Petitioner’s Exhibit 1

Shell Offshore Inc.
3601 C Street, Suite 1334
Anchorage, AK 99503

December 29, 2006

Daniel L. Meyer
Office of Air, Waste and Toxics
U.S. EPA, Region 10
1200 Sixth Avenue, OAQ-107
Seattle, WA 98101

Re: Shell Kulluk 40 CFR Part 55 Preconstruction Permit Application for the 2007 – 2009 Beaufort Sea OCS Exploration Drilling Program

Frontier Discoverer 40 CFR Part 55 Preconstruction Permit Application for the 2007 – 2009 Beaufort Sea OCS Exploration Drilling Program

Dear Mr. Meyer:

Please find enclosed two minor source air permit applications for the Shell Kulluk and the Frontier Discoverer exploratory drilling programs. The applications are a follow-up on Shell Offshore, Inc.'s March 22, 2006, notice of intent (NOI) letter to EPA to conduct exploratory drilling activity on its OCS lease-holding blocks located on the Beaufort Sea, Alaska. As you recall, EPA and Shell Offshore, Inc. (SOI) previously discussed the air permitting requirements for these two exploratory drilling programs this past September. Shell believes the two air permit applications comport with our mutual understanding of the EPA permitting requirements, including the ambient air quality impact analysis required under Alaska regulation for minor sources.

Shell will need a pre-construction permit by April 2007 to meet its anticipated August 1, 2007, project start date. As you can imagine, the ice conditions in the Beaufort Sea can significantly affect the project start date and the potential length of each drilling season, and thus any significant delay beyond April 2007 could threaten the 2007 drilling season. Representatives from AES Regulatory & Technical Services (AES RTS), Shell, and AES RTS's sub-contractor, Air Sciences Inc., will be available to assist the EPA in any way to process the air permitting documents. If you have any questions regarding this submittal, please contact Wayne Wooster, Air Sciences Inc., at (503) 525-9394 or at wwooster@airsci.com. For any questions regarding the project, please contact me (907) 770-3700 or at susan.childs@shell.com

Sincerely yours,

Shell Offshore, Inc.

Susan Childs

Susan Childs
Regulatory Coordinator, Alaska

Enclosures

cc: Anita Frankel, EPA Region 10
Rick Fox, Shell
Susan Childs, Shell
Keith Craik, Shell
Brad Boschetto, Shell
Kate Marstall, Shell
Bill Walker, ADEC, DAQ
Jeff Walker, MMS
Rance Wall, MMS
Don Perrin, ADNR, OPMP
Kyle Parker, Patton & Boggs
John Iani, VanNess Feldman
Gene Pavia, AES RTS
Greg Horner, AES RTS
Wayne Wooster, Air Sciences Inc.

Outer Continental Shelf Pre-Construction Air Permit Application

Shell Kulluk 2007 – 2009 Beaufort Sea Exploratory Drilling Program

Prepared for:

SHELL OFFSHORE, INC.

PROJECT 180-15
DECEMBER 29, 2006

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SECTION 1

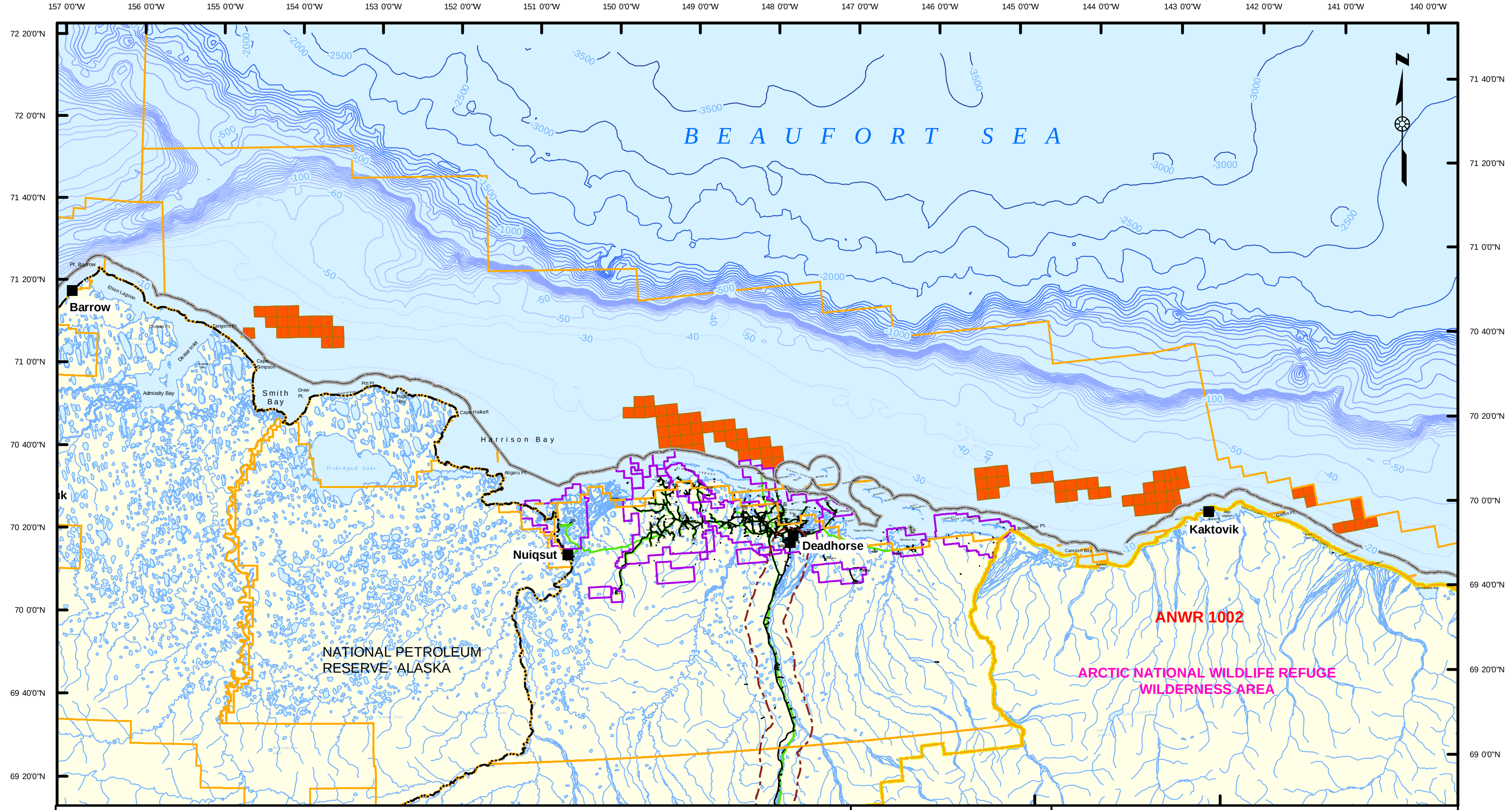
INTRODUCTION AND PROJECT DESCRIPTION

This application is submitted to U.S. EPA's Region 10 (EPA) office, pursuant to the requirements of Outer Continental Shelf Air Regulations, 40 CFR Part 55. Shell Offshore, Inc. (SOI) wishes to conduct exploratory drilling activity at its oil and gas lease blocks on Outer Continental Shelf (OCS) waters in the Beaufort Sea using the Kulluk drilling vessel and associated support vessels. Because of distance from the Alaska shore, the drilling activities will be regulated by the U.S. EPA rather than the Alaska Department of Environmental Conservation (ADEC). Figure 1 shows the locations of SOI's Beaufort Sea OCS lease blocks. SOI intends to conduct a three-year exploratory drilling program, 2007 through 2009, although drilling activity may occur in 2010 and 2011 if ice conditions prevent significant exploratory drilling activity in 2007, 2008, or 2009.

SOI believes that the available drilling season will range up to 120 days per calendar year, weather and ice conditions permitting. SOI anticipates that the drilling operations per drill site will range between 30 and 60 days. SOI, therefore, anticipates drilling up to three drill site locations per year. The drilling season is projected to run from approximately August 1 through November 30 each year, again weather and ice conditions permitting. Ice conditions in the Beaufort Sea were particularly heavy in 2006 resulting in a significantly less than an expected 90-day available drilling season. Pursuant to the 40 CFR 55.2 OCS source definition, each drill site is a stationary source, so the Shell Kulluk drilling activities could consist of a maximum of three sequential stationary sources per year. This application is, in fact, a single application for multiple portable stationary sources, all of which will be equal to or smaller than the hypothetical stationary source described herein.

SOI intends to conduct drilling operations in 2007 at its OCS lease block locations in Camden Bay, located in the central Beaufort Sea. SOI may conduct exploratory drilling operations at its other OCS lease block locations in the Beaufort Sea in 2008 and 2009. The proposed 2007 drilling sites are located approximately 13 to 16 miles from the state of Alaska shoreline. Drilling activities will be curtailed in the event that large ice flows force the drilling vessel off of the drilling site. For example, SOI experienced seven days and fifteen days of "force offs," respectively, during its 1985 and 1986 Beaufort Sea exploration drilling program. In the event of an ice flow caused "force off," drilling activities will resume once favorable ice conditions allow the drilling vessel to safely return to the drilling site.

Each drill site will carry with it a safety exclusion zone around the Shell Kulluk, established by the U.S. Coast Guard around the Shell Kulluk, protecting ocean traffic from possible entanglement with the Shell Kulluk anchors and any close-in related anchor and ice management. This safety exclusion zone establishes the ambient air boundary around the stationary source.



🟥 Shell Lease Blocks

■ Villages

— Roads

— Pipelines

☐ State Oil & Gas Units

☐ Planning Areas

☐ National Petroleum Reserve - Alaska

☐ State Restricted Area

— State-Federal Water Boundary

AES Lynx Enterprises, Inc.

3900 C Street, Suite 601

Anchorage, Alaska 99503

Phone (907) 339-5491

Fax (907) 339-5475

www.Lynx.asrcenergy.com

SHELL EXPLORATION & PRODUCTION CO.

Shell Beaufort Sea OCS Leases

SCALE: 0 12.5 25 50 Mi

FIGURE:

Lynx: 15067-204.mxd, 11/08/06, R00

SECTION 2

SOURCE DESCRIPTION AND EMISSIONS EVALUATION

This section provides a description of the Shell Kulluk fleet configuration, a description of the project vessels emission units and a project vessel-wide emission estimate, and includes SOI's request for an owner requested limit (ORL) to maintain synthetic minor permit status.

2.1 Shell Kulluk Fleet Configuration

The Shell Kulluk Exploratory Drilling Program exploration drilling activities will be conducted from Shell's conical drilling unit (CDU), the Kulluk, and assisted by a number of associated support vessels. The Shell Kulluk is a purpose-built floating vessel with an Arctic Class IV hull design. The associated support vessels will include two icebreakers, a re-supply vessel, and an oil spill response (OSR) fleet. SOI intends to operate two different fleet configurations during the Shell Kulluk Exploratory Drilling Program. In 2007, SOI will utilize the Tor Viking II for secondary ice management activity whereas in 2008 and 2009 SOI intends to use either the Nordica or the Fennica for secondary ice management activity. The Vladimir Ignatjuk will perform primary ice management duty (ice breaking) for 2007 through 2009. The two icebreakers will also tow the Kulluk into and away from the OCS lease blocks each drilling season. The Jim Kilabuk will serve as the re-supply vessel. The Kulluk OSR fleet will consist of one larger vessel and a number of smaller craft. Photographs and diagrams of the Shell Kulluk and associated support vessels are provided in Appendix A.

The exploratory drilling process consists of three phases, drilling vessel placement, drilling operations, and drilling vessel removal, all of which are considered part of the stationary sources to be permitted.

Drilling vessel placement: Prior to the rig placement and anchoring to the seabed in federal OCS waters, the Shell Kulluk is simply a portable, floating marine vessel and as such is not triggering the definition of an OCS source. Pursuant to 40 CFR 55.2, the Shell Kulluk becomes an OCS source once it is placed and anchored to the seabed on OCS waters. The Shell Kulluk will be towed from the vicinity of the McKinley Bay, Northwest Territory prior to the 2007 exploratory drilling activity to the SOI lease-holding OCS drill site and maneuvered and anchored in place. Both ice management vessels (the Vladimir Ignatjuk and either the Tor Viking II or the Nordica / Fennica) will assist with the towing activity. One of the icebreakers will assist in the anchor management activity. The Shell Kulluk anchor pattern consists of 12 anchors, and each anchor will reach approximately 700 meters away from the Shell Kulluk. The entire anchor setting process is estimated to take less than 24 hours. SOI has contacted the U.S. Coast Guard to obtain a Safety Exclusion Zone around the Shell Kulluk pursuant to 33 CFR Part 147 to help ensure that the public remains at a safe distance from the drilling platform and marine support vessels. A copy of the Safety Exclusion Zone Application will be submitted to the EPA under a separate cover. The U.S. Coast Guard routinely authorizes Safety Exclusion Zones up to 500 meters away from an OCS source, and thus SOI anticipates receiving a Safety Exclusion Zone of at least 500 meters from the edge of the Shell Kulluk drilling vessel. Following the rig placement and anchoring to the seabed, the two ice breakers will move away from the Shell Kulluk typically three to twelve miles (five to twenty kilometers) upwind to perform ice management activity.

Drilling vessel drilling operations: When the exploratory drilling operation is completed, the two icebreakers Following the rig placement and anchor setting, the Shell Kulluk will commence exploratory drilling operations (and become an OCS source as defined in 40 CFR 55.2). SOI intends to utilize the Shell Kulluk fleet configuration that includes the Tor Viking II to drill its deeper wells. SOI expects exploratory drilling operations to last about 45 days per site for the deeper wells and about 30 days per site for the shallower wells. Under ideal ice conditions and unanticipated drilling issues the drilling program could possibly continue for up to 75 days and 60 days, respectively, per lease block drill site location for the deeper and the shallower wells. SOI however considers a 59-day drilling program for the deeper wells and a 43-day drilling program for the shallower wells to represent a conservatively long estimate, and maximum emissions are based on the 59-day drilling program with the Tor Viking II and on the 43-day drilling program with the Nordica / Fennica. When the exploratory drilling operation is completed, the two icebreakers will assist in retrieving the Shell Kulluk anchors. This task will be completed in about 24 hours. The two icebreakers will then tow the Shell Kulluk to the next OCS lease-holding drill site location where the process is repeated. SOI will station its OSR fleet adjacent (typically within one to two kilometers) to the Shell Kulluk during periods of potential penetration into hydrocarbon bearing strata. The OSR fleet will be standing by in the case of a spill and will also conduct oil spill response drill exercises. The Shell Kulluk will be fully outfitted prior to the beginning of each drilling season. Personnel and some provisions will be shuttled to the Shell Kulluk from shore by helicopter. Diesel fuel and other provisions will be provided to the Shell Kulluk by the Jim Kilabuk every two to three weeks during the drilling season.

Drilling vessel removal: At the end of each drilling season the two icebreakers will tow the Kulluk to the vicinity of McKinley Bay or to another over-winter safe harbor in the Beaufort Sea.

2.2 Shell Kulluk Fleet Emission Sources and Emission Estimate

The Shell Kulluk Exploratory Drilling Program consists of the Shell Kulluk drilling vessel, two icebreaker vessels, a re-supply vessel, and an oil spill response (OSR) fleet. The sources of emissions for the Shell Kulluk and its associated marine support vessels consist primarily of internal combustion engines and heaters. There will be no flares or other industrial sources, except for one incinerator located on an icebreaker. The combustion sources consist of marine / non-road compression-ignition internal combustion engines, electrical generators, and boilers and heaters. All of these combustion sources will be fired with diesel fuel. The engines will have the purpose of generating electricity, pumping, compressing, providing direct drive mechanical power, and for powering mobile machinery. The Shell Kulluk Exploratory Drilling Program emissions are generated from relatively few large emissions sources: the Shell Kulluk main drilling engines and the support vessels propulsion engines. For example, the Shell Kulluk main drilling engines and deck cranes engines account for 95 percent to more than 98 percent of the vessel emissions. In addition, the support vessels main propulsion engines / electrical generators account for 98 percent to more than 99 percent of the support vessel emissions. SOI estimates the Shell Kulluk drilling vessel will account for approximately 10 percent to 20 percent of the combined fleet emissions; the icebreaker vessels (the Vladimir Ignatjuk, the Tor Viking II and / or the Nordica / Fennica) will account for approximately 70 percent to 80 percent of the combined fleet emissions; and the OSR fleet vessels will account for approximately 3 to 4 percent of the combined fleet emissions. SOI estimates the re-supply vessel, the Jim Kilabuk, will account for less than 1 percent of the combined fleet emissions. The Shell Kulluk Exploratory Drilling Program vessels, combustion sources identification, size rating, emission factor, hourly emissions, and project site yearly emissions are provided in Appendix B.

Below, SOI presents its maximum expected emissions from the stationary source so that the approximate split in emissions among all of the sources and the largest source units are apparent. The proposed compliance equation estimates emissions for these sources based on fuel consumption. As a practical matter of avoiding the tracking of inconsequential source units, the emissions for the smaller sources are proposed to be held constant. Any imprecision in these is assumed to be less than 5 tons per year so that even if the estimate is off by nearly 5 tons per year, the total NO_x emissions will remain below 250-tons-per-year major new source review threshold value.

Shell Kulluk Drilling Vessel: SOI believes the drilling vessel operations and thus emissions per drill site location will be fairly consistent irrespective of the Beaufort Sea ice conditions, and thus SOI can reasonably predict maximum emissions from the Shell Kulluk drilling vessel and can therefore estimate the drilling vessel emissions with a high degree of certainty. For example, SOI estimates the Shell Kulluk drilling vessel NO_x emissions from the Tor Viking II included fleet configuration will be approximately 49 tons or about 20 percent of the Prevention of Significant Deterioration (PSD) 250 ton-per-year major source review threshold.

Shell Kulluk Associated Support Vessels: SOI's prediction of maximum emissions from the associated support vessels, primarily the two icebreaker vessels, is imprecise; however, it is expected to account for 70 percent to 80 percent of the combined fleet emissions. The icebreaker vessels emissions will depend greatly on the ice conditions experienced in the Beaufort Sea with light ice conditions resulting in lesser engine load factor and lower emissions, and heavy ice conditions resulting in a higher engine load factor and higher emissions.

SOI in an attempt to estimate potential icebreaker vessels emissions evaluated the ice conditions in the Beaufort for the past three years and determined a weighted average of "open water," "moderate ice," and "heavy ice" conditions. For this permit application SOI assumed open water, moderate ice, and heavy ice conditions at 62 percent, 23 percent, and 15 percent, respectively. SOI applied a varying engine usage/load factor for each open water/ice condition to determine a weighted engine horsepower-hours factor for all of the associated vessel emission units. SOI obtained engine load factors from the support vessels owner and/or operator for each open water/ice condition. SOI then determined an "equivalent operating days" of operation for each emission unit using the engine load factors for each open water/ice condition. SOI applied the applicable engine emission factor (e.g., vendor specification, EPA AP42, etc.) to each of the emission units "equivalent operating days" to calculate the Shell Kulluk Exploratory Drilling Program estimated emissions (tons per year) per drill site. SOI believes the emissions from the Shell Kulluk drilling vessel will not be as dependent on open water/ice conditions except in the case of very heavy ice that the icebreaker vessels cannot safely and effectively manage and thus forces the drilling vessel off of the drill site. Likewise, SOI believes the emissions from the OSR fleet and the re-supply vessel will be unaffected by open water/ice conditions. The OSR fleet emission estimates conservatively assume that the OSR fleet would be with the drilling vessel for the duration of the drilling activity even though the potential days of a hydrocarbon release is less than the number of drilling days, i.e., drilling the mud line cellar, installing piping/casing, plugging the well.

SOI intends to collect generated on-site trash from the Shell Kulluk for off-site disposal/management and/or for incineration on one of the icebreaker vessels incinerators. SOI will not incinerate trash on the Shell Kulluk. Nor does SOI intend to flare drilling well off-gases during the project.

With a stationary source such as this, which includes large machinery that only operates at capacity for short periods of time, maximum emissions are based on an assemblage of reasonable maximum activity level assumptions, none of which are absolute maxima. These assumptions include length of drilling program, number of engines needed for drilling, time of icebreaker activity at maximum power, fleet configuration, etc. Using these assumptions (listed in Appendix B) the maximum emissions for NO_x, CO, PM_{10}, SO_2, and VOC for the Shell Kulluk combined fleet including the Tor Viking II per drill site per calendar year is estimated and the estimate presented in Table 1. A similar maximum emissions estimate for the Shell Kulluk combined fleet including the Nordica/Fennica is provided in Table 2. The estimated diesel fuel consumption for these emission estimates is presented in Tables 3 and 4. The emissions from all vessels associated with the drilling project have been calculated and included, following the requirements of 40 CFR 55.4(b)(3). The annual emissions of hazardous air pollutants (HAPs) from the Shell Kulluk and its associated support vessels are less than 10 tons for each HAP and less than 25 tons for all HAPs. All emission calculations are provided in Appendix B.

Table 1: Shell Kulluk Fleet 2007 Emissions Estimate with Tor Viking II

Emissions	NO_x (tpy)	CO (tpy)	PM_{10} (tpy)	VOC (tpy)	SO_2 (tpy)
Shell Kulluk	48.7	7.9	2.3	1.9	4.6
Vladimir Ignatjuk	162.9	44.5	3.6	7.2	10.5
Tor Viking II	21.1	19.8	1.7	2.9	6.4
Jim Kilabuk	1.6	0.4	0.04	0.06	0.09
Kulluk OSR Fleet	10.7	9.2	0.5	1.2	1.0
Total	245.0	81.8	8.1	13.3	22.6

Table 2: Shell Kulluk Fleet 2008 – 2009 Emissions Estimate with Nordica/Fennica

Emissions	NO_x (tpy)	CO (tpy)	PM_{10} (tpy)	VOC (tpy)	SO_2 (tpy)
Shell Kulluk	35.8	5.9	1.7	1.4	3.4
Vladimir Ignatjuk	117.0	32.2	2.6	5.2	7.5
Nordica / Fennica	83.0	2.9	1.8	2.9	5.5
Jim Kilabuk	1.2	0.3	0.03	0.06	0.07
Kulluk OSR Fleet	7.9	6.8	0.4	0.9	0.8
Total	245.0	48.0	6.5	10.5	17.3

Table 3: Shell Kulluk Fleet Diesel Fuel Consumption Estimate with Tor Viking II

Material	Quantity gallons	Quantity cubic meters
Shell Kulluk drilling vessel	329,409	1,247
Vladimir Ignatjuk	709,461	2,686
Tor Viking II	429,663	1,626
Jim Kilabuk	6,728	25
Shell Kulluk OSR Fleet	67,864	257
Total Diesel Fuel Consumption	1,543,125	5,841

Table 4: Shell Kulluk Fleet Diesel Fuel Consumption Estimate with Nordica/Fennica

Material	Quantity gallons	Quantity cubic meters
Shell Kulluk drilling vessel	242,265	917
Vladimir Ignatjuk	509,823	1,930
Nordica / Fennica	472,586	1,789
Jim Kilabuk	5,046	19
Shell Kulluk OSR Fleet	50,303	190
Total Diesel Fuel Consumption	1,432,801	5,424

2.3 Shell Kulluk Owner Requested Limit (ORL)

The drilling operation (stationary source) carries with it uncertainties in length of drilling at each site, weather and ice conditions associated in support of drilling at each site. Therefore, it is impossible to estimate precisely the quantity of emissions associated with each stationary source. The drilling emissions may be above expectation, while ice management vessel use might be below expectation. The emissions defined in Tables 1 and 2 are considered to represent a reasonable maximum, and SOI is confident that it will be able to execute each drilling program within these limits. In order to demonstrate synthetic minor source status, SOI proposes a facility-wide emissions cap, tracked by fuel consumption of the largest emitters, using an equation for determination of compliance with a 245-ton-per year NO_x threshold. Diesel fuel consumption of the largest source units would be measured every day, and the equation would be tested every 30 days to demonstrate an annual emission rate within the 245-ton-per-year threshold. Since all other combustion related criteria pollutants will be well below this quantity, and they track with the combustion related NO_x emissions, no other compliance tracking will be necessary.

SOI proposes to group the sources by applicable emission factor (all Shell Kulluk main drilling engines as one group, the Vladimir Ignatjuk main propulsion engines as a second group, etc.) and calculate emissions from each group by multiplying that group's fuel consumption by the applicable source-type emission factor multiplied by the appropriate heat rates and unit conversions. There are several small sources with emissions below 4 tons per year that SOI proposes to not track but to use the drill site NO_x emission estimate as a constant in the compliance equation. SOI will then sum each source group's emissions to determine the project fleet-wide emissions running total. SOI proposes to implement fuel consumption monitoring on each project vessel on a 30-day basis to ensure that the project-wide annual NO_x emissions (for each drill site) remain less than 245 tons per drill site per year.

SOI proposes the following compliance equation for the Shell Kulluk Fleet that includes the Tor Viking II:

$$K_{RICE}*((F_{A1}*EF_{A1})+(F_{A2}*EF_{A2})+(F_{B1}*EF_{B1})+(F_{C1}*EF_{C1})+(F_{C2}*EF_{C2})+(F_{E1}*EF_{E1}))+K_{HEAT}$$
$$*((F_{A3}*EF_{A3})+(F_{B2}*EF_{B2})+(F_{C3}*EF_{C3})) + 0.8 + 0.1 + 0.6 +1.6 + 3.8 < 245 \text{ tpy}$$

Where:

K_{RICE} = 137,000 (Btu / gal) / 7,000 (Btu / hp-hr) / 2000 (lb / ton) = 0.00979 Hp-hr-ton / gal-lb

K_{HEAT} = 137,000 (Btu / gal) / 1,000,000 (Btu / mmBtu) / 2,000 (lb / ton)
= 0.0000685 mmBtu-ton / gal-lb

Fi = fuel consumption per source group (i)

Efi = emission factor per source group (i)

0.8 = Shell Kulluk remaining emissions (tons)

0.1 = Vladimir Incinerator (tons)

0.6 = Tor Viking II remaining emissions (tons)

1.6 = Jim Kilabuk emissions (tons)

3.8 = Shell Kulluk OSR Fleet remaining emissions (tons)

Table 5: Shell Kulluk Project ORL Variables with Tor Viking II

Source Group	Vessel Source Identification	NO_x Emission Factor (EF)
Kulluk main drilling engines	A1	0.0156 lb / hp-hr
Kulluk deck crane engines	A2	0.031 lb / hp-hr
Kulluk boilers / hot water heaters	A3	0.143 lb / mmBtu
VI main propulsion engines / generators	B1	0.024 lb / hp-hr
VI boiler / hot water heater	B2	0.143 lb / mmBtu
TV main propulsion engines / generators (father engines)	C1	0.0057 lb / hp-hr
TV main propulsion engines / generators (son engines)	C2	0.0046 lb / hp-hr
TV boiler	C3	0.143 lb / mmBtu
Kulluk OSR Fleet – OSRV generator	E1	0.0151 lb / hp-hr

SOI proposes the following compliance equation for the Shell Kulluk Fleet that includes the Nordica / Fennica:

$$K_{RICE}*((F_{A1}*EF_{A1})+(F_{A2}*EF_{A2})+(F_{B1}*EF_{B1})+(F_{C1}*EF_{C1})+(F_{E1}*EF_{E1}))+K_{HEAT}*((F_{A3}*EF_{A3}) +(F_{B2}*EF_{B2})+(F_{C2}*EF_{C2})) + 0.6 + 0.1 +1.2 + 2.8 < 245 \text{ tpy}$$

Where:

K_{RICE} = 137,000 (Btu / gal) / 7,000 (Btu / hp-hr) / 2000 (lb / ton) = 0.00979 Hp-hr-ton / gal-lb

K_{HEAT} = 137,000 (Btu / gal) / 1,000,000 (Btu / mmBtu) / 2,000 (lb / ton)
= 0.0000685 mmBtu-ton / gal-lb

Fi = fuel consumption per source group (i)

Efi = emission factor per source group (i)

0.6 = Shell Kulluk remaining emissions (tons)

0.1 = Vladimir Incinerator (tons)

1.2 = Jim Kilabuk emissions (tons)

2.8 = Shell Kulluk OSR Fleet remaining emissions (tons)

Table 6: Shell Kulluk Project ORL Variables with Nordica/Fennica

Source Group	Vessel Source Identification	NO_x Emission Factor (EF)
Kulluk main drilling engines	A1	0.0156 lb / hp-hr
Kulluk deck crane engines	A2	0.031 lb / hp-hr
Kulluk boilers / hot water heaters	A3	0.143 lb / mmBtu
VI main propulsion engines / generators	B1	0.024 lb / hp-hr
VI boiler / hot water heater	B2	0.143 lb / mmBtu
N / F four main propulsion engines	C1	0.0189 lb / hp-hr
F / N two boilers	C2	0.143 lb / mmBtu
Kulluk OSR Fleet – OSRV generator	E1	0.0151 lb / hp-hr

SOI has included vessel diesel fuel monitoring and resulting emission calculation as an ORL in the permit application forms in Appendix C. The applicable NO_x emission factors are included in Tables 5 and 6. An example calculation of the compliance equation from fuel consumption is presented in Appendix B.

SOI proposes to begin fuel consumption monitoring and record-keeping once the Shell Kulluk and the icebreaker vessels are on OCS waters and within 25 miles of the project drilling site. SOI will also begin fuel consumption monitoring and record-keeping for the re-supply vessel and the OSR fleet vessels once these vessels are on OCS waters and within 25 miles of the project drilling site.

SECTION 3

REGULATORY APPLICABILITY

This section provides the applicable regulatory administrative history prior to the submittal of this application, a description on the EPA's guidance in permitting this project, a brief discussion on the Notice of Intent requirements contained in 40 CFR Part 55, the roles of the respective regulatory agencies (EPA and ADEC), and a discussion of the Corresponding Onshore Area (COA) air quality designation, and applicable federal and state regulatory requirements.

3.1 EPA Guidance and 40 CFR Part 55 NOIs

SOI met with the EPA in September 2006 to discuss the air quality permitting requirements and applicable guidance documents pertaining to this project. Following this meeting the EPA confirmed that the Shell Kulluk drilling vessel, when anchored or otherwise attached to the seabed at each drill site, was a separate "stationary source." The EPA's position is consistent with the requirements of 40 CFR 55.2 whereby the Shell Kulluk becomes an OCS source once it is placed and anchored to the seabed on OCS waters. The EPA's guidance further required that the emissions from the project's associated support vessels be included in the "source" potential-to-emit (PTE) when the support vessels are within 25 miles of the anchored drilling vessel. These guidance interpretations are consistent with the OCS source definition found in 40 CFR 55.2.

SOI submitted the required Notice of Intent (NOI) for the Pre-Construction Air Permit for OCS activities (specifically a proposed 2006 Mud Line Cellar project) to the EPA on March 22, 2006. A copy of the NOI was also submitted to ADEC as required by 40 CFR 55.4(a). The EPA pursuant to 40 CFR 55.12(c)(1) and section 328(a)(1) of the Clean Air Act published a proposed Part 55 OCS Consistency Determination for ADEC's current air quality regulations (18 AAC 50 Air Quality Control as amended through December 3, 2005) in the August 22, 2006, Federal Register (V.71, No. 162, p. 48879 – 48883) to ensure that the part 55 requirements were consistent with the corresponding onshore area (COA) state of Alaska requirements. ADEC recently amended its 18 AAC 50 Air Quality Control regulations through December 14, 2006. However, ADEC made no changes to its December 3, 2005, regulations. SOI nevertheless updated its March 2006 NOI and attached it to this application in Appendix D. A second EPA consistency determination is unnecessary since the December 14, 2006, ADEC regulations were not changed from the December 3, 2005, ADEC regulations. SOI therefore believes it has satisfied all of the applicable administrative requirements pursuant to 40 CFR 55.12(f) prior to submitting this permit application.

3.2 EPA and ADEC Agency Permitting Roles

The Shell Kulluk Exploratory Drilling Program will be an exploration project conducting exploratory oil and gas drilling operations (North American Industry Classification System [NAICS] code 211111 Crude Petroleum and Natural Gas Extraction) on SOI's oil and gas lease-holdings located on federal OCS waters on the Beaufort Sea. SOI's OCS lease blocks are located between longitude 141 degrees W to longitude 155 degrees W. SOI's lease holdings are located outside the jurisdiction of the state of Alaska's three-mile seaward boundary but are within 25 miles of Alaska's seaward boundary. Therefore, the project is subject to the requirements of 40 CFR Part 55 with the U.S. EPA as the regulatory approval agency. 40 CFR 55.1 requires the EPA to review and approve the project pursuant to the part 55 requirements including the corresponding onshore area (COA) (Alaska) requirements in 40 CFR 55.14 and 18 AAC 50. ADEC has no direct regulatory authority over the review and approval of this application and thus will serve as an interested member of the public. The EPA may of course confer with ADEC with potential interpretation issues pertaining to the applicable COA regulatory requirements.

3.3 Synthetic Minor Source Permitting

SOI intends to operate (and permit) the Shell Kulluk and its associated support vessels as a synthetic minor source that will not exceed 250 tons of any new source review regulated air contaminant per drilling site per year. The project's primary air contaminant is nitrogen oxides (NO_2) with lesser quantities of carbon monoxide (CO), small-diameter particulate matter (PM_{10}), volatile organic compounds (VOC), and sulfur dioxide (SO_2). SOI will seek federally enforceable requirements to ensure that the project retains a minor source permit status. It is SOI's intent that the ORL described in Section 2.3 above will satisfy the federal enforceability requirement.

3.4 Area Designation

The Outer Continental Shelf (OCS) permitting requirements of 40 CFR Part 55.14 require that a permit application address the Corresponding Onshore Area (COA) requirements, which for the Shell Kulluk Exploratory Drilling Program are the ADEC requirements for the Northern Alaska Intrastate Air Quality Control Region (AQCR) 9. This region is designated attainment or unclassifiable for all criteria pollutants pursuant to 40 CFR 81.302. This area is designated as a Prevention of Significant Deterioration (PSD) Class II Area per 18 AAC 50.015. There are no Class I areas within 300 kilometers of the project location. The nearest Class I area (Denali National Park) is located approximately 700 kilometers to the south of the project location.

3.5 State Requirements Applicable to OCS Sources

Pursuant to 40 CFR 55.14(e), the applicable state of Alaska (the COA) requirements have been promulgated by the EPA as being applicable to the Shell Kulluk project. The following describes the Alaska Administrative Code (AAC) emissions standards and limitations of ADEC that are applicable to the Shell Kulluk Exploratory Drilling Program's air emission sources. The relevant portions of ADEC's permit application forms have been completed and provided in Appendix C. The ambient air quality analysis, pursuant to 18 AAC 50.540(c)(2)(B) is presented in Section 4.

The following ADEC emissions standards and limitations apply to industrial processing and fuel burning equipment on the Shell Kulluk drilling vessel:

- Visible emissions, excluding condensed water vapor, from each stationary IC engine and each boiler, may not reduce visibility through the exhaust effluent by greater than 20 percent averaged over any six consecutive minutes, per 18 AAC 50.055(a)(1).
- Particulate matter emitted from each stationary IC engine and each boiler may not exceed, per cubic foot of exhaust gas corrected to standard conditions and averaged over three hours, 0.05 grains, per 18 AAC 50.055(b)(1).
- Sulfur-compound emissions, expressed as sulfur dioxide, from each stationary IC engine and each boiler, may not exceed 500 ppm averaged over a period of three hours, per 18 AAC 50.055(c).

SOI proposes to limit the Shell Kulluk Exploratory Drilling Program emissions to less than 250 tons per drill site per year by limiting the project’s diesel fuel consumption by the owner requested limit (ORL), per 18 AAC 50.540(j), and described in Section 2.3.

3.6 Federal Requirements Applicable to OCS Sources

The federal requirements pursuant to 40 CFR 55.13 have been promulgated by the EPA as being applicable to the Shell Kulluk project. This section addresses the requirements of New Source Performance Standards (NSPS), Prevention of Significant Deterioration (PSD), and Hazardous Air Pollutants (HAPs) pursuant to 40 CFR 55.13(c), (d) and (e).

New Source Performance Standards (NSPS): With the possible exception of NSPS Subpart CCCC Standards of Performance for Commercial and Industrial Solid Waste Incineration Units for Which Construction Is Commenced After November 30, 1999, or for Which Modification or Reconstruction Is Commenced on or After June 1, 2001; the Shell Kulluk drilling vessel and its associated support vessels are not subject to any 40 CFR Part 60 NSPS. The Shell Kulluk Exploratory Drilling Program vessel incinerators due to their small size (less than 35 tons per day of municipal solid waste) are exempt from federal requirements aside from an initial notification to the EPA administrator and quarterly record-keeping of the waste material burned. 40 CFR 60.2020 (NSPS Subpart CCCC) requirements apply to the project incinerator(s) that commenced construction after November 30, 1999, whereas federal requirements 40 CFR 62.14525 apply to the project incinerator(s) that commenced construction before November 30, 1999.

Prevention of Significant Deterioration (PSD): The applicable potential emissions threshold under the PSD requirements of 40 CFR 52.21 for the construction of a new source is 250 tons per year for each pollutant. SOI proposes to limit the Shell Kulluk Exploratory Drilling Program potential emissions to less than 250 tons per drill site per year (for each pollutant) so that the Shell Kulluk drilling vessel and its associated support vessels are not subject to review under the PSD rules. Emission calculations are provided in Appendix B. The requested limitation on the project’s fuel use is provided on ADEC permit forms in Appendix C and is discussed in Section 2.3 of this application.

National Emission Standards for Hazardous Air Pollutants (NESHAPs) and National Emission Standards for Hazardous Air Pollutants for Source Categories - Maximum Achievable Control Technology (MACT) Requirements: The Shell Kulluk Exploratory Drilling Program and its combustion sources are not subject to a national emissions standard for hazardous air pollutants of 40 CFR Part 61 and are not subject to a national emissions standard for hazardous air pollutants for source categories under 40 CFR Part 63, subparts A, and C through to the end. The calculations provided in Appendix B show that the Shell Kulluk Exploratory Drilling Program combined vessel fleet potential emissions of each hazardous air pollutant is less than 10 tons per year, and the aggregate of all hazardous air pollutant emissions is less than 25 tons per, and thus it is not a major source of HAPs and therefore not subject to the control technology determination requirements of 40 CFR 63 Subpart B.

SECTION 4

AMBIENT IMPACT ANALYSIS (DISPERSION MODELING)

This section describes the ambient standards to be addressed for the exploration drilling activities, the model selected for use in addressing these standards, and the selection of inputs to the model in a manner believed to be consistent with acceptable EPA and ADEC modeling methods.

The Outer Continental Shelf (OCS) permitting requirements of 40 CFR Part 55.14 require that a permit application address the Corresponding Onshore Area (COA) requirements, which for the project are the ADEC requirements for the Northern Alaska Intrastate Air Quality Control Region (AQCR) 9. This AQCR is unclassifiable / in attainment for all pollutants. In addition, there are no Class I areas within 300 kilometers of the project location.

Thus, expected impacts from the exploration drilling activities were evaluated in relation to the National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS). Because this project is a temporary minor source, it would not consume increment under ADEC's rules. Therefore, the impacts are not compared with the Class II PSD increments.

Emissions from the project will not exceed the 250-ton-per-year Prevention of Significant Deterioration (PSD) major source review threshold. However, because the project is considered a portable oil and gas operation by the ADEC, a minor permit is required per ADEC Regulation 18 AAC 50.502(c)(2)(A). As a result, a National Ambient Air Quality Standards (NAAQS) modeling analysis for SO_2, NO_x, and PM_{10} is required per ADEC Regulation 18 AAC 50.540(c)(2)(B). For the impact analysis, emissions from the stationary source (the Kulluk) and the mobile sources (i.e., icebreakers, oil spill response vessels, and a re-supply vessel) were modeled for impact.

4.1 Source Characterization

SOI has defined the worst-case modeling impact scenario as the Shell Kulluk drill rig operating at maximum emissions. During maximum Shell Kulluk operations, impacts from the OSR fleet and the Jim Kilabuk re-supply vessel both operating adjacent to the Shell Kulluk are considered. In addition, primary and secondary icebreaker impacts are also included. The icebreakers are assumed to operate at their maximum capacities in heavy ice (worst-case emissions), and their impacts are calculated at the Shell Kulluk’s point of maximum impact. The emissions from propulsion engines on the Shell Kulluk and the Jim Kilabuk are not considered in the assessment, since these propulsion engines will be used very briefly to maneuver the Shell Kulluk when it is being anchored or to maneuver the Jim Kilabuk when it is near the Shell Kulluk drill rig. The propulsion engines will not be operated concurrently with the drill rig and support vessels when they are operating at maximum emissions levels.

SOI has estimated the duration at a given drill site is expected to be less than 60 days. Even though the Shell Kulluk Exploratory Drilling Program will be permitted as a minor source and does not trigger PSD requirements, the modeling analysis conservatively considers sources operating 24 hours per day and 60 days per year. These assumptions combined with the use of the conservative SCREEN3 model (which incorporates worst-case assumptions) are expected to greatly overestimate real-world impacts from the project.

Shell Kulluk Drill Rig

For modeling, some sources on the Shell Kulluk were merged together because of size and location considerations. Many identical sources / stacks are located near each other and were collocated so that single-source stack parameters were used with combined emissions. The locations of the collocated stacks were conservatively placed at the actual stack location nearest the ambient air boundary.

The following sources on the Shell Kulluk were collocated: two main engines (stack #1), two air compressors (stack #2), two HPP engines (stack #3), and three deck cranes (stack #4). The boiler used for space heating emits to the atmosphere via a single stack (stack #5). Emissions from the small 2.4 mmBTU hot water heater were added to the boiler emissions (stack #5) because the boiler has low dispersion characteristics compared with the other sources. A logging winch also emits to the atmosphere via a single stack (stack #6). These six stacks were considered as point sources in the modeling analysis.

The two main engine stacks (stack #1) and boiler stack (stack #5) emit horizontally. These stacks were modeled in accordance with ADEC's recommendations. ADEC's recommended adjustments provide for the retention of buoyancy while addressing the impediment to the vertical momentum of the release. The following procedure was utilized to model horizontally emitting stacks:

- Set the actual stack velocity (V_{actual}) to an adjusted stack exit velocity ($V_{adjusted}$) of 0.001 meters per second.
- To conserve volumetric flow, determine an adjusted stack diameter ($D_{adjusted}$) by adjusting the actual stack inside diameter (D_{actual}) to account for buoyancy of the plume by using the following equation:

  $$D_{adjusted} = 31.6(D_{actual})(V_{actual})^{0.5}$$

- Use the adjusted parameters, $V_{adjusted}$ and $D_{adjusted}$, in the modeling analysis.

The physical characteristics of the stacks on the Shell Kulluk are provided in Table 7. Photographs and diagrams of the Kulluk are provided in Appendix A.

Table 7: Shell Kulluk Source Stack Parameters

Source Description	Model Source ID	Source Type	Vertical or Horizontal?	Release Ht. [1] (ft)	Release Ht. [1] (m)	Stack Dia. (ft)	Stack Dia. (m)	Exit Temp. (deg F)	Exit Temp. (deg K)	Exit Vel. (m / s)
Stack #1: 2 Main Engines [A]	MAINENGS	Point	horizontal	34.5	10.52	318.6	97.1	750	672	0.001
Stack #2: 2 Air Compressors	COMPENGS	Point	vertical	8.0	2.44	0.69	0.21	800	700	40.0
Stack #3: 2 HPP Engines	HPPENGS	Point	vertical	8.0	2.44	0.60	0.18	800	700	40.0
Stack #4: 3 Crane Engines	DECKCRNS	Point	vertical	50.0	15.24	0.83	0.25	750	672	20.1
Stack #5: 1 Boiler / 1 Water Heater [B]	BOILHEAT	Point	horizontal	28.0	8.53	62.4	19.0	200	366	0.001
Stack #6: 1 Logging Winch	LOGWNCH	Point	vertical	10.3	3.12	0.33	0.10	820	711	53.0

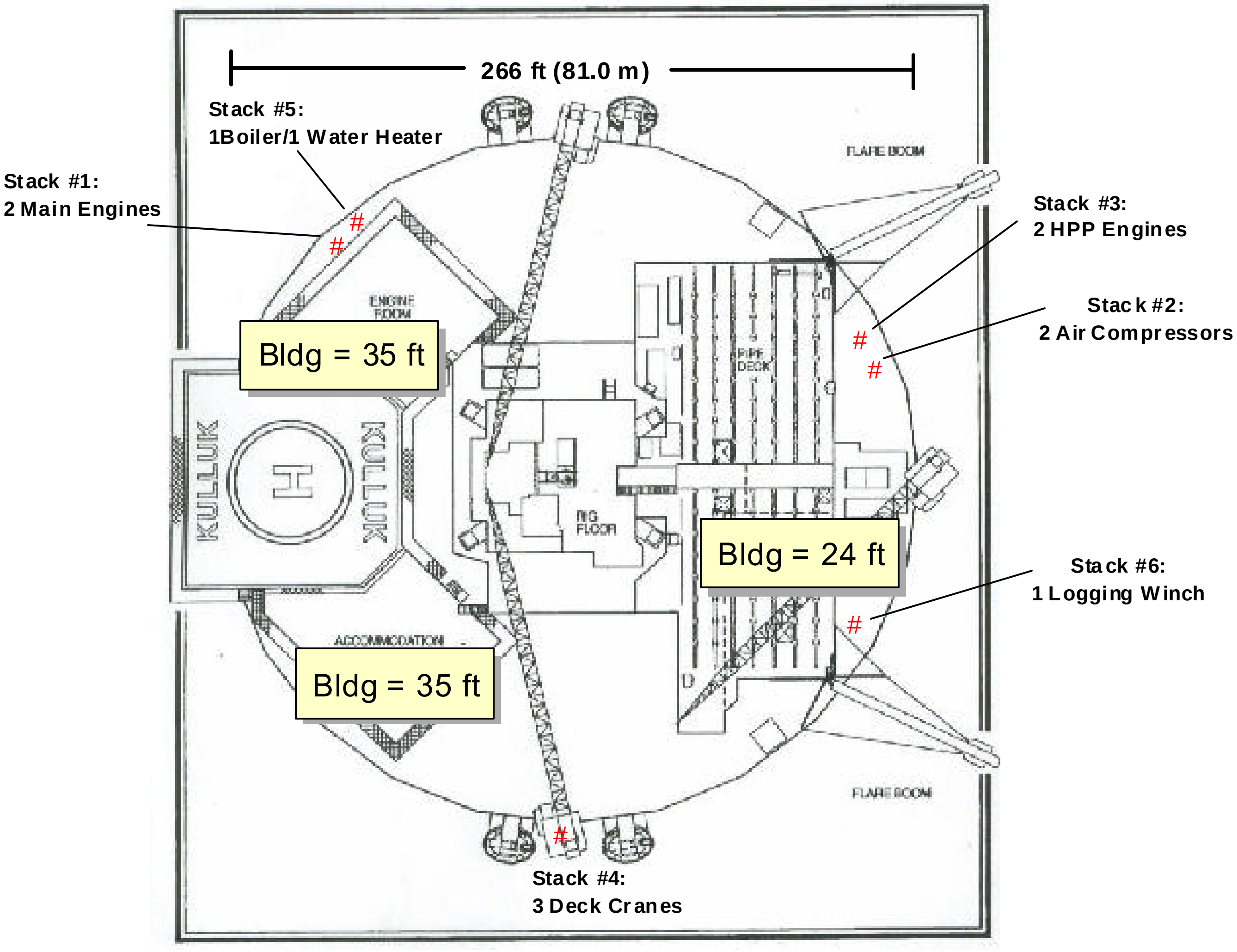
[A] Diameter and exit velocity is adjusted since stacks emit horizontally.
Non-adjusted stack diameter is 1.67 feet (0.51 meters) and non-adjusted exit velocity is 36.6 m / sec.

[B] Diameter and exit velocity are adjusted since stacks emit horizontally.
Non-adjusted stack diameter is 0.5 feet (0.15 meters) and non-adjusted exit velocity is 16.1 m / sec.

[1] Above main deck that is approximately 7.3 meters (24 feet) above the water surface.

The configuration of the sources on the Shell Kulluk deck is shown on Figure 2.

Figure 2: Configuration of Platform Equipment



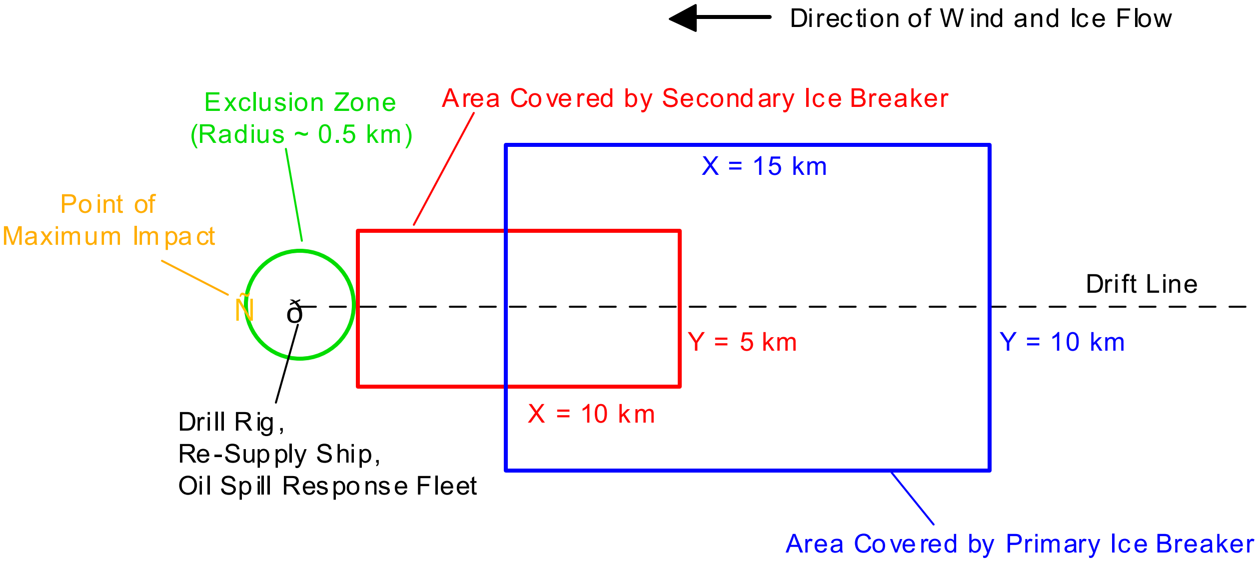
Given the configuration of the stacks and structures on the Shell Kulluk, it is expected that the plumes will be down-washed and pulled into the wake of the Shell Kulluk. In SCREEN3, the dimensions of buildings in proximity to the stacks are needed to simulate building downwash. For this analysis, the "building" length and width are assumed to be the length and width of the Shell Kulluk. For sources located near the engine building, the building height is assumed to be the highest point of the engine room building (35 feet above main deck). For sources located near the pipe deck, the building height is assumed to be the highest point of the pipe deck structure (24 feet above main deck).

Shell Kulluk Support Vessels

The OSR vessels assigned to the rig will stay very close to the rig at all times. Periodically, the workboats will do response exercises, but it is not expected that any of the OSR vessels will travel more than 2 miles away from the rig. To be conservative, the OSR vessels are considered adjacent to the drill rig in the modeling assessment. In addition, the Jim Kilabuk re-supply vessel is also assumed to be considered adjacent to the drill rig. For the Jim Kilabuk, emissions from the two main engines and a generator are considered for modeling. The emissions from the Bow Thruster Diesel engine (propulsion engine) are not considered in the assessment, since the propulsions engines will be used very briefly to maneuver the Kilabuk near the drill rig. For the project, maximum emissions of any pollutant for the propulsion engines on the Jim Kilabuk will be approximately 1.5 tons of NO_x per year and less than 0.1 tons per year of either PM_{10} or SO_2.

Figure 3 displays the configuration of the worst-case modeling scenario for the drill rig and associated support vessels.

Figure 3: Modeling Configuration for Drill Rig and Support Vessels



For the worst-case modeling scenario, the primary and secondary icebreakers are assumed to be operating in heavy ice, which results in maximum emissions from these vessels. The distance the icebreakers operate from the drill rig is variable based on the character of the ice, the drift rate of the ice, and the weather forecast/conditions. In general, the icebreakers will break ice directly upstream from the drill rig. The line directly upstream from the drill rig is called the drift line.

The primary icebreaker (Vladimir Ignatjuk) will range from approximately 5 km to 20 km upstream from the drill rig. The primary icebreaker will move back and forth perpendicular to the drift line approximately 5 km either side of the drift line to the rig. The secondary icebreaker will range from the buoy pattern of the drill rig up to 10 km upstream of the rig. The secondary ice breaker will move back and forth perpendicular to the drift line approximately 2.5 km either side of the drift line to the rig. Secondary ice management for the Kulluk will be performed by the Tor Viking II in 2007 and possibly for 2008 and 2009. SOI may replace the Tor Viking II with either the Nordica or Fennica for 2008 and 2009 secondary ice management activity. The Nordica / Fennica was conservatively considered in the modeling analysis since these vessels have higher emissions than the Tor Viking II.

The icebreakers are constantly moving to break ice upstream of the drill rig. To account for the movement of the icebreakers, the sources were modeled as elevated area sources rather than point sources. Each icebreaker was initially modeled as a point source to account for mechanical and buoyant lift from the ship's stacks. The final plume rise for the icebreakers was determined, and the emissions from each icebreaker were then modeled as an elevated area source (based on the final plume heights) covering the ice management areas for each icebreaker.

For the support vessels, stack heights were estimated from photographs and ship diagrams. Other stack parameters were determined using ship-specific information, engineering judgment, and data for comparable sources. Emissions from each ship are assumed to be released to the atmosphere via a single stack.

The physical characteristics of the stacks on the support vessels are provided in Table 8. Photographs and diagrams of the support vessels are provided in Appendix A.

Table 8: Support Vessel Source Stack Parameters

Source Description	Model Source ID	Source Type	Ship Type	Release Ht. [1] (ft)	(m)	Stack Dia. (ft)	(m)	Exit Temp. (deg F)	(deg K)	Exit Vel. (m / s)
Vladimir Ignatjuk [3, 4]	VLADIMIR / VLAD_BIG	Point / Area	Primary Icebreaker	80.0	24.38	1.31	0.40	662	623	18.7
Nordica / Fennica [3, 5, 6]	FENNICA / FEN_SM	Point / Area	Secondary Icebreaker	105.0	32.00	0.87	0.27	572	573	36.0
Oil Response Ships - Kulluk [2]	KILABUK	Point	Oil Spill Response Fleet	50.0	15.24	0.60	0.18	800	700	40.0
Jim Kilabuk - Kulluk	KILABUK	Point	Re-supply Ship	50.0	15.24	0.60	0.18	800	700	40.0

[1] Absolute height above water.

[2] Assume same stack parameters as the Jim Kilabuk re-supply ship.

[3] These sources are constantly moving to break ice upstream of the drill rig. To account for movement of the vessels, the plume rise for each icebreaker was determined by modeling each ship as a point source. Then, the emissions for each icebreaker were modeled as an elevated area source (based on plume rise) covering the ice management area for each ship.

[4] Vladimir Ignatjuk ice management activity covers 150,000,000 sq. meters; final plume rise used for area source release height is 57.2 meters.

[5] Fennica / Nordica ice management activity covers 50,000,000 sq. meters; final plume rise used for area source release height is 60.9 meters.

[6] Secondary ice management for the Kulluk will be performed by the Tor Viking II in 2007. In 2008 and 2009, the Fennica / Nordica will be used for secondary ice management activity. The Fennica / Nordica was conservatively considered in the modeling analysis since this ship has higher emissions than the Tor Viking II.

4.2 Modeled Emissions

The modeling analysis conservatively considers all emission sources operating 24 hours per day and 60 days per year even though actual durations at a given drill site will be significantly less.

Tables 9, 10, and 11 present the modeled emissions for NO_x, PM_{10}, and SO_2, respectively.

Table 9: Modeled NO_x Emissions

				Emissions			
	#	Operations		Max. 1-Hour		Max. 24-Hour	Max. Annual
Source ID	Stacks	hr/day	hr/yr	(lb/hr)	(g/sec)	(g/sec)	(g/sec) [1]
Drill Rig: Shell Kulluk							
Stack #1: 2 Main Engines	1	24	1,440	87.86	1.11E+01	1.11E+01	1.82E+00
Stack #2: 2 Air Compressors	1	24	1,440	6.58	8.29E-01	8.29E-01	1.36E-01
Stack #3: 2 HPP Engines	1	24	1,440	15.50	1.95E+00	1.95E+00	3.21E-01
Stack #4: 3 Crane Engines	1	24	1,440	31.62	3.98E+00	3.98E+00	6.55E-01
Stack #5: 1 Boiler/1 Water Heater	1	24	1,440	0.42	5.30E-02	5.30E-02	8.71E-03
Stack #6: 1 Logging Winch	1	24	1,440	4.34	5.47E-01	5.47E-01	8.99E-02
Support Vessels: Shell Kulluk Fleet							
Vladimir Ignatjuk	1	24	1,440	591.66	7.45E+01	7.45E+01	1.23E+01
Fennica/Nordica	1	24	1,440	523.07	6.59E+01	6.59E+01	1.08E+01
Oil Response Ships - Kulluk	1	24	1,440	202.23	2.55E+01	2.55E+01	4.19E+00
Jim Kilabuk - Kulluk	1	24	1,440	181.85	2.29E+01	2.29E+01	3.77E+00

[1] Emission rate (in g/s) for annual periods is adjusted to account for a maximum of 60 days each drill site.

Table 10: Modeled PM_{10} Emissions

				Emissions			
	#	Operations		Max. 1-Hour		Max. 24-Hour	Max. Annual
Source ID	Stacks	hr / day	hr / yr	(lb / hr)	(g / sec)	(g / sec)	(g / sec) [1]
Drill Rig: Shell Kulluk							
Stack #1: 2 Main Engines	1	24	1,440	3.97	5.00E-01	5.00E-01	8.22E-02
Stack #2: 2 Air Compressors	1	24	1,440	0.33	4.15E-02	4.15E-02	6.81E-03
Stack #3: 2 HPP Engines	1	24	1,440	1.10	1.39E-01	1.39E-01	2.28E-02
Stack #4: 3 Crane Engines	1	24	1,440	2.24	2.83E-01	2.83E-01	4.65E-02
Stack #5: 1 Boiler / 1 Water Heater	1	24	1,440	0.07	8.74E-03	8.74E-03	1.44E-03
Stack #6: 1 Logging Winch	1	24	1,440	0.31	3.88E-02	3.88E-02	6.38E-03
Support Vessels: Shell Kulluk Fleet							
Vladimir Ignatjuk	1	24	1,440	11.10	1.40E+00	1.40E+00	2.30E-01
Fennica / Nordica	1	24	1,440	11.27	1.42E+00	1.42E+00	2.34E-01
Oil Response Ships - Kulluk	1	24	1,440	5.21	6.57E-01	6.57E-01	1.08E-01
Jim Kilabuk - Kulluk	1	24	1,440	3.53	4.45E-01	4.45E-01	7.31E-02

[1] Emission rate (in g / s) for annual periods is adjusted to account for a maximum of 60 days each drill site.

Table 11: Modeled SO_2 Emissions

				Emissions			
	#	Operations		Max. 1-Hour		Max. 24-Hour	Max. Annual
Source ID	Stacks	hr / day	hr / yr	(lb / hr)	(g / sec)	(g / sec)	(g / sec) [1]
Drill Rig: Shell Kulluk							
Stack #1: 2 Main Engines	1	24	1,440	8.66	1.09E+00	1.09E+00	1.79E-01
Stack #2: 2 Air Compressors	1	24	1,440	1.54	1.94E-01	1.94E-01	3.18E-02
Stack #3: 2 HPP Engines	1	24	1,440	0.77	9.68E-02	9.68E-02	1.59E-02
Stack #4: 3 Crane Engines	1	24	1,440	1.57	1.98E-01	1.98E-01	3.25E-02
Stack #5: 1 Boiler / 1 Water Heater	1	24	1,440	0.08	1.01E-02	1.01E-02	1.67E-03
Stack #6: 1 Logging Winch	1	24	1,440	0.22	2.71E-02	2.71E-02	4.46E-03
Support Vessels: Shell Kulluk Fleet							
Vladimir Ignatjuk	1	24	1,440	38.02	4.79E+00	4.79E+00	7.88E-01
Fennica / Nordica	1	24	1,440	34.74	4.38E+00	4.38E+00	7.20E-01
Oil Response Ships - Kulluk	1	24	1,440	18.74	2.36E+00	2.36E+00	3.88E-01
Jim Kilabuk - Kulluk	1	24	1,440	11.52	1.45E+00	1.45E+00	2.39E-01

[1] Emission rate (in g / s) for annual periods is adjusted to account for a maximum of 60 days each drill site.

4.3 Model Selection

After research into the availability of meteorological data for use in modeling, it was determined that representative meteorological data meeting U.S. EPA’s requirements is not available for the project location. This issue was discussed with both ADEC and the EPA. On March 30, 2006, the EPA approved the use of the SCREEN3 model for the project. SCREEN3 is a U.S. EPA-approved model, which incorporates worst-case assumptions. As a result, modeled impacts using SCREEN3 are expected to overestimate real-world impacts from the project.

For this analysis, the most recent version of the SCREEN3 model (version 96043) was used. SCREEN3 is a steady-state, single-source, Gaussian dispersion model developed to provide an easy–to-use method of obtaining pollutant concentration estimates. SCREEN3 is a U.S EPA-approved screening model for estimating impacts at receptors located in simple terrain and complex terrain due to emissions from simple sources. The model is capable of calculating downwind ground-level concentrations due to point, area, and volume sources. In addition, SCREEN3 incorporates algorithms for the simulation of aerodynamic downwash induced by buildings. The model utilizes a range of worst-case meteorological data rather than using site-specific meteorological conditions.

4.4 Meteorological Data

For this analysis, SCREEN3's full array of screening meteorological data was used. Screening meteorological data are the meteorological categories listed in U.S. EPA's "SCREEN3 Model User's Guide" (EPA-454/B-95-004) and as shown in Table 12. A total of 36 wind directions, at 10-degree intervals, are used. Thus, the screening meteorological file contains all combinations of meteorological conditions and wind directions. This meteorological data considers theoretical worst-case conditions regardless if these conditions will actually occur at the project locations.

Table 12: Wind Speed and Stability Class Combinations Used by the SCREEN3 Model

	Wind Speed (m/sec)												
Stability	1	1.5	2	2.5	3	3.5	4	4.5	5	8	10	15	20
A	*	*	*	*	*								
B	*	*	*	*	*	*	*	*	*				
C	*	*	*	*	*	*	*	*	*	*	*		
D	*	*	*	*	*	*	*	*	*	*	*	*	*
E	*	*	*	*	*	*	*	*	*				
F	*	*	*	*	*	*	*						

Based on a review of the meteorological data in the vicinity of the project location, an ambient temperature of 273 K was utilized. This temperature is more representative of the project location and duration than SCREEN3's default ambient temperature of 293 K.

4.5 Background Concentrations

When comparing a project's impact to the ambient air quality standards, an ambient background concentration is needed. For the project, ADEC recommended ambient background concentrations from BP's Arctic North Slope Eastern Region (ANSER) monitoring program, which took place east of BP's Badami facility in 1999. The data is considered representative of the SOI project locations and has been reviewed and approved by ADEC. ADEC considers this data the best available regional data set for a North Slope project located 10 to 20 km or further offshore. Table 13 presents the background concentrations for use in the modeling analysis.

Table 13: Background Concentrations

Pollutant	Averaging Period	Background Concentration (μg / m³)
NO_2	Annual	3.0
PM_{10}	24-hour	7.9
	Annual	1.8
SO_2	3-hour	9.8
	24-hour	7.2
	Annual	2.6

ADEC was also consulted regarding existing industrial sources in the vicinity of the project. Because of the remote offshore location of the project, impacts from other sources are anticipated to be insignificant and are not included in the modeling assessment.

4.6 Evaluation Methodology

The SCREEN3 model can only be used to predict maximum 1-hour concentrations from a single source. When screening models are utilized for multiple sources, it is necessary to model each source separately and then add maximum impacts from each model run to determine an overall impact value. Results utilizing this methodology are expected to be conservative since the maximum impacts from each modeled source (regardless of different impact locations at different times) are summed together for a total impact value from a facility.

Conversion factors, also referred to as persistence factors, are needed to convert maximum 1-hour values to other averaging periods of concern. Table 14 presents the U.S. EPA's recommended conversion factors for SCREEN3.

Table 14: Conversion Factors for Screen3 Modeling

	Desired Averaging Period						
Model Output	1-hr	3-hr	8-hr	24-hr	Month	Quarter	Annual
Simple Terrain	1	0.9	0.7	0.4	0.18	0.13	0.08

The maximum short-term emissions (i.e. maximum hourly and maximum daily emissions) from the project were compared to the short-term ambient air quality standards. Annual impacts consider the totality of emissions over 60-day project duration. Because emissions used in the analysis are based on a 60-day operating period, the annual emissions from the project are distributed over 60 days (rather than 365) and a factor of 0.1644 (60 days / 365 days) is applied to annualize the subsequent impacts.

SCREEN3 modeling was performed using a methodology referred to as X / Q, which assumes that concentration impacts (X) are proportional to the emissions (Q) from a source. Under this approach, each collocated source was modeled with a 1 gram / second emission rate. The resulting X / Q impacts were converted to appropriate averaging times using the factors in Table 10 and then multiplied by the actual emission rate of each pollutant to determine a modeled impact.

Flat terrain and rural dispersion coefficients and were used in the modeling analysis. For the SCREEN3 modeling analysis, it was assumed that the ambient air boundary for the Kulluk is a 500-meter safety exclusion zone measured from the side of the Kulluk. SOI expects to obtain a 500-meter radius Safety Exclusion Zone (SEZ) from the United States Coast Guard by March or April 2007. A copy of the SEZ Application will be submitted to EPA under a separate cover. SOI will implement institutional controls to maintain the SEZ. Such controls will include buoys marking the SEZ and anchor chains, and using shipboard and on-shore communication systems and support vessels to patrol the SEZ to keep unauthorized persons at a safe distance away from the Kulluk drilling vessel.

The calculations and modeled impacts associated with this modeling analysis are provided in Appendix E.

4.7 Modeling Results

Table 15 summarizes the results of the SCREEN3 modeling analysis. Based on the modeling analysis results in Table 15, the predicted impacts from the SOI project comply with the National Ambient Air Quality Standards.

Table 15: Modeling Analysis Results

	Averaging	Concentration ($\mu g / m^3$)				NAAQS	
Pollutant	Period	Max. Kulluk	Max. Vessels	Background	Total	($\mu g / m^3$)	Comply?
NO_2 [A]	Annual	25.3	28.1	3.0	56.5	100	Yes
PM_{10}	24-hour	63.0	25.9	7.9	96.8	150	Yes
	Annual	2.1	0.9	1.8	4.7	50	Yes
SO_2	3-hour	192.2	201.1	9.8	403.1	1,300	Yes
	24-hour	85.4	89.4	7.2	182.0	365	Yes
	Annual	2.8	2.9	2.6	8.3	80	Yes

[A] Assume that all $NO_2 = NOx * 0.75$.

APPENDIX A

Drawings and Photographs

Shell Kulluk

Vladimir Ignatjuk (formerly named Arctic Kalvik)

Tor Viking II

Fennica/Nordica

Jim Kilabuk

Supporting Information – Shell Kulluk

BeauDril

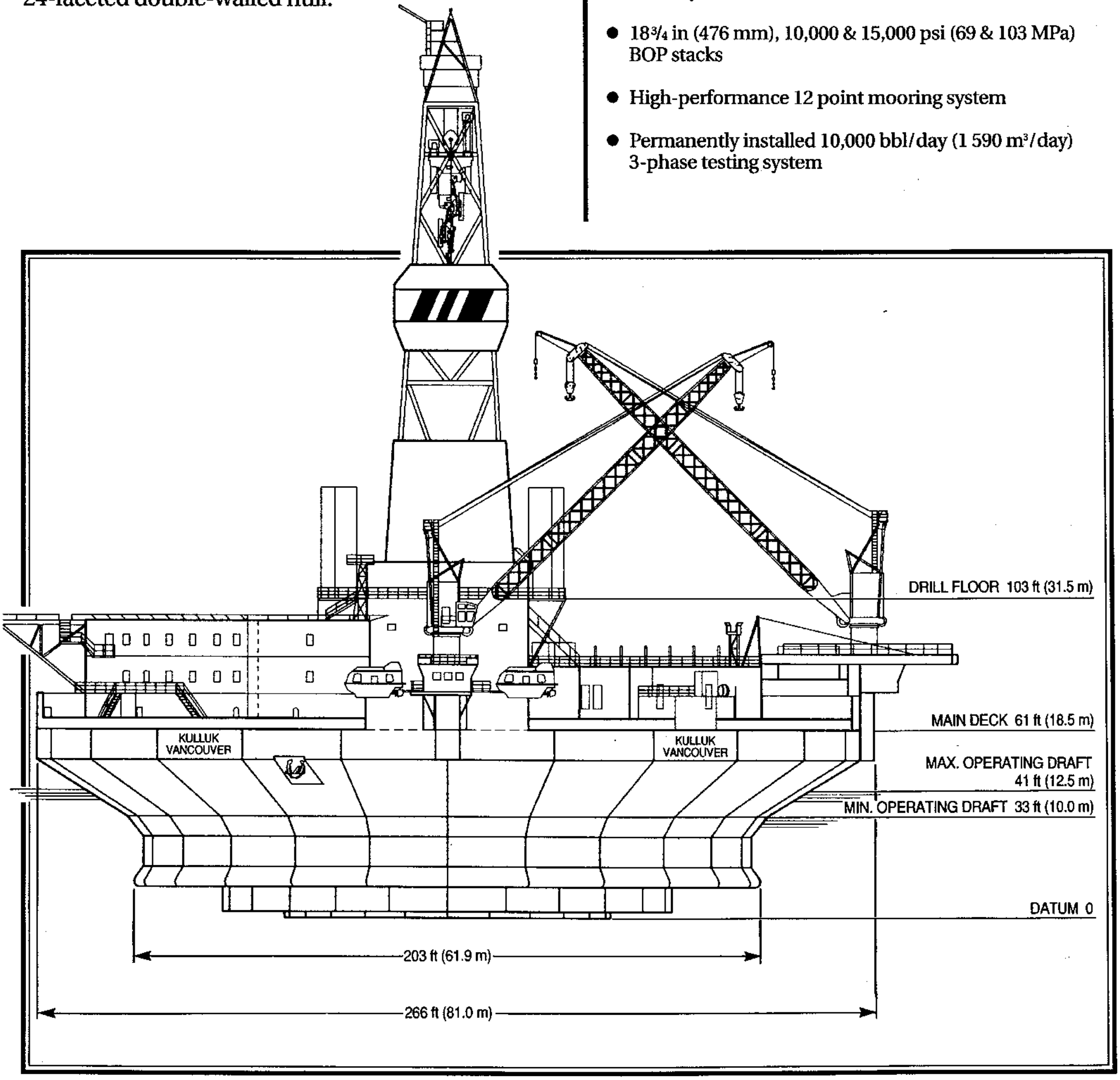
Kulluk

Kulluk is the first floating drilling vessel designed and constructed for extended season drilling operations in deep Arctic waters.

An improvement on the floating drillship concept, Kulluk is a conically shaped, ice strengthened floating drilling unit with a 24-faceted double-walled hull.

Key Features

- Unique, purpose-built conical Arctic Class IV hull design
- Operating water depth 60 to 600 ft (18.3 to 183 m), drilling depth up to 20,000 ft (6 096 m)
- Electrically driven Varco top drive drilling system
- 24 ft (7.3 m) diameter glory hole bit capable of drilling and setting a steel caisson 40 ft (12.2 m) into the seabed for ice scour protection
- Partially enclosed derrick
- $18^{3}/_{4}$ in (476 mm), 10,000 & 15,000 psi (69 & 103 MPa) BOP stacks
- High-performance 12 point mooring system
- Permanently installed 10,000 bbl/day (1 590 m^3/day) 3-phase testing system



Weight 17,000 tons

Classification

The unit has been designated as Arctic Class IV (by the Canadian Coast Guard) under Canadian Arctic Shipping Pollution Prevention Regulations, and as Ice Class 1AA by the American Bureau of Shipping.

Specifications

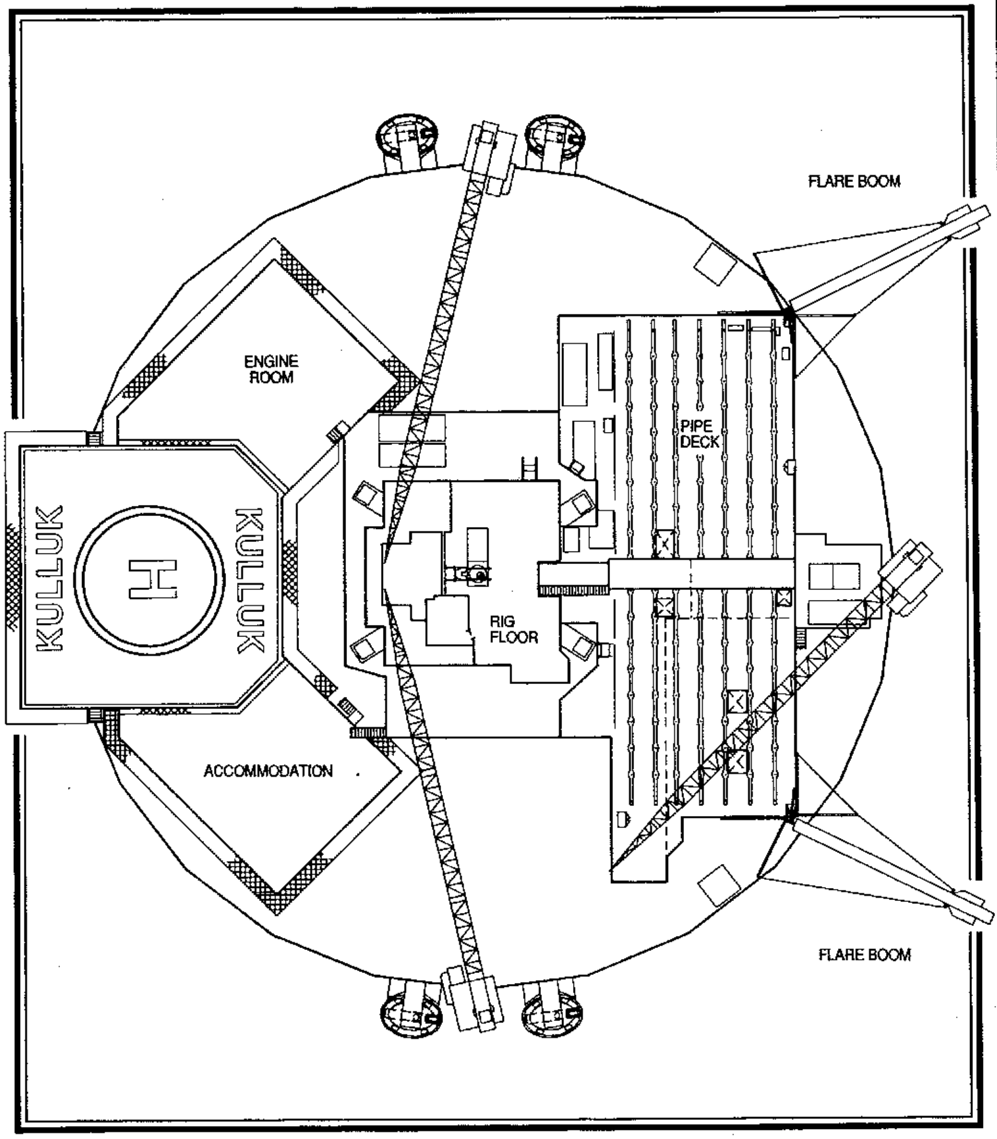
Owner:	BeauDril Limited
Flag:	Canadian
Rig Type:	Conical Drilling Unit (CDU)
Delivered:	1983
Rig Design:	Earl & Wright - Lavalin
Built By:	Mitsui Engineering and Shipbuilding, Japan

Dimensions

Diameter at main deck:	266 ft (81.0 m)
Diameter at pump deck:	196 ft (59.7 m)
Hull Depth:	61 ft (18.5 m)

Operations

Draft (max. operating):	41 ft (12.5 m)
Draft (min. operating):	33 ft (10.0 m)
Draft (light ship):	26 ft (8.0 m)
Light Ship Displacement:	19,300 tons (17 510 tonnes)
Maximum Drilling Depth:	20,000 ft (6 096 m)
Operating Water Depth:	60 to 600 ft (18.3 to 183 m)



Variable Load

7,717 tons (7 000 tonnes)

Storage Capacities

Barite & cement bulk:	21,471 cf (608 m³)
Liquid mud:	2,605 bbl (414 m³)
Drill water:	4,227 bbl (672 m³)
Fuel:	10,085 bbl (1 603 m³)
Potable water:	1,961 bbl (312 m³)
Ballast:	35,928 bbl (5 712 m³)
Pipe & casing (pipe deck):	1,543 tons (1 400 tonnes)
Brine:	2,010 bbl (320 m³)

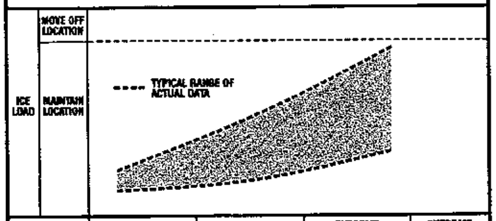
Operational Limits

Stationkeeping Conditions

Kulluk was built to operate in the ice infested waters of the Arctic offshore. The unit was developed to extend the drilling season available to more conventional floating vessels by enabling operations to be carried out through spring breakup conditions, the summer months, and well into the early winter period.

Kulluk was designed to maintain location in a drilling mode in moving first-year ice of 4 ft (1.2 m) thickness. With ice management support provided by BeauDril's Arctic Class IV icebreakers, the unit can maintain location in more severe conditions as shown below.

EXPECTED ICE LOADS ON KULLUK
WITH ICE MANAGEMENT SUPPORT



CONDITION	BREAK-UP/ SUMMER ICE	FREEZE-UP	EXTREME SUMMER ICE	EXTREME EVENTS
% ICE COVERAGE	10 - 90%	90 - 100%	70 - 90%	UNMANAGEABLE OR PRESSURED
FIRST-YEAR ICE	MEDIUM TO THICK	THIN TO THICK	MEDIUM TO THICK	
MULTI-YEAR ICE	SMALL FLOES	SMALL FLOES	LARGE FLOES	

In terms of Kulluk's open water performance, the drilling unit was designed to maintain location in storm conditions associated with maximum wave heights of 18 ft (5.5 m) while drilling and 40 ft (12.2 m) while disconnected (assumed storm duration of 24 hrs).

If ice or open water storm conditions become more severe than those indicated, the unit's mooring system, which incorporates acoustic release devices, is disconnected from the anchors and the unit moves off location.

SHELL OFFSHORE INC.

SHELL
KULLUK

ARCTIC FLOATING DRILLING PLATFORM

13 January 2006

SHELL
KULLUK

Builder	*Mitsui Engineering & Shipbuilding Co. Ltd* *Tamano Works, Japan* *Hull No. F* 564
Owner	*Shell Offshore Inc.*
Managing Company	*Frontier Drilling*
Designers	*Earl and Wright-Lavalin*

PRINCIPAL DIMENSIONS

Radius @ main deck	133 ft.	(40.50 m)
Radius @ pump deck	98 ft.	(29.85 m)
Hull depth	60.69 ft.	(18.50 m)
Water depth	60-600 ft.	(25-183 m)
Lightship weight	18,386 Tons	(18,681 tonnes)
Maximum allowable variable deck load	6889.4 Tons	(7,000 tonnes)
Gross Tonnage	28,686.5 Tons	(29,147 tonnes)
Regular Tonnage	24,249.7 Tons	(24,639 tonnes)

STORAGE CAPACITY

KC1 brine	2,012 bbls	(319 m3)
Bulk cement and barite (13 silos)	21,478 ft3	(608 m3)
Liquid mud	2,589 bbls	(411 m3)
Fuel	9,995 bbls	(1,603 m3)
Casing and drill pipe	1,543 Tons	(1,400 tonnes)
Potable water	1,961 bbls	(311 m3)
Drill water	4,227 bbls	(672 m3)

POWER PLANT

Engines	Three electric motive diesel Rated at 2100 kW each
Emergency power	One Cullen Detroit, 650 W

ANCHOR SYSTEM

Mooring system	1220,000 kt 19.7 Tons (20 tonnes) anchors. Twelve point system with acoustic quick release devices on all twelve lines. Twelve Hepburn electric single-drum winches, each driven by a GE Model 752-AR motor. Band brake holding of 408.4 Tons (415 tonnes).

The mooring lines 3 1/2 inches (89 mm) x 3,763 ft. (1147 mm) pass through.

Hepburn swivel-type wire fair leads (underside of hull) over fixed tension monitoring fairleads (topside of hull). Variety of Bruce/Stevpris and LWT anchors from 9 Tons to 20 Tons.

MAJOR DRILLING EQUIPMENT

Derrick	160 ft. high, 40 ft. x 40 ft. (48.7 m high, 12.19 x 12.19 m) base 625 Tons (635 tonnes) capacity.
Drawworks	Ideco E3000 with three GE motors rated at 940 kWeach
Top Drive	Varco TDS-3
Rotary Table	Ideco LR 49549.5" (1257 mm)
Motion Compensator	NL Rucker model 18/400, 178.5 Tons (181.4 tonnes) 18ft. (5.5 m) travel
Mud Pumps	Two Ideco T 1600 triplex Four
Solids Control	Thule VSM-120 shakers: One Brandt SR3 desander and one SE 24 desilter: Wagna Sigma 100 centrifuge: Thule VSM-200 mud cleaner: AlfaLaval AX30 mud cooler. ~ Dowell Dr-600 R717J
Cement Pumps	22,639 ft. (6900 m) 5" Grades E,
Drill String	G and S drill pipes.

BOP Equipment	One NL Shaffer 10M, 18 3/4" (476.24 mm) BOP stack with two annular and four ram type preventers. 10,000 psi (69 mPa). One NL Shaffer 15M, 18 3/4" (476.25 mm) BOP: stack with two annual preventers 15,000 psi (103 Mpa) and four ram type preventers 14,854 psi (102 Mpa)
Risers	600 ft. (184 m) 21" (533 mm) riser complete with slip joint and ball joint. One complete 30" (762 mm) riser system complete with pin-connector and ball joints.
Diverters	One Regan KFDS 24" (610 mm) One Regan KFDS 27.9" (711 mm)
BOP Controls	NL Shaffer with 100 gal fluid reservoir (378.5 L)

Riser Tensioner	Western Gear 4 @ 80,000 lbs (35.700 daN) capacity each
Guide Line System	Western Gear 4 @ 16,000 lbs (1717 daN)

AUXILIARY EQUIPMENT

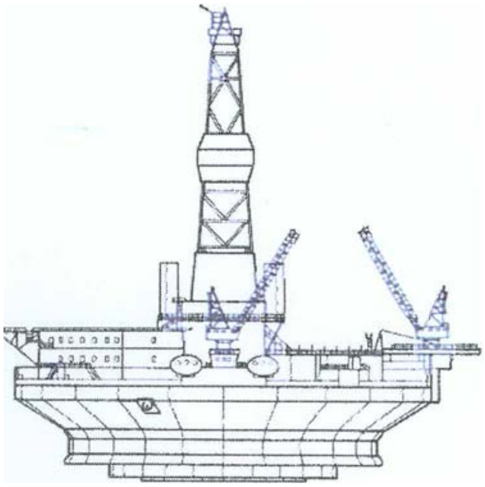
Cranes	Three Liebherr 805/8500 64 Tons (65 tonnes) @ 32 ft. (9.7 m) radius
Forklift	Toyota electric
Reposition	Honeywell RS 904

SPECIAL FEATURES Ice

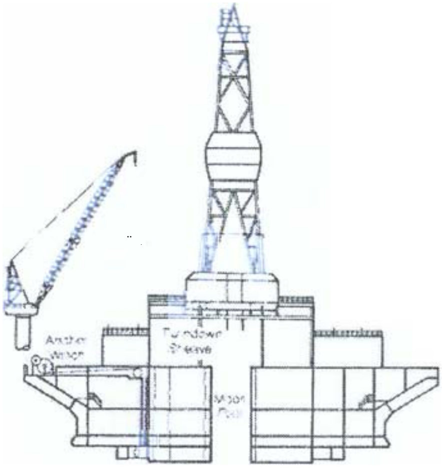
Standards	Built to Canadian Arctic Shipping Pollution Prevention Act Class IV
30" (27" ID)	Built to negate the need to underream in the 26" hole section
Helideck	Suitable for Sikorski S-6l or similar plus fuelling station
Accommodations	Quarters for 108 persons 4-bed hospital, recreation areas.

SHELL KULLUK

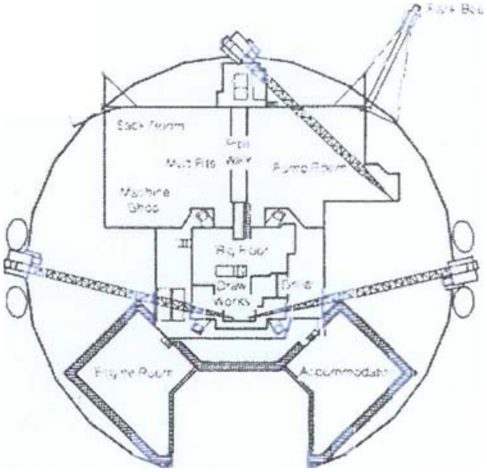
GENERAL ARRANGEMENT OF VESSEL



PROFILE



SECTION VIEW



PLAN VJEW

Supporting Information - Vladimir Ignatjuk

AHTS M/V " Vladimir Ignatjuk " (ex. Artic Kalvik)

Design	Canadian
Classification	Lloyd's Register of Shipping + 100 A1 Icebreaker Tug + LMC Lloyd's Register of Shipping 100 A1 LMC, icebreaking tow, ice class - 1A Super
Built / Delivered	

DIMENSIONS

Length Over All (LOA)	88.02	m	ft
Length between p.p		m	ft
Breath Moulded	17.51	m	ft
Depth to main deck		m	ft
Draught design	8,3	m	ft
Freeboard design		m	ft

TONNAGE

Dead weight (DWT)	2113 Metric tonnes
Light Ship	Metric tonnes
Gross tonnage (GRT)	Metric tonnes
Net tonnage (NET)	Metric tonnes

CAPACITIES

Dry bulk	M^3	ft^3	In four tanks
Potable water	m^3		
Drill Water - Ballast	M^3		
Oil / water based mud	m^3		Specific Gravity 2.5
Base Oil	m^3		
Fuel Oil	m^3		Marine gas oil
Urea	m^3		

Clear Deck Area	m^2
Deck load	tonnes
	m^3

DISCHARGE RATES

Dry Bulk
Pot Water
Drill water / Ballast
Brine
Oil Based Mud
Base Oil
Fuel Oil (Diesel)
Discharge Stations
Discharge Lines

Tank Cleaning
Flow Meters

PROPULSION

Main Engines	4 x 5800 BHP. Two-shaft diesel-reduction gear engine with 4 main engines and variable-pitch propeller.GD type - 8TM410, Stork Werkspoor Diesel
Thrusters	
Propellers	
Rudders	

BOLLARD PULL

Bollard pull	202 tonnes BP continous (DnV certified) approx. 210 t max pull

SPEED / CONSUMPTION

16 knots	Approx 42.5 tonnes /day @ 6 m. draught
12 knots	Approx 15.6 tonnes /day @ 6 m. draught
10 knots	Approx 10 tonnes /day @ 6 m. draught

TOWING ANCHORHANDLING EQUIPMENT

AHT Winch	Brattvaag towing/anchorhandling winch 400 ts pull / 550 ts brake holding cap
AHT Drum	One of 1,400 mm dia. x 3,750 dia x (1,250 mm + 1,250 mm) length
Wire Capacity	2 x 1,900 m of 77 mm wire or 2 x 1,650 m of 83 mm wire
AH Drum	One of 1,400 mm dia. x 3,750 mm dia. x 3,000 mm length
Wire Capacity	4,100 m of 83 mm wire
Winch Control	TOWCON 2000 Aut. Control with printer
Pennant Reels/Caps	One off 2 x 1,500 m of 77 mm wire or 2 x 1,300 m of 83 mm wire capacity One off 3,400 m of 77 mm wire or 1 x 3,100 m of 83 mm wire capacity

Cable Lifters	2 x 76 mm and 2 x 84 mm onboard
Chain Lockers	2 x 125 m^3 / giving abt 2 x 6,000 ft of 3 inch chain
Shark Jaws	2 pairs of Karm Forks arranged for chain up to 165 mm dia / 750 ts SWL Inserts for handling 65, 75, 85, 100, and 120 mm dia. wire/chain
Stern Roller	One of 3,5 m dia. x 6.0 m length – SWL 500 ts
Guide Pins	2 pairs of Karm Fork Hydraulic pins – SWL 170 ts

DECK EQUIPMENT

Capstans	2 x 15 ts pull
Tugger Winches	2 x 15 ts pull
Smit Brackets	One bracket on B Deck FW – SWL 250 ts
Cranes	1 hydraulic crane on forep cargo deck giving 6 / 12 ts at 20/10 m arm (360 degr 1 telescopic crane on aft cargo deck giving 1.5 / 3 ts at 15/10 m arm (360 degr) 1 hydraulic crane on fore-castle deck for stores etc
Windlass	1 hydraulic windlass / mooring winch. Two de-clutchable drums 46 mm K3 chain

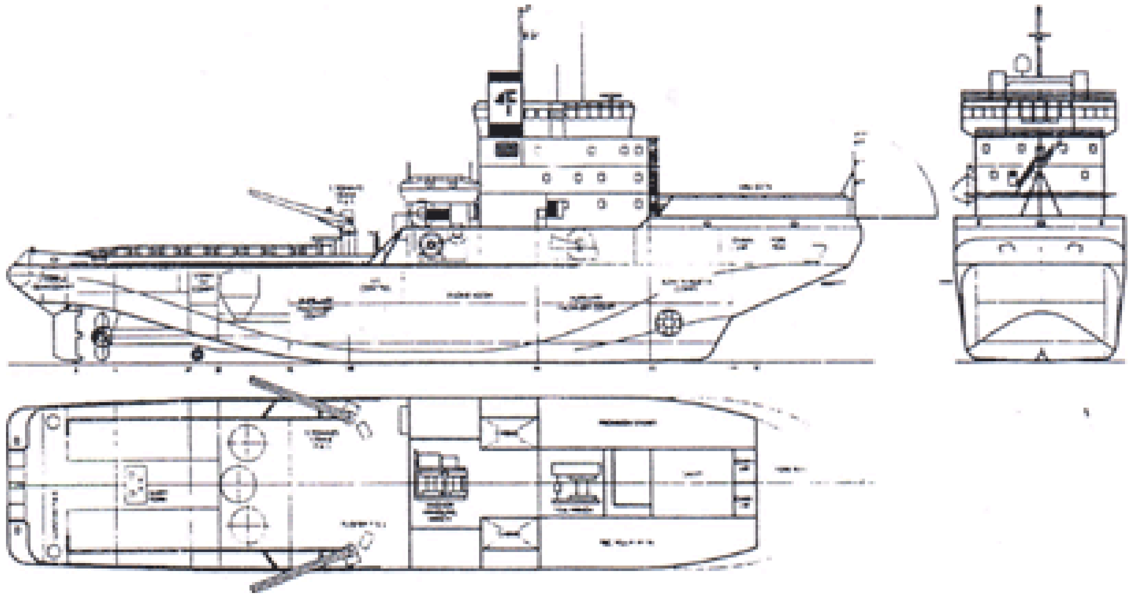
Accommodation

Accommodation for a total of 23 persons, including crew
All accommodation equipped with air-condition and humidification facilities.

Misc.

We would like to highlight the exceptional good maneuverability of the vessel. Also please note the environmental bonus using ”Tor Viking” due to her exceptional low noise level, and the installed Exhaust Gas Treatment Systems (Catalyst), effectively reducing the NOx levels. ”Tor Viking” is also equipped with diesel overflow tank with alarm system. The vessels design, and her possibility for running 2 engines, (“father/son”) gives a very favourable fuel consumption.

DynPos 2 – Kongsberg Simrad SDP21 system will be installed during winter 2002/03



Supporting Information – Tor Viking II

AHTS/Icebreaker Tor Viking II - Main Characteristics

Design :
KMAR 808 AHTS/ ICEBREAKER (Now; MOSSMAR)

Classification :
DnV,+1A1, TUG/SUPPLY VESSEL, SF, EO, ICEBREAKER ICE-10, HELDK-SH,
WI-OC DK(+), HK(2.8), DYNPOS-AUTR (DP-Green)

Built / Delivered :
Havyard Leirvik, Norway - 03/2000

Flag / Registered :
Swedish / Skärhamn

Owners :
Trans Viking Icebreaking & Offshore AS , Kristiansand, Norway

Commercial Managers :
Viking Supply Ships A/S, Kristiansand, Norway

Dimensions
Length Over All (LOA) : 83.70 metres
Length between p.p. : 75.20 metres
Breadth, moulded : 18.00 metres
Depth, moulded : 8.50 metres
Draught (scantling) : 7.20 metres
Draught (design) : 6.00 metres
Freeboard (design) : 2.50 metres

Tonnage
Dead Weight : 2,528 tonnes
Light Ship : 4,289 tonnes
Gross : 3,382 tonnes
Net : 1,145 tonnes

Capacities
Dry Bulk : 283 m 3 in 4 tanks - totalling 10,000 ft 3
Pot Water : 724 m 3
Drill Water / Ballast : 1,113 m 3
Brine : 400 m 3 – SG 2.5
Oil Based Mud : 657 m 3 – SG 2.8
Base Oil : 242 m 3
Fuel Oil : 1,190 m 3 Marine Gas Oil (Diesel)
Urea : 94 m 3
Diesel Overflow : 21 m 3 with alarm
Diesel Service / Settling : 2 x 20 m 3
Deck Load : Abt 1,350 ts
Deck Area : 603 m 2 / 40.20 m x 15.0 m

All products in dedicated tanks – no dual purpose tanks

Discharge Rates / Lines etc.
Dry Bulk : 2 x 25 m 3/h compressors – 80 psi. Two separate discharge systems.
Discharge rate 2 x 75 m 3 / h at 90 metres head
Pot Water : Discharge rate 1 x 250 m 3 / h at 9 bar
Drill Water / Ballast : Discharge rate 1 x 250 m 3 / h at 9 bar
Brine : Discharge rate 2 x 75 m 3 / h at 18 bar
Oil Based Mud : Discharge rate 2 x 75 m 3 / h at 24 bar - Oil Mud Agitators fitted
Base Oil : Discharge rate 1 x 75 m 3 / h at 9 bar
Fuel Oil (Diesel) : Discharge rate 1 x 250 m 3 / h at 9 bar
Discharge Stations : All products mid and aft both SB and PS
Discharge Lines : 6 inch Weco system with reducers for Pot / Drill Water, Fuel Oil and Dry Bulk
: 5 inch Weco system with reducers for Brine, Base Oil and Oil Base Mud
Tank cleaning : Mud and Base Oil tanks fitted with permanent tank cleaning system and heating
Flow Meters : Flow meters fitted for Pot Water and Fuel Oil (Digital display + printer for MGO)

Propulsion
Main Engine : MAK 18,300 BHP - 4 eng (father/son) 2 x 3,840 kW + 2 x 2,880 kW = 13,440 kW
Thrusters : Bow 1,200 BHP in tunnel (Electr) + 1,200 BHP 360 deg retractable = 2,400 BHP
: Stern 1,200 BHP in tunnel (Electrical)
Propellers : 2 KaMeWa 4 blades in nozzles – dia abt 4.0 meter
Rudders : 2 spade rudders

Bollard Pull
Bollard Pull : 202 continuous (DnV certified) / Abt 210 max pull

Speed/Consumption
Speed/Consumption : 16 knots – Abt. 42.7 MT / 24 hrs at 6.0 meter draught
: 12 knots – Abt. 15.6 MT
: 10 knots – Abt. 8.6 MT

Towing & Anchorhandling Equipment
AHT Winch : Brattvaag towing/anchorhandling winch 400 ts pull / 550 ts brake holding cap
AHT Drum : One of 1,400 mm dia. x 3,750 dia x (1,250 mm + 1,250 mm) length
Wire Capacity : 2 x 1,900 m of 77 mm wire or 2 x 1,650 m of 83 mm wire
AH Drum : One of 1,400 mm dia. x 3,750 mm dia. x 3,000 mm length
Wire Capacity : 4,100 m of 83 mm wire
Winch Control : TOWCON 2000 Aut. Control with printer
Pennant Reels/Caps : One off 2 x 1,500 m of 77 mm wire or 2 x 1,300 m of 83 mm wire capacity
: One off 3,400 m of 77 mm wire or 1 x 3,100 m of 83 mm wire capacity

Spooling device :
Work / Towing drums arranged according to latest NMD requirements
Cable Lifters : 2 x 76 mm and 2 x 84 mm onboard
Chain Lockers : 2 x 127 m 3 / giving abt 2 x 6,000 ft of 3 inch chain
Shark Jaws : 2 sets of Karm Forks arranged for chain up to 165 mm dia / 750 ts SWL
Inserts for handling 65, 75, 85, 100, and 120 mm dia. wire/chain
: Forks arranged with alarm system acc to latest NMD requirements
Stern Roller : One of 3,5 m dia. x 6.0 m length – SWL 500 ts
Guide Pins : 2 pairs of Karm Fork Hydraulic pins – SWL 170 ts

Workwires
Work Wire : 300 metres of 77 mm dia
Chase Wire : 1,000 metres of 83 mm dia
Main Tow Wire : 1,500 metres of 83 mm dia
Spare Tow Wire : 1,300 metres of 83 mm dia

Deck Equipment
Capstans : 2 x 15 ts pull
Tugger Winches : 2 x 15 ts pull
Smit Brackets : One bracket on B Deck FW – SWL 250 ts
Cranes : 1 hydraulic crane on forep cargo deck giving 6 / 12 ts at 20/10 m arm (360 degr)
: 1 telescopic crane on aft cargo deck giving 1.5 / 3 ts at 15/10 m arm (360 degr)
: 1 hydraulic crane on fore-castle deck for stores etc
Windlass : 1 hydraulic windlass / mooring winch. Two de-clutch able drums 46 mm K3 chain

Accommodation
Accommodation for a total of 23 persons, including crew
All accommodation equipped with air-condition and humidification facilities.

Misc.
We would like to highlight the exceptional good manoeuvrability of the vessel. Also please note the environmental bonus using ”Tor Viking II” due to her exceptional low noise level, and the installed Exhaust Gas Treatment Systems (Catalyst), effectively reducing the NOx levels. ”Tor Viking II” is also equipped with diesel overflow tank with alarm system. The vessels design, and her possibility for running 2 engines, (“father/son”) gives very favourable fuel consumption.
Spooling Devizes and DynPos 2 – Kongsberg Simrad SDP21 – “DP Green” system were installed in May 2003

Particulars believed to be correct, without guarantee

Viking Supply Ships A/S
P.O. Box 204
Markensgate 9
4662 Kristiansand S, Norway

Telephone: (+47) 38 12 41 70
Telefax: (+47) 38 04 83 38
E-Mail: vikingsupply@vikingsupply.com
Web Site: www.vikingsupply.com

Supporting Information - Fennica/Nordica

Powerful, high-tech, multipurpose vessels for global underwater oil field construction

Designed for the management, maintenance and service of offshore oil wells, the 97-metre Botnica is a multipurpose vessel specialised in marine construction and icebreaking, as are the 116-metre vessels Fennica and Nordica. They are equipped with diesel-electric propulsion systems and their innovative combination of capabilities, based on extensive design and engineering work, facilitates their use in both arctic and tropical conditions. All three of these multipurpose vessels are highly advanced, powerful and extremely well designed and built.

Unique technology for demanding conditions

These vessels are ideal for offshore operations. The working deck is about 1,000 m^2, making it exceptionally large and level for ships of this length. The deck was designed for fast equipment changes. Depending on the ship, such equipment may range from simple deck cranes to a 160-tonne pedestal active heave compensated crane, or from deepwater installation equipment to pipe-laying systems, underwater machinery control or the towing and installation of large pipelines.

With their 15,000 kW power output and 230-tonne bollard pull, the Nordica and the Fennica are ideal for seabed ploughing and towing, and they are also fully equipped for anchor-handling operations. The ships' main engine and generator solution makes it possible to perform heavy-duty maintenance tasks without affecting their operating ability.

Both the Fennica and the Nordica are also equipped with a stern roller.

Accurate, safe and highly suitable

The Botnica's moon pool and the large size of its working deck make this ship highly suitable for a variety of offshore operations. Different types of special tools and structures can be installed on the working deck. The attributes of the Botnica, a class 3 DP ship, are in keeping with the strict rules and stipulations demanded in oil well management, as well as the requirements on oil fields set by the Norwegian Maritime Directorate.

The multipurpose icebreakers are equipped with Kongsberg Simrad's Dynamic Positioning (DP) system, which has five independent control units operating their main propellers and three bow thrusters. Even in a sector in which ocean vessels equipped with DP systems are a normal sight, these vessels have performed their tasks exceptionally well in terms of manoeuvrability and accuracy. Their unusual asymmetrical and spacious navigation bridge was designed with an eye to the requirements placed on the ship's multiple applications, both on the open sea and in icebreaking and towing operations.

The vessels have a separate deck for the clients' use, with cabins and offices and a separate data network. The high quality facilities accommodate a total of 45-47 guests, depending on the ship.

Fennica

Dimensions

Length	116.00 m
Beam	26.00 m
Draught	8.40 m max.
Built	1993
Max. speed	16 knots

Class
DnV + 1A1 – Tug Supply Vessel – SF – EO – Icebreaker polar – 10, Dynpos, AUTR, Helideck

Dynpos
Simrad ADP 702

Accommodation
82 persons
24 cabins for client use (47 persons)
Client's offices: 1 operation centre on 4th bridge deck, 1 x 20 m^2 office

Helideck
Superpuma or similar

Deck
Working deck area 1090 m^2
Anchor handling/winch
Aquamaster TAW 3000/3000 E

Machinery
Main engines
2 x Wärtsilä Diesel, Vasa 16V 32, each 6000 kW
2 x Wärtsilä Diesel, Vasa 12V 32, each 4500 kW
Generators
ABB Strömberg Drives
2 x HSG 1120 MP8, power 8.314 kVA, Volt 6.3 KV, speed750 rpm
2 x HSG 900 LR8, power 6.235 kVA, Volt 6.3 KV, speed 750 rpm
Propellers
2 x HSSOL 18/1654, output 7.500 kW each, ABB Strömberg Drives
2x Aquamater-Rauma US ARC 1, 7500 kW each,
FP propellers, variable RPM
Bow thrusters
3 x Brunvoll FV-80 LTC-2250, VP propellers 1.050 kW each

Bollard pull 234 tons

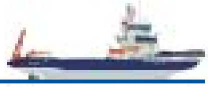
Crane(s) (optional)

Stb	30 tons/38 metre jib
Port	15 tons
A-frame	120 tons

Navigation Equipment
Robertson ECDIS Navigation System
Doppler speed log
Loran C
GPS
Fiber optic gyros
Differential GPS Gyro.
Navintra Ecdis
Direction finder
Echo sounder
Facsimile recorder

Communication Equipment
1 x Skanti TRP 8400D MF/HF SSB, including all GMDSS requirements
1 x Watch receiver
1 x Aero VHF. Helicopter communication
6 x VHF
1 x Navtex receiver
1 x Inmarsat B satellite comm. system
VSAT online satellite comm. system
3 x UHF walkie-talkie
3 x VHF walkie-talkie
2 x Freefloat EPRIB, 121,5 and 406 MHz
2 x Distress transponders, 96 Hz
Call signal OJAD

Nordica



Dimensions

Length	116.00 m
Beam	26.00 m
Draught	8.40 m max.
Built	1994
Max. speed	16 knots

Class
DnV + 1A1 – Tug Supply Vessel – SF – EO – Icebreaker polar – 10, Dynpos, AUTR, Helideck

Dynpos
Simrad ADP 702

Accommodation
82 persons
24 cabins for client use (47 persons)
Client's offices: 1 operation centre on 4th bridge deck, 1 x 20 m^2 office

Helideck
Superpuma or similar

Deck
Working deck area 1090 m^2
Anchor handling/towing winch
Aquamaster TAW 3000/3000 E

Machinery
Main engines
2 x Wärtsilä Diesel, Vasa 16V 32, each 6000 kW
2 x Wärtsilä Diesel, Vasa 12V 32, each 4500 kW
Generators
ABB Strömberg Drives
2 x HSG 1120 MP8, power 8.314 kVA, Volt 6.3 KV, speed750 rpm
2 x HSG 900 LR8, power 6.235 kVA, Volt 6.3 KV, speed 750 rpm
Propellers
2 x HSSOL 18/1654, output 7.500 kW each, ABB Strömberg Drives
2x Aquamater-Rauma US ARC 1, 7500 kW each,
FP propellers, variable RPM
Bow thrusters
3 x Brunvoll FV-80 LTC-2250, VP propellers 1.050 kW each

Bollard pull 234 tons

Main crane (optional)

Lifting capacity	160 T/9 m 30 T/32 m
Main winch	Active Heave Compensated Constant Tension
Heave amplitude	+ 3,5 m double part + 7 m single part
Operating depth	500 m–160 T (double part) 1000 m–80 T (single part)
Aux winch	10 T, 33 m, Constant Tension
Tugger winches	2 x 4 T Constant Tension
Port	15 tons

A-frame (optional) 120 tons

Navigation Equipment
Navintra ECDIS Navigation System
Doppler speed log
Loran C
GPS
Fiber Optic Gyros
Differential GPS Gyro.
Direction finder
Echo sounder
Facsimile recorder

Communication Equipment
1 x Skanti TRP 8400D MF/HF SSB, including all GMDSS requirements
1 x Watch receiver
1 x Aero VHF. Helicopter communication
6 x VHF
1 x Navtex receiver
1 x Inmarsat B satellite comm. system
VSAT online satellite comm. system
3 x UHF walkie-talkie
3 x VHF walkie-talkie
2 x Freefloat EPRIB, 121,5 and 406 MHz
2 x Distress transponders, 96 Hz
Call signal OJAE

Botnica

Dimensions

Length	96.70 m
Beam	24.00 m
Draught	7.2 to 8.5 m
Built	1998
Max. speed	15 knots

Class
DnV + 1A1 – Supply Vessel – SF – EO – Icebreaker Ice – 10,
Dynpos AUTRO, RPS
NMD Mobile offshore Units, DP UNIT, with equipment class 3

Dynpos
Simrad SDP22 + SDP12 backup
2 x HIPAP combined SSBL/MULBL hydroacoustic system
2 x Seatex DPS DGPS combined GPS/Glonass

Accommodation
72 persons
24 cabins for client use (45 pers.)
2 x client's office

Helideck
Superpuma or similar

Deck
Working deck area 1000 m^2

Machinery
Main engines
12 x Caterpillar 3512B, 1257 kW, 1500 rpm
Main generators
6 x ABB-AMG 560, 2850 kVA, 3,3 kV 3 N, 50 Hz
Emergency generators
1 x Caterpillar 3406, 200 kW, 400 V, 3 N, 50 Hz
Main propulsion
Stern 2 x 5000 kW Azipod, FP
Bow thrusters
3 x Brunvol tunnel, variable pitch á 1150 kW

Bollard pull 117 tons

Crane(s) (optional)
1 x Hydralift, 160 tons
1 x 15 tons

Main cranes

Lifting capacity	160 T/9 m 30 T/32 m
Main winch	Active Heave Compensated Constant Tension
Heave amplitude	+ 4 m double part + 8 m single part
Operating Depth	550 m–160 T (double part) 1100 m– 80 (single part)
Aux winch	10 T, 33 m, Constant Tension

Moonpool 6.5 x 6.5 metres

Navigation and communication equipment
GMDSS
Inmarsat B
VSAT online satellite comm. system
Call signal OJAK

FINSTASHIP

Shipping Enterprise
Valimotie 16
FI-00380 Helsinki, Finland
Phone +358 30 620 7000, fax +358 30 620 7030
e-mail: shipping@finstaship.fi
www.finstaship.fi

GDV Maritime AS
Brygga Næringssenter
Vikaveien 31, N-4817 His, Norway
Phone +47 3701 2260, fax +47 3701 2862
e-mail: maritime@gdv.no
www.gdv.no

APPENDIX B

Emission Calculations

AIR SCIENCES INC.
DENVER • PORTLAND

CALCULATIONS

PROJECT TITLE: Shell Kulluk	**BY:** D. Young
PROJECT NO: 180-15	PAGE 1 OF 3 SHEET 1
SUBJECT: Emissions in Tons	**DATE:** 12/22/2006

Kulluk Rig and Associated Vessels (Year 2007)

EMISSIONS SUMMARY @ EXPECTED MAXIMUM	Yearly Emissions at any location				
	NOx	CO	PM10	VOC	SO2
Rig / Vessel	tons	tons	tons	tons	tons
Kulluk Rig	48.7	7.9	2.3	1.9	4.6
Vladimir Ignatjuk	162.9	44.5	3.6	7.2	10.5
Tor Viking II (2007)	21.1	19.8	1.7	2.9	6.4
Jim Kilabuk (resupply vessel)	1.6	0.4	0.0	0.1	0.1
Kulluk's OSR Fleet	10.7	9.2	0.5	1.2	1.0
	245.0	81.8	8.1	13.3	22.6

Each Source

Kulluk Rig			Yearly Emissions at any location				
	Rated Capacity		NOx	CO	PM10	VOC	SO2
			tons	tons	tons	tons	tons
Main Engine	2,816	Hp	31.06	4.78	1.4	0.97	3.06
Main Engine	2,816	Hp	12.23	1.88	0.55	0.38	1.21
Main Engine	2,816	Hp					
Emergency Generator	920	Hp					
Air Compressor	500	Hp	0.146	0.128	0.007	0.146	0.034
Air Compressor	500	Hp	0.039	0.035	0.002	0.039	0.009
Air Compressor	500	Hp					
HPP Engine	250	Hp	0.093	0.02	0.007	0.008	0.005
HPP Engine	250	Hp	0.093	0.02	0.007	0.008	0.005
Deck Crane	340	Hp	2.487	0.536	0.177	0.201	0.123
Deck Crane	340	Hp	0.933	0.201	0.066	0.076	0.046
Deck Crane	340	Hp	0.933	0.201	0.066	0.076	0.046
Thrustmaster Cat. 3516 B	2,000	Hp	0.048	0.011	0.001	0.001	0.003
Thrustmaster Cat. 3516 B	2,000	Hp	0.048	0.011	0.001	0.001	0.003
Anchor Winches		Electric					
Cementing Unit		Electric					
Logging Diesel Winch	140	Hp	0.29	0.06	0.02	0.02	0.01
Logging Backup Winch Detroit 471	120	Hp					
Heat Boiler	2.4	mmBtu	0.243	0.061	0.04	0.007	0.046
Heat Boiler	2.4	mmBtu					
Hot Water Heat	0.54	mmBtu	0.018	0.0045	0.003	5E-04	0.0034
Hot Water Heat	0.54	mmBtu					
Incinerator		N/A					
			48.66	7.95	2.35	1.93	4.60

Kulluk Rig and Associated Vessels (Year 2007) - Each Source, continued

Vladimir Ignatjuk			Yearly Emissions at any location				
	Rated Capacity		NOx tons	CO tons	PM10 tons	VOC tons	SO2 tons
Main Engine	5,800	Hp	63.96	14.66	1.07	1.88	4.1
Main Engine	5,800	Hp	63.96	14.66	1.07	1.88	4.1
Main Engine	5,800	Hp	10.37	2.38	0.17	0.3	0.66
Main Engine	5,800	Hp	10.37	2.38	0.17	0.3	0.66
Generator	1,431	Hp	14.01	3.21	0.23	0.41	0.9
Generator	1,431	Hp					
Emergency Generator	292	Hp					
Heat Boiler	2.4	mmBtu	0.11	0.027	0.018	0.003	0.021
Hot Water Heat	0.54	mmBtu	0.0546	0.0136	0.009	0.002	0.0104
Incinerator	0.033	ton/hr	0.07	7.13	0.83	2.38	0.06
			162.90	44.46	3.57	7.15	10.51

Tor Viking II (2007)			Yearly Emissions at any location				
	Rated Capacity		NOx tons	CO tons	PM10 tons	VOC tons	SO2 tons
Main Engine/Generator	5,046	Hp	5.39	4.54	0.38	0.67	1.46
Main Engine/Generator	5,046	Hp	6.13	5.17	0.43	0.76	1.66
Main Engine/Generator	3,784	Hp	5.23	5.44	0.46	0.8	1.75
Main Engine/Generator	3,784	Hp	3.72	3.87	0.32	0.57	1.24
Harbor generator	1,168	Hp	0.58	0.77	0.06	0.11	0.25
Emergency Generator	254	Hp					
Heat Boiler	1.37	mmBtu	0.069	0.017	0.011	0.002	0.013
Incinerator		N/A					
			21.12	19.81	1.66	2.91	6.37

AIR SCIENCES INC.
DENVER • PORTLAND

CALCULATIONS	PROJECT TITLE: Shell Kulluk	BY: D. Young
	PROJECT NO: 180-15	PAGE 3 OF 3 SHEET 1
	SUBJECT: Emissions in Tons	DATE: 12/22/2006

Kulluk Rig and Associated Vessels (Year 2007) - Each Source, continued

Jim Kilabuk (resupply vessel)			Yearly Emissions at any location				
	Rated Capacity		NOx	CO	PM10	VOC	SO2
			tons	tons	tons	tons	tons
Main Engine EMD V20 645	3,600	hp	0.69	0.16	0.01	0.02	0.04
Main Engine EMD V20 645	3,600	Hp	0.69	0.16	0.01	0.02	0.04
Generator, Cat. D3406	292	Hp	0.18	0.04	0.01	0.01	0.01
Generator, Cat. D3406	292	Hp					
HPP, Cat. D343	300	Hp					
Bow Thruster Cat. D343	300	Hp	0.074	0.016	0.005	0.006	0.004
			1.63	0.38	0.04	0.06	0.09

Kulluk's OSR Fleet			Yearly Emissions at any location				
	Rated Capacity		NOx	CO	PM10	VOC	SO2
			tons	tons	tons	tons	tons
Engine 1 on OSRV	2,710	Hp	0.71	0.06	0.01	0.08	0.07
Engine 2 on OSRV	2,710	Hp	0.71	0.06	0.01	0.08	0.07
Generator 1 on OSRV	1,285	Hp	6.86	8.49	0.4	0.97	0.7
Generator 2 on OSRV	1,285	Hp					
Emergency generator on OSRV	1,285	Hp	0.087	0.108	0.005	0.012	0.009
Kvichak 34' work boat #1	300	Hp	0.046	0.001	0.001	0.002	0.007
Kvichak 34' work boat #1	300	Hp	0.046	0.001	0.001	0.002	0.007
Kvichak 34' work boat #2	300	Hp	0.046	0.001	0.001	0.002	0.007
Kvichak 34' work boat #2	300	Hp	0.046	0.001	0.001	0.002	0.007
Engine 1 on tug for supply barge	1,500	Hp	1.062	0.243	0.018	0.031	0.068
Engine 2 on tug for supply barge	1,500	Hp	1.062	0.243	0.018	0.031	0.068
			10.68	9.21	0.47	1.21	1.01

AIR SCIENCES INC. DENVER • PORTLAND	CALCULATIONS	PROJECT TITLE: Shell Kulluk	BY: D. Young
		PROJECT NO: 180-15	PAGE 1 OF 1 SHEET 2
		SUBJECT: Fuel Use Summary	DATE: 12/22/2006

Drill Rig and Vessel Diesel Fuel Use (Yr 2007)

Fuel use for Kulluk at any location
Year 2007

Rig/Vessel	gallons	cu meter
KULLUK RIG	329,409	1,247
VLADIMIR IGNATJUK	709,461	2,686
TOR VIKING II	429,663	1,626
JIM KILABUK	6,728	25
Kulluk's OSR Fleet	67,864	257
	1,543,125	5,841

Conversion factor: 264.1721 gal/cubic meter

AIR SCIENCES INC.

CALCULATIONS

PROJECT TITLE: Shell Kulluk	**BY:** D. Young
PROJECT NO: 180-15	PAGE 1 OF 3 SHEET 3
SUBJECT: Fuel Use & Operating Hours	**DATE:** 12/22/2006

Fuel Use & Operating Hours (Yr 2007)

Kulluk Rig	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Main Engine	2,816	Hp	1,414	203,451
Main Engine	2,816	Hp	557	80,143
Main Engine	2,816	Hp		
Emergency Generator	920	Hp		
Air Compressor	500	Hp	89	2,274
Air Compressor	500	Hp	24	613
Air Compressor	500	Hp		
HPP Engine	250	Hp	24	307
HPP Engine	250	Hp	24	307
Deck Crane	340	Hp	472	8,200
Deck Crane	340	Hp	177	3,075
Deck Crane	340	Hp	177	3,075
Thrustmaster Cat. 3516 B	2,000	Hp	2	204
Thrustmaster Cat. 3516 B	2,000	Hp	2	204
Anchor Winches		Electric		
Cementing Unit		Electric		
Logging Diesel Winch	140	Hp	132	944
Logging Backup Winch Detroit 471	120	Hp		
Heat Boiler	2.4	mmBtu	1,414	24,771
Heat Boiler	2.4	mmBtu		
Hot Water Heat	0.54	mmBtu	467	1,841
Hot Water Heat	0.54	mmBtu		
Incinerator		N/A		
				329,409

*Based on unit capacity, operating hours and diesel fuel heat content of 137,000 mmBtu/gal (AP42). Additionally for an engine the average brake-specific fuel consumption value of 7,000 btu/hp-hr (AP42) was used.

AIR SCIENCES INC.

CALCULATIONS	**PROJECT TITLE:** Shell Kulluk	**BY:** D. Young	
	PROJECT NO: 180-15	PAGE 2 OF 3 SHEET 3	
	SUBJECT: Fuel Use & Operating Hours	**DATE:** 12/22/2006	

Fuel Use & Operating Hours (Yr 2007) - continued

Vladimir Ignatjuk	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Main Engine	5,800	Hp	919	272,346
Main Engine	5,800	Hp	919	272,346
Main Engine	5,800	Hp	149	44,156
Main Engine	5,800	Hp	149	44,156
Generator	1,431	Hp	816	59,655
Generator	1,431	Hp		
Emergency Generator	292	Hp		
Heat Boiler	2.4	mmBtu	641	11,229
Hot Water Heat	0.54	mmBtu	1,414	5,573
Incinerator	0.033	ton/hr	1,440	
				709,461

Tor Viking II (2007)	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Main Engine/Generator	5,046	Hp	376	96,942
Main Engine/Generator	5,046	Hp	428	110,349
Main Engine/Generator	3,784	Hp	601	116,199
Main Engine/Generator	3,784	Hp	428	82,751
Harbor generator	1,168	Hp	274	16,352
Emergency Generator	254	Hp		
Heat Boiler	1.37	mmBtu	707	7,070
Incinerator		N/A		
				429,663

*Based on unit capacity, operating hours and diesel fuel heat content of 137,000 mmBtu/gal (AP42). Additionally for an engine the average brake-specific fuel consumption value of 7,000 btu/hp-hr (AP42) was used.

AIR SCIENCES INC.

CALCULATIONS	**PROJECT TITLE:** Shell Kulluk	**BY:** D. Young
	PROJECT NO: 180-15	PAGE 3 OF 3 SHEET 3
	SUBJECT: Fuel Use & Operating Hours	**DATE:** 12/22/2006

Fuel Use & Operating Hours (Yr 2007) - continued

Jim Kilabuk (resupply vessel)	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Main Engine EMD V20 645	3,600	hp	16	2,943
Main Engine EMD V20 645	3,600	Hp	16	2,943
Generator, Cat. D3406	292	Hp	40	597
Generator, Cat. D3406	292	Hp		
HPP, Cat. D343	300	Hp		
Bow Thruster Cat. D343	300	Hp	16	245
				6,728

Kulluk's OSR Fleet	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Engine 1 on OSRV	2,710	Hp	36	4,985
Engine 2 on OSRV	2,710	Hp	36	4,985
Generator 1 on OSRV	1,285	Hp	707	46,419
Generator 2 on OSRV	1,285	Hp		
Emergency generator on OSRV	1,285	Hp	9	591
Kvichak 34' work boat #1	300	Hp	30	460
Kvichak 34' work boat #1	300	Hp	30	460
Kvichak 34' work boat #2	300	Hp	30	460
Kvichak 34' work boat #2	300	Hp	30	460
Engine 1 on tug for supply barge	1,500	Hp	59	4,522
Engine 2 on tug for supply barge	1,500	Hp	59	4,522
				67,864

*Based on unit capacity, operating hours and diesel fuel heat content of 137,000 mmBtu/gal (AP42). Additionally for an engine the average brake-specific fuel consumption value of 7,000 btu/hp-hr (AP42) was used.

AIR SCIENCES INC.

CALCULATIONS

PROJECT TITLE: Shell Kulluk	**BY:** D. Young
PROJECT NO: 180-15	PAGE 1 OF 3 SHEET 4
SUBJECT: Emission Factors (EF)	**DATE:** 12/22/2006

Emission Factors (Yr 2007)

Kulluk Rig		rating unit	EF category	NOx	CO	PM10	VOC	SO2
				(lb/hp-hr or lb/mmBtu)				
Main Engine	2,816	Hp	Kulluk main engines (adj.)	0.0156	0.0024	0.000705	0.000485	0.0015371
Main Engine	2,816	Hp	Kulluk main engines (adj.)	0.0156	0.0024	0.000705	0.000485	0.0015371
Main Engine	2,816	Hp	Kulluk main engines (adj.)					
Emergency Generator	920	Hp	ICE >600 hp AP42					
Air Compressor	500	Hp	Air compressors	0.00658	0.00575	0.000329	0.00658	0.0015371
Air Compressor	500	Hp	Air compressors	0.00658	0.00575	0.000329	0.00658	0.0015371
Air Compressor	500	Hp	Air compressors					
HPP Engine	250	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
HPP Engine	250	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Deck Crane	340	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Deck Crane	340	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Deck Crane	340	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Thrustmaster Cat. 3516 B	2,000	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Thrustmaster Cat. 3516 B	2,000	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Anchor Winches		Electric	Not Applicable					
Cementing Unit		Electric	Not Applicable					
Logging Diesel Winch	140	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Logging Backup Winch Detroit 471	120	Hp	ICE <=600 hp AP42					
Heat Boiler	2.4	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Heat Boiler	2.4	mmBtu	Boiler <100 mmBtu AP42					
Hot Water Heat	0.54	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Hot Water Heat	0.54	mmBtu	Boiler <100 mmBtu AP42					
Incinerator		N/A	Not Applicable					

AIR SCIENCES INC.		**PROJECT TITLE:** Shell Kulluk	**BY:** D. Young
		PROJECT NO: 180-15	PAGE 2 OF 3 SHEET 4
	CALCULATIONS	**SUBJECT:** Emission Factors (EF)	**DATE:** 12/22/2006

Emission Factors (Yr 2007) - continued

Vladimir Ignatjuk		rating		NOx	CO	PM10	VOC	SO2
		unit	EF category	(lb/hp-hr or lb/mmBtu)				
Main Engine	5,800	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Main Engine	5,800	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Main Engine	5,800	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Main Engine	5,800	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Generator	1,431	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Generator	1,431	Hp	ICE >600 hp AP42					
Emergency Generator	292	Hp	ICE <=600 hp AP42					
Heat Boiler	2.4	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Hot Water Heat	0.54	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Incinerator	0.033	ton/hr	Shipboard incinerator. AP42	3	300	35	100	2.5

Tor Viking II (2007)		rating		NOx	CO	PM10	VOC	SO2
		unit	EF category	(lb/hp-hr or lb/mmBtu)				
Main Engine/Generator	5,046	Hp	ICE Tor Viking 8M	0.00568	0.004785	0.000401	0.000705	0.0015371
Main Engine/Generator	5,046	Hp	ICE Tor Viking 8M	0.00568	0.004785	0.000401	0.000705	0.0015371
Main Engine/Generator	3,784	Hp	ICE Tor Viking 6M	0.0046	0.004785	0.000401	0.000705	0.0015371
Main Engine/Generator	3,784	Hp	ICE Tor Viking 6M	0.0046	0.004785	0.000401	0.000705	0.0015371
Harbor generator	1,168	Hp	ICE Tor Viking Cat 3412	0.00362	0.004785	0.000401	0.000705	0.0015371
Emergency Generator	254	Hp	ICE <=600 hp AP42					
Heat Boiler	1.37	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Incinerator		N/A	Not Applicable					

AIR SCIENCES INC.

CALCULATIONS

PROJECT TITLE: Shell Kulluk
BY: D. Young
PROJECT NO: 180-15
PAGE 3 OF 3
SHEET 4
SUBJECT: Emission Factors (EF)
DATE: 12/22/2006

Emission Factors (Yr 2007) - continued

Jim Kilabuk (resupply vessel)		rating unit	EF category	NOx	CO	PM10	VOC	SO2
				(lb/hp-hr or lb/mmBtu)				
Main Engine EMD V20 645	3,600	hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Main Engine EMD V20 645	3,600	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Generator, Cat. D3406	292	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Generator, Cat. D3406	292	Hp	ICE <=600 hp AP42					
HPP, Cat. D343	300	Hp	ICE <=600 hp AP42					
Bow Thruster Cat. D343	300	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371

Kulluk's OSR Fleet		rating unit	EF category	NOx	CO	PM10	VOC	SO2
				(lb/hp-hr or lb/mmBtu)				
Engine 1 on OSRV	2,710	Hp	OSRV main engine	0.0146	0.0012	0.00028	0.00163	0.0015371
Engine 2 on OSRV	2,710	Hp	OSRV main engine	0.0146	0.0012	0.00028	0.00163	0.0015371
Generator 1 on OSRV	1,285	Hp	OSRV generator	0.0151	0.0187	0.00089	0.00214	0.0015371
Generator 2 on OSRV	1,285	Hp	OSRV generator					
Emergency generator on OSRV	1,285	Hp	OSRV generator	0.0151	0.0187	0.00089	0.00214	0.0015371
Kvichak 34' work boat #1	300	Hp	Kvic. 34' vessel engine	0.01024	0.000171	0.000169	0.000342	0.0015371
Kvichak 34' work boat #1	300	Hp	Kvic. 34' vessel engine	0.01024	0.000171	0.000169	0.000342	0.0015371
Kvichak 34' work boat #2	300	Hp	Kvic. 34' vessel engine	0.01024	0.000171	0.000169	0.000342	0.0015371
Kvichak 34' work boat #2	300	Hp	Kvic. 34' vessel engine	0.01024	0.000171	0.000169	0.000342	0.0015371
Engine 1 on tug for supply barge	1,500	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Engine 2 on tug for supply barge	1,500	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371

AIR SCIENCES INC.

CALCULATIONS	**PROJECT TITLE:** Shell Kulluk	**BY:** D. Young
	PROJECT NO: 180-15	PAGE 1 OF 3 SHEET 5
	SUBJECT: Hourly Emission Rate	**DATE:** 12/22/2006

Hourly Emissions (Yr 2007)

Kulluk Rig	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Main Engine	2,816	Hp	43.9296	6.7584	1.98528	1.36576	4.3284736
Main Engine	2,816	Hp	43.9296	6.7584	1.98528	1.36576	4.3284736
Main Engine	2,816	Hp					
Emergency Generator	920	Hp					
Air Compressor	500	Hp	3.29	2.875	0.1645	3.29	0.76855
Air Compressor	500	Hp	3.29	2.875	0.1645	3.29	0.76855
Air Compressor	500	Hp					
HPP Engine	250	Hp	7.75	1.67	0.55	0.6275	0.384275
HPP Engine	250	Hp	7.75	1.67	0.55	0.6275	0.384275
Deck Crane	340	Hp	10.54	2.2712	0.748	0.8534	0.522614
Deck Crane	340	Hp	10.54	2.2712	0.748	0.8534	0.522614
Deck Crane	340	Hp	10.54	2.2712	0.748	0.8534	0.522614
Thrustmaster Cat. 3516 B	2,000	Hp	48	11	0.802	1.41	3.0742
Thrustmaster Cat. 3516 B	2,000	Hp	48	11	0.802	1.41	3.0742
Anchor Winches		Electric					
Cementing Unit		Electric					
Logging Diesel Winch	140	Hp	4.34	0.9352	0.308	0.3514	0.215194
Logging Backup Winch Detroit 471	120	Hp					
Heat Boiler	2.4	mmBtu	0.3432	0.08568	0.05664	0.009528	0.065664
Heat Boiler	2.4	mmBtu					
Hot Water Heat	0.54	mmBtu	0.07722	0.019278	0.012744	0.0021438	0.0147744
Hot Water Heat	0.54	mmBtu					
Incinerator		N/A					

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CALCULATIONS

PROJECT TITLE: Shell Kulluk		**BY:** D. Young
PROJECT NO: 180-15		PAGE 2 OF 3 SHEET 5
SUBJECT: Emission Factors (EF)		**DATE:** 12/22/2006

Hourly Emissions (Yr 2007) - continued

Vladimir Ignatjuk	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Main Engine	5,800	Hp	139.2	31.9	2.3258	4.089	8.91518
Main Engine	5,800	Hp	139.2	31.9	2.3258	4.089	8.91518
Main Engine	5,800	Hp	139.2	31.9	2.3258	4.089	8.91518
Main Engine	5,800	Hp	139.2	31.9	2.3258	4.089	8.91518
Generator	1,431	Hp	34.3392	7.8694	0.573751	1.008714	2.19928268
Generator	1,431	Hp					
Emergency Generator	292	Hp					
Heat Boiler	2.4	mmBtu	0.3432	0.08568	0.05664	0.009528	0.065664
Hot Water Heat	0.54	mmBtu	0.07722	0.019278	0.012744	0.0021438	0.0147744
Incinerator	0.033	ton/hr	0.099	9.9	1.155	3.3	0.0825

Tor Viking II (2007)	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Main Engine/Generator	5,046	Hp	28.66128	24.14511	2.023446	3.55743	7.7562066
Main Engine/Generator	5,046	Hp	28.66128	24.14511	2.023446	3.55743	7.7562066
Main Engine/Generator	3,784	Hp	17.4064	18.10644	1.517384	2.66772	5.8163864
Main Engine/Generator	3,784	Hp	17.4064	18.10644	1.517384	2.66772	5.8163864
Harbor generator	1,168	Hp	4.22816	5.58888	0.468368	0.82344	1.7953328
Emergency Generator	254	Hp					
Heat Boiler	1.37	mmBtu	0.19591	0.048909	0.032332	0.0054389	0.0374832
Incinerator		N/A					

AIR SCIENCES INC. DENVER • PORTLAND	**PROJECT TITLE:** Shell Kulluk	**BY:** D. Young
	PROJECT NO: 180-15	PAGE 3 OF 3 SHEET 5
CALCULATIONS	**SUBJECT:** Emission Factors (EF)	**DATE:** 12/22/2006

Hourly Emissions (Yr 2007) - continued

Jim Kilabuk (resupply vessel)	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Main Engine EMD V20 645	3,600	hp	86.4	19.8	1.4436	2.538	5.53356
Main Engine EMD V20 645	3,600	Hp	86.4	19.8	1.4436	2.538	5.53356
Generator, Cat. D3406	292	Hp	9.052	1.95056	0.6424	0.73292	0.4488332
Generator, Cat. D3406	292	Hp					
HPP, Cat. D343	300	Hp					
Bow Thruster Cat. D343	300	Hp	9.3	2.004	0.66	0.753	0.46113

Kulluk's OSR Fleet	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Engine 1 on OSRV	2,710	Hp	39.566	3.252	0.7588	4.4173	4.165541
Engine 2 on OSRV	2,710	Hp	39.566	3.252	0.7588	4.4173	4.165541
Generator 1 on OSRV	1,285	Hp	19.4035	24.0295	1.14365	2.7499	1.9751735
Generator 2 on OSRV	1,285	Hp					
Emergency generator on OSRV	1,285	Hp	19.4035	24.0295	1.14365	2.7499	1.9751735
Kvichak 34' work boat #1	300	Hp	3.072	0.0513	0.0507	0.1026	0.46113
Kvichak 34' work boat #1	300	Hp	3.072	0.0513	0.0507	0.1026	0.46113
Kvichak 34' work boat #2	300	Hp	3.072	0.0513	0.0507	0.1026	0.46113
Kvichak 34' work boat #2	300	Hp	3.072	0.0513	0.0507	0.1026	0.46113
Engine 1 on tug for supply barge	1,500	Hp	36	8.25	0.6015	1.0575	2.30565
Engine 2 on tug for supply barge	1,500	Hp	36	8.25	0.6015	1.0575	2.30565

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CALCULATIONS

PROJECT TITLE: Shell Kulluk		**BY:** D. Young
PROJECT NO: 180-15		PAGE 1 OF 1 SHEET 6
SUBJECT: List of Emission Factors (Yr 2007)		**DATE:** 12/22/2006

List of Emission Factors (Yr 2007)

Emissions Unit	**Emission Factors**							**Reference**
	EF Unit	NOx	CO	PM10	VOC	SO2 value x S	SO2^ 0.19 = S	
Air compressors	lb/hp-hr	0.00658	0.00575	0.000329	0.00658	0.0015371	0.00809 S	Tier 3, (planned). 225 to 450kw range. 500hp = 373kW: NOx & VOC use NOX+NMHC value, CO, & PM. AP42: SO2.
Boiler <100 mmBtu AP42	lb/mmBtu	0.143	0.0357	0.0236	0.00397	0.02736	*0.144 S*	AP42 Tbl 1.3-1: NOx, CO, & SO2, Tbls 1.3-1 & 1.3-2; PM, and Tbl 1.2-3; VOC. 9/98
ICE <=600 hp AP42	lb/hp-hr	0.031	0.00668	0.0022	0.00251	0.0015371	0.00809 S	AP42 Tbl 3.3-1, 10/96
ICE >600 hp AP42	lb/hp-hr	0.024	0.0055	0.000401	0.000705	0.0015371	0.00809 S	AP42 Tbls 3.4-1 & 3.4-2 10/96
ICE Tor Viking 6M	lb/hp-hr	0.0046	0.004785	0.000401	0.000705	0.0015371	0.00809 S	Test of MaK 6M32: NOx; CO uses AP42 with CE^^. AP42 remainder.
ICE Tor Viking 8M	lb/hp-hr	0.00568	0.004785	0.000401	0.000705	0.0015371	0.00809 S	Test of MaK 8M32: NOx; CO uses AP42 with CE^^. AP42 remainder.
ICE Tor Viking Cat 3412	lb/hp-hr	0.00362	0.004785	0.000401	0.000705	0.0015371	0.00809 S	Test of Cat 3412: NOx; CO uses AP42 with CE^^. AP42 remainder.
Kulluk main engines (adj.)	lb/hp-hr	0.016	0.0024	0.000705	0.000485	0.0015371	0.00809 S	Spec for CBO Injectors, adjusted by 1.2: NOx, CO, PM, & VOC. AP42: SO2.
Kvic. 34' vessel engine	lb/hp-hr	0.01024	0.000171	0.000169	0.000342	0.0015371	0.00809 S	Cummins data: NOx, CO, PM10, & VOC. AP42: SO2.
Not Applicable		0	0	0	0	0		
OSRV generator	lb/hp-hr	0.0151	0.0187	0.00089	0.00214	0.0015371	0.00809 S	Tier 1 2000-2005 (vendor Cat data): NOx, CO, PM10, & VOC. AP42: SO2.
OSRV main engine	lb/hp-hr	0.0146	0.0012	0.00028	0.00163	0.0015371	0.00809 S	Client provided Cat data: NOx, CO, PM10, & VOC. AP42: SO2.
Shipboard incinerator. AP42	lb/ton	3	300	35	100	2.5		AP42 Tbl 2.1-12, Industrial/commercial and Domestic single chamber (largest factor of four) 10/96.

^ SO2 emission factor is based on S; the percent sulfur by weight in the fuel. For example the value of S would be 0.5 if the sulfur content is 0.5%. AP42 Tbl 3.4-1, 10/96

Sulfur in fuel by wgt. 1900 ppm is 0.19 % S

^^ CO CE (control efficiency): 87% CO control (% reduction) on Viking class (lowest of two).

AIR SCIENCES INC.	**PROJECT TITLE:** Frontier Discoverer	**BY:** W. Wooster
	PROJECT NO: 180-15	PAGE 1 OF 1 SHEET 2
CALCULATIONS	**SUBJECT:** Owner Requested Limit (ORL)	**DATE:** 12/28/2006

Shell Kulluk Owner Requested Limit (ORL) with Tor Viking II - Fleet wide Diesel Fuel Consumption

General ORL NOx Compliance Equation: $E_A + E_B + E_C + E_D + E_E$ < 245 tons NOx

Where:

E_A =	Emissions from Shell Kulluk	Vessel A
E_B =	Emissions from Vladimir Ignatjuk	Vessel B
E_C =	Emissions from Tor Viking II	Vessel C
E_D =	Emissions from Jim Kilabuk	Vessel D
E_E =	Emissions from Shell Kulluk OSR Fleet	Vessel E

Specific ORL NOx Compliance Equation:

$$K_{RICE}*((F_{A1}*EF_{A1})+(F_{A2}*EF_{A2})+(F_{B1}*EF_{B1})+(F_{C1}*EF_{C1})+(F_{C2}*EF_{C2})+(F_{E1}*EF_{E1}))+K_{HEAT}*((F_{A3}*EF_{A3})+(F_{B2}*EF_{B2})+(F_{C3}*EF_{C3}))+0.8+0.1+0.6+1.6+3.8 < 245 \text{ tons}$$

where

K_{RICE} = 137,000 / 7,000 / 2,000 = 0.00979 Hp-hr-ton / gal-lb

K_{HEAT} = 137,000 / 1,000,000 / 2,000 = 0.0000685 mmBtu-ton / gal-lb

F_i = Fuel consumption by source group i (gallons)

EF_i = Emission factor by source group i

0.8 tons	Shell Kulluk remaining emissions
0.1 tons	Vladimir Ignatjuk incinerator emissions
0.6 tons	Tor Viking II remaining emissions
1.6 tons	Jim Kilabuk emissions
3.8 tons	OSR Fleet remaining emissions

137,000	Btu/gallon	AP42 diesel fuel heat content
7,000	Btu/hp-hr	AP42 average brake-specific fuel consumption
2,000	lb/ton	Conversion factor
1,000,000	Btu/mmBtu	Conversion factor

Example Calculation of NOx Emissions and Comparison with ORL

ORL Equation Variables:	Vessel Source Identification	NOx Emission Factor (EF)	Assumed Diesel Fuel Consumption (F)
Kulluk main drilling engines	A1	0.0156 lb/hp-hr	250,000 gallons
Kulluk deck crane engines	A2	0.031 lb/hp-hr	12,000 gallons
Kulluk boilers/hot water heaters	A3	0.143 lb/mmBtu	25,000 gallons
VI main propulsion engines/generators	B1	0.024 lb/hp-hr	550,000 gallons
VI boiler/hot water heater	B2	0.143 lb/mmBtu	15,000 gallons
TV main propulsion engines/generators (father engines)	C1	0.0057 lb/hp-hr	200,000 gallons
TV main propulsion engines/generators (son engines)	C2	0.0046 lb/hp-hr	200,000 gallons
TV boiler	C3	0.143 lb/mmBtu	20,000 gallons
Kulluk OSR Fleet - OSRV generator	E1	0.0151 lb/hp-hr	45,000 gallons

ORL Equation Constants:	Source ID	Tons of NOx
Kulluk remaining sources	A4	0.8
VI incinerator	B3	0.1
TV remaining sources	C4	0.6
Jim Kilabuk sources	D	1.6
OSR Fleet sources	E2	3.8

Find: (where A1 = Vessel Source Identification EF x fuel consumption value; A2 etc.)

$$\text{Is 245.0 tons} > \frac{137{,}000 \text{ Btu}}{\text{gallon}} \Big| \frac{\text{hp-hr}}{7{,}000 \text{ Btu}} \Big| \frac{\text{ton}}{2{,}000 \text{ lb}} \quad x \quad ((F_{A1}*EF_{A1})+(F_{A2}*EF_{A2})+(F_{B1}*EF_{B1})+(F_{C1}*EF_{C1})+(F_{C2}*EF_{C2})+(F_{E1}*EF_{E1}))$$

$$+ \frac{137{,}000 \text{ Btu}}{\text{gallon}} \Big| \frac{\text{mmBtu}}{10\text{^}6 \text{ Btu}} \Big| \frac{\text{ton}}{2{,}000 \text{ lb}} \quad x \quad ((F_{A3}*EF_{A3})+(F_{B2}*EF_{B2})+(F_{C3}*EF_{C3})) + 0.8 + 0.1 + 0.6 + 1.6 + 3.8 =$$

205.2 tons NOx

Yes, 245 tons is greater than 205.2 tons NOx

Therefore, equation demonstrates compliance with this hypothetical example

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CALCULATIONS

PROJECT TITLE: Shell Kulluk	**BY:** D. Young
PROJECT NO: 180-15	PAGE 1 OF 3 SHEET 7
SUBJECT: Emissions in Tons	**DATE:** 12/22/2006

Kulluk Rig and Associated Vessels (Yr 2008/2009)

EMISSIONS SUMMARY @ EXPECTED MAXIMUM

	Yearly Emissions at any location				
	NOx	CO	PM10	VOC	SO2
Rig / Vessel	tons	tons	tons	tons	tons
Kulluk Rig	35.8	5.9	1.7	1.4	3.4
Vladimir Ignatjuk	117.0	32.2	2.6	5.2	7.5
Nordica/Fennica (2008-2009)	83.0	2.9	1.8	2.9	5.5
Jim Kilabuk (resupply vessel)	1.2	0.3	0.0	0.1	0.1
Kulluk's OSR Fleet	7.9	6.8	0.4	0.9	0.8
	245.0	48.0	6.5	10.5	17.3

Each Source

Kulluk Rig			Yearly Emissions at any location				
	Rated Capacity		NOx	CO	PM10	VOC	SO2
			tons	tons	tons	tons	tons
Main Engine	2,816	Hp	22.91	3.52	1.04	0.71	2.26
Main Engine	2,816	Hp	8.9	1.37	0.4	0.28	0.88
Main Engine	2,816	Hp					
Emergency Generator	920	Hp					
Air Compressor	500	Hp	0.094	0.082	0.005	0.094	0.022
Air Compressor	500	Hp	0.039	0.035	0.002	0.039	0.009
Air Compressor	500	Hp					
HPP Engine	250	Hp	0.093	0.02	0.007	0.008	0.005
HPP Engine	250	Hp	0.093	0.02	0.007	0.008	0.005
Deck Crane	340	Hp	1.834	0.395	0.13	0.148	0.091
Deck Crane	340	Hp	0.69	0.149	0.049	0.056	0.034
Deck Crane	340	Hp	0.69	0.149	0.049	0.056	0.034
Thrustmaster Cat. 3516 B	2,000	Hp	0.048	0.011	0.001	0.001	0.003
Thrustmaster Cat. 3516 B	2,000	Hp	0.048	0.011	0.001	0.001	0.003
Anchor Winches		Electric					
Cementing Unit		Electric					
Logging Diesel Winch	140	Hp	0.18	0.04	0.01	0.01	0.01
Logging Backup Winch Detroit 471	120	Hp					
Heat Boiler	2.4	mmBtu	0.179	0.045	0.03	0.005	0.034
Heat Boiler	2.4	mmBtu					
Hot Water Heat	0.54	mmBtu	0.0133	0.0033	0.002	4E-04	0.0025
Hot Water Heat	0.54	mmBtu					
Incinerator		N/A					
			35.81	5.85	1.73	1.42	3.39

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CALCULATIONS

PROJECT TITLE:	BY:
Shell Kulluk	D. Young
PROJECT NO:	PAGE 2 OF 3
180-15	SHEET 7
SUBJECT:	DATE:
Emissions in Tons	12/22/2006

Kulluk Rig and Associated Vessels (Yr 2008/2009) - Each Source, continued

Vladimir Ignatjuk			Yearly Emissions at any location				
	Rated Capacity		NOx	CO	PM10	VOC	SO2
			tons	tons	tons	tons	tons
Main Engine	5,800	Hp	45.73	10.48	0.76	1.34	2.93
Main Engine	5,800	Hp	45.73	10.48	0.76	1.34	2.93
Main Engine	5,800	Hp	7.52	1.72	0.13	0.22	0.48
Main Engine	5,800	Hp	7.52	1.72	0.13	0.22	0.48
Generator	1,431	Hp	10.34	2.37	0.17	0.3	0.66
Generator	1,431	Hp					
Emergency Generator	292	Hp					
Heat Boiler	2.4	mmBtu	0.081	0.02	0.013	0.002	0.016
Hot Water Heat	0.54	mmBtu	0.0403	0.0101	0.007	0.001	0.0077
Incinerator	0.033	ton/hr	0.05	5.35	0.62	1.78	0.04
			117.01	32.15	2.59	5.20	7.54

Nordica/Fennica (2008-2009)			Yearly Emissions at any location				
	Rated Capacity		NOx	CO	PM10	VOC	SO2
			tons	tons	tons	tons	tons
Main Engine	7,884	Hp	19.6	0.68	0.42	0.68	1.3
Main Engine	7,884	Hp	22.44	0.78	0.48	0.78	1.48
Main Engine	5,913	Hp	23.93	0.83	0.51	0.83	1.58
Main Engine	5,913	Hp	16.83	0.59	0.36	0.59	1.11
Auxiliary Engine	710	Hp					
Emergency Generator	300	Hp					
Heat Boiler	4.44	mmBtu	0.166	0.041	0.027	0.005	0.032
Heat Boiler	4.44	mmBtu	0.081	0.02	0.013	0.002	0.015
Incinerator		N/A					
			83.05	2.94	1.81	2.89	5.52

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CALCULATIONS

	PROJECT TITLE: Shell Kulluk	**BY:** D. Young
	PROJECT NO: 180-15	PAGE 3 OF 3 SHEET 7
CALCULATIONS	**SUBJECT:** Emissions in Tons	**DATE:** 12/22/2006

Kulluk Rig and Associated Vessels (Yr 2008/2009) - Each Source, continued

Jim Kilabuk (resupply vessel)			Yearly Emissions at any location				
	Rated Capacity		NOx	CO	PM10	VOC	SO2
			tons	tons	tons	tons	tons
Main Engine EMD V20 645	3,600	hp	0.52	0.12	0.01	0.02	0.03
Main Engine EMD V20 645	3,600	Hp	0.52	0.12	0.01	0.02	0.03
Generator, Cat. D3406	292	Hp	0.14	0.03	0.01	0.01	0.01
Generator, Cat. D3406	292	Hp					
HPP, Cat. D343	300	Hp					
Bow Thruster Cat. D343	300	Hp	0.056	0.012	0.004	0.005	0.003
			1.24	0.28	0.03	0.06	0.07

Kulluk's OSR Fleet			Yearly Emissions at any location				
	Rated Capacity		NOx	CO	PM10	VOC	SO2
			tons	tons	tons	tons	tons
Engine 1 on OSRV	2,710	Hp	0.53	0.04	0.01	0.06	0.06
Engine 2 on OSRV	2,710	Hp	0.53	0.04	0.01	0.06	0.06
Generator 1 on OSRV	1,285	Hp	5.06	6.27	0.3	0.72	0.52
Generator 2 on OSRV	1,285	Hp					
Emergency generator on OSRV	1,285	Hp	0.068	0.084	0.004	0.01	0.007
Kvichak 34' work boat #1	300	Hp	0.034	0.001	0.001	0.001	0.005
Kvichak 34' work boat #1	300	Hp	0.034	0.001	0.001	0.001	0.005
Kvichak 34' work boat #2	300	Hp	0.034	0.001	0.001	0.001	0.005
Kvichak 34' work boat #2	300	Hp	0.034	0.001	0.001	0.001	0.005
Engine 1 on tug for supply barge	1,500	Hp	0.792	0.182	0.013	0.023	0.051
Engine 2 on tug for supply barge	1,500	Hp	0.792	0.182	0.013	0.023	0.051
			7.91	6.80	0.35	0.90	0.77

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CALCULATIONS

PROJECT TITLE: Shell Kulluk	**BY:** D. Young	
PROJECT NO: 180-15	PAGE 1 OF 1	SHEET 8
SUBJECT: Fuel Use Summary	**DATE:** 12/22/2006	

Drill Rig and Vessel Diesel Fuel Use

Fuel use for Kulluk at any location

Year 2008 or 2009

Rig/Vessel	gallons	cu meter
KULLUK RIG	242,265	917
VLADIMIR IGNATJUK	509,823	1,930
NORDICA/FENNICA	472,586	1,789
JIM KILABUK	5,046	19
Kulluk's OSR Fleet	50,303	190
	1,280,023	4,845

Conversion factor: 264.1721 gal/cubic meter

AIR SCIENCES INC.

CALCULATIONS	**PROJECT TITLE:** Shell Kulluk	**BY:** D. Young
	PROJECT NO: 180-15	PAGE 1 OF 3 SHEET 9
	SUBJECT: Fuel Use & Operating Hours	**DATE:** 12/22/2006

Fuel Use & Operating Hours (Yr 2008/2009)

Kulluk Rig	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Main Engine	2,816	Hp	1,043	150,070
Main Engine	2,816	Hp	405	58,273
Main Engine	2,816	Hp		
Emergency Generator	920	Hp		
Air Compressor	500	Hp	57	1,456
Air Compressor	500	Hp	24	613
Air Compressor	500	Hp		
HPP Engine	250	Hp	24	307
HPP Engine	250	Hp	24	307
Deck Crane	340	Hp	348	6,046
Deck Crane	340	Hp	131	2,276
Deck Crane	340	Hp	131	2,276
Thrustmaster Cat. 3516 B	2,000	Hp	2	204
Thrustmaster Cat. 3516 B	2,000	Hp	2	204
Anchor Winches		Electric		
Cementing Unit		Electric		
Logging Diesel Winch	140	Hp	84	601
Logging Backup Winch Detroit 471	120	Hp		
Heat Boiler	2.4	mmBtu	1,043	18,272
Heat Boiler	2.4	mmBtu		
Hot Water Heat	0.54	mmBtu	345	1,360
Hot Water Heat	0.54	mmBtu		
Incinerator		N/A		
				242,265

*Based on unit capacity, operating hours and diesel fuel heat content of 137,000 mmBtu/gal (AP42). Additionally for an engine the average brake-specific fuel consumption value of 7,000 btu/hp-hr (AP42) was used.

AIR SCIENCES INC.		PROJECT TITLE: Shell Kulluk	BY: D. Young
		PROJECT NO: 180-15	PAGE 2 OF 3 SHEET 9
	CALCULATIONS	SUBJECT: Fuel Use & Operating Hours	DATE: 12/22/2006

Fuel Use & Operating Hours (Yr 2008/2009) - continued

Vladimir Ignatjuk	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Main Engine	5,800	Hp	657	194,702
Main Engine	5,800	Hp	657	194,702
Main Engine	5,800	Hp	108	32,006
Main Engine	5,800	Hp	108	32,006
Generator	1,431	Hp	602	44,010
Generator	1,431	Hp		
Emergency Generator	292	Hp		
Heat Boiler	2.4	mmBtu	473	8,286
Hot Water Heat	0.54	mmBtu	1,043	4,111
Incinerator	0.033	ton/hr	1,080	
				509,823

Nordica/Fennica (2008-2009)	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Main Engine	7,884	Hp	263	105,945
Main Engine	7,884	Hp	301	121,252
Main Engine	5,913	Hp	428	129,309
Main Engine	5,913	Hp	301	90,939
Auxiliary Engine	710	Hp		
Emergency Generator	300	Hp		
Heat Boiler	4.44	mmBtu	522	16,912
Heat Boiler	4.44	mmBtu	254	8,229
Incinerator		N/A		
				472,586

*Based on unit capacity, operating hours and diesel fuel heat content of 137,000 mmBtu/gal (AP42). Additionally for an engine the average brake-specific fuel consumption value of 7,000 btu/hp-hr (AP42) was used.

Fuel Use & Operating Hours (Yr 2008/2009) - continued

Jim Kilabuk (resupply vessel)	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Main Engine EMD V20 645	3,600	hp	12	2,207
Main Engine EMD V20 645	3,600	Hp	12	2,207
Generator, Cat. D3406	292	Hp	30	448
Generator, Cat. D3406	292	Hp		
HPP, Cat. D343	300	Hp		
Bow Thruster Cat. D343	300	Hp	12	184
				5,046

Kulluk's OSR Fleet	Rated Capacity		Equivalent Operating Hours	Fuel Use* Gallons
Engine 1 on OSRV	2,710	Hp	27	3,739
Engine 2 on OSRV	2,710	Hp	27	3,739
Generator 1 on OSRV	1,285	Hp	522	34,273
Generator 2 on OSRV	1,285	Hp		
Emergency generator on OSRV	1,285	Hp	7	460
Kvichak 34' work boat #1	300	Hp	22	337
Kvichak 34' work boat #1	300	Hp	22	337
Kvichak 34' work boat #2	300	Hp	22	337
Kvichak 34' work boat #2	300	Hp	22	337
Engine 1 on tug for supply barge	1,500	Hp	44	3,372
Engine 2 on tug for supply barge	1,500	Hp	44	3,372
				50,303

*Based on unit capacity, operating hours and diesel fuel heat content of 137,000 mmBtu/gal (AP42). Additionally for an engine the average brake-specific fuel consumption value of 7,000 btu/hp-hr (AP42) was used.

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Emission Factors (Yr 2008/2009)

Kulluk Rig		rating		NOx	CO	PM10	VOC	SO2
		unit	EF category			(lb/hp-hr or lb/mmBtu)		
Main Engine	2,816	Hp	Kulluk main engines (adj.)	0.0156	0.0024	0.000705	0.000485	0.0015371
Main Engine	2,816	Hp	Kulluk main engines (adj.)	0.0156	0.0024	0.000705	0.000485	0.0015371
Main Engine	2,816	Hp	Kulluk main engines (adj.)					
Emergency Generator	920	Hp	ICE >600 hp AP42					
Air Compressor	500	Hp	Air compressors	0.00658	0.00575	0.000329	0.00658	0.0015371
Air Compressor	500	Hp	Air compressors	0.00658	0.00575	0.000329	0.00658	0.0015371
Air Compressor	500	Hp	Air compressors					
HPP Engine	250	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
HPP Engine	250	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Deck Crane	340	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Deck Crane	340	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Deck Crane	340	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Thrustmaster Cat. 3516 B	2,000	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Thrustmaster Cat. 3516 B	2,000	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Anchor Winches		Electric	Not Applicable					
Cementing Unit		Electric	Not Applicable					
Logging Diesel Winch	140	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Logging Backup Winch Detroit 471	120	Hp	ICE <=600 hp AP42					
Heat Boiler	2.4	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Heat Boiler	2.4	mmBtu	Boiler <100 mmBtu AP42					
Hot Water Heat	0.54	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Hot Water Heat	0.54	mmBtu	Boiler <100 mmBtu AP42					
Incinerator		N/A	Not Applicable					

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Emission Factors (Yr 2008/2009) - continued

Vladimir Ignatjuk		rating		NOx	CO	PM10	VOC	SO2
		unit	EF category		(lb/hp-hr or lb/mmBtu)			
Main Engine	5,800	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Main Engine	5,800	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Main Engine	5,800	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Main Engine	5,800	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Generator	1,431	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Generator	1,431	Hp	ICE >600 hp AP42					
Emergency Generator	292	Hp	ICE <=600 hp AP42					
Heat Boiler	2.4	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Hot Water Heat	0.54	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Incinerator	0.033	ton/hr	Shipboard incinerator. AP42	3	300	35	100	2.5

Nordica/Fennica (2008-2009)		rating		NOx	CO	PM10	VOC	SO2
		unit	EF category		(lb/hp-hr or lb/mmBtu)			
Main Engine	7,884	Hp	Fennica/Nordica main engines	0.01891	0.000658	0.000401	0.000658	0.0012502
Main Engine	7,884	Hp	Fennica/Nordica main engines	0.01891	0.000658	0.000401	0.000658	0.0012502
Main Engine	5,913	Hp	Fennica/Nordica main engines	0.01891	0.000658	0.000401	0.000658	0.0012502
Main Engine	5,913	Hp	Fennica/Nordica main engines	0.01891	0.000658	0.000401	0.000658	0.0012502
Auxiliary Engine	710	Hp	ICE >600 hp AP42					
Emergency Generator	300	Hp	ICE <=600 hp AP42					
Heat Boiler	4.44	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Heat Boiler	4.44	mmBtu	Boiler <100 mmBtu AP42	0.143	0.0357	0.0236	0.00397	0.02736
Incinerator		N/A	Not Applicable					

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Emission Factors (Yr 2008/2009) - continued

Jim Kilabuk (resupply vessel)		rating		NOx	CO	PM10	VOC	SO2
		unit	EF category			(lb/hp-hr or lb/mmBtu)		
Main Engine EMD V20 645	3,600	hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Main Engine EMD V20 645	3,600	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Generator, Cat. D3406	292	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371
Generator, Cat. D3406	292	Hp	ICE <=600 hp AP42					
HPP, Cat. D343	300	Hp	ICE <=600 hp AP42					
Bow Thruster Cat. D343	300	Hp	ICE <=600 hp AP42	0.031	0.00668	0.0022	0.00251	0.0015371

Kulluk's OSR Fleet		rating		NOx	CO	PM10	VOC	SO2
		unit	EF category			(lb/hp-hr or lb/mmBtu)		
Engine 1 on OSRV	2,710	Hp	OSRV main engine	0.0146	0.0012	0.00028	0.00163	0.0015371
Engine 2 on OSRV	2,710	Hp	OSRV main engine	0.0146	0.0012	0.00028	0.00163	0.0015371
Generator 1 on OSRV	1,285	Hp	OSRV generator	0.0151	0.0187	0.00089	0.00214	0.0015371
Generator 2 on OSRV	1,285	Hp	OSRV generator					
Emergency generator on OSRV	1,285	Hp	OSRV generator	0.0151	0.0187	0.00089	0.00214	0.0015371
Kvichak 34' work boat #1	300	Hp	Kvic. 34' vessel engine	0.01024	0.000171	0.000169	0.000342	0.0015371
Kvichak 34' work boat #1	300	Hp	Kvic. 34' vessel engine	0.01024	0.000171	0.000169	0.000342	0.0015371
Kvichak 34' work boat #2	300	Hp	Kvic. 34' vessel engine	0.01024	0.000171	0.000169	0.000342	0.0015371
Kvichak 34' work boat #2	300	Hp	Kvic. 34' vessel engine	0.01024	0.000171	0.000169	0.000342	0.0015371
Engine 1 on tug for supply barge	1,500	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371
Engine 2 on tug for supply barge	1,500	Hp	ICE >600 hp AP42	0.024	0.0055	0.000401	0.000705	0.0015371

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Hourly Emissions (Yr 2008/2009)

Kulluk Rig	Rated Capacity		NOx	CO	PM10	VOC	SO2
			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr
Main Engine	2,816	Hp	43.9296	6.7584	1.98528	1.36576	4.3284736
Main Engine	2,816	Hp	43.9296	6.7584	1.98528	1.36576	4.3284736
Main Engine	2,816	Hp					
Emergency Generator	920	Hp					
Air Compressor	500	Hp	3.29	2.875	0.1645	3.29	0.76855
Air Compressor	500	Hp	3.29	2.875	0.1645	3.29	0.76855
Air Compressor	500	Hp					
HPP Engine	250	Hp	7.75	1.67	0.55	0.6275	0.384275
HPP Engine	250	Hp	7.75	1.67	0.55	0.6275	0.384275
Deck Crane	340	Hp	10.54	2.2712	0.748	0.8534	0.522614
Deck Crane	340	Hp	10.54	2.2712	0.748	0.8534	0.522614
Deck Crane	340	Hp	10.54	2.2712	0.748	0.8534	0.522614
Thrustmaster Cat. 3516 B	2,000	Hp	48	11	0.802	1.41	3.0742
Thrustmaster Cat. 3516 B	2,000	Hp	48	11	0.802	1.41	3.0742
Anchor Winches		Electric					
Cementing Unit		Electric					
Logging Diesel Winch	140	Hp	4.34	0.9352	0.308	0.3514	0.215194
Logging Backup Winch Detroit 471	120	Hp					
Heat Boiler	2.4	mmBtu	0.3432	0.08568	0.05664	0.009528	0.065664
Heat Boiler	2.4	mmBtu					
Hot Water Heat	0.54	mmBtu	0.07722	0.019278	0.012744	0.0021438	0.0147744
Hot Water Heat	0.54	mmBtu					
Incinerator		N/A					

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Hourly Emissions (Yr 2008/2009) - continued

Vladimir Ignatjuk	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Main Engine	5,800	Hp	139.2	31.9	2.3258	4.089	8.91518
Main Engine	5,800	Hp	139.2	31.9	2.3258	4.089	8.91518
Main Engine	5,800	Hp	139.2	31.9	2.3258	4.089	8.91518
Main Engine	5,800	Hp	139.2	31.9	2.3258	4.089	8.91518
Generator	1,431	Hp	34.3392	7.8694	0.573751	1.008714	2.19928268
Generator	1,431	Hp					
Emergency Generator	292	Hp					
Heat Boiler	2.4	mmBtu	0.3432	0.08568	0.05664	0.009528	0.065664
Hot Water Heat	0.54	mmBtu	0.07722	0.019278	0.012744	0.0021438	0.0147744
Incinerator	0.033	ton/hr	0.099	9.9	1.155	3.3	0.0825

Nordica/Fennica (2008-2009)	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Main Engine	7,884	Hp	149.08644	5.187672	3.161484	5.187672	9.8565768
Main Engine	7,884	Hp	149.08644	5.187672	3.161484	5.187672	9.8565768
Main Engine	5,913	Hp	111.81483	3.890754	2.371113	3.890754	7.3924326
Main Engine	5,913	Hp	111.81483	3.890754	2.371113	3.890754	7.3924326
Auxiliary Engine	710	Hp					
Emergency Generator	300	Hp					
Heat Boiler	4.44	mmBtu	0.634737	0.158462	0.104754	0.0176217	0.12144338
Heat Boiler	4.44	mmBtu	0.634737	0.158462	0.104754	0.0176217	0.12144338
Incinerator		N/A					

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Hourly Emissions (Yr 2008/2009) - continued

Jim Kilabuk (resupply vessel)	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Main Engine EMD V20 645	3,600	hp	86.4	19.8	1.4436	2.538	5.53356
Main Engine EMD V20 645	3,600	Hp	86.4	19.8	1.4436	2.538	5.53356
Generator, Cat. D3406	292	Hp	9.052	1.95056	0.6424	0.73292	0.4488332
Generator, Cat. D3406	292	Hp					
HPP, Cat. D343	300	Hp					
Bow Thruster Cat. D343	300	Hp	9.3	2.004	0.66	0.753	0.46113

Kulluk's OSR Fleet	Rated Capacity		NOx lb/hr	CO lb/hr	PM10 lb/hr	VOC lb/hr	SO2 lb/hr
Engine 1 on OSRV	2,710	Hp	39.566	3.252	0.7588	4.4173	4.165541
Engine 2 on OSRV	2,710	Hp	39.566	3.252	0.7588	4.4173	4.165541
Generator 1 on OSRV	1,285	Hp	19.4035	24.0295	1.14365	2.7499	1.9751735
Generator 2 on OSRV	1,285	Hp					
Emergency generator on OSRV	1,285	Hp	19.4035	24.0295	1.14365	2.7499	1.9751735
Kvichak 34' work boat #1	300	Hp	3.072	0.0513	0.0507	0.1026	0.46113
Kvichak 34' work boat #1	300	Hp	3.072	0.0513	0.0507	0.1026	0.46113
Kvichak 34' work boat #2	300	Hp	3.072	0.0513	0.0507	0.1026	0.46113
Kvichak 34' work boat #2	300	Hp	3.072	0.0513	0.0507	0.1026	0.46113
Engine 1 on tug for supply barge	1,500	Hp	36	8.25	0.6015	1.0575	2.30565
Engine 2 on tug for supply barge	1,500	Hp	36	8.25	0.6015	1.0575	2.30565

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SUBJECT: List of Emission Factors (Yr 2008/2009)		**DATE:** 12/22/2006	

List of Emission Factors (Yr 2008/2009)

Emissions Unit	**Emission Factors**							**Reference**
	EF Unit	NOx	CO	PM10	VOC	SO2 value x S	SO2^ 0.19 = S	
Air compressors	lb/hp-hr	0.00658	0.00575	0.000329	0.00658	0.0015371	0.00809 S	Tier 3, (planned). 225 to 450kw range. 500hp = 373kW: NOx & VOC use NOX+NMHC value, CO, & PM. AP42: SO2.
Boiler <100 mmBtu AP42	lb/mmBtu	0.143	0.0357	0.0236	0.00397	0.02736	*0.144 S*	AP42 Tbl 1.3-1: NOx, CO, & SO2, Tbls 1.3-1 & 1.3-2; PM, and Tbl 1.2-3; VOC. 9/98
Fennica/Nordica main engines	lb/hp-hr	0.01891	0.000658	0.000401	0.000658	0.0012502	0.00658 S	Client provided data: NOx, CO, VOC, & SO2. AP42: PM.
ICE <=600 hp AP42	lb/hp-hr	0.031	0.00668	0.0022	0.00251	0.0015371	0.00809 S	AP42 Tbl 3.3-1, 10/96
ICE >600 hp AP42	lb/hp-hr	0.024	0.0055	0.000401	0.000705	0.0015371	0.00809 S	AP42 Tbls 3.4-1 & 3.4-2 10/96
Kulluk main engines (adj.)	lb/hp-hr	0.016	0.0024	0.000705	0.000485	0.0015371	0.00809 S	Spec for CBO Injectors, adjusted by 1.2: NOx, CO, PM, & VOC. AP42: SO2.
Kvic. 34' vessel engine	lb/hp-hr	0.01024	0.000171	0.000169	0.000342	0.0015371	0.00809 S	Cummins data: NOx, CO, PM10, & VOC. AP42: SO2.
Not Applicable		0	0	0	0	0		
OSRV generator	lb/hp-hr	0.0151	0.0187	0.00089	0.00214	0.0015371	0.00809 S	Tier 1 2000-2005 (vendor Cat data): NOx, CO, PM10, & VOC. AP42: SO2.
OSRV main engine	lb/hp-hr	0.0146	0.0012	0.00028	0.00163	0.0015371	0.00809 S	Client provided Cat data: NOx, CO, PM10, & VOC. AP42: SO2.
Shipboard incinerator. AP42	lb/ton	3	300	35	100	2.5		AP42 Tbl 2.1-12, Industrial/commercial and Domestic single chamber (largest factor of four) 10/96.

^ SO2 emission factor is based on S; the percent sulfur by weight in the fuel. For example the value of S would be 0.5 if the sulfur content is 0.5%. AP42 Tbl 3.4-1, 10/96

Sulfur in fuel by wgt. 1900 ppm is 0.19 % S

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	Owner Requested Limit (ORL)	12/28/2006

Shell Kulluk Owner Requested Limit (ORL) with Nordica/Fennica - Fleet wide Diesel Fuel Consumption

General ORL NOx Compliance Equation: $E_A + E_B + E_C + E_D + E_E$ < 245 tons NOx

Where:

E_A =	Emissions from Shell Kulluk	Vessel A
E_B =	Emissions from Vladimir Ignatjuk	Vessel B
E_C =	Emissions from Nordica/Fennica	Vessel C
E_D =	Emissions from Jim Kilabuk	Vessel D
E_E =	Emissions from Shell Kulluk OSR Fleet	Vessel E

Specific ORL NOx Compliance Equation:

$$K_{RICE}*((F_{A1}*EF_{A1})+(F_{A2}*EF_{A2})+(F_{B1}*EF_{B1})+(F_{C1}*EF_{C1})+(F_{E1}*EF_{E1}))+K_{HEAT}*((F_{A3}*EF_{A3})+(F_{B2}*EF_{B2})+(F_{C2}*EF_{C2}))+0.6+0.1+1.2+2.8 < 245 \text{ tons}$$

where

K_{RICE} = 137,000 / 7,000 / 2,000 = 0.00979 Hp-hr-ton / gal-lb

K_{HEAT} = 137,000 / 1,000,000 / 2,000 = 0.0000685 mmBtu-ton / gal-lb

F_i = Fuel consumption by source group i (gallons)

EF_i = Emission factor by source group i

0.8 tons	Shell Kulluk remaining emissions
0.1 tons	Vladimir Ignatjuk incinerator emissions
0.6 tons	Tor Viking II remaining emissions
1.6 tons	Jim Kilabuk emissions
3.8 tons	OSR Fleet remaining emissions

137,000	Btu/gallon	AP42 diesel fuel heat content
7,000	Btu/hp-hr	AP42 average brake-specific fuel consumption
2,000	lb/ton	Conversion factor
1,000,000	Btu/mmBtu	Conversion factor

Example Calculation of NOx Emissions and Comparison with ORL

ORL Equation Variables:	Vessel Source Identification	NOx Emission Factor (EF)		Assumed Diesel Fuel Consumption (F)	
Kulluk main drilling engines	A1	0.0156	lb/hp-hr	200,000	gallons
Kulluk deck crane engines	A2	0.031	lb/hp-hr	10,000	gallons
Kulluk boilers/hot water heaters	A3	0.143	lb/mmBtu	20,000	gallons
VI main propulsion engines/generators	B1	0.024	lb/hp-hr	450,000	gallons
VI boiler/hot water heater	B2	0.143	lb/mmBtu	10,000	gallons
N/F four main propulsion engines	C1	0.0189	lb/hp-hr	350,000	gallons
N/F two boilers	C2	0.143	lb/mmBtu	20,000	gallons
Kulluk OSR Fleet - OSRV generator	E1	0.0151	lb/hp-hr	30,000	gallons

ORL Equation Constants:	Source ID	Tons of NOx
Kulluk remaining sources	A4	0.6
VI incinerator	B3	0.1
Jim Kilabuk sources	D	1.2
OSR Fleet sources	E2	2.8

Find: (where A1 = Vessel Source Identification EF x fuel consumption value; A2 etc.)

$$\text{Is 245.0 tons} > \frac{137{,}000\text{ Btu}}{\text{gallon}}\left|\frac{\text{hp-hr}}{7{,}000\text{ Btu}}\right|\frac{\text{ton}}{2{,}000\text{ lb}} \quad x \quad ((F_{A1}*EF_{A1})+(F_{A2}*EF_{A2})+(F_{B1}*EF_{B1})+(F_{C1}*EF_{C1})+(F_{E1}*EF_{E1}))$$

$$+ \frac{137{,}000\text{ Btu}}{\text{gallon}}\left|\frac{\text{mmBtu}}{10^{\wedge}6\text{ Btu}}\right|\frac{\text{ton}}{2{,}000\text{ lb}} \quad x \quad ((F_{A3}*EF_{A3})+(F_{B2}*EF_{B2})+(F_{C2}*EF_{C2})) + 0.6 + 0.1 + 1.2 + 2.8 =$$

213.7 tons NOx

Yes, 245 tons is greater than 213.7 tons NOx

Therefore, equation demonstrates compliance with this hypothetical example

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PROJECT NO: 180-15	PAGE 1 OF 2 SHEET 13
SUBJECT: HAPs	**DATE:** 12/12/2006

HAZARDOUS AIR POLLUTANTS (HAPs), as defined pursuant to Section 112(b) of the Clean Air Act.

To simplify the estimate of emission; a yearly fuel use value is set at a more than the proposed total fuel use limitation and conservatively applied to each set of emission factors.

HAPs - Fuel Oil Combustion; Engines

The estimated maximum amount of diesel fuel combusted by the engines larger than 600 hp, expressed in units of heat input:

2,000,000 gallons	137,000 Btu*	MMBtu	=	274,000 MMBtu/Yr
year	gallons	1,000,000 Btu		

*AP-42 Appendix A, Diesel heating value, 9/85.

The estimated HAP emissions from IC engines with >600 hp output:

HAP	Emission Factor lb/MMBtu*	**Emissions** lb/yr	**Emissions** ton/yr
Benzene	7.76E-04	212.6	0.106
Toluene	2.81E-04	77.0	0.038
Xylenes	1.93E-04	52.9	0.026
Formaldehyde	7.89E-05	21.6	0.011
Acetaldehyde	2.52E-05	6.9	0.003
Acrolein	7.88E-06	2.2	0.001
Naphthalene	1.30E-04	35.6	0.018
Total PAH**	8.20E-05	22.5	0.011
			0.216

*AP-42, Stationary IC sources, Table 3.4-3.

**Emission factor excludes the already accounted for naphthalene.

The estimated maximum amount of diesel fuel combusted by the engines equal to or less than 600 hp, expressed in units of heat input:

2,000,000 gallons	137,000 Btu*	MMBtu	=	274,000 MMBtu/Yr
year	gallons	1,000,000 Btu		

*AP-42 Appendix A, Diesel heating value, 9/85.

The estimated HAP emissions from IC engines with ≤600 hp output:

HAP	Emission Factor lb/MMBtu*	**Emissions** lb/yr	**Emissions** ton/yr
Benzene	9.33E-04	255.6	0.1278
Toluene	4.09E-04	112.1	0.0560
Xylenes	2.85E-04	78.1	0.0390
Propylene	2.58E-03	706.9	0.3535
1,3-Butadiene	3.91E-05	10.7	0.0054
Formaldehyde	1.18E-03	323.3	0.1617
Acetaldehyde	7.67E-04	210.2	0.1051
Acrolein	9.25E-05	25.3	0.0127
Naphthalene	8.48E-05	23.2	0.0116
Total PAH**	8.32E-05	22.8	0.0114
			0.884

*AP-42, Stationary IC sources, Table 3.3-2.

**Emission factor excludes the already accounted for naphthalene.

AIR SCIENCES INC.	CALCULATIONS	PROJECT TITLE: Shell Kulluk	BY: D. Young
		PROJECT NO: 180-15	PAGE 2 OF 2 SHEET 13
		SUBJECT: HAPs	DATE: 12/12/2006

HAZARDOUS AIR POLLUTANTS (HAPs), as defined pursuant to Section 112(b) of the Clean Air Act - continued

HAPs - Fuel Oil Combustion; Boilers

The estimated maximum amount of diesel fuel combusted by boilers, expressed in units of heat input:

2,000,000 gallons	137,000 Btu*	MMBtu	=	274,000 MMBtu/Yr
year	gallons	1,000,000 Btu		

*AP-42 Appendix A, Diesel heating value, 9/85.

The estimated HAP emissions from boilers:

HAP	Emission Factor lb/1000 gal*	Emissions lb/yr	 ton/yr
POM	3.30E-03	6.6	0.0033
Formaldehyde	6.10E-02	122.0	0.0610
	lb/10^{12} Btu**		
Arsenic	4	1.1	0.00055
Beryllium	3	0.8	0.00041
Cadmium	3	0.8	0.00041
Chromium	3	0.8	0.00041
Lead	9	2.5	0.00123
Mercury	3	0.8	0.00041
Manganese	6	1.6	0.00082
Nickel	3	0.8	0.00041
Selenium	15	4.1	0.00206
			0.071

*AP-42, External Combustion Sources, Table 1.3-8, Distillate Oil, 9/98.
**AP-42, External Combustion Sources, Table 1.3-10, Distillate Oil, 9/98.

HAPs - Summary

1.171 TPY. Total emissions of all HAPs from all diesel fueled sources.

Shell Kulluk Main Drilling Engines Emission Factors

Kulluk Prime Mover Emissions Performance of Several Injector Alternatives

Assumptions:

1. Information from Dave Panting Letter of 4/19, email of 5/16
2. CBOI injectors increase the amount of visible smoke at less than 100 percent load.
3. Units are grams/BHP/Hr

Load Range	**PM**	**NOx**	**CO**	**HC**
Original Configuation				
100%	0.27	11.00	1.66	0.18
75%	0.30	13.66	0.18	0.23
50%	0.37	13.99	0.16	0.33
25%	0.44	15.21	0.49	0.70
1993 Modification (Current Performance)				
100%	0.30	7.70	1.83	0.20
75%	0.33	9.56	0.20	0.25
50%	0.41	9.79	0.18	0.36
25%	0.48	10.65	0.54	0.77
CBOI Injectors				
100%	0.27	5.90	0.91	0.18
75%	0.30	6.30	0.33	0.20
50%	0.37	7.49	0.22	0.37
25%	0.44	9.99	0.52	0.76

Tor Viking II Engines Emission Factors

ME, Christer André

2000-02-25

Report No M1898004 / 00-02

Emission measurements on board MV Tor Viking II - Havyard Leirvik NB 282.

Summary

The vessel is fitted with catalytic exhaust emission control, (ABB SCR Converter System) on all main- and auxiliary engines with following configuration:

Engine No	Engine Type	Location
ME 1	MaK 6M32	Starboard outer
ME 2	MaK 8M32	Starboard inner
ME 3	MaK 8M32	Port inner
ME 4	MaK 6M32	Port outer
AE 1	Caterpillar 3412	Starboard
AE 2	Caterpillar 3412	Port

The system consist of a SCR (Selective Catalytic Reduction) stage for NO_x reduction, and an Oxidation stage for reduction of un-completely burned fuel species such as CO, HC and Soot. The SCR stage use Urea as reagent.

The contractor carried out emission measurement during commissioning period at shiyard (2000-02-10) and at sea trials (2000-02-18). A summary of the results is presented in the table below.

Chemical species	Sort	ME 1 & 4	ME 2 & 3	AE	Comment
NO_x after SCR	g/kWh	1,2	1,8	1,4	Minimum
Reduction of CO	%	35	36	89	See comment below
Ammonium slip	ppm	< 2	< 2	< 2	
Urea consumption	l/h	29	40	5,4	At 3,0 g/kWh NO_x emission

Comments:

1. This summary shows minimum measured NO_x level after SCR. During commissioning the plant was finaly adjusted according detailed tables below. It is possible to adjust the plant to achive NO_x reduction down to above minimum values.
2. CO reduction for main engines is low due to very low CO content before SCR. Compare wit AE values.
3. Exhaust temperature from main engines are very low and close to lower limit for urea injection. This means risk for HC accumulation which may lead to rising pressure drop and loss of efficiency of the installation.
4. Ammonium slip was below detection limit, 2 ppm.

ABB Fläkt Marine AB

Postal Address
ABB Fläkt Marine AB
P.O. Box 1043
S-436 21 ASKIM
Sweden

Street Address
Ekonomivägen 3-5
ASKIM
Gothenburg

Telephone National 031-709 22 00 International +46 31 709 22 00
Telefax National 031-28 42 89 International +46 31 28 42 89

Bank Giro Account
240-7641

Postal Giro Account
2585 42-0

Bank
SE Banken, Stockholm
Account
5037-1193567
Swift Address
ESSESESS

Instrumentation

Portable exhaust emission analysers were used according to specification below. The instruments were calibrated with span gas before the measurements started. Zero calibration was carried out between every measuring cycle.

Make	**Type**	**Parameters**	**Range**	**Accuracy**	**Method**
ECOM	KD	O_2	0-21 %	± 0,1%	Electrochemical
		CO	0-4000 ppm	± 16 ppm	Electrochemical
		NO	0-2000 ppm	± 8 ppm	Electrochemical
		NO_2	0-200 ppm	± 10 ppm	Electrochemical
		Soot	0-10 Bacharach	± 0,5	Visual
Testo	300M	O_2	0-21 %	± 0,2 %	Electrochemical
		CO	0-3000 ppm	± 20 ppm	Electrochemical
		NO	0-3000 ppm	-100 ppm: ± 5ppm -2000 ppm: ± 5 %	Electrochemical
Dräger	accuro	NH_3	2-30 ppm	± 15%	Chemical / Visual

Results for the Main Engine SCR Converter System

Detailed measurements were carried out for one of the main engine of each type. Check values from the other engines showed similar results.

Date for tests	2000-02-18				
Ship	Kvaerner Leirvik, NB 282				
Fuel	Gas Oil, 0,1% Sulphur				
		ME 1	**ME 2**	**ME 3**	**ME 4**
Load	%	84	83	80	82
Speed	rpm	600	600	600	600
Diff. Pressure	kPa	0,6	0,5	0,5	0,4
Measured emissions					
	Before SCR				
NO_X	ppm	795	812	831	881
CO	ppm	44	48	49	43
Exhaust temp	°C	268	274	281	290
	After SCR				
NO_X	ppm	244	210	255	239
CO	ppm	28	31	31	29
Ammonia slip	ppm	< 2	< 2	< 2	< 2
Exhaust temp	°C	264	268	262	268
Urea flow, 40%	l/h	28,0	38,5	42,0	30,5
Calculated emissions					
Adjusted values NO_X	g / kWh	2,8	3,1	3,8	2,8
Minimum values NO_X	g / kWh	1,2	1,8	1,8	1,2
CO reduction	%	36	35	37	33

Results for the Auxiliary Engine SCR Converter System

Detailed measurements were carried out for one of the auxiliary engines only. Check values from the other engine showed similar results.

Date for tests	2000-02-10		
Ship	Kvaerner Leirvik, NB 282		
Fuel	Gas Oil, 0,1% Sulphur		
		AE 1	**AE 2**
Load	%	75	75
Speed	rpm	1500	1500
Diff. Pressure	kPa	0,6	0,5
Measured emissions			
	Before SCR		
NO_x	ppm	1502	1320
CO	ppm	266	392
Exhaust temp	°C	366	364
	After SCR		
NO_x	ppm	250	230
CO	ppm	35	36
Ammonia slip	ppm	< 2	< 2
Exhaust temp	°C	365	348
Urea flow, 40%	l/h	5,5	5,3
Calculated emissions			
Adjusted values NO_x	g / kWh	2,3	2,1
Minimum values NO_x	g / kWh	1,4	1,4
CO reduction	%	87	91

/end of document

2000-02-15 / CA

ABB SCR Converter^{TM} System

Test protocol

Yard Kvaerner Leirvik
NB 282
Name Tor Viking
Owner B&N Viking AS

ABB project no M1898004

		ME 1	**ME 2**	**ME 3**	**ME 4**	**AE 1**	**AE 2**
Type of engine		MaK 6M32	MaK 8M32	MaK 8M32	MaK 6M32	Caterpillar 3412	Caterpillar 3412
Power at 100% MCR	kW	2 880	3 840	3 840	2 880	430	430
Engine load	%	84	83	80	82	75	75
NO_x before converter	ppm	795	812	831	881	1502	1320
NO_x after converter	ppm	244	210	255	239	250	230
Urea consumption	l / h	28	38,5	42	30,5	5,5	5,3
CO before converter	ppm	44	48	49	43	266	392
CO after converter	ppm	28	31	31	29	35	36
Ammonium slip actual	ppm	0	0	0	0	0	0
Test date		00-02-19	00-02-18	00-02-18	00-02-18	00-02-10	00-02-10
Owner / Shipyard representative							
ABB representative							
Mak representative		J. Cordsen	J. Cordsen	J. Cordsen	J. Cordsen		

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Test_values.xls

Primary values

AIR SCIENCES INC.
DENVER • PORTLAND

Air Sciences Inc.

CALCULATIONS

PROJECT TITLE: OCS - Beaufort Sea	**BY:** D. Young	
PROJECT NO: 180-15	PAGE 1 OF 2	SHEET 0
SUBJECT: Tor Viking II	**DATE:** 10/18/2006	

Review emissions control for CO and NOx, and calculate NOx emission factors ("EF")

Main Engines ("ME") Emissions Reduction

	Referance
SCR for NOx control	(1)
Oxidation Catalyst for CO, HC and soot control.	(1)

NOx - PPM

	ME1	ME4	ME2	ME3	
Engine	MaK 6M32	MaK 6M32	MaK 8M32	MaK 8M32	(1)
Before - Control	795	881	812	831	(1)
After - Control	244	239	210	255	(1)
NOx Reduction (%)	69%	73%	74%	69%	

CO - PPM

	ME1	ME4	ME2	ME3	
Before - Control	44	43	48	49	(1)
After - Control	28	29	31	31	(1)
CO Reduction (%)	36%	33%	35%	37%	

NOx Emissions post control

	ME1	ME4	ME2	ME3	
g/kwh	2.8	2.8	3.1	3.8	(1) "Adjusted values"
lb/kwh	0.00617	0.00617	0.00683	0.00838	(2)
lb/hp-h	0.0046	0.0046	0.0051	0.00625	(3)
EF lb/hp-h	*0.00460*	*0.00460*	*0.00510*	*0.00625*	*Round to* 5
EF to g/kwh	2.8	2.8	3.1	3.8	
Delta %	-0.07%	-0.07%	0.07%	0.05%	To use EF the Delta ≤ ±0.25%.

NOx Emissions pre-control

	ME1	ME4	ME2	ME3	
EF lb/hp-h	0.00460	0.00460	0.00510	0.00625	From above calculation.
NOx Reduction %	69%	73%	74%	69%	From above calculation
EF lb/hp-h (pre-SCR)	0.015	0.017	0.020	0.020	

Referance(s)

(1) ABB Feb 25 2000, emissions test summary report. Commreport282.pdf

(2) 453.6 g/lb
(3) 1.341 hp/kw

AIR SCIENCES INC. DENVER • PORTLAND	**Air Sciences Inc.** **CALCULATIONS**	**PROJECT TITLE:** OCS - Beaufort Sea	**BY:** D. Young
		PROJECT NO: 180-15	PAGE 2 OF 2 SHEET 0
		SUBJECT: Tor Viking II	**DATE:** 10/18/2006

Auxiliary Engines ("AE") Emissions Reduction

	Referance
SCR for NOx control	(1)
Oxidation Catalyst for CO, HC and soot control.	(1)

NOx - PPM

	AE1	AE2	
Engine	Cat 3412	Cat 3412	(1)
Before - Control	1502	1320	(1)
After - Control	250	230	(1)
Reduction (%)	83%	83%	

CO - PPM

	AE1	AE2	
Before - Control	266	392	(1)
After - Control	35	36	(1)
Reduction (%)	87%	91%	

NOx Emissions post control

	AE1	AE2	
g/kwh	2.3	2.1	(1) "Adjusted values"
lb/kwh	0.00507	0.00463	(2)
lb/hp-h	0.00378	0.00345	(3)
EF lb/hp-h	*0.00378*	*0.00345*	*Round to* 5
EF to g/kwh	2.3	2.1	
Delta %	-0.03%	-0.07%	To use EF the Delta ≤ ±0.25%.

NOx Emissions pre-control

	AE1	AE2	
EF lb/hp-h	0.00378	0.00345	From above calculation.
NOx Reduction %	83%	83%	From above calculation
EF lb/hp-h (pre-SCR)	0.023	0.020	

Fennica/Nordica Main Engines Emission Factors

-----Original Message-----
From: Niemelä Helena [mailto:Helena.Niemela@finstaship.fi]
Sent: Wednesday, October 25, 2006 10:33 AM
To: Craik, Keith KM SIEP-EPW
Cc: Power, Alan T SEPCO; Kondratjeff Peter
Subject: Emissions

Keith,

I trust you have already received this report of Viking’s and the information about Fennica´s emissions, but I’m still sending them just in case.

Emissions

Engine loads	100 %	75 %	50 %
No_x [g/kWh]	11,5	12	11,5
CO [g/kWh]	0,4	0,45	0,6
THC as CH_4 [g/kWh]	0,4	0,6	0,8
CO_2 [g/kWh]	620	620	645
SO_2 [g/kWh]*	2	2	2

* Sulphur content of fuel is 0,5%

Could you please tell me if you have some sort of a plan concerning the emission minimizing in any way? Could you in any way prioritise the emissions? This would help us in order to plan and inquire more information about any possible modifications or installations etc to Fennica.

Regards,
Helena

Helena Niemelä
FINSTASHIP / Offshore
e-mail: helena.niemela@finstaship.fi
tel. +358 306 20 7108
mob. +358 46 876 7108

OSRV Main Engines Emission Factors

3608

DIESEL ENGINE TECHNICAL DATA

CATERPILLAR®

Marine RATING: Industrial 10/11/2006

ENGINE SPEED (rpm): 1000
COMPRESSION RATIO: 13:1
AFTERCOOLER WATER (°C): 50
JACKET WATER OUTLET (°C): 90
IGNITION SYSTEM: MUI
EXHAUST MANIFOLD: DRY

TURBOCHARGER PART #: 194-8722
FUEL TYPE: Distillate

RATING	NOTES	LOAD		100%	75%	50%
ENGINE POWER	(2)	bkW		2710	2033	1355

ENGINE DATA						
FUEL CONSUMPTION (ISO 3046/1)	**(1)**	**g/bkw-hr**		**198.7**	**197.6**	**206.2**
FUEL CONSUMPTION (NOMINAL)	(1)	g/bkw-hr		202.5	201.4	210.2
FUEL CONSUMPTION (90% CONFIDENCE)	(1)	g/bkw-hr		204.7	203.9	213.0
AIR FLOW (@ 25°C, 101.3 kPaa)		Nm3/min		297.6	236.5	164.7
AIR MASS FLOW		kg/hr		19921	15826	11020
COMPRESSOR OUTLET PRESSURE		kPa (abs)		280.8	199.6	110.3
COMPRESSOR OUTLET TEMPERATURE		°C		196.9	157.9	110.0
INLET MANIFOLD PRESSURE		kPa (abs)		277.0	196.9	108.8
INLET MANIFOLD TEMPERATURE		°C		45.9	43.2	42.3
TIMING	(9)	°BTDC		12.5	12.5	12.5
EXHAUST STACK TEMPERATURE		°C		370.9	354.4	371.9
Catsmoke				0.0068	0.0100	0.0178
EXHAUST GAS MASS FLOW		kg/hr		20473	16237	11304

EMISSIONS						
NOx (as NO)	(3)	g/bkW-hr		8.88	9.65	10.55
CO	(3)	g/bkW-hr		0.73	0.65	0.88
THC (molecular weight of 13.018)	(3)	g/bkW-hr		0.99	1.26	1.51
Particulates	(3)	g/bkW-hr		0.17	0.20	0.25

ENERGY BALANCE DATA						
FUEL INPUT ENERGY (LHV) (NOMINAL)	(1)	KW		6566	4883	3390
HEAT REJ. TO JACKET WATER (NOMINAL)	(4)	KW		539	440	343
HEAT REJ. TO ATMOSPHERE (NOMINAL)	(5)	KW		131	98	68
HEAT REJ. TO OIL COOLER (NOMINAL)	(6)	KW		285	251	218
HEAT REJ. TO EXH. (LHV to 25°C) (NOMINAL)	(4)	KW		2082	1575	1186
HEAT REJ. TO EXH. (LHV to 177°C) (NOMINAL)	(4)	KW		1632	1349	925
HEAT REJ. TO AFTERCOOLER (NOMINAL)	(7) (8)	KW		800	479	218

CONDITIONS AND DEFINITIONS

ENGINE RATING OBTAINED AND PRESENTED IN ACCORDANCE WITH ISO 3046/1 AND SAE J1995 JAN90 STANDARD REFERENCE CONDITIONS OF 25°C, 100 KPA, 30% RELATIVE HUMIDITY AND 150M ALTITUDE AT THE STATED AFTERCOOLER WATER TEMPERATURE.
CONSULT ALTITUDE CURVES FOR APPLICATIONS ABOVE MAXIMUM RATED ALTITUDE AND/OR TEMPERATURE.
PERFORMANCE AND FUEL CONSUMPTION ARE BASED ON 35 API, 16°C FUEL HAVING A LOWER HEATING VALUE OF 42.780 KJ/KG USED AT 29°C WITH A DENSITY OF 838.9 G/LITER.

NOTES

1) FUEL CONSUMPTION TOLERANCE. ISO 3046/1 IS 0, + 5% OF FULL LOAD DATA. NOMINAL IS ± 3 % OF FULL LOAD DATA.
2) ENGINE POWER TOLERANCE IS ± 3 % OF FULL LOAD DATA.
3) EMISSION DATA SHOWN ARE NOT TO EXCEED VALUES.
4) HEAT REJECTION TO JACKET AND EXHAUST TOLERANCE IS ± 10% OF FULL LOAD DATA. (heat rate based on treated water)
5) HEAT REJECTION TO ATMOSPHERE TOLERANCE IS ±50% OF FULL LOAD DATA. (heat rate based on treated water)
6) HEAT REJECTION TO LUBE OIL TOLERANCE IS ± 20% OF FULL LOAD DATA. (heat rate based on treated water)
7) HEAT REJECTION TO AFTERCOOLER TOLERANCE IS ± 5% OF FULL LOAD DATA. (heat rate based on treated water)
8) TOTAL AFTERCOOLER HEAT = AFTERCOOLER HEAT x ACHRF (heat rate based on treated water)
9) TIMING BASED ON AFM INJECTORS.

OSRV Generators Emission Factors

GEN SET PERFORMANCE DATA [S2B00313]

OCTOBER 11, 2006

For Help Desk Phone Numbers Click here

Performance Number: DM6976

Change Level: 02

Sales Model: 3508BDITA
Combustion: DI
Aspr: TA
Engine Power: 910 W/O F EKW 1,298 HP
Speed: 1,800 RPM
After Cooler: SCAC
Manifold Type: DRY
Governor Type: ADEM3
After Cooler Temp(F): 86
Turbo Quantity: 2
Engine App: GS
Turbo Arrangement: Parallel
Hertz: 60
Engine Rating: MA
Strategy:
Rating Type: PRIME
Certification: IMO 2000 - EPA TIER-I 2004 - 2007 EPA TIER-I 2000 - 2005

General Performance Data

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BHP	ENGINE BMEP PSI	FUEL RATE LB/BHP-HR	FUEL RATE GPH	INTAKE MFLD TEMP DEG F	INTAKE MFLD P IN-HG	INTAKE AIR FLOW CFM	EXH MFLD TEMP DEG F	EXH STACK TEMP DEG F	EXH GAS FLOW CFM
910.0	100	1285	268	0.336	61.7	114.4	71.1	3,058.3	1,035.5	688.8	6,773.4
819.0	90	1154	241	0.338	55.8	111.9	64.8	2,895.8	994.1	660.0	6,261.3
728.0	80	1024	214	0.342	50.0	109.4	58.6	2,722.8	953.1	637.9	5,752.8
682.5	75	959	200	0.344	47.1	108.0	55.3	2,627.4	932.7	629.4	5,495.0
637.0	70	895	187	0.346	44.3	106.0	51.3	2,514.4	912.4	622.6	5,226.6
546.0	60	767	160	0.352	38.6	102.0	43.4	2,284.9	872.1	609.1	4,686.3
455.0	50	640	134	0.361	33.0	98.4	35.5	2,048.3	831.4	595.2	4,135.4
364.0	40	515	108	0.373	27.4	96.1	27.9	1,811.6	778.6	575.4	3,588.0
273.0	30	389	81	0.393	21.8	94.1	20.3	1,575.0	712.6	547.9	3,030.0
227.5	25	326	68	0.409	19.0	93.2	16.4	1,455.0	674.4	531.0	2,751.0
182.0	20	261	55	0.435	16.2	92.3	13.3	1,359.6	625.5	503.2	2,493.2
91.0	10	132	28	0.572	10.8	90.5	7.6	1,183.0	509.4	432.3	2,002.3

EMISSIONS DATA

IMO 2000 - ** M1
Gaseous emissions data measurements are consistent with those described
in REGULATION 13 of ANNEX VI of MARPOL 73/78 and ISO 8178 for measuring HC, CO, PM, and NOx.

This engine's exhaust emissions are in compliance with the INTERNATIONAL
MARINE ORGANIZATION'S IMO regulations.

EPA TIER-I 2004 - 2007 ** L1
Gaseous emissions data measurements are consistent with those described
in EPA 40 CFR PART 94.103 and ISO 8178 for measuring HC, CO, PM, and
NOx.

This engine conforms to US EPA MARINE compression-ignition emission regulations.

LOCALITY	AGENCY/LEVEL
U.S. (incl Calif)	EPA/TIER-1

EPA TIER-I 2000 - 2005 *** A4
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-1	CO:11.4 HC:1.3 NOx:9.2 PM:0.54

RATED SPEED "Not to exceed data"

EKW	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
910.0	100	1285	24.47	1.08	0.89	.340	11.60	2.2	1.28
682.5	75	1154	13.20	1.01	0.58	.230	12.60	2.0	1.28
455.0	50	1024	7.88	1.40	0.49	.240	13.50	2.7	1.28
227.5	25	959	4.29	1.73	0.45	.240	15.00	3.4	1.35
91.0	10	895	2.23	4.07	0.68	.350	16.80	3.6	1.38

RATED SPEED "Nominal Data"

EKW	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
910.0	100	1285	20.39	0.60	0.67	1,347.9	0.240	11.60	2.2	1.28
682.5	75	959	11.00	0.56	0.44	1,033.0	0.160	12.60	2.0	1.28
455.0	50	640	6.57	0.78	0.37	720.1	0.170	13.50	2.7	1.28
227.5	25	326	3.58	0.96	0.34	412.6	0.170	15.00	3.4	1.35
91.0	10	132	1.86	2.26	0.51	230.1	0.250	16.80	3.6	1.38

Kvichak Work Boats Main Engines Emission Factors

CUMMINS MERCRUISER DIESEL
Charleston, SC 29405
Marine Performance Curves

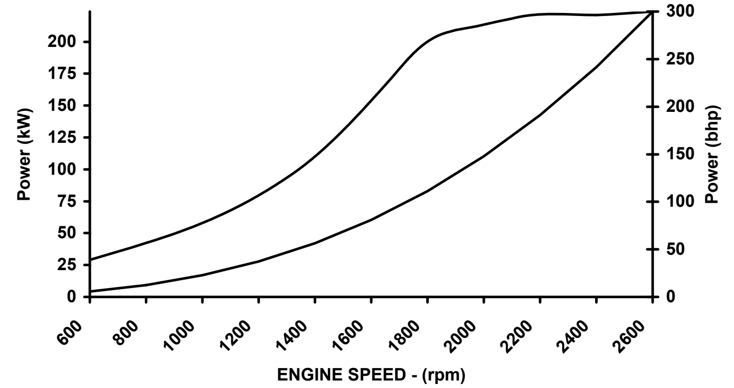
Basic Engine Model:	Curve Number:	
QSB5.9-305 MCD	**M-91365**	
Engine Configuration:	CPL Code	Date:
D403075MX03	**8464**	**1-Jan-06**

Displacement: **5.9 liter** **[359 in^3]**
Bore: **102 mm** **[4.02 in]**
Stroke: **120 mm** **[4.72 in]**
Fuel System: **HPCR**
Cylinders: **6**

kW [bhp, mhp] @ rpm
Advertised Power: **224 [300, 305] @ 2600**

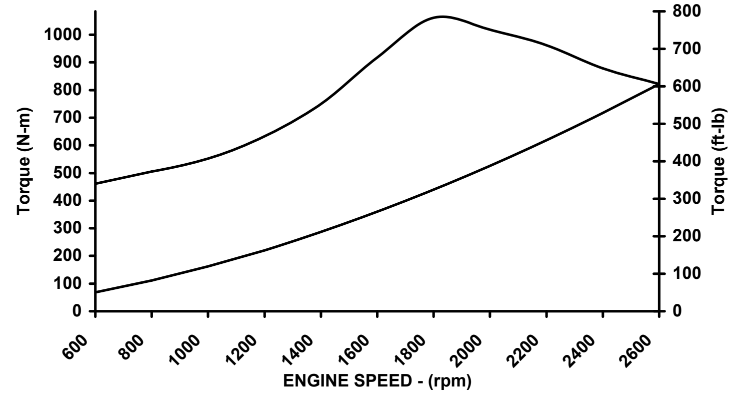
Aspiration: **Turbocharged / Sea Water Aftercooled**
Rating Type: **Medium Continuous Duty**

CERTIFIED: This marine diesel engine is certified to the model year requirements of EPA Marine Tier 2 per 40 CFR 94 and conforms with the NOx requirements of the International Maritime Organization (IMO), MARPOL 73/78 Annex VI, Regulation 13 as applicable.



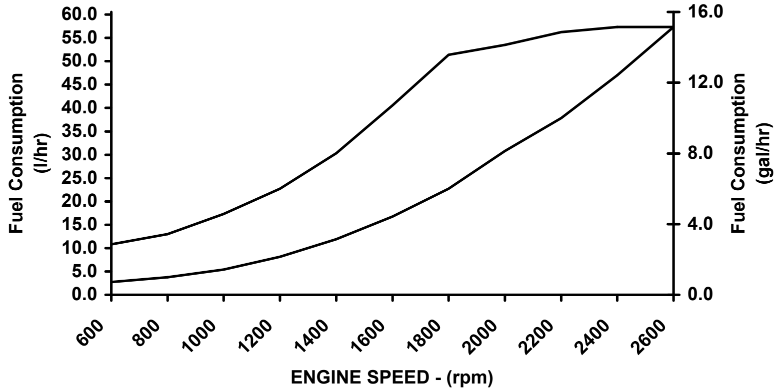
RATED POWER OUTPUT CURVE

rpm	kW	bhp
2600	224	300
2400	221	296
2200	222	297
2000	213	286
1800	200	268
1600	154	206
1400	110	147
1200	80	107
1000	58	77
800	42	57
600	29	39



FULL LOAD TORQUE CURVE

rpm	N-m	ft-lb
2600	822	606
2400	879	648
2200	961	709
2000	1018	751
1800	1062	783
1600	918	677
1400	750	553
1200	633	467
1000	552	407
800	506	373
600	461	340



FUEL CONSUMPTION - PROP CURVE

rpm	l/hr	gal/hr
2600	57.3	15.1
2400	47.0	12.4
2200	37.9	10.0
2000	30.8	8.1
1800	22.7	6.0
1600	16.8	4.4
1400	11.9	3.1
1200	8.1	2.1
1000	5.4	1.4
800	3.8	1.0
600	2.7	0.7

Rated Conditions: Ratings are based upon ISO 8665 and SAE J1228 reference conditions; air pressure of 100 kPa [29.612 in Hg], air temperature 25 deg. C [77 deg. F] and 30% relative humidity. Power is in accordance with IMCI procedure. Member NMMA.

Rated Curves (upper) represents rated power at the crankshaft for mature gross engine performance capabilities obtained and corrected in accordance with ISO 3046. Propeller Curve (lower) is based on a typical fixed propeller demand curve using a 2.7 exponent. Propeller Shaft Power is approximately 3% less than rated crankshaft power after typical reverse/reduction gear losses and may vary depending on the type of gear or propulsion system used.

Fuel Consumption is based on fuel of 35 deg. API gravity at 16 deg. C [60 deg. F0 having LHV of 42,780 kj/kg [18390 Btu/lb] and weighing 838.9 g/liter [7.001 lb/U.S. gal].

Medium Continuous Rating: This power rating is intended for continuous use in variable load applications where full power is limited to six (6) hours out of every twelve (12) hours of operation. Also, reduced power operations must be at or below 200 RPM of the maximum rated RPM. This is an ISO 3046 Fuel Stop Power Rating and is for applications that operate 3,000 hours per year or less.

James D Kahlenbeck

CHIEF ENGINEER

Marine Engine Performance Data

Curve No.: M-91365
DS-3075
DATE: 01Jan06

General Engine Data

Engine Model			QSB5.9-305 MCD
Rating Type			Med. Cont. Duty
Rated Engine Power		kW [bhp]	224 [300]
Rated Engine Speed		rpm	2600
Rated HP Production Tolerance		±%	5
Rated Engine Torque		N•m [ft•lb]	822 [606]
Peak Engine Torque @ 1800 rpm		N•m [ft•lb]	1062 [783]
Brake Mean Effective Pressure		kPa [psi]	1755 [255]
Indicated Mean Effective Pressure		kPa [psi]	N/A
Minimum Idle Speed Setting		rpm	600
Normal Idle Speed Variation		±rpm	10
High Idle Speed Range	Minimum	rpm	2665
	Maximum	rpm	2685
Maximum Allowable Engine Speed		rpm	2685
Maximum Torque Capacity from Front of Crank[2]		N•m [ft•lb]	468 [345]
Compression Ratio			17.2:1
Piston Speed		m/sec [ft/min]	10.4 [2045]
Firing Order			1-5-3-6-2-4
Weight (Dry) Engine only - Average		kg [lb]	N.A.
Weight (Dry) Engine With Heat Exchanger System - Average		kg [lb]	612 [1350]
Weight Tolerance (Dry) Engine only - Average		kg [lb]	N.A.

Noise and Vibration

Average Noise Level – Top	(Idle)	dBA @ 1m	76
	(Rated)	dBA @ 1m	97
Average Noise Level – Right Side	(Idle)	dBA @ 1m	76
	(Rated)	dBA @ 1m	98
Average Noise Level – Left Side	(Idle)	dBA @ 1m	77
	(Rated)	dBA @ 1m	107
Average Noise Level – Front	(Idle)	dBA @ 1m	76
	(Rated)	dBA @ 1m	98

Fuel System[1]

Average Fuel Consumption – ISO 8178 E3Standard Test Cycle		l/hr [gal/hr]	38.7 [10.2]
Fuel Consumption @ Rated Speed		l/hr [gal/hr]	57 [15]
Approximate Fuel Flow to Pump		l/hr [gal/hr]	189 [50]
Maximum Allowable Fuel Supply to Pump Temperature		°C [°F]	60 [140]
Approximate Fuel Flow Return to Tank		l/hr [gal/hr]	132 [35]
Approximate Fuel Return to Tank Temperature		°C [°F]	66 [150]
Maximum Heat Rejection to Drain Fuel[5]		kW [Btu/min]	2 [99]
Fuel Transfer Pump Pressure Range		kPa [psi]	76 [11]
Fuel Rail Pressure	Gauge	kPa [psi]	N.A.
	INSITE	kPa [psi]	135,999 [19,725]

Air System[1]

Intake Manifold Pressure		kPa [in Hg]	172 [51]
Intake Air Flow		l/sec [cfm]	278 [58]
Heat Rejection to Ambient		kW [Btu/min]	32 [1810]
Maximum Air Cleaner Inlet Temperature Rise Over Ambient		°C [°F]	17 [30]

Exhaust System[1]

Exhaust Gas Flow		l/sec [cfm]	600 [1272]
Exhaust Gas Temperature	Turbine Out	°C [°F]	421 [789]
	Manifold	°C [°F]	559 [1038]

TBD = To Be Decided **N/A = Not Applicable** **N.A. = Not Available**

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[1] All Data at Rated Conditions
[2] Consult Installation Direction Booklet for Limitations
[3] Heat rejection values are based on 50% water/ 50% ethylene glycol mix and do NOT include fouling factors. If sourcing your own cooler, a service fouling factor should be applied according to the cooler manufacturer's recommendation.
[4] Consult option notes for flow specifications of optional Cummins seawater pumps, if applicable.
[5] May not be at rated load and speed. Maximum heat rejection may occur at other than rated conditions.

CUMMINS ENGINE COMPANY, INC.
COLUMBUS, INDIANA

Marine Engine Performance Data

Curve No.: M-91365
DS-3075
DATE: 01Jan06

Emissions (in accordance with ISO 8178 Cycle E3)

NOx (Oxides of Nitrogen)	g/kw·hr [g/hp·hr]	6.227 [4.644]
HC (Hydrocarbons)	g/kw·hr [g/hp·hr]	0.104 [0.078]
CO (Carbon Monoxide)	g/kw·hr [g/hp·hr]	0.208 [0.155]
PM (Particulate Matter)	g/kw·hr [g/hp·hr]	0.103 [0.077]

Cooling System[1]

Sea Water Pump Specifications	MAB 0.08.17-07/16/2001	
Pressure Cap Rating (With Heat Exchanger Option)	kPa [psi]	103 [15]

Sea Water Aftercooled Engine (SWAC)

Coolant Flow to Engine Heat Exchanger		l/min [gal/min]	238 [63]
Standard Thermostat Operating Range	Start to Open	°C [°F]	74 [165]
	Full Open	°C [°F]	85 [185]
Heat Rejection to Engine Coolant[3]		kW [Btu/min]	166 [9470]

Engines with Low Temperature Aftercooling (LTA)
Single Loop LTA

Coolant Flow to Cooler (with blocked open thermostat)		l/min [gal/min]	238 [63]
LTA Thermostat Operating Range	Start to Open	°C [°F]	66 [150]
	Full Open	°C [°F]	80 [175]
Heat Rejection to LTA Coolant[3]		kW [Btu/min]	183 [10420]
Maximum LTA Coolant Return Temperature		°C [°F]	54 [130]

TBD = To Be Decided **N/A = Not Applicable** **N.A. = Not Available**

1All Data at Rated Conditions
2Consult Installation Direction Booklet for Limitations
3Heat rejection values are based on 50% water/ 50% ethylene glycol mix and do NOT include fouling factors. If sourcing your own cooler, a service fouling factor should be applied according to the cooler manufacturer's recommendation.
4Consult option notes for flow specifications of optional Cummins seawater pumps, if applicable.
5May not be at rated load and speed. Maximum heat rejection may occur at other than rated conditions.

CUMMINS ENGINE COMPANY, INC.
COLUMBUS, INDIANA

All Data is Subject to Change Without Notice - Consult the following Cummins intranet site for most recent data: http://www.cummins.com

APPENDIX C

ADEC Owner Requested Limit Forms

OWNER REQUESTED LIMIT IDENTIFICATION FORM

Alaska Department of Environmental Conservation **Owner Requested Limit Application**	**ADEC USE ONLY** Receiving Date: ADEC Control #: ORL :

STATIONARY SOURCE IDENTIFICATION FORM

Section 1 Stationary Source Information

Stationary Source Name:Kulluk drilling unit and associated vessels				
Project Name (if different): Shell Kulluk Exploration Drilling Program	Stationary Source Contact:Shell Offshore, Inc.			
Source Physical Address:Beaufort Sea OSC Waters	City:New Orleans	State:LA	Zip:70139	
	Telephone:504-728-7673			
	E-Mail Address:Robert.McAlister@Shell.com			
UTM Coordinates or Latitude/Longitude:	Northing:	Easting:		Zone:
	Latitude:	Longitude:		

Section 2 Legal Owner

Name:Shell Offshore, Inc.		
Mailing Address:701 Poydras Street		
City:New Orleans	State:LA	Zip:70139
Telephone #:504-728-7673		
E-Mail Address:Robert.McAlister@Shell.com		

Section 3 Operator *(if different from owner)*

Name:		
Mailing Address:		
City:	State:	Zip:
Telephone #:		
E-Mail Address:		

Section 4 Designated Agent *(for service of process)*

Name:ASRC Energy Services, RTS		
Mailing Address:3900 C Street, Suite 601		
City Anchorage	State:AK	Zip:99503
Physical Address:Same		
City:	State:	Zip:
Telephone #:(907)339-5486		
E-Mail Address:Greg.Horner@asrcenergy.com		

Section 5 Billing Contact Person *(if different from owner)*

Name:		
Mailing Address:		
City:	State:	Zip:
Telephone #:		
E-Mail Address:		

Section 6 Application Contact

Name:Wayne Wooster, Air Sciences, Inc			
Mailing Address:421 SW 6th Ave Ste 1400	City:Portland	State:OR	Zip:97204
	Telephone:503-525-9394 ext. 15		
	E-Mail Address:wwooster@airsci.com		

OWNER REQUESTED LIMIT IDENTIFICATION FORM

Section 7 Certification

This certification applies to the Air Quality Control Owner Requested Limit Application for the submitted to the department on: 12/29/06 .

Kulluk
(Stationary Source Name)

Type of Application
☒ Initial Application
☐ Change to Initial Application

The application is **NOT** complete unless the certification of truth, accuracy, and completeness on this form bears the **signature of a responsible official** of the firm making the application. (18 AAC 50.205)

CERTIFICATION OF TRUTH, ACCURACY, AND COMPLETENESS

"Based on information and belief formed after reasonable inquiry, I certify that the statements and information in and attached to this document are true, accurate, and complete."

Signature:	Date:12/29/06
Printed Name: Susan Childs	Title:Regulatory Coodinator, Alaska

Section 13 Attachments

☒ Attachments Included. List attachments:
Fuel use limitations
Fuel sulfur content limitation

APPENDIX D

40 CFR Part 55 NOI Letters

40 CFR 55.4 Requirements to Submit a Notice of Intent

Notice of Intent (NOI) to submit an Application for Preconstruction Permit Shell Kulluk 2007-2009 Beaufort Sea Exploratory Drilling Program

Shell Offshore, Inc. (SOI) hereby submits the information below pursuant to the 40 CFR Part 55 Outer Continental Shelf (OCS) Air Regulations, Section 55.4 Requirements to submit a notice of intent. Paragraph 55.4(b) lists nine specific requirements for exploratory sources to include in the notice of intent (NOI). Each of the requirements is paraphrased below followed by SOI's response.

Requirement No. 1 - 40 CFR 55.4(b)(1): General company information.

The pertinent owner, owner's agent, operator, and facility contact information is presented in Table 1.

Table 1: Company and Operator Information

Owner and Operator	
Name	Shell Offshore, Inc.
Address	701 Poydras Street, New Orleans, LA 70139
Contact	Keith Craik
Contact phone number	(713) 546-6669
Contact e-mail address	keith.craik@shell.com
Agent	
Name	ASRC Energy Services, RTS
Address	3900 C Street, Suite 601, Anchorage, AK 99503
Contact	Greg Horner
Contact phone number	(907) 339-5486
Contact e-mail address	greg.horner@asrcenergy.com

Requirement No. 2 - 40 CFR 55.4(b)(2): Facility description.

The Shell Kulluk Exploratory Drilling Program will be an exploration project conducting exploratory oil and gas drilling operations (North American Industry Classification System [NAICS] code 211111 Crude Petroleum and Natural Gas Extraction) on SOI's oil and gas lease-holdings on federal OCS waters located in the Beaufort Sea. The proposed drilling sites are located on federal OCS waters between longitude 144 degrees W and longitude 151 degrees W. SOI's leases in the Beaufort Sea exist, at their closest point, approximately nine miles north of Point Thomson shoreline and five miles northwest of Barter Island shoreline for the eastern lease-holding locations, and twelve miles north of Anachlik Island shoreline for the western lease-holding locations.

The project is scheduled to last three drilling seasons (2007, 2008, and 2009) lasting up to 120 days per calendar year, weather and ice conditions permitting SOI anticipates drilling operations per drill site will range from 30 to 60 days. SOI, therefore, anticipates drilling up to three drill site locations per year. The drilling season is projected to run from approximately August 1 through November 30 each year, again weather and ice conditions permitting SOI intends to conduct a three-year exploratory drilling program, 2007 through 2009, although drilling activity may occur in 2010 and 2011 if ice conditions prevent significant exploratory drilling activity in 2007, 2008 or 2009. The project is scheduled to begin in mid-to-late July 2007 and end December 1, 2009, but may extend into 2010 and 2011 if ice and weather conditions limit the extent of drilling in 2007, 2008, or 2009.

The Shell Kulluk Exploratory Drilling Program exploratory drilling program will consist of several vessels. The primary exploration drilling activities will be conducted from Shell's conical drilling unit (CDU), the Kulluk. The Kulluk is a purpose-built floating drilling vessel with Arctic Class IV hull design. The Kulluk CDU will be supported by a number of associated support vessels. The associated support vessels will include two icebreaker vessels, a re-supply ship, and an oil spill response (OSR) fleet. The Vladimir Ignatjuk will perform primary ice management duty (icebreaking). The Tor Viking II will assist the Vladimir Ignatjuk with ice management duty in 2007. The Nordica or its identical sister vessel, the Fennica, may replace the Tor Viking II in 2008 and 2009. The two icebreakers will also tow the Kulluk into and away from the OCS lease-holding blocks each drilling season. The Jim Kilabuk will serve as the re-supply vessel. The OSR fleet will consist of one larger OSR vessel and a number of smaller boats. Photographs and diagrams of the Kulluk and associated support vessels will be provided in the air permit application.

The exploratory drilling process consists of three phases, rig placement, drilling operations, and rig removal. One or more of the icebreaker vessels will tow the Kulluk to one of SOI's OCS lease-holdings, will then assist the Kulluk to maneuver and anchor it to the seabed, and will then move away from the Kulluk to perform ice management duty. The Kulluk will perform its drilling operations and at operation completion of that drill site one of the icebreaker vessels will assist the Kulluk to pull anchors and then to tow the Kulluk to the next drill site location, and then assist in the anchoring and ice management duty as described above. Meanwhile, the Jim Kilabuk will re-supply the Kulluk every two to three weeks. The Kulluk OSR fleet will be stationed nearby the Kulluk in case of a spill and will conduct oil spill drill response drill exercises. At the end of the drilling season the two icebreaker vessels will assist the Kulluk to pull anchors and tow the Kulluk to an over-winter safe harbor location. A complete facility description will be provided in the air permit application.

Requirement No. 3 - 40 CFR 55.4(b)(3): Estimate of the proposed project's potential emissions (PTE).

Following September 2006, EPA Region 10 (EPA) guidance SOI has defined the Shell Kulluk drilling vessel, when anchored or otherwise attached to the seabed at each drill site, as a separate "stationary source." EPA's September 2006 guidance further requires that the emissions from the project's associated support vessels be included in the "source" potential-to-emit (PTE) when the support vessels are within 25 miles of the anchored drilling vessel. These guidance interpretations are consistent with the OCS source definition found in 40 CFR 55.2. SOI intends to operate the Kulluk and its associated support vessels as a synthetic minor source that will not exceed 250 tons per year of any new source review regulated air contaminant. The project's primary air contaminant is nitrogen oxides (NO_2) with lesser quantities of carbon monoxide (CO), small-diameter particulate matter (PM_{10}), volatile organic compounds (VOC), and sulfur dioxide (SO_2). The project's potential emissions will vary depending on the length of the drilling operations per drill site, the compliment of ice management vessels employed, and the severity of the ice conditions surrounding the drill site. For example, SOI estimates the Kulluk drilling vessel for a 60-day drilling operation will result in approximately 50 tons NO_x. The associated support vessels NO_x emissions may approach 200 tons, again depending on the icebreaker vessels combination employed and the severity of the ice conditions surrounding the Kulluk drilling vessel. The 2007 emissions estimated based on a 59-day drill site are presented in Table 2.

Table 2: Kulluk 2007 Emissions Estimate (Based on Projected 59-Day Drill Site Operation)

Emissions	NO_x (tpy)	CO (tpy)	PM_{10} (tpy)	VOC (tpy)	SO_2 (tpy)
Kulluk	48.7	7.9	2.3	1.9	4.6
Vladimir Ignatjuk	162.9	44.5	3.6	7.2	10.5
Tor Viking	21.1	19.8	1.7	2.9	6.4
Kulluk OSR Fleet	10.7	9.2	0.5	1.2	1.0
Jim Kilabuk	1.6	0.4	0.04	0.06	0.09
Total	245.0	81.8	8.1	13.3	22.6

SOI intends to limit drill operations at each drilling site (e.g., a fleet wide fuel consumption limit) to ensure that no air contaminant exceeds 250 tons per year, i.e., a synthetic minor new source.

SOI will accept federally enforceable operational limits to stay below the 250-ton-per-year major new source review threshold value.

Requirement No. 4 – 40 CFR 55.4(b)(4): Description of all emission points including associated vessels.

A complete description of the Shell Kulluk Exploratory Drilling Program vessels, combustion sources identification, size rating, emission factor, hourly emissions, and project site yearly emissions will be provided in the air permit application. However, the dominant emission source for the project is the associated support vessel main propulsion engines. The support vessel main propulsion engines / electrical generators account for 98 percent to more than 99 percent of the support vessel emissions. As for the drilling vessel itself, the Kulluk main drilling engines and deck cranes account for 95 percent to more than 98 percent of the drilling vessel emissions. All of the Kulluk and the associated marine support vessels combustion sources will consist of marine / non-road compression-ignition internal combustion engines, boilers and heaters. All of these combustion sources will be diesel fuel fired. The engines will have the purpose of generating electricity, pumping, compressing, providing direct drive mechanical power, and for powering mobile machinery. SOI intends to collect generated on-site trash for off-site disposal / management and / or for incineration on one of the icebreaker incinerators. SOI does not intend to burn trash in the Kulluk's on-site trash incinerator. Nor does SOI intend to flare drilling well off-gases during the project.

Requirement No. 5 – 40 CFR 55.4(b)(5): Estimate of quantity and type of fuels and raw materials to be used.

The estimated diesel fuel consumption for the 59-day drilling operation described above is presented in Table 3.

Table 3: Shell Kulluk Exploratory Drilling Program Diesel Fuel Consumption Estimate (Based on Projected 59-Day Drill Site Operation)

Material	Quantity	Units
Kulluk drilling vessel diesel fuel	0.33	Million gallons
Associated support vessels diesel fuel	1.21	Million gallons
Total Shell Kulluk Exploratory Drilling Program diesel fuel	1.54	Million gallons

Requirement No. 6 – 40 CFR 55.4(b)(6): Description of proposed air pollution control equipment.

SOI intends to install CBOI injectors on the Kulluk main drilling engines to reduce NO_x emissions. The CBOI injectors are projected to reduce NO_x emissions by approximately 30 tons over a 59-day drilling season. No add-on air pollution control equipment is being proposed for any of the other Kulluk emission sources. The Tor Viking II is equipped with SCR NO_x combustion control using a urea-based scrubbing reagent. The SCR system was installed during the initial Viking vessel construction as the retrofit cost of installing SCR controls is very expensive. No add-on air pollution control equipment is being proposed for the other support vessels.

Requirement No. 7 – 40 CFR 55.4(b)(7): Proposed limitations on source operations or any work practice standards affecting emissions.

SOI, since all combustion sources are diesel fuel fired, proposes to limit the project drill site emissions to less than 250 tons by monitoring diesel fuel consumption on each project vessel – the Kulluk drilling vessel, each of the icebreaker vessels, the re-supply vessel, and the combined OSR fleet. SOI proposes to calculate emissions from each vessel's fuel consumption by using an assigned vessel-wide emission factor (e.g., the icebreaker vessel main propulsion engine emission factor – lb / hp-hr), multiplied by fuel consumption and EPA AP42 average brake specific fuel consumption and diesel fuel heating values. SOI will then sum each vessel's emissions to determine the project fleet-wide emissions running total. SOI proposes to implement fuel consumption monitoring on each project vessel on a weekly and as necessary, a daily basis, to ensure that the project-wide fuel consumption limits emissions to less than 250 tons per drill site per year. SOI believes the fleet-wide diesel fuel consumption can easily be monitored and documented. Fuel consumption can be measured weekly or daily, as necessary, by dipstick in the fuel tanks and documented as part of the operations procedures.

Requirement No. 8 – 40 CFR 55.4(b)(8): Other information affecting emissions.

In March 2006, SOI and its contractors, ASRC Energy Services, RTS, and Air Sciences Inc., discussed with the EPA Region 10 staff the choice of an approved air quality model. EPA directed SOI and Air Sciences to model the project emissions with a conservative screening model, SCREEN3. The SCREEN3 model (which incorporates worst-case assumptions) frequently overestimates real-world impacts from the project. SOI will model the project emissions to demonstrate compliance with applicable air quality standards. SOI will include the modeled source characterization (i.e., short-term emission rate, stack heights, stack diameter, stack height, exit velocity, and temperature, etc.), model selection, meteorological data, background concentrations, evaluation methodology, and modeling results in the air permit application. In addition, SOI intends to obtain at least a 500-meter Safety Exclusion Zone from the United States Coast Guard to help keep non-project related people and vessels a safe distance away from the drilling vessel. SOI will model the project emissions to the 500-meter Safety Exclusion Zone as the point of ambient air. SOI will provide a copy of the United States Coast Guard Safety Exclusion Zone application to EPA under a separate cover letter from the air permit application.

Requirement No. 9 – 40 CFR 55.4(b)(9): Such other information as may be necessary to determine the applicability of onshore requirements.

The Corresponding Onshore Area (COA) for the Shell Kulluk project is the Northern Alaska Intrastate Air Quality Control Region that has been classified by the Alaska Department of Environmental Conservation (ADEC) as Air Quality Class II area. ADEC suggested using the background ambient air quality concentrations measured at the Arctic North Slope Eastern Region (ANSER) for ambient air quality modeling purposes. SOI concurs with the ADEC's recommendation that the ANSER background ambient air quality concentration is appropriate since no significant growth activity has occurred in the nearby areas of the western or eastern SOI lease-holding OCS blocks.

APPENDIX E

Modeling Calculations and SCREEN3 Model Output

Shell Kulluk - Beaufort Sea, Alaska
Modeling Calculations
12/13/2006

	Distance	Max. Modeled X/Q (µg*s/m^{3}*g)				
Averaging Period >	**(m)**	**1-hour**	**3-hour**	**8-hour**	**24-hour**	**Annual**
Drill Rig: Kulluk						
Stack #1: 2 Main Engines	500 [A]	75.19	67.67	52.63	30.08	6.02
Stack #2: 2 Air Compressors	500 [A]	282.30	254.07	197.61	112.92	22.58
Stack #3: 2 HPP Engines	500 [A]	349.00	314.10	244.30	139.60	27.92
Stack #4: 3 Crane Engines	500 [A]	113.70	102.33	79.59	45.48	9.10
Stack #5: 1 Boiler / 1 Water Heater	500 [A]	317.90	286.11	222.53	127.16	25.43
Stack #6: 1 Logging Winch	500 [A]	641.50	577.35	449.05	256.60	51.32
Support Vessels: Kulluk Fleet						
Vladimir Ignatjuk	13,500 [B]	0.455	0.41	0.32	0.18	0.04
Fennica/Nordica	6,000 [C]	1.041	0.94	0.73	0.42	0.08
Oil Response Ships - Kulluk	500 [A]	56.84	51.16	39.79	22.74	4.55
Jim Kilabuk - Kulluk	500 [A]	56.84	51.16	39.79	22.74	4.55

[A] Distance to exclusion zone (i.e. ambient air boundary).

[B] Center of primary icebreaker ice management activity to point of maximum impact.

[C] Center of secondary icebreaker ice management activity to point of maximum impact.

	#	Emissions (g/sec)					Max. Modeled X/Q (µg*s/m^{3}*g)					Max. Modeled Impact (µg/m^{3})				
Source ID	**Stacks**	**1-hour**	**3-hour**	**8-hour**	**24-hour**	**Annual**	**1-hour**	**3-hour**	**8-hour**	**24-hour**	**Annual**	**1-hour**	**3-hour**	**8-hour**	**24-hour**	**Annual**
NOx																
Drill Rig: Kulluk																
Stack #1: 2 Main Engines	1	---	---	---	---	1.82E+00	---	---	---	---	6.02	---	---	---	---	10.9
Stack #2: 2 Air Compressors	1	---	---	---	---	1.36E-01	---	---	---	---	22.58	---	---	---	---	3.1
Stack #3: 2 HPP Engines	1	---	---	---	---	3.21E-01	---	---	---	---	27.92	---	---	---	---	9.0
Stack #4: 3 Crane Engines	1	---	---	---	---	6.55E-01	---	---	---	---	9.10	---	---	---	---	6.0
Stack #5: 1 Boiler / 1 Water Heater	1	---	---	---	---	8.71E-03	---	---	---	---	25.43	---	---	---	---	0.2
Stack #6: 1 Logging Winch	1	---	---	---	---	8.99E-02	---	---	---	---	51.32	---	---	---	---	4.6
Support Vessels: Kulluk Fleet																
Vladimir Ignatjuk	1	---	---	---	---	1.23E+01	---	---	---	---	0.04	---	---	---	---	0.4
Fennica/Nordica	1	---	---	---	---	1.08E+01	---	---	---	---	0.08	---	---	---	---	0.9
Oil Response Ships - Kulluk	1	---	---	---	---	4.19E+00	---	---	---	---	4.55	---	---	---	---	19.0
Jim Kilabuk - Kulluk	1	---	---	---	---	3.77E+00	---	---	---	---	4.55	---	---	---	---	17.1
											NOx Total Impact >	---	---	---	---	71.3
PM_{10}																
Drill Rig: Kulluk																
Stack #1: 2 Main Engines	1	---	---	---	5.00E-01	8.22E-02	---	---	---	30.08	6.02	---	---	---	15.0	0.5
Stack #2: 2 Air Compressors	1	---	---	---	4.15E-02	6.81E-03	---	---	---	112.92	22.58	---	---	---	4.7	0.2
Stack #3: 2 HPP Engines	1	---	---	---	1.39E-01	2.28E-02	---	---	---	139.60	27.92	---	---	---	19.3	0.6
Stack #4: 3 Crane Engines	1	---	---	---	2.83E-01	4.65E-02	---	---	---	45.48	9.10	---	---	---	12.9	0.4
Stack #5: 1 Boiler / 1 Water Heater	1	---	---	---	8.74E-03	1.44E-03	---	---	---	127.16	25.43	---	---	---	1.1	0.04
Stack #6: 1 Logging Winch	1	---	---	---	3.88E-02	6.38E-03	---	---	---	256.60	51.32	---	---	---	10.0	0.3
Support Vessels: Kulluk Fleet																
Vladimir Ignatjuk	1	---	---	---	1.40E+00	2.30E-01	---	---	---	0.18	0.04	---	---	---	0.3	0.01
Fennica/Nordica	1	---	---	---	1.42E+00	2.34E-01	---	---	---	0.42	0.08	---	---	---	0.6	0.02
Oil Response Ships - Kulluk	1	---	---	---	6.57E-01	1.08E-01	---	---	---	22.74	4.55	---	---	---	14.9	0.5
Jim Kilabuk - Kulluk	1	---	---	---	4.45E-01	7.31E-02	---	---	---	22.74	4.55	---	---	---	10.1	0.3
											PM_{10} Total Impact >	---	---	---	88.9	2.9
SO_2																
Drill Rig: Kulluk																
Stack #1: 2 Main Engines	1	---	1.09E+00	---	1.09E+00	1.79E-01	---	67.67	---	30.08	6.02	---	73.8	---	32.8	1.1
Stack #2: 2 Air Compressors	1	---	1.94E-01	---	1.94E-01	3.18E-02	---	254.07	---	112.92	22.58	---	49.2	---	21.9	0.7
Stack #3: 2 HPP Engines	1	---	9.68E-02	---	9.68E-02	1.59E-02	---	314.10	---	139.60	27.92	---	30.4	---	13.5	0.4
Stack #4: 3 Crane Engines	1	---	1.98E-01	---	1.98E-01	3.25E-02	---	102.33	---	45.48	9.10	---	20.2	---	9.0	0.3
Stack #5: 1 Boiler / 1 Water Heater	1	---	1.01E-02	---	1.01E-02	1.67E-03	---	286.11	---	127.16	25.43	---	2.9	---	1.3	0.04
Stack #6: 1 Logging Winch	1	---	2.71E-02	---	2.71E-02	4.46E-03	---	577.35	---	256.60	51.32	---	15.7	---	7.0	0.2
Support Vessels: Kulluk Fleet																
Vladimir Ignatjuk	1	---	4.79E+00	---	4.79E+00	7.88E-01	---	0.41	---	0.18	0.04	---	2.0	---	0.9	0.03
Fennica/Nordica	1	---	4.38E+00	---	4.38E+00	7.20E-01	---	0.94	---	0.42	0.08	---	4.1	---	1.8	0.1
Oil Response Ships - Kulluk	1	---	2.36E+00	---	2.36E+00	3.88E-01	---	51.16	---	22.74	4.55	---	120.8	---	53.7	1.8
Jim Kilabuk - Kulluk	1	---	1.45E+00	---	1.45E+00	2.39E-01	---	51.16	---	22.74	4.55	---	74.2	---	33.0	1.1
											SO_2 Total Impact >	---	393.3	---	174.8	5.7

Stack #1: 2 Main Engines – MAINENGS

```
                                                                            12/11/06
                                                                            08:53:56
  ***  SCREEN3 MODEL RUN  ***
  *** VERSION DATED 96043 ***



 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE              =        POINT
    EMISSION RATE (G/S)      =      1.00000
    STACK HEIGHT (M)         =      17.8308
    STK INSIDE DIAM (M)      =      97.1122
    STK EXIT VELOCITY (M/S)=          .0010
    STK GAS EXIT TEMP (K)    =     672.0389
    AMBIENT AIR TEMP (K)     =     273.0000
    RECEPTOR HEIGHT (M)      =        .0000
    URBAN/RURAL OPTION       =        RURAL
    BUILDING HEIGHT (M)      =      17.9832
    MIN HORIZ BLDG DIM (M) =        81.0768
    MAX HORIZ BLDG DIM (M) =        81.0768

 THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


 BUOY. FLUX =   13.728 M**4/S**3;  MOM. FLUX =     .001 M**4/S**2.

 *** FULL METEOROLOGY ***

 **********************************
 *** SCREEN AUTOMATED DISTANCES ***
 **********************************

 *** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

   DIST     CONC              U10M   USTK  MIX HT   PLUME  SIGMA   SIGMA
    (M)   (UG/M**3)   STAB   (M/S)  (M/S)    (M)   HT (M)  Y (M)   Z (M)  DWASH
 -------  ----------  ----   -----  -----  ------  ------  ------  ------  -----
    500.   75.19        6     1.0    1.4 10000.0   42.28   25.74   23.41    SS
    600.   70.44        6     1.0    1.4 10000.0   42.28   28.90   23.95    SS
    700.   66.51        6     1.0    1.4 10000.0   42.28   32.03   24.49    SS
    800.   63.17        6     1.0    1.4 10000.0   42.28   35.13   25.02    SS
    900.   60.28        6     1.0    1.4 10000.0   42.28   38.19   25.53    SS
   1000.   57.72        6     1.0    1.4 10000.0   42.28   41.24   26.04    SS
   1100.   55.44        6     1.0    1.4 10000.0   42.28   44.25   26.54    SS
   1200.   51.38        6     1.0    1.4 10000.0   42.28   47.25   26.36    SS
   1300.   49.73        6     1.0    1.4 10000.0   42.28   50.23   26.86    SS
   1400.   48.06        6     1.0    1.4 10000.0   42.28   53.18   27.29    SS
   1500.   46.48        6     1.0    1.4 10000.0   42.28   56.12   27.70    SS
   1600.   45.01        6     1.0    1.4 10000.0   42.28   59.04   28.10    SS
   1700.   43.64        6     1.0    1.4 10000.0   42.28   61.95   28.50    SS
   1800.   42.37        6     1.0    1.4 10000.0   42.28   64.84   28.89    SS
   1900.   41.17        6     1.0    1.4 10000.0   42.28   67.71   29.27    SS
   2000.   40.04        6     1.0    1.4 10000.0   42.28   70.57   29.65    SS
   2100.   38.97        6     1.0    1.4 10000.0   42.28   73.42   30.02    SS
   2200.   37.96        6     1.0    1.4 10000.0   42.28   76.26   30.39    SS
   2300.   37.00        6     1.0    1.4 10000.0   42.28   79.08   30.75    SS
   2400.   36.09        6     1.0    1.4 10000.0   42.28   81.89   31.11    SS
   2500.   35.23        6     1.0    1.4 10000.0   42.28   84.70   31.46    SS
   2600.   34.40        6     1.0    1.4 10000.0   42.28   87.49   31.81    SS
   2700.   33.61        6     1.0    1.4 10000.0   42.28   90.27   32.15    SS
   2800.   32.85        6     1.0    1.4 10000.0   42.28   93.04   32.49    SS
   2900.   32.13        6     1.0    1.4 10000.0   42.28   95.80   32.83    SS
   3000.   31.43        6     1.0    1.4 10000.0   42.28   98.55   33.16    SS
   3500.   28.35        6     1.0    1.4 10000.0   42.28  112.17   34.76    SS
   4000.   25.77        6     1.0    1.4 10000.0   42.28  125.60   36.29    SS
   4500.   23.59        6     1.0    1.4 10000.0   42.28  138.85   37.74    SS
   5000.   21.73        6     1.0    1.4 10000.0   42.28  151.94   39.13    SS
   5500.   20.07        6     1.0    1.4 10000.0   42.28  164.90   39.74    SS
```

```
  6000.   18.67        6     1.0    1.4 10000.0   42.28  177.73    40.94    SS
  6500.   17.44        6     1.0    1.4 10000.0   42.28  190.43    42.07    SS
  7000.   16.36        6     1.0    1.4 10000.0   42.28  203.03    43.15    SS
  7500.   15.38        6     1.0    1.4 10000.0   42.28  215.53    44.20    SS
  8000.   14.51        6     1.0    1.4 10000.0   42.28  227.93    45.21    SS
  8500.   13.73        6     1.0    1.4 10000.0   42.28  240.24    46.20    SS
  9000.   13.01        6     1.0    1.4 10000.0   42.28  252.47    47.15    SS
  9500.   12.36        6     1.0    1.4 10000.0   42.28  264.62    48.08    SS
 10000.   11.77        6     1.0    1.4 10000.0   42.28  276.69    48.98    SS
 15000.   7.913        6     1.0    1.4 10000.0   42.28  393.93    55.69    SS
 20000.   5.900        6     1.0    1.4 10000.0   42.28  506.25    60.96    SS

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   500.   75.19        6     1.0    1.4 10000.0   42.28   25.74    23.41    SS

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
          (BRODE, 1988)
****************************************


 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)     =    457.2        CONC (UG/M**3)     =    457.2
  CRIT WS @10M (M/S) =     1.00        CRIT WS @10M (M/S) =     1.00
  CRIT WS @ HS (M/S) =     1.12        CRIT WS @ HS (M/S) =     1.12
  DILUTION WS (M/S)  =     1.00        DILUTION WS (M/S)  =     1.00
  CAVITY HT (M)      =    18.07        CAVITY HT (M)      =    18.07
  CAVITY LENGTH (M)  =    66.70        CAVITY LENGTH (M)  =    66.70
  ALONGWIND DIM (M)  =    81.08        ALONGWIND DIM (M)  =    81.08

****************************************
      END OF CAVITY CALCULATIONS
****************************************


     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION         MAX CONC    DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)    HT (M)
--------------     -----------   -------   -------
SIMPLE TERRAIN       75.19          500.        0.

BLDG. CAVITY-1       457.2           67.       --  (DIST = CAVITY LENGTH)

BLDG. CAVITY-2       457.2           67.       --  (DIST = CAVITY LENGTH)


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

Stack #2: 2 Air Compressors – COMPENGS

```
                                                                       12/11/06
                                                                       08:53:59

 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***
```

```
SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      1.00000
   STACK HEIGHT (M)       =       9.7536
   STK INSIDE DIAM (M)    =        .2089
   STK EXIT VELOCITY (M/S)=      39.9995
   STK GAS EXIT TEMP (K)  =     699.8167
   AMBIENT AIR TEMP (K)   =     273.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =      14.6304
   MIN HORIZ BLDG DIM (M) =      81.0768
   MAX HORIZ BLDG DIM (M) =      81.0768

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


BUOY. FLUX =    2.611 M**4/S**3;  MOM. FLUX =    6.812 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)  Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   282.3        6     1.5    1.5 10000.0   22.34   17.97   16.23    SS
   600.   248.2        6     1.5    1.5 10000.0   22.34   21.24   17.03    SS
   700.   221.8        6     1.5    1.5 10000.0   22.34   24.46   17.81    SS
   800.   200.5        6     1.5    1.5 10000.0   22.34   27.63   18.56    SS
   900.   182.8        6     1.5    1.5 10000.0   22.34   30.78   19.30    SS
  1000.   167.9        6     1.5    1.5 10000.0   22.34   33.88   20.02    SS
  1100.   155.0        6     1.5    1.5 10000.0   22.34   36.96   20.73    SS
  1200.   146.1        6     1.0    1.0 10000.0   28.20   40.01   19.85    SS
  1300.   140.5        6     1.0    1.0 10000.0   28.20   43.04   20.56    SS
  1400.   134.9        6     1.0    1.0 10000.0   28.20   46.05   21.26    SS
  1500.   126.5        6     1.0    1.0 10000.0   28.20   49.03   21.21    SS
  1600.   121.9        6     1.0    1.0 10000.0   28.20   51.99   21.85    SS
  1700.   117.2        6     1.0    1.0 10000.0   28.20   54.94   22.43    SS
  1800.   112.8        6     1.0    1.0 10000.0   28.20   57.87   23.00    SS
  1900.   108.6        6     1.0    1.0 10000.0   28.20   60.78   23.55    SS
  2000.   104.6        6     1.0    1.0 10000.0   28.20   63.68   24.10    SS
  2100.   100.8        6     1.0    1.0 10000.0   28.20   66.56   24.63    SS
  2200.   97.24        6     1.0    1.0 10000.0   28.20   69.42   25.15    SS
  2300.   93.84        6     1.0    1.0 10000.0   28.20   72.28   25.67    SS
  2400.   90.62        6     1.0    1.0 10000.0   28.20   75.12   26.18    SS
  2500.   87.56        6     1.0    1.0 10000.0   28.20   77.95   26.67    SS
  2600.   84.42        6     1.0    1.0 10000.0   28.20   80.76   26.46    SS
  2700.   81.76        6     1.0    1.0 10000.0   28.20   83.57   26.95    SS
  2800.   79.21        6     1.0    1.0 10000.0   28.20   86.36   27.37    SS
  2900.   76.78        6     1.0    1.0 10000.0   28.20   89.15   27.78    SS
  3000.   74.48        6     1.0    1.0 10000.0   28.20   91.92   28.18    SS
  3500.   64.54        6     1.0    1.0 10000.0   28.20  105.65   30.09    SS
  4000.   56.66        6     1.0    1.0 10000.0   28.20  119.17   31.87    SS
  4500.   50.30        6     1.0    1.0 10000.0   28.20  132.50   33.55    SS
  5000.   45.07        6     1.0    1.0 10000.0   28.20  145.67   35.13    SS
  5500.   40.71        6     1.0    1.0 10000.0   28.20  158.69   36.64    SS
  6000.   37.04        6     1.0    1.0 10000.0   28.20  171.58   38.07    SS
  6500.   33.90        6     1.0    1.0 10000.0   28.20  184.34   39.45    SS
  7000.   31.35        6     1.0    1.0 10000.0   28.20  196.99   40.40    SS
  7500.   29.04        6     1.0    1.0 10000.0   28.20  209.54   41.55    SS
  8000.   27.02        6     1.0    1.0 10000.0   28.20  221.98   42.65    SS
  8500.   25.24        6     1.0    1.0 10000.0   28.20  234.34   43.72    SS
  9000.   23.65        6     1.0    1.0 10000.0   28.20  246.61   44.75    SS
  9500.   22.24        6     1.0    1.0 10000.0   28.20  258.79   45.74    SS
 10000.   20.96        6     1.0    1.0 10000.0   28.20  270.90   46.71    SS
```

```
  15000.   13.09        6     1.0    1.0 10000.0   28.20  388.43   54.88    SS
  20000.   9.447        6     1.0    1.0 10000.0   28.20  500.95   60.29    SS

 MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
    500.   282.3        6     1.5    1.5 10000.0   22.34   17.97   16.23    SS

  DWASH=   MEANS NO CALC MADE (CONC = 0.0)
  DWASH=NO MEANS NO BUILDING DOWNWASH USED
  DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
  DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
  DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 ****************************************
      *** REGULATORY (Default) ***
     PERFORMING CAVITY CALCULATIONS
   WITH ORIGINAL SCREEN CAVITY MODEL
          (BRODE, 1988)
 ****************************************


  *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
   CONC (UG/M**3)     =    297.1         CONC (UG/M**3)     =    297.1
   CRIT WS @10M (M/S) =     3.78         CRIT WS @10M (M/S) =     3.78
   CRIT WS @ HS (M/S) =     3.78         CRIT WS @ HS (M/S) =     3.78
   DILUTION WS (M/S)  =     1.89         DILUTION WS (M/S)  =     1.89
   CAVITY HT (M)      =    14.63         CAVITY HT (M)      =    14.63
   CAVITY LENGTH (M)  =    59.48         CAVITY LENGTH (M)  =    59.48
   ALONGWIND DIM (M)  =    81.08         ALONGWIND DIM (M)  =    81.08

 ****************************************
       END OF CAVITY CALCULATIONS
 ****************************************


      ***************************************
      *** SUMMARY OF SCREEN MODEL RESULTS ***
      ***************************************

  CALCULATION          MAX CONC    DIST TO   TERRAIN
   PROCEDURE          (UG/M**3)    MAX (M)    HT (M)
 --------------     -----------   -------   -------
 SIMPLE TERRAIN        282.3          500.        0.

 BLDG. CAVITY-1        297.1           59.       --   (DIST = CAVITY LENGTH)

 BLDG. CAVITY-2        297.1           59.       --   (DIST = CAVITY LENGTH)


 ***************************************************
 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
 ***************************************************
```

Stack #3: 2 HPP Engines - HPPENGS

```
                                                                      12/11/06
                                                                      08:53:59
  ***  SCREEN3 MODEL RUN  ***
  *** VERSION DATED 96043 ***


 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE            =        POINT
    EMISSION RATE (G/S)    =      1.00000
    STACK HEIGHT (M)       =       9.7536
    STK INSIDE DIAM (M)    =        .1836
    STK EXIT VELOCITY (M/S)=      39.9990
    STK GAS EXIT TEMP (K)  =     699.8167
    AMBIENT AIR TEMP (K)   =     273.0000
```

```
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =      14.6304
   MIN HORIZ BLDG DIM (M) =      81.0768
   MAX HORIZ BLDG DIM (M) =      81.0768

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


BUOY. FLUX =    2.015 M**4/S**3;  MOM. FLUX =    5.258 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC            U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)  Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   349.0        6     1.5    1.5 10000.0   19.87   17.97   16.77    SS
   600.   299.9        6     1.5    1.5 10000.0   19.87   21.24   17.55    SS
   700.   263.0        6     1.5    1.5 10000.0   19.87   24.46   18.31    SS
   800.   238.7        6     1.0    1.0 10000.0   24.89   27.63   17.46    SS
   900.   223.3        6     1.0    1.0 10000.0   24.89   30.78   18.22    SS
  1000.   209.3        6     1.0    1.0 10000.0   24.89   33.88   18.97    SS
  1100.   196.7        6     1.0    1.0 10000.0   24.89   36.96   19.70    SS
  1200.   185.3        6     1.0    1.0 10000.0   24.89   40.01   20.41    SS
  1300.   174.8        6     1.0    1.0 10000.0   24.89   43.04   21.11    SS
  1400.   163.2        6     1.0    1.0 10000.0   24.89   46.05   21.05    SS
  1500.   155.0        6     1.0    1.0 10000.0   24.89   49.03   21.72    SS
  1600.   147.2        6     1.0    1.0 10000.0   24.89   51.99   22.30    SS
  1700.   140.1        6     1.0    1.0 10000.0   24.89   54.94   22.87    SS
  1800.   133.5        6     1.0    1.0 10000.0   24.89   57.87   23.43    SS
  1900.   127.4        6     1.0    1.0 10000.0   24.89   60.78   23.98    SS
  2000.   121.8        6     1.0    1.0 10000.0   24.89   63.68   24.51    SS
  2100.   116.5        6     1.0    1.0 10000.0   24.89   66.56   25.04    SS
  2200.   111.6        6     1.0    1.0 10000.0   24.89   69.42   25.55    SS
  2300.   107.1        6     1.0    1.0 10000.0   24.89   72.28   26.06    SS
  2400.   102.8        6     1.0    1.0 10000.0   24.89   75.12   26.56    SS
  2500.   99.21        6     1.0    1.0 10000.0   24.89   77.95   26.31    SS
  2600.   95.53        6     1.0    1.0 10000.0   24.89   80.76   26.80    SS
  2700.   92.09        6     1.0    1.0 10000.0   24.89   83.57   27.24    SS
  2800.   88.88        6     1.0    1.0 10000.0   24.89   86.36   27.65    SS
  2900.   85.85        6     1.0    1.0 10000.0   24.89   89.15   28.06    SS
  3000.   83.00        6     1.0    1.0 10000.0   24.89   91.92   28.45    SS
  3500.   70.92        6     1.0    1.0 10000.0   24.89  105.65   30.35    SS
  4000.   61.59        6     1.0    1.0 10000.0   24.89  119.17   32.11    SS
  4500.   54.21        6     1.0    1.0 10000.0   24.89  132.50   33.77    SS
  5000.   48.24        6     1.0    1.0 10000.0   24.89  145.67   35.34    SS
  5500.   43.33        6     1.0    1.0 10000.0   24.89  158.69   36.84    SS
  6000.   39.23        6     1.0    1.0 10000.0   24.89  171.58   38.27    SS
  6500.   35.77        6     1.0    1.0 10000.0   24.89  184.34   39.64    SS
  7000.   33.01        6     1.0    1.0 10000.0   24.89  196.99   40.53    SS
  7500.   30.50        6     1.0    1.0 10000.0   24.89  209.54   41.68    SS
  8000.   28.30        6     1.0    1.0 10000.0   24.89  221.98   42.77    SS
  8500.   26.37        6     1.0    1.0 10000.0   24.89  234.34   43.83    SS
  9000.   24.67        6     1.0    1.0 10000.0   24.89  246.61   44.86    SS
  9500.   23.15        6     1.0    1.0 10000.0   24.89  258.79   45.85    SS
 10000.   21.79        6     1.0    1.0 10000.0   24.89  270.90   46.82    SS
 15000.   13.47        6     1.0    1.0 10000.0   24.89  388.43   54.88    SS
 20000.   9.678        6     1.0    1.0 10000.0   24.89  500.95   60.29    SS

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   500.   349.0        6     1.5    1.5 10000.0   19.87   17.97   16.77    SS

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
```

```
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
          (BRODE, 1988)
*****************************************


 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)     =    344.4        CONC (UG/M**3)     =    344.4
  CRIT WS @10M (M/S) =     3.26        CRIT WS @10M (M/S) =     3.26
  CRIT WS @ HS (M/S) =     3.26        CRIT WS @ HS (M/S) =     3.26
  DILUTION WS (M/S)  =     1.63        DILUTION WS (M/S)  =     1.63
  CAVITY HT (M)      =    14.63        CAVITY HT (M)      =    14.63
  CAVITY LENGTH (M)  =    59.48        CAVITY LENGTH (M)  =    59.48
  ALONGWIND DIM (M)  =    81.08        ALONGWIND DIM (M)  =    81.08

*****************************************
      END OF CAVITY CALCULATIONS
*****************************************


     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION         MAX CONC    DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)    HT (M)
--------------     -----------   -------   -------
SIMPLE TERRAIN       349.0          500.        0.

BLDG. CAVITY-1       344.4           59.       --  (DIST = CAVITY LENGTH)

BLDG. CAVITY-2       344.4           59.       --  (DIST = CAVITY LENGTH)


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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Stack #4: 3 Deck Cranes - DECKCRNS

```
                                                                   12/11/06
                                                                   08:54:00
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***



SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      1.00000
   STACK HEIGHT (M)       =      22.5552
   STK INSIDE DIAM (M)    =        .2540
   STK EXIT VELOCITY (M/S)=      20.0624
   STK GAS EXIT TEMP (K)  =     672.0389
   AMBIENT AIR TEMP (K)   =     273.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =      17.9832
   MIN HORIZ BLDG DIM (M) =      81.0768
   MAX HORIZ BLDG DIM (M) =      81.0768

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.
```

```
BUOY. FLUX =    1.884 M**4/S**3;  MOM. FLUX =    2.637 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   113.7        6     1.5    2.3 10000.0   28.76   17.97   17.67    SS
   600.   102.6        6     1.5    2.3 10000.0   28.76   21.24   18.43    SS
   700.   95.32        6     1.0    1.6 10000.0   31.98   24.46   18.00    SS
   800.   91.68        6     1.0    1.6 10000.0   31.98   27.63   18.75    SS
   900.   88.22        6     1.0    1.6 10000.0   31.98   30.78   19.49    SS
  1000.   84.90        6     1.0    1.6 10000.0   31.98   33.88   20.20    SS
  1100.   81.72        6     1.0    1.6 10000.0   31.98   36.96   20.91    SS
  1200.   78.65        6     1.0    1.6 10000.0   31.98   40.01   21.60    SS
  1300.   72.96        6     1.0    1.6 10000.0   31.98   43.04   21.56    SS
  1400.   70.35        6     1.0    1.6 10000.0   31.98   46.05   22.15    SS
  1500.   67.83        6     1.0    1.6 10000.0   31.98   49.03   22.72    SS
  1600.   65.43        6     1.0    1.6 10000.0   31.98   51.99   23.28    SS
  1700.   63.15        6     1.0    1.6 10000.0   31.98   54.94   23.83    SS
  1800.   60.99        6     1.0    1.6 10000.0   31.98   57.87   24.37    SS
  1900.   58.93        6     1.0    1.6 10000.0   31.98   60.78   24.90    SS
  2000.   56.97        6     1.0    1.6 10000.0   31.98   63.68   25.42    SS
  2100.   55.10        6     1.0    1.6 10000.0   31.98   66.56   25.93    SS
  2200.   53.33        6     1.0    1.6 10000.0   31.98   69.42   26.43    SS
  2300.   51.64        6     1.0    1.6 10000.0   31.98   72.28   26.93    SS
  2400.   49.42        6     1.0    1.6 10000.0   31.98   75.12   26.60    SS
  2500.   47.99        6     1.0    1.6 10000.0   31.98   77.95   27.07    SS
  2600.   46.58        6     1.0    1.6 10000.0   31.98   80.76   27.48    SS
  2700.   45.24        6     1.0    1.6 10000.0   31.98   83.57   27.89    SS
  2800.   43.96        6     1.0    1.6 10000.0   31.98   86.36   28.29    SS
  2900.   42.74        6     1.0    1.6 10000.0   31.98   89.15   28.68    SS
  3000.   41.57        6     1.0    1.6 10000.0   31.98   91.92   29.07    SS
  3500.   36.48        6     1.0    1.6 10000.0   31.98  105.65   30.92    SS
  4000.   32.37        6     1.0    1.6 10000.0   31.98  119.17   32.65    SS
  4500.   28.99        6     1.0    1.6 10000.0   31.98  132.50   34.28    SS
  5000.   26.18        6     1.0    1.6 10000.0   31.98  145.67   35.83    SS
  5500.   23.80        6     1.0    1.6 10000.0   31.98  158.69   37.30    SS
  6000.   21.78        6     1.0    1.6 10000.0   31.98  171.58   38.71    SS
  6500.   20.12        6     1.0    1.6 10000.0   31.98  184.34   39.61    SS
  7000.   18.62        6     1.0    1.6 10000.0   31.98  196.99   40.83    SS
  7500.   17.31        6     1.0    1.6 10000.0   31.98  209.54   41.96    SS
  8000.   16.16        6     1.0    1.6 10000.0   31.98  221.98   43.05    SS
  8500.   15.14        6     1.0    1.6 10000.0   31.98  234.34   44.10    SS
  9000.   14.23        6     1.0    1.6 10000.0   31.98  246.61   45.11    SS
  9500.   13.41        6     1.0    1.6 10000.0   31.98  258.79   46.10    SS
 10000.   12.67        6     1.0    1.6 10000.0   31.98  270.90   47.06    SS
 15000.   8.051        6     1.0    1.6 10000.0   31.98  388.43   54.93    SS
 20000.   5.851        6     1.0    1.6 10000.0   31.98  500.95   60.33    SS

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   500.   113.7        6     1.5    2.3 10000.0   28.76   17.97   17.67    SS

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
```

```
          (BRODE, 1988)
 ****************************************


  *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
   CONC (UG/M**3)     =    .0000        CONC (UG/M**3)     =    .0000
   CRIT WS @10M (M/S) =    99.99        CRIT WS @10M (M/S) =    99.99
   CRIT WS @ HS (M/S) =    99.99        CRIT WS @ HS (M/S) =    99.99
   DILUTION WS (M/S)  =    99.99        DILUTION WS (M/S)  =    99.99
   CAVITY HT (M)      =    18.07        CAVITY HT (M)      =    18.07
   CAVITY LENGTH (M)  =    66.70        CAVITY LENGTH (M)  =    66.70
   ALONGWIND DIM (M)  =    81.08        ALONGWIND DIM (M)  =    81.08

 CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

 ****************************************
       END OF CAVITY CALCULATIONS
 ****************************************


      ***************************************
      *** SUMMARY OF SCREEN MODEL RESULTS ***
      ***************************************

  CALCULATION         MAX CONC    DIST TO    TERRAIN
   PROCEDURE         (UG/M**3)    MAX (M)     HT (M)
 --------------     -----------   -------    -------
 SIMPLE TERRAIN       113.7          500.        0.


 ***************************************************
 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
 ***************************************************
```

Stack #5: 1 Boiler / 1 Hot Water Heater – BOILHEAT

```
                                                                     12/11/06
                                                                     08:54:00
  ***  SCREEN3 MODEL RUN  ***
  *** VERSION DATED 96043 ***



 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE              =        POINT
    EMISSION RATE (G/S)      =      1.00000
    STACK HEIGHT (M)         =      15.8496
    STK INSIDE DIAM (M)      =      19.0133
    STK EXIT VELOCITY (M/S)=          .0010
    STK GAS EXIT TEMP (K)    =     366.4833
    AMBIENT AIR TEMP (K)     =     273.0000
    RECEPTOR HEIGHT (M)      =        .0000
    URBAN/RURAL OPTION       =        RURAL
    BUILDING HEIGHT (M)      =      17.9832
    MIN HORIZ BLDG DIM (M) =        81.0768
    MAX HORIZ BLDG DIM (M) =        81.0768

 THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


 BUOY. FLUX =     .226 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

 *** FULL METEOROLOGY ***

 **********************************
 *** SCREEN AUTOMATED DISTANCES ***
```

```
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   317.9        6     1.0    1.3 10000.0   16.71   25.74   23.41    SS
   600.   279.8        6     1.0    1.3 10000.0   16.71   28.90   23.95    SS
   700.   249.6        6     1.0    1.3 10000.0   16.71   32.03   24.49    SS
   800.   225.0        6     1.0    1.3 10000.0   16.71   35.13   25.02    SS
   900.   204.5        6     1.0    1.3 10000.0   16.71   38.19   25.53    SS
  1000.   187.3        6     1.0    1.3 10000.0   16.71   41.24   26.04    SS
  1100.   172.6        6     1.0    1.3 10000.0   16.71   44.25   26.54    SS
  1200.   162.3        6     1.0    1.3 10000.0   16.71   47.25   26.36    SS
  1300.   150.9        6     1.0    1.3 10000.0   16.71   50.23   26.86    SS
  1400.   141.1        6     1.0    1.3 10000.0   16.71   53.18   27.29    SS
  1500.   132.5        6     1.0    1.3 10000.0   16.71   56.12   27.70    SS
  1600.   124.8        6     1.0    1.3 10000.0   16.71   59.04   28.10    SS
  1700.   117.9        6     1.0    1.3 10000.0   16.71   61.95   28.50    SS
  1800.   111.6        6     1.0    1.3 10000.0   16.71   64.84   28.89    SS
  1900.   105.9        6     1.0    1.3 10000.0   16.71   67.71   29.27    SS
  2000.   100.7        6     1.0    1.3 10000.0   16.71   70.57   29.65    SS
  2100.   96.01        6     1.0    1.3 10000.0   16.71   73.42   30.02    SS
  2200.   91.67        6     1.0    1.3 10000.0   16.71   76.26   30.39    SS
  2300.   87.66        6     1.0    1.3 10000.0   16.71   79.08   30.75    SS
  2400.   83.96        6     1.0    1.3 10000.0   16.71   81.89   31.11    SS
  2500.   80.53        6     1.0    1.3 10000.0   16.71   84.70   31.46    SS
  2600.   77.35        6     1.0    1.3 10000.0   16.71   87.49   31.81    SS
  2700.   74.38        6     1.0    1.3 10000.0   16.71   90.27   32.15    SS
  2800.   71.62        6     1.0    1.3 10000.0   16.71   93.04   32.49    SS
  2900.   69.03        6     1.0    1.3 10000.0   16.71   95.80   32.83    SS
  3000.   66.60        6     1.0    1.3 10000.0   16.71   98.55   33.16    SS
  3500.   56.45        6     1.0    1.3 10000.0   16.71  112.17   34.76    SS
  4000.   48.76        6     1.0    1.3 10000.0   16.71  125.60   36.29    SS
  4500.   42.75        6     1.0    1.3 10000.0   16.71  138.85   37.74    SS
  5000.   37.94        6     1.0    1.3 10000.0   16.71  151.94   39.13    SS
  5500.   34.52        6     1.0    1.3 10000.0   16.71  164.90   39.74    SS
  6000.   31.24        6     1.0    1.3 10000.0   16.71  177.73   40.94    SS
  6500.   28.50        6     1.0    1.3 10000.0   16.71  190.43   42.07    SS
  7000.   26.17        6     1.0    1.3 10000.0   16.71  203.03   43.15    SS
  7500.   24.15        6     1.0    1.3 10000.0   16.71  215.53   44.20    SS
  8000.   22.39        6     1.0    1.3 10000.0   16.71  227.93   45.21    SS
  8500.   20.85        6     1.0    1.3 10000.0   16.71  240.24   46.20    SS
  9000.   19.49        6     1.0    1.3 10000.0   16.71  252.47   47.15    SS
  9500.   18.28        6     1.0    1.3 10000.0   16.71  264.62   48.08    SS
 10000.   17.20        6     1.0    1.3 10000.0   16.71  276.69   48.98    SS
 15000.   10.77        6     1.0    1.3 10000.0   16.71  393.93   55.69    SS
 20000.   7.711        6     1.0    1.3 10000.0   16.71  506.25   60.96    SS

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   500.   317.9        6     1.0    1.3 10000.0   16.71   25.74   23.41    SS

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
          (BRODE, 1988)
****************************************


 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)     =    457.2        CONC (UG/M**3)     =    457.2
  CRIT WS @10M (M/S) =     1.00        CRIT WS @10M (M/S) =     1.00
  CRIT WS @ HS (M/S) =     1.10        CRIT WS @ HS (M/S) =     1.10
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```
  DILUTION WS (M/S)  =     1.00        DILUTION WS (M/S)  =     1.00
  CAVITY HT (M)      =    18.07        CAVITY HT (M)      =    18.07
  CAVITY LENGTH (M)  =    66.70        CAVITY LENGTH (M)  =    66.70
  ALONGWIND DIM (M)  =    81.08        ALONGWIND DIM (M)  =    81.08

 *****************************************
       END OF CAVITY CALCULATIONS
 *****************************************


      ***************************************
      *** SUMMARY OF SCREEN MODEL RESULTS ***
      ***************************************

  CALCULATION         MAX CONC    DIST TO   TERRAIN
   PROCEDURE         (UG/M**3)    MAX (M)    HT (M)
 --------------    -----------    -------   -------
 SIMPLE TERRAIN      317.9          500.        0.

 BLDG. CAVITY-1      457.2           67.       --   (DIST = CAVITY LENGTH)

 BLDG. CAVITY-2      457.2           67.       --   (DIST = CAVITY LENGTH)


 ***************************************************
 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
 ***************************************************
```

Stack #6: 1 Logging Winch – LOGWNCH

```
                                                                      12/11/06
                                                                      08:54:00
  ***  SCREEN3 MODEL RUN  ***
  *** VERSION DATED 96043 ***



 SIMPLE TERRAIN INPUTS:
    SOURCE TYPE            =        POINT
    EMISSION RATE (G/S)    =      1.00000
    STACK HEIGHT (M)       =      10.3632
    STK INSIDE DIAM (M)    =        .1016
    STK EXIT VELOCITY (M/S)=      52.9734
    STK GAS EXIT TEMP (K)  =     710.9278
    AMBIENT AIR TEMP (K)   =     273.0000
    RECEPTOR HEIGHT (M)    =        .0000
    URBAN/RURAL OPTION     =        RURAL
    BUILDING HEIGHT (M)    =      17.9832
    MIN HORIZ BLDG DIM (M) =      81.0768
    MAX HORIZ BLDG DIM (M) =      81.0768

 THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
 THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


 BUOY. FLUX =     .826 M**4/S**3;  MOM. FLUX =    2.781 M**4/S**2.

 *** FULL METEOROLOGY ***

 **********************************
 *** SCREEN AUTOMATED DISTANCES ***
 **********************************

 *** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

   DIST     CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
    (M)   (UG/M**3)    STAB   (M/S)  (M/S)   (M)    HT (M)  Y (M)   Z (M)  DWASH
 -------  ----------   ----   -----  -----  ------  ------  ------  ------  -----
    500.    641.5        6      1.0    1.0 10000.0   14.84   17.97   21.19    SS
```

```
   600.   538.6        6     1.0    1.0 10000.0   14.84   21.24   21.51    SS
   700.   460.8        6     1.0    1.0 10000.0   14.84   24.46   22.11    SS
   800.   402.0        6     1.0    1.0 10000.0   14.84   27.63   22.68    SS
   900.   355.8        6     1.0    1.0 10000.0   14.84   30.78   23.24    SS
  1000.   318.7        6     1.0    1.0 10000.0   14.84   33.88   23.79    SS
  1100.   288.1        6     1.0    1.0 10000.0   14.84   36.96   24.33    SS
  1200.   262.5        6     1.0    1.0 10000.0   14.84   40.01   24.86    SS
  1300.   240.8        6     1.0    1.0 10000.0   14.84   43.04   25.38    SS
  1400.   222.1        6     1.0    1.0 10000.0   14.84   46.05   25.89    SS
  1500.   205.9        6     1.0    1.0 10000.0   14.84   49.03   26.40    SS
  1600.   191.7        6     1.0    1.0 10000.0   14.84   51.99   26.89    SS
  1700.   183.0        6     1.0    1.0 10000.0   14.84   54.94   26.57    SS
  1800.   171.6        6     1.0    1.0 10000.0   14.84   57.87   27.05    SS
  1900.   161.6        6     1.0    1.0 10000.0   14.84   60.78   27.46    SS
  2000.   152.6        6     1.0    1.0 10000.0   14.84   63.68   27.86    SS
  2100.   144.5        6     1.0    1.0 10000.0   14.84   66.56   28.26    SS
  2200.   137.2        6     1.0    1.0 10000.0   14.84   69.42   28.66    SS
  2300.   130.5        6     1.0    1.0 10000.0   14.84   72.28   29.04    SS
  2400.   124.3        6     1.0    1.0 10000.0   14.84   75.12   29.43    SS
  2500.   118.7        6     1.0    1.0 10000.0   14.84   77.95   29.80    SS
  2600.   113.5        6     1.0    1.0 10000.0   14.84   80.76   30.17    SS
  2700.   108.7        6     1.0    1.0 10000.0   14.84   83.57   30.54    SS
  2800.   104.2        6     1.0    1.0 10000.0   14.84   86.36   30.90    SS
  2900.   100.1        6     1.0    1.0 10000.0   14.84   89.15   31.25    SS
  3000.   96.23        6     1.0    1.0 10000.0   14.84   91.92   31.60    SS
  3500.   80.34        6     1.0    1.0 10000.0   14.84  105.65   33.29    SS
  4000.   68.58        6     1.0    1.0 10000.0   14.84  119.17   34.89    SS
  4500.   59.55        6     1.0    1.0 10000.0   14.84  132.50   36.41    SS
  5000.   52.42        6     1.0    1.0 10000.0   14.84  145.67   37.85    SS
  5500.   46.67        6     1.0    1.0 10000.0   14.84  158.69   39.24    SS
  6000.   42.52        6     1.0    1.0 10000.0   14.84  171.58   39.92    SS
  6500.   38.60        6     1.0    1.0 10000.0   14.84  184.34   41.10    SS
  7000.   35.28        6     1.0    1.0 10000.0   14.84  196.99   42.22    SS
  7500.   32.44        6     1.0    1.0 10000.0   14.84  209.54   43.30    SS
  8000.   29.98        6     1.0    1.0 10000.0   14.84  221.98   44.34    SS
  8500.   27.84        6     1.0    1.0 10000.0   14.84  234.34   45.35    SS
  9000.   25.95        6     1.0    1.0 10000.0   14.84  246.61   46.33    SS
  9500.   24.28        6     1.0    1.0 10000.0   14.84  258.79   47.28    SS
 10000.   22.80        6     1.0    1.0 10000.0   14.84  270.90   48.20    SS
 15000.   14.00        6     1.0    1.0 10000.0   14.84  388.43   55.35    SS
 20000.   9.965        6     1.0    1.0 10000.0   14.84  500.95   60.68    SS

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   500.   641.5        6     1.0    1.0 10000.0   14.84   17.97   21.19    SS

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****************************************
     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
          (BRODE, 1988)
****************************************


 *** CAVITY CALCULATION - 1 ***       *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)     =    457.2        CONC (UG/M**3)     =    457.2
  CRIT WS @10M (M/S) =     1.49        CRIT WS @10M (M/S) =     1.49
  CRIT WS @ HS (M/S) =     1.50        CRIT WS @ HS (M/S) =     1.50
  DILUTION WS (M/S)  =     1.00        DILUTION WS (M/S)  =     1.00
  CAVITY HT (M)      =    18.07        CAVITY HT (M)      =    18.07
  CAVITY LENGTH (M)  =    66.70        CAVITY LENGTH (M)  =    66.70
  ALONGWIND DIM (M)  =    81.08        ALONGWIND DIM (M)  =    81.08

****************************************
      END OF CAVITY CALCULATIONS
****************************************
```

```
     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION         MAX CONC    DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)    HT (M)
--------------     -----------   -------   -------
SIMPLE TERRAIN       641.5          500.        0.

BLDG. CAVITY-1       457.2           67.       --  (DIST = CAVITY LENGTH)

BLDG. CAVITY-2       457.2           67.       --  (DIST = CAVITY LENGTH)


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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Vladimir Ignatjuk, Initial Point Source – VLADIMIR

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                                                                     12/11/06
                                                                     09:02:49
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***



SIMPLE TERRAIN INPUTS:
   SOURCE TYPE             =        POINT
   EMISSION RATE (G/S)     =      1.00000
   STACK HEIGHT (M)        =      24.3840
   STK INSIDE DIAM (M)     =        .4001
   STK EXIT VELOCITY (M/S)=       18.6947
   STK GAS EXIT TEMP (K)   =     623.1500
   AMBIENT AIR TEMP (K)    =     273.0000
   RECEPTOR HEIGHT (M)     =        .0000
   URBAN/RURAL OPTION      =        RURAL
   BUILDING HEIGHT (M)     =        .0000
   MIN HORIZ BLDG DIM (M) =         .0000
   MAX HORIZ BLDG DIM (M) =         .0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


BUOY. FLUX =    4.121 M**4/S**3;  MOM. FLUX =    6.126 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)    STAB  (M/S)  (M/S)   (M)     HT (M)   Y (M)   Z (M)  DWASH
-------  ----------   ----  -----  -----  ------  ------  ------  ------  -----
   500.   23.20         3     2.5    2.7   800.0   47.06   55.15   33.07    NO
   600.   23.03         3     2.0    2.2   640.0   52.73   65.21   39.17    NO
   700.   22.25         3     1.5    1.6   480.0   62.18   75.27   45.42    NO
   800.   21.34         3     1.5    1.6   480.0   62.18   84.83   51.01    NO
   900.   19.89         3     1.5    1.6   480.0   62.18   94.30   56.56    NO
  1000.   19.40         3     1.0    1.1   320.0   81.07  104.38   63.25    NO
  1100.   18.59         3     1.0    1.1   320.0   81.07  113.62   68.65    NO
  1200.   17.64         4     2.0    2.3   640.0   51.49   80.81   36.91    NO
```

```
  1300.   17.12        4     2.0    2.3   640.0   51.49   86.86   38.78    NO
  1400.   16.52        4     2.0    2.3   640.0   51.49   92.88   40.60    NO
  1500.   16.15        4     1.5    1.7   480.0   60.53   99.08   42.93    NO
  1600.   15.80        4     1.5    1.7   480.0   60.53  105.00   44.65    NO
  1700.   15.39        4     1.5    1.7   480.0   60.53  110.89   46.33    NO
  1800.   14.96        4     1.5    1.7   480.0   60.53  116.74   47.99    NO
  1900.   14.50        4     1.5    1.7   480.0   60.53  122.57   49.61    NO
  2000.   14.04        4     1.5    1.7   480.0   60.53  128.36   51.20    NO
  2100.   13.59        4     1.5    1.7   480.0   60.53  134.13   52.77    NO
  2200.   13.13        4     1.5    1.7   480.0   60.53  139.86   54.32    NO
  2300.   12.93        4     1.0    1.1   320.0   78.60  146.03   57.02    NO
  2400.   12.72        4     1.0    1.1   320.0   78.60  151.71   58.49    NO
  2500.   12.50        4     1.0    1.1   320.0   78.60  157.36   59.94    NO
  2600.   12.44        5     1.0    1.4 10000.0   66.33  121.96   40.71    NO
  2700.   12.42        5     1.0    1.4 10000.0   66.33  126.16   41.52    NO
  2800.   12.37        5     1.0    1.4 10000.0   66.33  130.34   42.32    NO
  2900.   12.30        5     1.0    1.4 10000.0   66.33  134.50   43.11    NO
  3000.   12.22        5     1.0    1.4 10000.0   66.33  138.65   43.89    NO
  3500.   11.65        5     1.0    1.4 10000.0   66.33  159.21   47.64    NO
  4000.   10.95        5     1.0    1.4 10000.0   66.33  179.46   51.19    NO
  4500.   10.43        6     1.0    1.6 10000.0   57.18  132.83   33.89    NO
  5000.   10.27        6     1.0    1.6 10000.0   57.18  145.97   35.47    NO
  5500.   10.03        6     1.0    1.6 10000.0   57.18  158.97   36.96    NO
  6000.   9.747        6     1.0    1.6 10000.0   57.18  171.83   38.39    NO
  6500.   9.445        6     1.0    1.6 10000.0   57.18  184.58   39.76    NO
  7000.   9.133        6     1.0    1.6 10000.0   57.18  197.22   41.08    NO
  7500.   8.797        6     1.0    1.6 10000.0   57.18  209.75   42.22    NO
  8000.   8.473        6     1.0    1.6 10000.0   57.18  222.18   43.31    NO
  8500.   8.164        6     1.0    1.6 10000.0   57.18  234.53   44.36    NO
  9000.   7.869        6     1.0    1.6 10000.0   57.18  246.79   45.38    NO
  9500.   7.589        6     1.0    1.6 10000.0   57.18  258.96   46.36    NO
 10000.   7.323        6     1.0    1.6 10000.0   57.18  271.06   47.32    NO
 15000.   5.318        6     1.0    1.6 10000.0   57.18  388.54   55.68    NO
 20000.   4.110        6     1.0    1.6 10000.0   57.18  501.04   61.02    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   500.   23.20        3     2.5    2.7   800.0   47.06   55.15   33.07    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
 13500.   5.814        6     1.0    1.6 10000.0   57.18  353.90   53.37    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      23.20          500.        0.
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***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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Vladimir Ignatjuk, Final Area Source – VLAD_BIG

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                                                                   12/11/06
                                                                   09:05:33
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***



SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                  =         AREA
   EMISSION RATE (G/(S-M**2))  =      .666667E-08
   SOURCE HEIGHT (M)            =      57.1800
   LENGTH OF LARGER SIDE (M)    =   15000.0000
   LENGTH OF SMALLER SIDE (M)   =   10000.0000
   RECEPTOR HEIGHT (M)          =        .0000
   URBAN/RURAL OPTION           =        RURAL
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

   MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC            U10M   USTK  MIX HT   PLUME  MAX DIR
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)   (M)    HT (M)  (DEG)
-------  ----------  ----  -----  -----  ------  ------  -------
   500.   .3018        4     1.0    1.3   320.0   57.18     31.
   600.   .3045        4     1.0    1.3   320.0   57.18     31.
   700.   .3073        4     1.0    1.3   320.0   57.18     31.
   800.   .3100        4     1.0    1.3   320.0   57.18     31.
   900.   .3127        4     1.0    1.3   320.0   57.18     31.
  1000.   .3154        4     1.0    1.3   320.0   57.18     31.
  1100.   .3180        4     1.0    1.3   320.0   57.18     31.
  1200.   .3207        4     1.0    1.3   320.0   57.18     31.
  1300.   .3233        4     1.0    1.3   320.0   57.18     31.
  1400.   .3272        4     1.0    1.3   320.0   57.18     30.
  1500.   .3300        4     1.0    1.3   320.0   57.18     30.
  1600.   .3334        4     1.0    1.3   320.0   57.18     31.
  1700.   .3361        4     1.0    1.3   320.0   57.18     31.
  1800.   .3387        4     1.0    1.3   320.0   57.18     31.
  1900.   .3407        4     1.0    1.3   320.0   57.18     30.
  2000.   .3433        4     1.0    1.3   320.0   57.18     30.
  2100.   .3460        4     1.0    1.3   320.0   57.18     30.
  2200.   .3486        4     1.0    1.3   320.0   57.18     30.
  2300.   .3512        4     1.0    1.3   320.0   57.18     30.
  2400.   .3538        4     1.0    1.3   320.0   57.18     30.
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  2500.   .3564        4     1.0    1.3   320.0   57.18     30.
  2600.   .3590        4     1.0    1.3   320.0   57.18     30.
  2700.   .3616        4     1.0    1.3   320.0   57.18     30.
  2800.   .3642        4     1.0    1.3   320.0   57.18     30.
  2900.   .3667        4     1.0    1.3   320.0   57.18     30.
  3000.   .3693        4     1.0    1.3   320.0   57.18     30.
  3500.   .3871        4     1.0    1.3   320.0   57.18     27.
  4000.   .4027        4     1.0    1.3   320.0   57.18     30.
  4500.   .4149        4     1.0    1.3   320.0   57.18     29.
  5000.   .4273        4     1.0    1.3   320.0   57.18     29.
  5500.   .4288        4     1.0    1.3   320.0   57.18     29.
  6000.   .4401        4     1.0    1.3   320.0   57.18     29.
  6500.   .4513        4     1.0    1.3   320.0   57.18     29.
  7000.   .4615        4     1.0    1.3   320.0   57.18     28.
  7500.   .4723        4     1.0    1.3   320.0   57.18     28.
  8000.   .4829        4     1.0    1.3   320.0   57.18     28.
  8500.   .4964        4     1.0    1.3   320.0   57.18     26.
  9000.   .5085        4     1.0    1.3   320.0   57.18     32.
  9500.   .5139        4     1.0    1.3   320.0   57.18     33.
 10000.   .5159        4     1.0    1.3   320.0   57.18     33.
 15000.   .4408        5     1.0    1.8 10000.0   57.18     32.
 20000.   .3969        5     1.0    1.8 10000.0   57.18     31.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
  9817.   .5167        4     1.0    1.3   320.0   57.18     33.

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC            U10M   USTK  MIX HT   PLUME  MAX DIR
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   (DEG)
-------  ----------  ----  -----  -----  ------  ------  -------
 13500.   .4550        5     1.0    1.8 10000.0   57.18     32.

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      .5167         9817.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
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Fennica/Nordica, Initial Point Source – FENNICA

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                                                                    12/11/06
                                                                    09:02:49
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***



SIMPLE TERRAIN INPUTS:
   SOURCE TYPE              =        POINT
   EMISSION RATE (G/S)      =      1.00000
   STACK HEIGHT (M)         =      32.0040
   STK INSIDE DIAM (M)      =        .2659
   STK EXIT VELOCITY (M/S)=      36.0084
   STK GAS EXIT TEMP (K)  =     573.1500
   AMBIENT AIR TEMP (K)   =     273.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


BUOY. FLUX =    3.269 M**4/S**3;  MOM. FLUX =   10.920 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC            U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)    HT (M)  Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   21.16         2    1.5    1.6   480.0   64.02   83.26   51.91    NO
   600.   21.29         2    1.0    1.1   320.0   80.02   98.46   63.90    NO
   700.   21.05         3    1.5    1.7   480.0   62.92   75.01   45.00    NO
   800.   20.37         3    1.5    1.7   480.0   62.92   84.61   50.63    NO
   900.   20.44         3    1.0    1.1   320.0   78.38   94.61   57.08    NO
  1000.   19.88         3    1.0    1.1   320.0   78.38  103.96   62.56    NO
  1100.   18.94         3    1.0    1.1   320.0   78.38  113.23   68.01    NO
  1200.   17.83         3    1.0    1.1   320.0   78.38  122.43   73.44    NO
  1300.   16.67         3    1.0    1.1   320.0   78.38  131.57   78.84    NO
  1400.   15.52         3    1.0    1.1   320.0   78.38  140.64   84.22    NO
  1500.   15.05         4    1.5    1.8   480.0   61.17   98.89   42.49    NO
  1600.   14.77         4    1.5    1.8   480.0   61.17  104.82   44.23    NO
  1700.   14.44         4    1.5    1.8   480.0   61.17  110.72   45.93    NO
  1800.   14.06         4    1.5    1.8   480.0   61.17  116.58   47.60    NO
  1900.   13.86         4    1.0    1.2   320.0   75.76  122.77   50.11    NO
  2000.   13.74         4    1.0    1.2   320.0   75.76  128.55   51.69    NO
  2100.   13.59         4    1.0    1.2   320.0   75.76  134.31   53.24    NO
  2200.   13.39         4    1.0    1.2   320.0   75.76  140.04   54.77    NO
  2300.   13.17         4    1.0    1.2   320.0   75.76  145.75   56.28    NO
  2400.   12.93         4    1.0    1.2   320.0   75.76  151.43   57.77    NO
  2500.   12.68         4    1.0    1.2   320.0   75.76  157.09   59.24    NO
  2600.   12.42         4    1.0    1.2   320.0   75.76  162.73   60.68    NO
  2700.   12.15         4    1.0    1.2   320.0   75.76  168.34   62.12    NO
  2800.   11.88         4    1.0    1.2   320.0   75.76  173.93   63.53    NO
```

```
  2900.   11.61        4     1.0    1.2   320.0   75.76  179.51   64.92    NO
  3000.   11.34        4     1.0    1.2   320.0   75.76  185.06   66.31    NO
  3500.   10.05        4     1.0    1.2   320.0   75.76  212.55   72.56    NO
  4000.   9.107        5     1.0    1.5 10000.0   69.62  179.38   50.91    NO
  4500.   8.560        5     1.0    1.5 10000.0   69.62  199.37   53.90    NO
  5000.   8.026        5     1.0    1.5 10000.0   69.62  219.12   56.74    NO
  5500.   7.520        5     1.0    1.5 10000.0   69.62  238.66   59.44    NO
  6000.   7.163        6     1.0    1.9 10000.0   60.89  171.78   38.14    NO
  6500.   7.023        6     1.0    1.9 10000.0   60.89  184.53   39.52    NO
  7000.   6.861        6     1.0    1.9 10000.0   60.89  197.17   40.84    NO
  7500.   6.661        6     1.0    1.9 10000.0   60.89  209.70   41.98    NO
  8000.   6.460        6     1.0    1.9 10000.0   60.89  222.14   43.08    NO
  8500.   6.263        6     1.0    1.9 10000.0   60.89  234.48   44.14    NO
  9000.   6.070        6     1.0    1.9 10000.0   60.89  246.75   45.16    NO
  9500.   5.883        6     1.0    1.9 10000.0   60.89  258.93   46.15    NO
 10000.   5.703        6     1.0    1.9 10000.0   60.89  271.03   47.11    NO
 15000.   4.265        6     1.0    1.9 10000.0   60.89  388.52   55.50    NO
 20000.   3.338        6     1.0    1.9 10000.0   60.89  501.02   60.86    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   555.   21.54        2     1.0    1.1   320.0   80.02   92.07   59.02    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB   (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----   -----  -----  ------  ------  ------  ------  -----
  6000.   7.163        6     1.0    1.9 10000.0   60.89  171.78   38.14    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION         MAX CONC    DIST TO    TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)     HT (M)
--------------    -----------    -------    -------
SIMPLE TERRAIN       21.54          555.         0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
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Fennica/Nordica, Final Area Source – FEN_SM

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                                                                 12/11/06
                                                                 09:05:33
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***



SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                  =         AREA
   EMISSION RATE (G/(S-M**2))  =      .200000E-07
   SOURCE HEIGHT (M)            =      60.8900
   LENGTH OF LARGER SIDE (M)    =   10000.0000
   LENGTH OF SMALLER SIDE (M)   =    5000.0000
   RECEPTOR HEIGHT (M)          =        .0000
   URBAN/RURAL OPTION           =        RURAL
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

   MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME  MAX DIR
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   (DEG)
-------  ----------  ----  -----  -----  ------  ------  -------
   500.   .5526        4     1.0    1.3   320.0   60.89     22.
   600.   .5626        4     1.0    1.3   320.0   60.89     22.
   700.   .5726        4     1.0    1.3   320.0   60.89     22.
   800.   .5810        4     1.0    1.3   320.0   60.89     21.
   900.   .5910        4     1.0    1.3   320.0   60.89     21.
  1000.   .6009        4     1.0    1.3   320.0   60.89     21.
  1100.   .6107        4     1.0    1.3   320.0   60.89     21.
  1200.   .6205        4     1.0    1.3   320.0   60.89     21.
  1300.   .6302        4     1.0    1.3   320.0   60.89     21.
  1400.   .6399        4     1.0    1.3   320.0   60.89     21.
  1500.   .6495        4     1.0    1.3   320.0   60.89     21.
  1600.   .6590        4     1.0    1.3   320.0   60.89     21.
  1700.   .6683        4     1.0    1.3   320.0   60.89     21.
  1800.   .6758        4     1.0    1.3   320.0   60.89     20.
  1900.   .6851        4     1.0    1.3   320.0   60.89     20.
  2000.   .6943        4     1.0    1.3   320.0   60.89     20.
  2100.   .7034        4     1.0    1.3   320.0   60.89     20.
  2200.   .7125        4     1.0    1.3   320.0   60.89     20.
  2300.   .7215        4     1.0    1.3   320.0   60.89     20.
  2400.   .7304        4     1.0    1.3   320.0   60.89     20.
  2500.   .7393        4     1.0    1.3   320.0   60.89     20.
  2600.   .7482        4     1.0    1.3   320.0   60.89     20.
  2700.   .7570        4     1.0    1.3   320.0   60.89     20.
  2800.   .7641        4     1.0    1.3   320.0   60.89     19.
  2900.   .7728        4     1.0    1.3   320.0   60.89     19.
  3000.   .7815        4     1.0    1.3   320.0   60.89     19.
  3500.   .8224        4     1.0    1.3   320.0   60.89     18.
  4000.   .8640        4     1.0    1.3   320.0   60.89     18.
  4500.   .9030        4     1.0    1.3   320.0   60.89     17.
  5000.   .9456        4     1.0    1.3   320.0   60.89     21.
  5500.   .9830        4     1.0    1.3   320.0   60.89     21.
  6000.  1.024         4     1.0    1.3   320.0   60.89     21.
  6500.  1.040         4     1.0    1.3   320.0   60.89     24.
  7000.  1.034         4     1.0    1.3   320.0   60.89     25.
  7500.  1.013         4     1.0    1.3   320.0   60.89     24.
  8000.   .9871        4     1.0    1.3   320.0   60.89     24.
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  8500.   .9586        4     1.0    1.3   320.0   60.89     23.
  9000.   .9316        4     1.0    1.3   320.0   60.89     23.
  9500.   .9044        4     1.0    1.3   320.0   60.89     22.
 10000.   .8763        4     1.0    1.3   320.0   60.89     20.
 15000.   .7511        5     1.0    1.9 10000.0   60.89     17.
 20000.   .6704        5     1.0    1.9 10000.0   60.89      6.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
  6609.   1.041        4     1.0    1.3   320.0   60.89     25.

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC            U10M   USTK  MIX HT   PLUME  MAX DIR
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)  (DEG)
-------  ----------  ----  -----  -----  ------  ------  -------
  6000.   1.024        4     1.0    1.3   320.0   60.89     21.

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION        MAX CONC    DIST TO    TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)     HT (M)
--------------    -----------   -------    -------
SIMPLE TERRAIN      1.041         6609.         0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
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Jim Kilabuk – KILABUK

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                                                                  12/11/06
                                                                  09:02:49
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***
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SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      1.00000
   STACK HEIGHT (M)       =      15.2400
   STK INSIDE DIAM (M)    =        .1836
   STK EXIT VELOCITY (M/S)=      39.9990
   STK GAS EXIT TEMP (K)  =     699.8167
   AMBIENT AIR TEMP (K)   =     273.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


BUOY. FLUX =    2.015 M**4/S**3;  MOM. FLUX =    5.258 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   56.84        3     1.5    1.6   480.0   38.40   55.17   33.10    NO
   600.   53.26        4     2.0    2.1   640.0   32.25   42.99   21.76    NO
   700.   51.91        4     2.0    2.1   640.0   32.25   49.43   24.52    NO
   800.   50.13        4     1.5    1.6   480.0   37.92   55.95   27.56    NO
   900.   48.17        4     1.5    1.6   480.0   37.92   62.22   30.17    NO
  1000.   45.47        4     1.5    1.6   480.0   37.92   68.43   32.74    NO
  1100.   42.87        4     1.0    1.1   320.0   49.26   74.94   35.48    NO
  1200.   41.40        4     1.0    1.1   320.0   49.26   81.02   37.38    NO
  1300.   39.77        4     1.0    1.1   320.0   49.26   87.06   39.22    NO
  1400.   38.07        4     1.0    1.1   320.0   49.26   93.06   41.03    NO
  1500.   36.35        4     1.0    1.1   320.0   49.26   99.02   42.79    NO
  1600.   34.68        4     1.0    1.1   320.0   49.26  104.94   44.51    NO
  1700.   33.06        4     1.0    1.1   320.0   49.26  110.83   46.20    NO
  1800.   31.50        4     1.0    1.1   320.0   49.26  116.69   47.86    NO
  1900.   30.03        4     1.0    1.1   320.0   49.26  122.52   49.49    NO
  2000.   29.17        5     1.0    1.2 10000.0   50.15   96.22   34.94    NO
  2100.   29.47        6     1.0    1.3 10000.0   43.41   67.04   23.62    NO
  2200.   29.77        6     1.0    1.3 10000.0   43.41   69.89   24.16    NO
  2300.   29.98        6     1.0    1.3 10000.0   43.41   72.72   24.69    NO
  2400.   30.10        6     1.0    1.3 10000.0   43.41   75.55   25.21    NO
  2500.   30.15        6     1.0    1.3 10000.0   43.41   78.36   25.72    NO
  2600.   30.13        6     1.0    1.3 10000.0   43.41   81.16   26.22    NO
  2700.   30.06        6     1.0    1.3 10000.0   43.41   83.96   26.71    NO
  2800.   29.95        6     1.0    1.3 10000.0   43.41   86.74   27.20    NO
  2900.   29.79        6     1.0    1.3 10000.0   43.41   89.51   27.68    NO
  3000.   29.60        6     1.0    1.3 10000.0   43.41   92.27   28.15    NO
  3500.   27.96        6     1.0    1.3 10000.0   43.41  105.96   30.08    NO
  4000.   26.23        6     1.0    1.3 10000.0   43.41  119.44   31.87    NO
  4500.   24.55        6     1.0    1.3 10000.0   43.41  132.75   33.55    NO
  5000.   22.96        6     1.0    1.3 10000.0   43.41  145.89   35.14    NO
  5500.   21.50        6     1.0    1.3 10000.0   43.41  158.90   36.65    NO
  6000.   20.16        6     1.0    1.3 10000.0   43.41  171.77   38.09    NO
  6500.   18.94        6     1.0    1.3 10000.0   43.41  184.52   39.47    NO
  7000.   17.82        6     1.0    1.3 10000.0   43.41  197.16   40.80    NO
  7500.   16.80        6     1.0    1.3 10000.0   43.41  209.69   41.94    NO
  8000.   15.88        6     1.0    1.3 10000.0   43.41  222.13   43.04    NO
  8500.   15.04        6     1.0    1.3 10000.0   43.41  234.48   44.10    NO
  9000.   14.28        6     1.0    1.3 10000.0   43.41  246.74   45.12    NO
  9500.   13.58        6     1.0    1.3 10000.0   43.41  258.92   46.11    NO
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 10000.   12.94        6     1.0    1.3 10000.0   43.41  271.02   47.08    NO
 15000.   8.625        6     1.0    1.3 10000.0   43.41  388.51   55.47    NO
 20000.   6.422        6     1.0    1.3 10000.0   43.41  501.01   60.83    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND   500. M:
   500.   56.84        3     1.5    1.6   480.0   38.40   55.17   33.10    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*********************************
*** SCREEN DISCRETE DISTANCES ***
*********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
   500.   56.84        3     1.5    1.6   480.0   38.40   55.17   33.10    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      56.84          500.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
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