inhalation occurs.
May cause damage to liver, kidneys and nervous system by repeated and prolonged inhalation.

Toxic if inhaled.
May cause drowsiness or dizziness by inhalation.
Toxic to aquatic life with long lasting effects.

Precautionary statements

Prevention

Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Keep away from heat, sparks, open flames, welding and hot surfaces.
No smoking.
Keep container tightly closed.
Ground and/or bond container and receiving equipment.
Use explosion-proof electrical equipment.
Use only non-sparking tools if tools are used in flammable atmosphere.
Take precautionary measures against static discharge.
Wear gloves, eye protection and face protection as needed to prevent skin and eye contact with liquid.
Wash hands or liquid-contacted skin thoroughly after handling.
Do not eat, drink or smoke when using this product.
Avoid breathing vapors or mists.
Use only outdoors or in a well-ventilated area.

Response

In case of fire: Use dry chemical, CO2, water spray or fire fighting foam to extinguish.
If swallowed: Immediately call a poison center, doctor, hospital emergency room, medical clinic or 911. Do NOT induce vomiting. Rinse mouth.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower.
If in eye: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
If skin or eye irritation persists, get medical attention.
If inhaled: Remove person to fresh air and keep comfortable for breathing.
Immediately call or doctor or emergency medical provider. See Section 4 and Section 11 for medical treatment information.

Storage

Store in a well ventilated place. Keep cool. Store locked up. Keep container tightly closed . Use only approved containers.

Disposal

Dispose of contents/containers to approved disposal site in accordance with local, regional, national, and/or international regulations.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No.	Weight %
Fuels, diesel, No 2; Gasoil - unspecified	68476-34-6	100%
Nonane	111-84-2	0 - 5%
Naphthalene	91-20-3	0 - 1%

1,2,4-Trimethylbenzene	95-63-6	0 - 2%
Xylene	1330-20-7	0 - 2%
Sulfur	7704-34-9	15 ppm maximum

SECTION 4. FIRST AID MEASURES

Inhalation : Move to fresh air. Give oxygen. If breathing is irregular or stopped, administer artificial respiration. Seek medical attention immediately.

Skin contact : Take off all contaminated clothing immediately. Wash off immediately with soap and plenty of water. Wash contaminated clothing before re-use. If skin irritation persists, seek medical attention immediately.

Eye contact : Remove contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes. If symptoms persist, seek medical attention.

Ingestion : Do not induce vomiting without medical advice. If a person vomits when lying on his back, place him in the recovery position. Seek medical attention immediately.

Notes to physician : Symptoms: Dizziness, Discomfort, Headache, Nausea, Disorder, Vomiting, Lung edema, Liver disorders, Kidney disorders. Aspiration may cause pulmonary edema and pneumonitis.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media : SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray or fire fighting foam. LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers. Keep containers and surroundings cool with water spray.

Specific hazards during fire fighting : Fire Hazard Do not use a solid water stream as it may scatter and spread fire. Cool closed containers exposed to fire with water spray.

Special protective equipment for fire-fighters : Wear self-contained breathing apparatus and protective suit. Use personal protective equipment.

Further information : Exposure to decomposition products may be a hazard to health. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions : Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to contain spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact. Ensure adequate ventilation. Use personal protective equipment.

Environmental precautions	:	Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection. Discharge into the environment must be avoided. If the product contaminates rivers and lakes or drains inform respective authorities.
Methods for cleaning up	:	Take up with sand or oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

SECTION 7. HANDLING AND STORAGE

Precautions for safe handling

: Keep away from fire, sparks and heated surfaces. No smoking near areas where material is stored or handled. The product should only be stored and handled in areas with intrinsically safe electrical classification.

: Hydrocarbon liquids including this product can act as a non-conductive flammable liquid (or static accumulators), and may form ignitable vapor-air mixtures in storage tanks or other containers. Precautions to prevent static-initated fire or explosion during transfer, storage or handling, include but are not limited to these examples:

(1) Ground and bond containers during product transfers. Grounding and bonding may not be adequate protection to prevent ignition or explosion of hydrocarbon liquids and vapors that are static accumulators.

(2) Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil or diesel) is loaded into tanks previously containing low flash point products (such gasoline or naphtha).

(3) Storage tank level floats must be effectively bonded.

For more information on precautions to prevent static-initated fire or explosion, see NFPA 77, Recommended Practice on Static Electricity (2007), and API Recommended Practice 2003, Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents (2008).

Conditions for safe storage, including incompatibilities

: Keep away from flame, sparks, excessive temperatures and open flame. Use approved containers. Keep containers closed and clearly labeled. Empty or partially full product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose containers to sources of ignition. Store in a well-ventilated area. The storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

: Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure.

Keep away from food, drink and animal feed. Incompatible with oxidizing agents. Incompatible with acids.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

List	Components	CAS-No.	Type:	Value
OSHA Z1	Xylene	1330-20-7	PEL	100 ppm 435 mg/m3
	Naphthalene	91-20-3	PEL	10 ppm 50 mg/m3
ACGIH	Diesel Fuel	68476-30-2	TWA	100 mg/m3
	Xylene	1330-20-7	TWA	100 ppm
		1330-20-7	STEL	150 ppm
	Naphthalene	91-20-3	TWA	10 ppm
		91-20-3	STEL	15 ppm
	Nonane	111-84-2	TWA	200 ppm

Engineering measures : Use adequate ventilation to keep gas and vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces. Use only intrinsically safe electrical equipment approved for use in classified areas.

Eye protection : Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Hand protection : Gloves constructed of nitrile, neoprene, or PVC are recommended. Consult manufacturer specifications for further information.

Skin and body protection : If needed to prevent skin contact, chemical protective clothing such as of DuPont TyChem®, Saranex or equivalent recommended based on degree of exposure. The resistance of specific material may vary from product to product as well as with degree of exposure.

Respiratory protection : A NIOSH/ MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, ANSI Z88.2-1992, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection. Use a NIOSH/ MSHA-approved positive-pressure supplied-air respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Work / Hygiene practices : Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Clear to straw colored liquid
Odor	Characteristic petroleum or kerosene-like odor
Odor threshold	0.1 - 1 ppm typically reported
pH	Not applicable
Melting point/freezing point	Gel point can be about -15°F; freezing requires laboratory conditions
Initial boiling point & range	154 - 372 °C (310° - 702 °F)
Flash point	38°C Minimum for #1 Diesel, 52°C Minimum for #2 Diesel
Evaporation rate	Higher initially and declining as lighter components evaporate
Flammability (solid, gas)	Flammable vapor released by liquid
Upper explosive limit	6.5 %(V)
Lower explosive limit	0.6 %(V)
Vapor pressure	< 2 mm Hg at 20 °C
Vapor density (air = 1)	> 4.5
Relative density (water = 1)	0.86 g/mL
Solubility (in water)	0.0005 g/100 mL
Partition coefficient (n-octanol/water)	> 3.3 as log Pow
Auto-ignition temperature	257 °C (495 °F)
Decomposition temperature	Will evaporate or boil and possibly ignite before decomposition occurs.
Kinematic viscosity	1 to 6 mm²/s range reported for No.1 or No.2 diesel at ambient temperatures
Conductivity (conductivity can be reduced by environmental factors such as a decrease in temperature	Diesel Fuel Oils at terminal load rack: At least 25 pS/m Ultra Low Sulfur Diesel (ULSD) without conductivity additive: 0 pS/m to 5 pS/m ULSD at terminal load rack with conductivity additive: At least 50 pS/m JP-8 at terminal load rack: 150 pS/m to 600 pS/m

SECTION 10. STABILITY AND REACTIVITY

Reactivity	: Vapors may form explosive mixture with air. Hazardous polymerization does not occur.
Chemical stability	Stable under normal conditions.
Possibility of hazardous reactions	Can react with strong oxidizing agents, peroxides, acids and alkalies. Do not use with Viton or Fluorel gaskets or seals.
Conditions to avoid	Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources. Avoid static charge accumulation and discharge (see Section 7).
Hazardous decomposition products	Ignition and burning can release carbon monoxide, carbon dioxide, non-combusted hydrocarbons (smoke) and, depending on formulation, trace amounts

of sulfur dioxide. Diesel exhaust particals may be a lung hazard (see Section 11).

SECTION 11. TOXICOLOGICAL INFORMATION

Inhalation : Vapors or mists from this material can irritate the nose, throat, and lungs, and can cause signs and symptoms of central nervous system depression, depending on the concentration and duration of exposure.

Skin contact Skin irritation leading to dermatitis may occur upon prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed. Long-term, repeated skin contact may cause skin cancer.

Eye contact Eye irritation may result from contact with liquid, mists, and/or vapors.

Ingestion Harmful or fatal if swallowed. Do NOT induce vomiting. This material can irritate the mouth, throat, stomach, and cause nausea, vomiting, diarrhea and restlessness Aspiration hazard if liquid is inhaled into lungs, particularly from vomiting after ingestion. Aspiration may result in chemical pneumonia, severe lung damage, respiratory failure and even death.

Target organs Central nervous system, Eyes, Skin, Kidney, Liver

Further information Studies have shown that similar products produce skin cancer or skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation.
Repeated over-exposure may cause liver and kidney injury
IARC classifies whole diesel fuel exhaust particulates as carcinogenic to humans (Group 1). NIOSH regards whole diesel fuel exhaust particulates as a potential cause of occupational lung cancer based on animal studies and limited evidence in humans.

Component:

Fuels, diesel, No 2; Gasoil - unspecified	68476-34-6	Acute oral toxicity: LD50 rat Dose: 5,001 mg/kg Acute dermal toxicity: LD50 rabbit Dose: 2,001 mg/kg Acute inhalation toxicity: LC50 rat Dose: 7.64 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Severe skin irritation Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation
Nonane	111-84-2	Acute oral toxicity: LD50 mouse Dose: 218 mg/kg Acute inhalation toxicity: LC50 rat Exposure time: 4 h
Naphthalene	91-20-3	Acute oral toxicity: LD50 rat Dose: 2,001 mg/kg Acute dermal toxicity: LD50 rat Dose: 2,501 mg/kg

		Acute inhalation toxicity: LC50 rat Dose: 101 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation Carcinogenicity: N11.00422130
1,2,4-Trimethylbenzene	95-63-6	Acute inhalation toxicity: LC50 rat Dose: 18 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Skin irritation Eye irritation: Classification: Irritating to eyes. Result: Eye irritation
Xylene	1330-20-7	Acute oral toxicity: LD50 rat Dose: 2,840 mg/kg Acute dermal toxicity: LD50 rabbit Dose: ca. 4,500 mg/kg Acute inhalation toxicity: LC50 rat Dose: 6,350 mg/l Exposure time: 4 h Skin irritation: Classification: Irritating to skin. Result: Mild skin irritation Repeated or prolonged exposure may cause skin irritation and dermatitis, due to degreasing properties of the product. Eye irritation: Classification: Irritating to eyes. Result: Mild eye irritation

Carcinogenicity

NTP Naphthalene (CAS-No.: 91-20-3)

IARC Naphthalene (CAS-No.: 91-20-3)

OSHA No component of this product which is present at levels greater than or equal to 0.1 % is identified as a carcinogen or potential carcinogen by OSHA.

CA Prop 65 WARNING! This product contains a chemical known to the State of California to cause cancer.
naphthalene (CAS-No.: 91-20-3)

SECTION 12. ECOLOGICAL INFORMATION

Additional ecological information : Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable, under Federal and State regulations.

Component:

Diesel	68476-34-6	Toxicity to fish: LC50 Species: Jordanella floridae Dose: 54 mg/l

Exposure time: 96 h

Toxicity to crustacia:
Species: Palaemonetes pugio
TLm (48 hour) = 3.4 mg/l

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal : Dispose of container and unused contents in accordance with federal, state and local requirements.

SECTION 14. TRANSPORT INFORMATION

CFR

Proper shipping name	: DIESEL FUEL
UN-No.	: UN1202 (NA 1993)
Class	: 3
Packing group	: III

TDG

Proper shipping name	: DIESEL FUEL
UN-No.	: UN1202 (NA 1993)
Class	: 3
Packing group	: III

IATA Cargo Transport

UN UN-No.	: UN1202 (NA 1993)
Description of the goods	: DIESEL FUEL
Class	: 3
Packaging group	: III
ICAO-Labels	: 3
Packing instruction (cargo aircraft)	: 366
Packing instruction (cargo aircraft)	: Y344

IATA Passenger Transport

UN UN-No.	: UN1202 (NA 1993)
Description of the goods	: DIESEL FUEL
Class	: 3
Packaging group	: III
ICAO-Labels	: 3
Packing instruction (passenger aircraft)	: 355
Packing instruction (passenger aircraft)	: Y344

IMDG-Code

UN-No.	: UN 1202 (NA 1993)
Description of the goods	: DIESEL FUEL
Class	: 3
Packaging group	: III
IMDG-Labels	: 3

EmS Number	:	F-E S-E
Marine pollutant	:	No

SECTION 15. REGULATORY INFORMATION

: **CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIROMENT)**
The CERCLA definition of hazardous substances contains a "petroleum exclusion" clause which exempts crude oil. Fractions of crude oil, and products (both finished and intermediate) from the crude oil refining process and any indigenous components of such from the CERCLA Section 103 reporting requirements. However, other federal reporting requirements, including SARA Section 304, as well as the Clean Water Act may still apply**.**

TSCA Status : On TSCA Inventory

DSL Status : All components of this product are on the Canadian DSL list.

SARA 311/312 Hazards : Fire Hazard
Acute Health Hazard
Chronic Health Hazard

SARA III — US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III Section 313 Toxic Chemicals (40 CFR 372.65) - Supplier Notification Required

Components	CAS-No.
Xylene	1330-20-7
1,2,4-Trimethylbenzene	95-63-6
Naphthalene	91-20-3

PENN RTK — US. Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)

Components	CAS-No.
Nonane	111-84-2
Naphthalene	91-20-3
1,2,4-Trimethylbenzene	95-63-6
xylene	1330-20-7
Fuels, diesel, No 2; Gasoil - unspecified	68476-34-6

MASS RTK — US. Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)

Components	CAS-No.
Xylene	1330-20-7
1,2,4-Trimethylbenzene	95-63-6
Naphthalene	91-20-3
Nonane	111-84-2

NJ RTK — US. New Jersey Worker and Community Right-to-Know Act (New Jersey Statute Annotated Section 34:5A-5)

Components	CAS-No.
Nonane	111-84-2

Naphthalene	91-20-3
1,2,4-Trimethylbenzene	95-63-6
Xylene	1330-20-7
Fuels, diesel, No 2; Gasoil - unspecified	68476-34-6

California Prop. 65 : WARNING! This product contains a chemical known to the State of California to cause cancer.

Naphthalene 91-20-3

SECTION 16. OTHER INFORMATION

Further information

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

10/29/2012

1153, 1250, 1443, 1454, 1814, 1815, 1866, 1925

Air RFAI: Attachment H

Lifeboat Engine Specifications

SABB MOTOR A/S
TESTDEPARTMENT

WORKS TEST CERTIFICATE

SABB

SABB MOTOR ORDER NO.:		0225479	
CUSTOMER:		JIANGYIN NORSAFE FRP	
CUSTOMER ORDER NO.:		06-IM739	
SABB SERIAL NO.:		L3 139LB 257 06	
AUTHORITY/CLASS SOCIETY:		MED	
CERTIFICATE NO:		MED-B-2294	
ENGINE TYPE:		L3 139LB 257 06	
ENGINE BLOCK NO.:		06008268	
GEARBOX TYPE / RATIO:		ZF 12M	2,63
GEARBOX SERIAL NO.:		30453	
ENGINE OUTPUT (HP):	29,5	FULL LOAD SPEED (RPM):	3000
SPEED UNLOADED MAX (RPM):	356	SPEED UNLOADED MIN (RPM):	1000
DYNAMOMETER SPEED (RPM):	1141	BRAKE LOAD (kg):	15,5
TEST BENCH NO.:	7	BRAKE CONSTANT:	600
AMBIENT TEMP. (°C):	25	HUMIDITY (%):	45
COOLANT TEMP. (°C):	80	AMB.PRESSURE (mmHg):	
ENGINE OIL TEMP. (°C):		LUB.OIL PRESSURE (bar):	2,8
EXHAUST TEMP. (°C):	549	CHARGE AIR PRESSURE (bar):	

THE ENGINE HAS BEEN TESTED IN ACC. WITH APPROVED ENGINE TEST PROCEDURES, AND ISO STANDARD 3046 I / II

DATE OF TESTING:	10,08,06	DATE OF INSPECTION:	10,08,06

SABB TESTDEPT. SIGN.	D.O	SABB INSPECTION DEPT. SIGN.	