AECOM
1601 Prospect Parkway
Fort Collins, Colorado 80525

970.493.8878 tel
970.493.0213 fax

June 25, 2010

Mr. Herman Wong
1200 Sixth Avenue
OEA-095
Seattle, WA 98101-1128

Subject: ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Air Quality Impact Analysis Supplemental Information

Dear Mr. Wong,

On February 12, ConocoPhillips (CP) submitted an Ambient Air Quality Impact Analysis supporting the Part 71 permit application for its planned 2010 Chukchi Sea exploration project. After reviewing the application and the three amendments with USEPA Region 10, and following review of recently promulgated standards and guidance it was determined that some clarifications and supplemental information should be submitted. We also take this opportunity to correct typographical and minor errors in the submittals. On behalf of ConocoPhillips, the attached document and digital files have been prepared by AECOM to present those supplemental materials.

If you have any questions please don't hesitate to contact me. As has been the case, we remain committed to working with Region 10 to resolve any issues needed to keep the review of the application moving forward.

Sincerely,

TA Damiana

Tom Damiana
Air Quality Meteorologist
Thomas.damiana@aecom.com
970 530 3465

cc: Doug Hardesty (USEPA Region 10)
Brad Thomas (ConocoPhillips Company)
Dave Newsad (Hoefler Consulting Group)

Attach: ConocoPhillips OCS Air Permit Application Air Quality Impact Analysis Supplemental Information

Electronic Files:

- Representative Jack-up Drill Rig - Side View.pdf
- Representative Jack-up Drill Rig - Top View.pdf
- CP Chukchi AQIA Appendix A.pdf
- 1-hour NO2 Modeling Archive.zip
- 1-hour SO2 Processing Files.zip
- OCD-MM5_Modeling_Archive.zip
- SO2 OCD-MM5_Modeling_Archive.zip

AECOM

Environment

Submitted to:
ConocoPhillips
Anchorage, Alaska

Submitted by:
AECOM
Fort Collins, CO
60136620
June 2010

ConocoPhillips OCS Air Permit Application Air Quality Impact Analysis Supplemental Information

Environment

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ConocoPhillips OCS Air Permit Application Air Quality Impact Analysis Supplemental Information

Final

TA Damiana

Reviewed By
Tom Damiana

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1.0 Introduction

On February 12, ConocoPhillips (CP) submitted an Ambient Air Quality Impact Analysis supporting the Part 71 permit application for its planned 2010 Chukchi Sea exploration project. After reviewing the application and the three amendments with USEPA Region 10, and following review of recently promulgated standards and guidance it was determined that some clarifications and supplemental information should be submitted. We also take this opportunity to correct typographical and minor errors in the submittals. This document has been prepared to present those supplemental materials.

To organize the presentation of supplemental materials, this document has been divided into five primary chapters. The chapters 2 through 4 are dedicated to providing supplemental information related to each of the major Title V application air quality impact analysis submittals as follows:

- Chapter 2.0 Ambient air quality impact analysis supporting the original Part 71 permit application titled "Modeling Report – Ambient Air Quality Impact Analysis for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea" submitted February 12, 2010 (CP Chukchi AQIA – CP 2010b).
- Chapter 3.0 Ambient air quality impact analysis demonstrating compliance with the recently promulgated 1-hour NO_2 National Ambient Air Quality Standard titled "Modeling Report – 1-Hour NO_2 Ambient Air Quality Impact Analysis for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea" submitted April 12, 2010 (CP Chukchi NO2 AQIA – CP 2010c).
- Chapter 4.0 A revised short-term PM_{10} ambient air quality impacts analysis titled "ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Revised PM_{10} Analysis" submitted April 26, 2010 (CP Chukchi PM10 AQIA – CP 2010d).

The two remaining primary chapters provide supplemental information related to the recently promulgated 1-hour SO_2 NAAQS, and additional modeling conducted with predicted meteorological data as follows:

- Chapter 5.0 SO_2 1-Hour Ambient Air Quality Impact Analysis
- Chapter 6.0 Comparison of Impacts Predicted with the Wainwright NWS Data to Offshore Data Developed from the MM5 Mesoscale Meteorological Model

A digital record containing supporting files has been transmitted electronically with this document. The files transmitted are described in the appropriate sections of this document.

2.0 Original Submittal

On February 12, ConocoPhillips (CP) submitted an Ambient Air Quality Impact Analysis supporting the Part 71 permit application for its planned 2010 Chukchi Sea exploration project. (CP Chukchi AQIA – CP 2010b). The following sections supplements and revises information presented in that submittal.

2.1 Typographical Error and Minor Corrections

1. The reference to Figure 1-2 on page 1-2, Section 1.3 of the CP Chukchi AQIA (CP 2010b) should be removed since the figure does not exist.

2. Figures 2-1 and 2-2 on pages 2-3 and 2-4, and Figure L2-1 on page L-9 of Appendix L of the CP Chukchi AQIA (CP 2010b) present representative jack-up drill rig layouts. Many of the annotations on these figures are not clear at the scale presented. Therefore, a clearly legible digital version of the plot plans presented on these two figures is provided with this document. Reference attached files "Representative Jack-up Drill Rig - Side View.pdf" and "Representative Jack-up Drill Rig - Side View.pdf".

3. The averaging period row labels for SO_2 on Table 6-2 on page 6-3 of the CP Chukchi AQIA (CP 2010b) are incorrect. The row labeled "3-hr" should be labeled "Annual", the row labeled "24-hr" should be labeled "3-hr", and the row labeled "Annual" should be labeled "24-hr".

4. The following corrections apply to Table 8-1 on page 8-5 of the CP Chukchi AQIA (CP 2010b):

   a. Under the pollutant column, the reference to footnote 4 on the NO_2 label should be changed to a reference to footnote 5.

   b. Footnote 5 should be added that reads "NO_2 modeled impacts were predicted assuming a 75% NO_x to NO_2 ambient ratio."

   c. The value of 17.9 listed for the $PM_{2.5}$ 24-hour NAAQS should be 35, and should have a reference to footnote 4 added.

5. The second paragraph in section 8.3.3 on page 8-8 of the CP Chukchi AQIA (CP 2010b) contains several typographical errors and should be corrected as follows:

   A breakdown of the source culpability for the primary maximum and secondary maximum concentrations is provided in Table 8-3. As shown in Table 8-3, drill rig sources account for most of the modeled concentrations with the main engines accounting for approximately half of the impacts at both the primary and secondary maximum impact areas identified (i.e., ~~8.9~~**8.5**/18.1 = 47%) at the primary maximum impact area, and 41% (6.9/16.9 = 41 %) at the secondary maximum impact area~~)~~. Table 8-3 also indicates that the project $PM_{2.5}$ impacts **at both the primary and secondary maximum impact area** associated with the supply vessel ($\leq$2.3 µg/m^3), OSRV ($\leq$1.1 µg/m^3), and "other" sources associated with the project ($\leq$0.3 µg/m^3) are all very low compared to 24-hour $PM_{2.5}$ NAAQS (35 µg/m^3).

6. The figures presented in Appendix A of the CP Chukchi AQIA (CP 2010b) are difficult to read at the scale presented, and do not include a suitable description of the information presented. Therefore, a clearly legible digital version of these figures including an explanation of the information presented is provided with this document. Reference the attached file "CP Chukchi AQIA Appendix A.pdf".

   The information presented in Appendix A is referenced on page 4-9 of the CP Chukchi AQIA (CP2010b) and is used to support development of representative air minus sea temperature values for the project area. Among other things, the histograms presented in the Appendix A figures display the frequency distribution of air minus sea surface temperature for a given month.

7. CP Chukchi AQIA (CP 2010b) Appendix E, page E-6, the subheader in the Ware Vessel Emission rate table should be corrected as follows:

   Ware Vessel In Transit ~~to~~ **away from** Drill Rig (50 trips at 3 hours one-way = 150 hours one-way)

8. CP Chukchi AQIA (CP 2010b) Appendix G, footnotes to Table G-1 on page G-4, footnotes 5 and 6 should be corrected as follows to provide clarification:

   [5] Stack height **values for the Emergency Generator and Cement Engines** based on professional judgment and internet photo (http://www.knupps.net/Bilder/Aker/Maersk_Resolute_Full_size.jpg).

   [6] Stack height **values for the Logging Winch, Heaters, and Incinerator** based on professional judgment considering similar sources.

9. Figure L1-2 on page L-7 in Appendix L of the CP Chukchi AQIA (CP 2010b) should be labeled Figure L1-1.

10. Table L4-2 on page L-16 in Appendix L of the CP Chukchi AQIA (CP 2010b) contains several errors related to improper row labeling. The corrected version of the table follows:

Table L4-2: REVISED Emissions Rates Used to Model Shell Sources [1]

Stack #	Source ID	Source Name	$PM_{2.5}$ (g/sec)	NO_x (g/sec)	$PM_{2.5}$ (g/sec)	NO_x (g/sec)
			Short-term Emissions		Annual Emissions	
Stationary Sources						
1	FD1-8	Generator Engines	1.57E-01	6.24E-01	6.91E-02	2.70E-01
2	FD9-11	MLC Compressors	7.00E-02	1.34E+00	7.48E-03	1.55E-01
3	FD12-13	HPU Engines	3.00E-02	1.36E+00	4.60E-03	2.35E-01
5a	FD14	Port Deck Crane	~~2.00E-02~~ **5.00E-03**	~~7.40E-01~~ **7.80E-01**	8.63E-04	1.37E-01
5b	FD15	Starboard Deck Crane	5.00E-03	7.80E-01	8.63E-04	1.37E-01
4	FD16-18	Cementing Units	~~5.00E-03~~ **2.00E-02**	~~7.80E-01~~ **7.40E-01**	9.21E-03	3.68E-01
6	FD21-22	Heat Boilers	5.00E-02	4.00E-01	2.19E-02	1.86E-01
7	FD19-20	Logging Winches	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8	FD23	Incinerator	1.00E-02	0.00E+00	1.29E-02	9.21E-03
9	FD-31	Resupply Ship - Docked	4.00E-02	5.70E-01	8.63E-04	1.24E-02
Mobile Sources (all Shell mobile sources modeled through Vladimir Ignatjuk icebreaker stack)						
-	VLADIGN2	Vladimir Ignatjuk	7.26	170.06	3.19	32.71

[1] Data from **Attachment A to Shell's comments on the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009** ~~**Shell's revised Chukchi Sea air permit application submitted on December 22, 2009**~~

2.2 Minor Clarifications

2.2.1 Drill Rig and Emissions

The following footnote appears on Table 2-2 of Section 2-1 of the CP Chukchi AQIA (CP 2010b) and requires clarification:

> “Emission rate is consistent with the application but lower than emissions rate modeled. Therefore, modeling is conservative.”

This footnote attempts to explain that emissions presented in the referenced tables are equivalent to those presented in Volume 1 of the ConocoPhillips Part 71 permit application for its planned 2010 Chukchi Sea exploration project (CP 2010a); however, modeled emissions for the four main drilling engines are higher than what is presented. This is because modeled emissions did not account for a decrease in annual CO, PM_{10}, $PM_{2.5}$, and SO_2 emissions associated with the four main drilling engines resulting from the redistribution of emissions. As shown in **Table 2-1**, this redistribution of emissions resulted from incorporating a scenario whereby two of the drill rig main engines could operate uncontrolled up to 125 hours per year. The new scenario was incorporated while holding the annual NO_x PTE constant. This shift of emissions from controlled to uncontrolled operations required an offset of 1,200 hours controlled for 250 hours uncontrolled and a total aggregate reduction in hours of operation for the main drilling engines from 6,000 to 5,050 hours. Therefore, NO_x emissions remained the same and annual CO, PM_{10}, $PM_{2.5}$, and SO_2 emissions decreased approximately 17 percent. The decrease occurs for CO, PM_{10}, $PM_{2.5}$, and SO_2 since emission factors for these pollutants remain the same between controlled and uncontrolled scenarios. This emission decrease was not captured by the modeling; therefore, modeled annual emissions are higher than permitted emissions and model predicted annual impacts are conservative.

Table 2-1 Comparison of Modeled and Permitted Main Engine Emissions

Scenario		Total Hours	Main Engine Emissions (TPY)							
			NO_x		CO		$PM_{10}/PM_{2.5}$		SO_2	
Permitted [1]	Controlled	4,800	24.0	30.0	43.9	46.2	3.20	3.37	8.55E-2	8.99E-2
	Uncontrolled	250	6.00		2.29		0.167		4.45E-3	
Modeled [2]	Controlled	6,000	30.0	30.0	54.9	54.9	4.00	3.99	1.07E-1	1.07E-1
	Uncontrolled	0	0		0		0		0	
Δ%				0		17		17		17

1 Reference Volume 1 of the ConocoPhillips Part 71 permit application page 265 through 267 (CP 2010a).

2 Reference Volume 2 of the ConocoPhillips Part 71 permit application Appendix E page E-3 (CP 2010b).

2.2.2 Support Vessel Emissions

The following footnote appears on Tables 2-3, and 2-4 of Section 2.2 of the CP Chukchi AQIA (CP 2010b) and requires clarification:

> “Emission rate is consistent with the application but lower than emissions rate modeled. Therefore, modeling is conservative.”

This footnote attempts to explain that emissions in the referenced tables are equivalent to those presented in Volume 1 of the ConocoPhillips Part 71 permit application for its planned 2010 Chukchi Sea exploration project (CP 2010a) but lower than what was modeled for the two ice breakers. This is because modeled ice breaker emissions did not account for an approximate 4 percent decrease in annual emissions associated with a reduction in the annual operating hours from 700 to 675 per vessel. Therefore, modeled annual emissions are higher than permitted emissions. Since this emission decrease was not captured by the modeling, modeled annual emissions are higher than permitted emissions and model predicted annual impacts are conservative.

2.2.3 Distance to Nearby Communities

For reference, **Table 2-2** lists the distance of the modeled ConocoPhillips OCS Source location to various nearby communities to use as reference through the analysis.

Table 2-2 Location of Nearby Communities Relative to the ConocoPhillips OCS Source

Community	Coordinates [1]				Distance from Drill Rig	
	Latitude	Longitude	UTME (m)	UTMN (m)	miles	km
CP OCS Source	70.928	165.723	473,620	7,869,620	N.A.	N.A.
Barrow	71.290	-156.780	793,470	7,929,760	200	330
Point Hope	68.350	-166.735	428,560	7,582,850	180	290
Wainwright	70.639	-160.029	683,770	7,844,650	130	210
Point Lay	69.743	-163.007	576,990	7,738,510	100	170

[1] WGS 84 datum used for Latitude and longitude, and UTM coordinates are zone 3N, NAD83.

2.2.4 Wainwright National Weather Service Data Capture Statistics

The data recovery statistics presented in Table 4-1 on page 4-4 of the CP Chukchi AQIA (2010b) represent the number of valid hours divided by the total number of hours in the period July 1 through November 30 for each year analyzed.

2.2.5 ConocoPhillips Research Vessel Meteorological Data

Throughout the CP Chukchi AQIA (CP 2010b) and amendments submitted, data collected by two research vessels over the project area have been used for various purposes. These vessels, the Bluefin and the Norseman, were chartered in the summer of 2008 to assess actual conditions in the project area. The period of data collection by each vessel includes:

1) data collected from July 27 through October 19, 2008 by the Bluefin, and
2) data collected from September 27 through November 3, 2008 by the Norseman.

Relevant aspects of the research program and the data used to support the application are thoroughly described in Appendix I of the CP Chukchi AQIA (CP 2010b).

With respect to the application ambient air quality impact analysis, the research vessels provide a comparison between data collected onshore at the Wainwright National Weather Service (NWS) station and data collected overwater in the project area to demonstrate that data collected at the Wainwright NWS station is representative of overwater locations. This is done two ways:

1) Evaluating the correlation of meteorological parameters used as input to the OCD dispersion model (reference Section 4.1 and Appendix I of the CP Chukchi AQIA), and
2) Demonstrating that impacts predicted with the Wainwright NWS data are equivalent to those predicted with the vessel data (reference Section 8.3.4 on page 8-13 of the CP Chukchi AQIA).

The research vessel data has not been used to demonstrate compliance with the NAAQS; therefore, it is not required to be PSD quality. Regardless, prior to using this data, various activities presented in Appendix I of the CP Chukchi AQIA (CP 2010b) were conducted to establish data quality. These activities included 1) evaluating manufacturer stated sensor performance, 2) conducting a comparison between data collected concurrently by the research vessels and the Wainwright NWS station to establish accuracy, and 3) conducting a comparison between data collected concurrently by the two research vessels to establish precision.

Generally, data collected by research vessels consisted of 1-second measurements, and analyses utilizing the vessel data were conducted with hourly averages developed from the 1-second measurements. When developing the hourly data, hourly averages were calculated using all available 1-second data collected during a given hour provided the 1-second data recovery was higher than 75 percent for the hour.

Table 2-3 details the hourly data recovery for each vessel, and data recovery for a data set created by combining data from the two vessels. Missing data primarily occurred when the vessels left the project area for resupply. As described in Appendix I of the CP Chukchi AQIA (CP 2010b), in order to use the combined data set for modeling with OCD, it needed to be 100 percent complete. Therefore, the filling procedure described in Appendix I of the CP Chukchi AQIA (CP 2010b) was used to transform it to a data recovery of 100 percent.

Table 2-3 ConocoPhillips 2008 Research Vessel Data Recovery

Data Set	Data Period	Data Recovery (all modeled parameters)
Bluefin	July 27 through October 19, 2008	64%
Norseman	September 27 through November 3, 2008	54%
Combined Vessel [1]	July 27 through November 3, 2008	62%
Combined Vessel Data used for OCD Modeling [2]	July 27 through November 3, 2008	100% [2]

1 Dataset used for quality assurance and correlation to Wainwright NWS data. When combining data from the two vessels when they were operating concurrently, data from the Bluefin was used preferentially.

2 Data Recovery increased to 100% using filling procedures described in the CP Chukchi AQIA (CP 2010b) Appendix I.

2.2.6 Sensitivity Modeling Protocols

CP Chukchi AQIA (CP 2010b) Tables 4-2, 4-3, and 4-4 on page 4-12 present the results of modeling conducted to evaluate the sensitivity of OCD model predicted impacts for a jack-up drill rig to three meteorological input parameters (air-sea temperature difference, mixing height, and relative humidity). This modeling was conducted using the following technical approaches:

- Modeling was conducted for the period July through November 2005 only. Both the overwater and overland meteorological input file were based on surface data from the Wainwright NWS station, and upper air data from the Barrow upper air station processed according to procedures described in Section 4.2 of the CP Chukchi AQIA (CP 2010b), and modified as require to conduct the specific sensitivity modeling. 2005 was selected from among the five years of available Wainwright NWS station data for modeling since that year generally produced the highest impacts for critical pollutants (i.e., $PM_{2.5}$, PM_{10}, and NO_2).
- Modeling was conducted using only sources located on the jack-up drill rig. Sources were modeled with the same physical stack exit characteristics as those used for the cumulative impact analysis. The sources and source characterization are presented in that portion of Table G-1 shown on page G-2 in Appendix G of the CP Chukchi AQIA (CP 2010b).
- To predict annual impacts, modeling was conducted with the same long-term PM_{10}/$PM_{2.5}$ emissions as those used for the cumulative impact analysis. Similarly, short-term impacts (i.e., any averaging period

24-hour or less) were predicted with the same short-term $PM_{10}/PM_{2.5}$ emissions as those used for the cumulative impact analysis. The exceptions to this were minor changes to logging winch and cement engine emission rates. With the exceptions noted, modeled emission rates are presented in Table G-2 on page G-6 in Appendix G of the CP Chukchi AQIA (CP 2010b).

2.2.7 Discussion of Typical ConocoPhillips OCS Source Operations

The normal ConocoPhillips OCS source operation is described on pages 2 through 4 of Volume 1 of the ConocoPhillips Part 71 permit application for its planned 2010 Chukchi Sea exploration project (CP 2010a). This description is reiterated in Chapter 5 of the CP Chukchi AQIA (CP 2010b) which describes the methodology for simulating the ConocoPhillips OCS source in order to demonstrate compliance with the NAAQS given that the vessel fleet and associated activities have a typical minimum operating distance from the drill rig, but no typical orientation relative to the drill rig (i.e., spill response exercises could occur any direction from the drill rig, or the OSV could approach the drill rig from any direction, etc.). The only exception to this would be relatively stationary vessel activities such as the OSV unloading supplies at the jack-up drill rig, or the OSRV laying boom in preparation for unloading supplies. The methodology for simulating the mobile vessel fleet was determined objectively based on typical minimum operating distances to the jack-up drill rig and extensive worst-case modeling described in Section L-3.0 in Appendix L of the CP Chukchi AQIA (CP 2010b). The worst-case modeling demonstrated that locating vessels east of the jack-up drill rig consistently produced the highest impacts; therefore, all vessels were simulated east of the drill rig at their typical minimum operating distance, and vessels with a similar minimum operating distance were collocated. Therefore, this simulation results in higher model predicted impacts than any actual operating scenario given the extremely low probability that the vessels will line up and collocate given the ambiguous, and often times unrelated, operational profiles of the various activities.

Though typical minimum operating distances often represent inherent design considerations (i.e., the drill rig and the ice breakers would never be closer than 5 miles while the drill rig is an OCS source), others represent typical operations and may require an enforceable limit in order to protect ambient air quality (i.e., based on the nature of research activities conducted, the research vessel would not typically operate within 1 mile of the drill rig; however, it could given special circumstances).

Understanding the difficulty in identifying typical operating scenarios, and following a strategy of maximizing operating flexibility by minimizing permit conditions; cumulative modeling to demonstrate compliance with the NAAQS was conducted with a hypothetical operating scenario that included all permitted activities occurring at the same time even though some of these activities cannot occur contemporaneously. Therefore, it is not possible to tie the compliance demonstration to a specific actual operating scenario. Development of the hypothetical scenario used to demonstrate compliance with the NAAQS is described in Section 5.3 on page 5-7 of the CP Chukchi AQIA (CP 2010b).

2.2.8 Description of OSV Transit Emissions Simulation

The simulation of emissions associated with all OSV operating scenarios are described in Section 5.2.4 of the CP Chukchi AQIA (CP 2010b). The following augments the discussion regarding just the transit emissions presented on page 5-4. When in route to the drill rig, OSV transit emissions occur as the OSV travels from a point 25 miles from the jack-up drill rig to the drill rig. These transit emissions were split proportional to the distance traveled into two parts and simulated at two static locations. One location was adjacent to the jack-up drill rig, and the other one mile from the jack-up drill rig. The two locations simulate the following:

- The location one mile from the drill rig simulates emissions occurring from a point 25 miles from the drill rig to a point 1 mile from the drill rig (i.e., a 24 mile transit). The OSV is simulated at a location closest to the drill rig for this portion of the transit (i.e., maximizes plume overlap). Modeled emissions at this location are equivalent to 24/25 of the total transit emissions (i.e., the ratio of the miles traveled during this portion of the transit (24 miles) to the total miles of the transit (25 miles)).
- Location adjacent to the drill rig simulates emissions occurring from a point 1 mile from the drill rig to the drill rig (i.e., a 1 mile transit). The OSV is simulated at a location closest to the drill rig for this

portion of the transit (i.e., maximizes OSV drill rig plume overlap). Modeled emissions at this location are equivalent to 1/25 of the total emissions (i.e., the ratio of the miles traveled during this portion of the transit (1 mile) to the total miles of the transit (25 miles)).

Between these two modeled OSV locations, the total transit emissions for an OSV traveling to the drill rig are simulated. The same procedure was used to simulate the OSV transit from the drill rig back out to a point 25 miles from the drill rig.

2.2.9 Description of the Ambient Boundary used for Annual NO_2, SO_2, PM_{10}, $PM_{2.5}$, and CO Modeling

For the ambient air quality impact analysis conducted for annual NO_2, all SO_2 averaging periods, all $PM_{2.5}$ averaging periods, and all PM_{10} averaging periods, the ambient boundary was defined as the edge of the jack-up drill rig and any attached vessels. As described in Chapter 3 of this document, the ambient air quality boundary used for the 1-hour NO_2 ambient air quality impact analysis was defined as a 500 meter radius circle centered on the drill rig.

2.2.10 Description of the PM_{10} and $PM_{2.5}$ Significant Impact Area

Section 6.2 on page 6-1 of the CP Chukchi AQIA (CP 2010b) presents the project significant impact radius for all pollutants and averaging periods. Though USEPA guidance limits the significant impact radius to 50 km when predicting impacts with a steady state Gaussian plume model such as OCD (USEPA 1990, Section IV.B, page C.26), an attempt was made to determine the significant impact radius even if it extended beyond 50 km in order to demonstrate that the project significant impact radius did not extend to shore. This deviates from established guidance and practice, and should not have been done. Therefore, following USEPA guidance (USEPA 1990), the PM_{10} and $PM_{2.5}$ significant impact radius should be revised to 50 km, and the revised project significant impact radius for each pollutant and averaging period is shown in **Table 2-4**. Subsequently an analysis of project ambient air quality impacts using OCD has been conducted and clearly demonstrates that project impacts for all pollutant and averaging periods are below significant impact levels at shore (CP 2010f).

2.2.11 Development of PM_{10} and $PM_{2.5}$ Background Concentrations

Section 7.2 on page 7-2 of the CP Chukchi AQIA (CP 2010b) describes the development of short-term PM_{10} and $PM_{2.5}$ background concentrations for predicting cumulative ambient impacts. At the time the application was submitted, the most recent and reviewed data collected by the Wainwright Near-Term Monitoring Program were used for the analysis. This included:

- PM_{10} data collected from November 2008 through October 2009 (12 months), and
- $PM_{2.5}$ data collected from March through October 2009 (8 months).

Section 7.2 presents an overview of the procedure used to develop the PM_{10} and $PM_{2.5}$ background concentrations. A full description of the procedure including a description of the fugitive dust sources, emission rates and release parameters used to characterize the fugitive dust sources is included in Appendix M of the CP Chukchi AQIA (CP 2010b).

Recognizing that the analysis presented in Appendix M and Section 7.2 did not include $PM_{2.5}$ data collected over the full drilling season (i.e., July through November), the analysis has been reevaluated for $PM_{2.5}$ to include November 2009 data from the Wainwright Near-Term Monitoring Program now that it is available.

The original analysis of short-term background particulate concentrations documented in Appendix M of the CP Chukchi AQIA (CP 2010b) found that the maximum 24-hour average regional background $PM_{2.5}$ and PM_{10} concentrations were 9.6 and 45.0 $\mu g/m^3$, respectively. A review of particulate data collected in November 2009 at the Wainwright Near-Term monitoring Station (AECOM 2010a) shows that the maximum 24-hour average

Table 2-4 Revised Project Significant Impact Radius by Pollutant

Pollutant	Averaging Period	Significant Impact Radius (km)	Reference
CO	1-hour	0.1	Section 6.0 and Table 6-2 of the CP Chukchi AQIA (CP 2010b).
	8-hour	0.8	
NO_2	1-hour	50	Set to 50 km since a SIL has not been established [1].
	Annual	4	Section 6.0 and Table 6-2 of the CP Chukchi AQIA (CP 2010b).
$PM_{2.5}$	24-hour	50	Set to 50 km following USEPA guidance [2].
	Annual	0.3	Section 6.0 and Table 6-2 of the CP Chukchi AQIA (CP 2010b).
PM_{10}	24-hour	50	Set to 50 km following USEPA guidance [2].
SO_2	1-hour	50	Set to 50 km since a SIL has not been established [1].
	3-hour	NA [3]	Section 6.0 and Table 6-2 of the CP Chukchi AQIA (CP 2010b).
	24-hour	NA [3]	
	Annual	NA [3]	

1 USEPA has not established significant impacts levels for this pollutant and averaging period to use in the determination of the significant impact radius. Therefore, the significant impact radius conservatively set at the maximum value recommended in USEPA 1990, Section IVB, page C.26.

2 USEPA 1990, Section IV.B, page C.26.

3 Project impacts are below the significant impact levels.

$PM_{2.5}$ and PM_{10} concentrations were 4 and 8 μg/m^3, respectively. Since maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations measured in November 2009 were below the values identified as regional background concentrations in Appendix M of the CP Chukchi AQIA (CP 2010b), including the data from November 2009 does not change the short-term background particulate concentration used in the cumulative impact analysis.

The original analysis of the annual background $PM_{2.5}$ concentration documented in Section 7.2 of the CP Chukchi AQIA (CP 2010b) found that the maximum annual measured $PM_{2.5}$ concentration was 3 μg/m^3. This is the same value as that presented in the Wainwright Near-Term Monitoring Station Annual report (AECOM 2010b) which was calculated for the period March through November 2009. Therefore, the project cumulative impact analysis for annual $PM_{2.5}$ does not change as a result of including $PM_{2.5}$ concentrations measured November 2009.

2.2.12 Offsite Source Inventory Considerations

Section 8.2 of the CP Chukchi AQIA (CP 2010b) describes the project cumulative impact analysis off-site emissions inventory development. Developing the off-site inventory considered all Nearby Sources as well as Other Sources (e.g., natural sources, minor sources and distant major sources) as required by 40 CFR 51 Appendix W Section 8.2.3a. Nearby Sources are those sources expected to cause a significant concentration gradient in the project impact area with Other Sources being everything else. Other Sources were addressed by including an appropriate background concentration following recommendations in 40 CFR 51 Appendix W Section 8.2.2b. Nearby Sources considered included:

- existing stationary sources,
- stationary sources which have received air quality permits but have not yet begun to operate,
- emissions from any proposed stationary source for which an air permit application exists but has not yet begun to operate, and

- mobile sources.

In all cases, stationary sources were considered even if they were not large enough to require an air quality permit. Following established USEPA guidance (USEPA 1990 Section IV.C.1, page C.32), Nearby Sources (mobile and stationary) should be explicitly modeled if they are located no further than 50 km beyond the project significant impact radius for a given pollutant and averaging period. Thus, only Nearby Sources located within 100 km of the project were considered Nearby Sources since the maximum project significant impact radius identified in **Table 2-4** is 50 km. Following this approach, the Shell OCS source was the only stationary source identified in Section 8.2 of the CP Chukchi AQIA (CP 2010b) as a Nearby Source required to be explicitly modeled. The remaining stationary sources, all of which are located onshore, were considered other sources and either included in the cumulative impact analysis as part of the background concentration or not considered since they would not cause a significant concentration gradient in the project impact area.

The Shell OCS source was modeled using input files provided by Shell to USEPA as part of several May 2009 submittals (Shell 2009a, and Shell 2009b) with locations, emissions, and stack parameter data adjusted to match those for the base operating scenario presented in Attachment A to Shell's comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c). These are also identical to those presented in Tables 5-6 and 5-7 on pages 102 and 103 of the SOB to the January 8, 2010 proposed permit for the Shell OCS source (USEPA 2010a). The only exception was the Shell mobile vessel fleet which was conservatively simplified by combining all emissions and modeling them through a single point source centered on the Frontier Discoverer. Stack parameters for this combined point source are those listed for the Vladimir Ignatjuk on Page 5 of Attachment A to Shell's comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c). Stack parameters for this vessel were selected because this vessel is responsible for a large part of the mobile vessel fleet emissions.

The modeled Shell emission unit inventory is shown in **Table 2-5**. Modeled stack parameters are shown in CP Chukchi AQIA (CP 2010b) Appendix L, Table L4-3. Modeled Shell OCS source emission rates are presented below in **Table 2-8** (NO_x annual) **Table 2-9** (CO) **Table 3-1** (NO_x 1-hour) **Table 4-1** (PM_{10} and $PM_{2.5}$ annual) and **Table 4-2** (PM_{10} and $PM_{2.5}$ short-term). The project significant impact analysis demonstrated that an SO_2 cumulative impact analysis was not required; therefore, the Shell OCS source was not explicitly included in any SO_2 modeling.

Except that the ConocoPhillips and Shell exploratory activities are constrained to various lease blocks within several prospects, the exact location relative to each other is unknown. Therefore, extensive modeling was conducted to determine the location to model the Shell OCS source relative to the ConocoPhillips OCS source in order to ensure that cumulative impacts were maximized. That modeling is thoroughly described in Section L-4.0 in Appendix L of the CP Chukchi AQIA (CP 2010b). In summary, five scenarios placing the Shell and ConocoPhillips OCS sources in the closest proximity were developed by considering all Shell lease holdings, not just lease holdings on the specific prospects detailed in Shells Exploration Plan for the first year of drilling. The five separate scenarios were then modeled to determine which location produced the maximum cumulative impacts. Figure L4-2 on Page L-20 in Appendix L of the CP Chukchi AQIA (CP 2010b) shows the relationship of each OCS source to one another for each of the five scenarios. **Table 2-6** lists the lease blocks that correspond to the five modeling scenarios, and the distance between the two OCS sources for each scenario. As described in Section L-4.0 in Appendix L of the CP Chukchi AQIA (CP 2010b) it was determined that Scenario 2 maximized cumulative impacts.

2.2.13 Sensitivity of Cumulative Annual NO_2 Impacts

The sensitivity of model predicted impacts to changes in annual emissions from individual vessels and emission units is briefly discussed in Section 8.3.2 at the top of page 8-6 of the CP Chukchi AQIA (CP 2010b). The purpose of this discussion is to demonstrate that the annual NAAQS for all pollutants would still be protected even if emissions were redistributed among the various vessels and emission units. Conservatively assuming the previously presented overall maximum annual impacts were due to a single vessel or emission

Table 2-5 Modeled Shell OCS Source Inventory

Modeled Stack #	Source ID	Source Name
Stationary Sources		
1	FD1-7	Generator Engines
	FD8	E-Generator Engine
2	FD9-11	MLC Compressors
3	FD12-13	HPU Engines
5a	FD14	Port Deck Crane
5b	FD15	Starboard Deck Crane
4	FD16-18	Cementing Units
7	FD19-20	Logging Winches
6	FD21-22	Heat Boilers
8	FD23	Incinerator
9	FD31	Resupply Ship – Docked
Mobile Sources		
MOBILE	Various	All Shell Mobile Sources [1]

[1] Emissions from the mobile vessel fleet were combined and modeled through a single point source centered on the Frontier Discoverer.

Table 2-6 ConocoPhillips and Shell Lease Blocks Used for Worst-Case Modeling

Modeling Scenario	CP Lease Block on the Devil's Paw Prospect	Shell Lease Block and Prospect	Distance Between Sources (km)
1	7101	6905 (unknown)	27
2	6069	7014 (Crackerjack)	27
3	6317	6561 (unknown)	37
4	6372	6722 (unknown)	34
5	7101	6962 (Burger)	55

unit, **Table 2-7** demonstrates that project annual air quality impacts remain well below the NAAQS even if emissions were increased by a factor of 5 for a particular vessel or emission unit. Therefore, for example, one of the ice breakers, which has proposed allowable annual emissions of 46 TPY NO_x, could be shut down, and all of its emissions added to the drill rig, which has proposed allowable annual emissions of 35 TPY (i.e., roughly a doubling of the drill rig emissions), and the analysis in **Table 2-7** demonstrates that ambient air quality impacts following redistribution of these emission would show compliance with the annual NO_2 NAAQS. This clearly demonstrates that with respect to annual standards, ambient air quality is protected if the ConocoPhillips OCS source annual potential to emit were treated as a source-wide limit, and ConocoPhillips were allowed to trade emissions between emission units as situations require. However, ConocoPhillips realizes that this trading of annual emissions could only occur to the extent that the short-term limits established though modeling will allow.

Table 2-7 Annual NO_2, and $PM_{2.5}$ Cumulative Impact Analysis Sensitivity to Emissions Increases

Pollutant	Averaging Period	Overall Maximum Impact [1] (µg/m^3)	Contribution from Increasing Emissions [2] (µg/m^3)	Background Conc. (µg/m^3)	Revised Cumulative Impact (µg/m^3)	NAAQS (µg/m^3)
NO_2	Annual	12.1	48.4	2	63	100
$PM_{2.5}$	Annual	2.3	9.2	3	14.5	15

1 Reference Table 8-1 on page 8-5 of the CP Chukchi AQIA (CP 2010b).

2 Calculated assuming the overall maximum impact is the result of a single vessel or emission unit and increasing the impact by increasing source emissions by a factor of 5.

2.2.14 Comparison of Impacts Predicted with the Wainwright NWS Data Compared to Onsite Vessel Data

As thoroughly discussed in Section 2.6 below, the information presented in CP Chukchi AQIA (CP 2010b) Section 8.3.4, and Table 8-4 are part of a strategy developed to prove that impacts predicted using the OCD model in combination with Wainwright NWS station data are representative and provide the most robust compliance demonstration. This part of the strategy relies on comparing impacts predicted with OCD and the Wainwright NWS station data to impacts predicted with OCD and site-specific data collected by two research vessels. It should be pointed out that impacts presented in this section were predicted from July through November for each year of the Wainwright NWS data, and from July 27 through November 3 for the vessel data.

2.3 Explicitly Modeled Offsite Inventory Emissions

As described in Section 8.2 of the CP Chukchi AQIA (CP 2010b) only emissions associated with the Shell Gulf of Mexico Inc. (Shell) OCS source were explicitly included the cumulative impact analysis. The Shell OCS source was modeled using input files provided by Shell to USEPA as part of several May 2009 submittals (Shell 2009a, and Shell 2009b) with locations, emissions, and stack parameter data adjusted to match those for the base operating scenario presented in Attachment A to Shell's comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c). Modeled NO_x and $PM_{2.5}$ emissions and stack parameter data are presented in the CP Chukchi AQIA (CP 2010b) Appendix L, Table L4-2 and L4-3. Modeled CO emissions are presented in **Table 2-9**. Cumulative modeling for SO_2 was not required; therefore, Shell SO_2 emissions have not been documented. Modeled emissions are different than those documented in the Statement of Basis (SOB) to the January 8, 2010 proposed permit for the Shell OCS source (USEPA 2010a). The differences for annual NO_x, and short-term CO are documented in **Table 2-8** and **Table 2-9** and are largely the result of changes to the mobile support vessel fleet and Frontier Discoverer incinerator characterization. **Table 2-8** clearly shows that modeled annual NO_x emissions were grossly overestimated resulting in an overestimation of annual cumulative NO_x impacts. CO emissions, which are documented in **Table 2-9**, were underestimated as a result of changes to the Shell mobile support vessel fleet. Because the Shell OCS source mobile support vessel fleet was conservatively modeled as a single point source centered on the Frontier Discoverer, and the Shell OCS source is located more 25 kilometers from the ConocoPhillips OCS source, the differences will have negligible effect on cumulative model predicted short-term CO impacts.

Table 2-8 Modeled Annual NO_x Emissions – Shell OCS Source

Modeled Stack #	Source ID	Source Name	Annual NO_x emissions (g/s)		
			Modeled [1]	Permit SOB [2]	Difference (Modeled-SOB)
Stationary Sources					
1	FD1-7	Generator Engines	0.59	0.27	0.32
	FD8	E-Generator Engine	0.034	0.0023	0.032
2	FD9-11	MLC Compressors	1.34	0.154	1.19
3	FD12-13	HPU Engines	1.36	0.235	1.13
5a	FD14	Port Deck Crane	0.780	0.273	1.29
5b	FD15	Starboard Deck Crane	0.780		
4	FD16-18	Cementing Units	0.740	0.341	0.4
7	FD19-20	Logging Winches	0		
6	FD21-22	Heat Boilers	0.400	0.186	0.21
8	FD23	Incinerator	0	0.002	-0.002
9	FD31	Resupply Ship – Docked	0.570	0.0124	0.56
Mobile Sources					
MOBILE	Various	All Shell Mobile Sources [3]	170	32.7	137

1 Base Operating Scenario – Maximum 24-hr NO_x emissions, Attachment A, page 2 of Shell's comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c).

2 Base Case Scenario – 24-hour PTE, Appendix A of Statement of Basis to the January 8, 2010 proposed permit for the Shell exploratory activity (USEPA 2010a).

3 For modeled emissions, this includes Ice Management Fleet (Ice breaker and anchor handler), Resupply – transit, OSR Main Ship, and OSR Work Boats. For the Permit SOB, this includes Ice Breaker #1, Ice Breaker #2 – Worst-case Tor Viking or Hull 247 Scenario, Supply Ship – Generic, Oil Spill Response Main Ship – Nanuq, Oil Spill Response, and Three Kvichak Work Boats.

Table 2-9 Modeled Short-Term CO Emissions – Shell OCS Source

Modeled Stack #	Source ID	Source Name	1 and 8-hour CO emissions (g/s) Modeled [1]	Permit SOB [2]	Difference (Modeled-SOB)
Stationary Sources					
1	FD1-7	Generator Engines	0.210	0.210	0
	FD8	E-Generator Engine	0.23	0.23	0
2	FD9-11	MLC Compressors	1.180	0.624	0.556
3	FD12-13	HPU Engines	0.0400	0	0.0400
5a	FD14	Port Deck Crane	0.015	0.016	-0.001
5b	FD15	Starboard Deck Crane	0.015	0.016	-0.001
4	FD16-18	Cementing Units	0.150	0.123	0.057
7	FD19-20	Logging Winches	0.0300		
6	FD21-22	Heat Boilers	0.16	0.16	0
8	FD23	Incinerator	0.54	0.54	0
9	FD31	Resupply Ship – Docked	0.490	0.245	0.245
Mobile Sources					
MOBILE	Various	All Shell Mobile Sources [3]	50.3	57.2	-6.90

[1] Base Operating Scenario – Maximum 1-hr CO emissions, Attachment A, page 2 of Shell's comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c).

[2] Base Case Scenario – 1-hour PTE, Appendix A of Statement of Basis to the January 8, 2010 proposed permit for the Shell exploratory activity (USEPA 2010a).

[3] For modeled emissions, this includes Ice Management Fleet (Ice breaker and anchor handler), Resupply – transit, OSR Main Ship, and OSR Work Boats. For the Permit SOB, this includes Ice Breaker #1, Ice Breaker #2 - Worst-case Tor Viking or Hull 247 Scenario, Supply Ship – Generic, Oil Spill Response Main Ship – Nanuq, Oil Spill Response, and Three Kvichak Work Boats.

2.4 Ambient Air Quality Impact from Secondary $PM_{2.5}$ Formation

None of the Gaussian plume dispersion models recommended in 40 CFR 51 Appendix W can account for the effects of secondary particulate formation on model predicted $PM_{2.5}$ impacts. Furthermore, at the time the ConocoPhillips Chukchi Sea exploration project Part 71 air permit application was submitted there were no USEPA procedures to account for the affects of secondary particulate formation on model predicted $PM_{2.5}$ impacts. Therefore, the CP Chukchi AQIA (CP 2010b) focused on compliance with the $PM_{2.5}$ NAAQS using direct $PM_{2.5}$ emissions based on our belief that secondary particulate formation is a negligible fraction of the maximum ambient air quality impacts because the transport distance between project sources and the maximum impact location is too small (i.e., less than 300 meters) for secondary particulate formation to be significant given the low project NO_x and SO_2 emission rates.

Since the application was submitted, USEPA has issued guidance (USEPA 2010c) to account for the effects of secondary particulate formation on model predicted impacts using Gaussian plume models. Though ConocoPhillips still believes that secondary particulate formation is an insignificant part of a NAAQS compliance demonstration for this project, the $PM_{2.5}$ cumulative impact analysis presented in Chapter 8.0 of the CP Chukchi AQIA (CP 2010b) has been revised to account for secondary particulate formation in model predicted $PM_{2.5}$ impacts using the recent guidance.

To account for secondary particulate formation using a Gaussian plume dispersion model, USEPA guidance recommends a screening approach. Following the suggested screening approach, the design value for comparison to the 24-hour $PM_{2.5}$ NAAQS is the maximum of the 5-year average of the highest-first-high 24-hour model predicted impact across all modeled receptors. USEPA asserts that the conservatism in this approach (i.e., using a design value based on the average highest-first-high impact over five years as opposed to the 5-year average of the highest-eighth-high modeled concentration) will account for secondary particulate formation. For the annual averaging period, USEPA recommends that the design value be calculated as the highest average of the modeled annual averages across 5 years.

Since the annual $PM_{2.5}$ cumulative impact analysis presented in Table 8-1 on page 8-5 of the CP Chukchi AQIA (CP 2010b) was conducted consistent with recently issued guidance, that analysis accounts for the effects of secondary particulate formation, and shows compliance with the $PM_{2.5}$ annual NAAQS. However, the same is not the case for the $PM_{2.5}$ 24-hour cumulative impact analysis.

Therefore, the short-term $PM_{2.5}$ cumulative analysis has been revised by reprocessing modeling conducted in support of the revised PM_{10} cumulative impact analysis submitted to USEPA on April 26, 2010 (CP Chukchi PM10 AQIA – CP 2010d). This is possible since $PM_{2.5}$ and PM_{10} emission rates are equivalent for this project. Therefore, revised cumulative $PM_{2.5}$ impacts have been predicted using the same methodologies, emission rates, project sources, offsite sources, and receptors as those described in the CP Chukchi PM10 AQIA (CP 2010d). In order to reprocess the results into a design value suitable for comparison to the NAAQS using USEPA guidance, the following steps were followed:

1. highest-first-high 24-hour $PM_{2.5}$ impacts from the ConocoPhillips OCS source were predicted with OCD for each modeled year.
2. highest-first-high 24-hour $PM_{2.5}$ impacts from the Shell OCS source were predicted using ISC-Prime with screening meteorology.
3. The values determined in steps 1 and 2 were added on a receptor by receptor basis for each modeled year to determine the highest-first-high cumulative 24-hour impact at each receptor.
4. The highest value from among those calculated in step 3 was determined for each year from among all modeled receptors.
5. The five values determined in step 4 were averaged to produce the model predicted design value for the cumulative impact analysis.

Table 2-10 presents the maximum cumulative impact for each modeled year determined in step 4 which were used to compute the 5-year average discussed in step 5. As shown in **Table 2-10**, the 5-year average of the highest 24-hour predicted impacts is 23.1 $\mu g/m^3$. Adding the $PM_{2.5}$ short-term background concentration of 10 $\mu g/m^3$ described in the CP Chukchi AQIA (CP 2010b) yields a maximum cumulative impact of 33.1 $\mu g/m^3$. This clearly demonstrates that using methodologies to account for secondary particulate formation, the model predicted maximum cumulative 24-hour $PM_{2.5}$ impact is in compliance with the $PM_{2.5}$ NAAQS. Three things are worth noting that add additional layers of conservatism to an already conservative analysis:

1. the regional component of background used in this analysis is the maximum of the 24-hour average regional concentrations measured from March though November 2009. This is more conservative than using the 98th percentile of measured 24-hour concentrations recommended in recent guidance.
2. The design value was calculated as the 5-year average of the highest 24-hour predicted impact for each year without considering if the value determined for each year occurred at the same receptor. This is more conservative than computing the 5-year average of the highest 24-hour predicted impact at each receptor and then using the maximum of those values as the design value.
3. Cumulative impacts from the ConocoPhillips and Shell OCS sources are conservative since they were added on a receptor by receptor basis without respect to time.

Table 2-10 Revised Short-Term $PM_{2.5}$ Cumulative Analysis Results (Concentrations in µg/m^3)

Pollutant	Avg Period	Maximum Impacts Predicted with Wainwright NWS Meteorological Data [1]					5-Year Average Maximum Impact	Max Bkgrnd.	Total	NAAQS
		1999	2002	2004	2005	2006				
$PM_{2.5}$	24-hr	22.2	22.4	22.9	22.4	25.4	23.1	10	33.1	35

1 Highest-first-high model predicted impact from the ConocoPhillips OCS source added on a receptor by receptor basis to the highest-first-high model predicted impact from the Shell OCS source.

2.5 Discussion of Model Predicted Annual NO_2 and CO Design Values used for Comparison to the NAAQS

Table 8-1 on page 8-5 of the CP Chukchi AQIA (CP 2010b) does not provide detailed information related to the model predicted concentration ranking (design value) used in the cumulative impact analysis to compare to the NAAQS. Therefore, **Table 2-11** has been compiled to provide that information and justify the ranking used. Since the results of the cumulative impact analysis presented in Table 8-1 of the CP Chukchi AQIA (CP 2010b) for 24-hour $PM_{2.5}$ and PM_{10} have been revised, please refer to Sections 2.4 and 4.4, respectively for a discussion of design values used for those pollutants and averaging periods.

Table 2-11 Design Concentrations used in the CO and Annual NO_2 Cumulative Impact Analysis

Pollutant	Averaging Period	Design Concentration Used	Justification
CO	1-hour	Highest-Second-High	When comparing to the short-term CO NAAQS it is appropriate to use the highest-second-high short term concentration over the entire receptor network for each individual year modeled since modeling was conducted with representative meteorology (40 CFR 58 Appendix W Section 7.2.1.1b)
	8-hour	Highest-Second-High	
NO_2	Annual	Highest-First-High	When comparing to the annual NO_2 NAAQS it is appropriate to use the highest annual average concentration over the entire receptor network for each individual year modeled since modeling was conducted with representative meteorology (40 CFR 58 Appendix W Section 7.2.1.1b).

2.6 Representativeness of Onshore Data for Offshore Applications

In a March 11, 2008 letter from Joyce C. Kelly of USEPA Region 10 Office of Environmental Assessment to Susan Childs Regulatory Affairs Manager for Alaska Shell Offshore, Incorporated (USEPA 2008a), USEPA Region 10 provided recommendations for meteorological data collection in the outer continental shelf of the Beaufort Sea for permitting purposes. Many of the recommendations were specific to a project conducted in the near-shore region of the Beaufort Sea and not applicable to a project conducted more than 100 miles offshore. Regardless, ConocoPhillips considered the recommendations seriously when developing the CP Chukchi AQIA (CP 2010b).

USEPA recommended that the Offshore and Coastal Dispersion (OCD) model was one of several models that could be used to predict concentration impacts from point, area and line sources located over water. However they noted that, OCD does not incorporate the PRIME downwash algorithm to address building wake effects. To address this deficiency, they recommended that OCD should be used with the AMS/EPA Regulatory Model (AERMOD) which includes the PRIME downwash algorithm.

Consistent with this recommendation, air quality impacts supporting the CP Chukchi AQIA (CP 2010b) were predicted with the OCD model. As discussed in Section 3.2 on page 3-1 of the CP Chukchi AQIA (CP 2010b), consideration was given as to whether or not it was appropriate to utilize the PRIME downwash algorithms. It was decided it was not appropriate because the PRIME downwash algorithms were not developed, nor evaluated for offshore platform type structures like a jack-up drill rig where there is air flow between the water surface and the bottom of the structure. In contrast it may be appropriate for structures like drill ships where no such airflow exists between the structure bottom and the water. Since the OCD model incorporates specific downwash algorithms developed for platform type structures through wind tunnel studies, it was decided the

OCD downwash algorithms were more appropriate for simulating the ConocoPhillips OCS source. Since the Shell OCS source does not incorporate a platform type structure, we believe that USEPA's recommendation to incorporate the PRIME downwash algorithms was specific to the proposed Shell OCS source where the PRIME algorithms may be more appropriate.

In a statement specific to Beaufort Sea OCS region and a project conducted within 30 miles of shore, USEPA Region 10 meteorologists stated they do not believe the use of meteorological data collected along the shoreline, or the use of meteorological data collected on a single buoy are representative of conditions throughout the OCS of the Beaufort Sea. Subsequently, in a March 19, 2008 letter from Joyce C. Kelly of USEPA Region 10 Office of Environmental Assessment, to Richard A. Wayland Director of the USEPA Air Quality Assessment Division, USEPA Region 10 requested Office of Air Quality Planning and Standards support of precedent setting monitoring and modeling activities related to oil development permitting actions in Alaska (USEPA 2008b). In this letter, USEPA Region 10 extended their previous recommendations to the Chukchi Sea OCS region.

To address USEPA Region 10 concerns as stated in the March 2008 letters, in collaboration with USEPA Region 10, ConocoPhillips conducted a cumulative impact analysis with OCD using MM5 predicted offshore meteorological input data. This analysis is described in Chapter 6 of this document. This analysis also plays a significant role in an overall strategy to demonstrate that the Wainwright NWS station data can be used to adequately represent impacts using the OCD model.

This overall strategy involves three approaches. 1) demonstrate that differences between onshore and offshore meteorology will either have no affect on model predicted impacts, or will result in conservative model predicted impacts, 2) demonstrate that model predicted impacts are not sensitive to the selection of oceanographic input data not measured onshore, and 3) demonstrate that impacts predicted with onshore data are equivalent to impacts predicted with available offshore data sets.

Following this strategy, Section 4.0 (specifically pages 4-4 through 4-11) of the CP Chukchi AQIA (CP 2010b) provides significant documentation demonstrating that any differences that might be expected between onshore and offshore data will either lead to equivalent or conservative model predicted impacts. Though these theoretical arguments are compelling and conclusive, the proof is clearly demonstrated in comparison of impacts predicted with the Wainwright NWS onshore data to 1) data collected over the project area by research vessels (reference CP Chukchi AQIA Section 8.3.4), and 2) to data predicted over the project area using the USEPA recommended MM5 model predicted meteorological data (reference Chapter 6 below). The correlation of model predicted impacts between these three datasets proves the equivalency of the three meteorological input data sets for predicting impacts with OCD. Since the data sets are equivalent for predicting impacts with OCD, then an analysis conducted with the Wainwright NWS station data will result in the most robust compliance demonstration since it provides the longest data record which best accounts for interannual meteorological variations. This is supported by 40 CFR 51 Appendix W Section 8.3.1 which recommends using a 5-year or longer data set as opposed to a single year provided model predicted impacts are adequately representative.

In looking at the representativeness issue from the standpoint of the combination of model and meteorological input data being capable of adequately characterizing impacts, the approach and analysis presented in the CP Chukchi AQIA (CP 2010b) and Chapter 6 below suggests that an analysis based on 5-years of Wainwright NWS data provides the most robust compliance demonstration.

2.7 Emissions Increase Associated with the Modeled OSRV Area Source

As indicated on page G-8 in Appendix G of the CP Chukchi AQIA (CP 2010b), the emissions from the following activities were combined and modeled as a single area source called the OSRV Spill Exercises area source:

- Two OSRVs Participating in Spill Response Exercises

- Anchor Handling Supply Tug
- Spill Response Storage Tanker
- OSV During Open Water Idling (annual modeling only)

However, the emissions that were modeled, and those presented in the table on page G-8 in Appendix G of the CP Chukchi AQIA (CP 2010b) only included emissions from a single OSRV. The correct OSRV Spill Exercises area source emission rates are shown in **Table 2-12** below and supersedes the information presented in the table presented on page G-8 in Appendix G of the CP Chukchi AQIA (CP 2010b). Though the modeled emissions for this source did not include a second OSRV, as shown below, the second OSRV can be added to the OSRV Spill Exercises area source without changing any of the conclusions of the project ambient air quality impact analysis and the project remains in compliance with the NO_2, CO, PM_{10}, $PM_{2.5}$, and SO_2 NAAQS.

With the exception of the 1-hour SO_2 modeling presented in Chapter 5 below, the OSRV Spill Exercises area source included the emissions from two OSRVs and was modeled with the correct emissions for all modeling submitted since February 12, 2010. Therefore, results presented in the revised modeling submitted for compliance with the 24-hour PM_{10} NAAQS (CP Chukchi PM10 AQIA - CP 2010d), the 24-hour $PM_{2.5}$ NAAQS (Reference Section 2.4 above), and 1-hour NO_2 NAAQS (CP Chukchi NO2 AQIA - CP 2010c) remain unchanged.

Modeling supporting the significant impact analysis for SO_2, and the cumulative impact analysis for 1 and 8-hour CO, annual NO_2, annual $PM_{2.5}$, and 1-hour SO_2 was conducted with only one OSRV included in the OSRV Spill Exercises area source; however, as demonstrated below and discussed above, cumulative project ambient air quality impacts remain in compliance with the NAAQS after including a second OSRV in the OSRV Spill Exercise area source.

Table 2-13 presents a revised analysis of the project SO_2 significant impact analysis after including a second OSRV in the OSRV Spill Exercises area source by conservatively assuming the previously presented overall maximum impact was due to the OSRV Spill Exercises area source. This analysis clearly demonstrates that project SO_2 air quality impacts remain well below the SILs after including a second OSRV in the OSRV Spill Exercises area source.

Table 2-14 presents a revised cumulative impact analysis for 1 and 8-hour CO, annual NO_2, and annual $PM_{2.5}$ after including a second OSRV in the OSRV Spill Exercises area source by conservatively assuming the previously presented overall maximum impact was due to the OSRV Spill Exercises area source. This analysis clearly demonstrates that project air quality impacts remain well below the NAAQS after including a second OSRV in the OSRV Spill Exercises area source.

Table 2-15 presents a revised cumulative impact analysis for 1-hour SO_2 after including a second OSRV in the OSRV Spill Exercises area source by conservatively assuming the previously presented overall maximum impact was due to the OSRV Spill Exercises area source. This analysis clearly demonstrates that project air quality impacts remain well below the NAAQS after including a second OSRV in the OSRV Spill Exercises area source.

Table 2-12 Modeled OSRV Spill Exercises Area Source Emissions

Vessel	Cumulative Vessel Emissions (g/s) [1]						
	NO_x		CO	PM_{10} and $PM_{2.5}$		SO_2	
	Short-Term	Annual	1-hour	Short-Term	Annual	Short-Term	Annual
OSRV(1)	2.06E+01	1.21E-01	4.85E+00	3.73E-01	2.22E-03	9.83E-03	5.76E-05
OSRV(2)	2.06E+01	1.21E-01	4.85E+00	3.73E-01	2.22E-03	9.83E-03	5.76E-05
AHST	2.01E+01	1.28E-01	4.77E+00	3.15E-01	2.34E-03	9.57E-03	6.12E-05
Spill Storage Tanker	1.19E+01	2.66E-02	2.75E+00	1.47E-01	5.76E-04	8.34E-03	2.71E-05
OSV Idling in Open Water [2]	-	9.82E-02	-	-	1.82E-03	-	4.68E-05
Total modeled OSRV Spill Exercises area source Emissions assuming one OSRV.	5.26E+01	3.74E-01	1.24E+01	8.35E-01	6.95E-03	2.77E-02	1.93E-04
Total modeled OSRV Spill Exercises area source Emissions assuming two OSRVs.	7.33E+01	4.94E-01	1.72E+01	1.21E+00	9.16E-03	3.76E-02	2.50E-04
Change in Emissions (Δ%)	39	32	39	45	32	35	30

1 Reference pages E-21 through E-24 of Appendix E of the CP Chukchi AQIA (CP 2010b).

2 As described in the notes to the table on page G-8 of Appendix G of the CP Chukchi AQIA (CP 2010b), this source is not included in the short-term scenario.

Table 2-13 SO_2 Significant Impact Analysis Including a Second OSRV

Pollutant	Averaging Period	Overall Maximum Impact [1] ($\mu g/m^3$)	Contribution from Second OSRV [2] ($\mu g/m^3$)	Revised Overall Maximum ($\mu g/m^3$)	SIL ($\mu g/m^3$)
SO_2	3-hour	4.7	1.6	6.3	25
	24-hour	2.3	0.8	3.1	5
	Annual	0.3	0.1	0.4	1

1 Reference Table 6-2 on page 6-3 of the CP Chukchi AQIA (CP 2010b).

2 Calculated assuming the overall maximum impact is the result of the OSRV Spill Exercises Area Source and increasing the impact according to the increase in emissions presented in **Table 2-12**.

Table 2-14 CO, NO_2, and $PM_{2.5}$ Cumulative Impact Analysis Including a Second OSRV

Pollutant	Averaging Period	Overall Maximum Impact [1] ($\mu g/m^3$)	Contribution from Second OSRV [2] ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)	Revised Cumulative Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
CO	1-hour	2,075	809	1,050	3,934	40,000
	8-hour	1,094	427	945	2,466	10,000
NO_2	Annual	12.1	4.7	2	19	100
$PM_{2.5}$	Annual	2.3	0.74	3	6.0	15

1 Reference Table 8-1 on page 8-5 of the CP Chukchi AQIA (CP 2010b).

2 Calculated assuming the overall maximum impact is the result of the OSRV Spill Exercises Area Source and increasing the impact according to the increase in emissions presented in **Table 2-12**.

Table 2-15 SO_2 1-Hour Cumulative Impact Analysis Including a Second OSRV

Pollutant	Averaging Period	Model Predicted Impact [1] ($\mu g/m^3$)	Contribution from Second OSRV [2] ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)	Revised Cumulative Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
SO_2	1-hour	76	2.6	2	81	196

1 Reference **Table 5-1** on page 5-2 of this document.

2 Calculated assuming the overall maximum impact attributed to the ConocoPhillips OCS source (7.4 $\mu g/m^3$) is the result of the OSRV Spill Exercises Area Source and increasing the impact according to the increase in emissions presented in **Table 2-12**.

3.0 NO_2 1-Hour Ambient Air Quality Impact Analysis

On April 12, ConocoPhillips (CP) submitted an Ambient Air Quality Impact Analysis demonstrating compliance with the recently promulgated 1-hour NO_2 National Ambient Air Quality Standard (CP Chukchi NO2 AQIA – CP 2010c). The following sections supplement and revise information presented in that submittal.

3.1 A Description of Modeled Emission Rates

As discussed in Section 2.2 on page 2-4 of the CP Chukchi NO2 AQIA (CP 2010c), NO_x emissions were decreased approximately 45 to 50 percent as a result of the use of Tier II engines on the OSV, OSRV, Ware Vessel, and Workboats. However, detailed emission rate calculations were not included. Therefore, that information is provided in Appendix B.

3.2 Explicitly Modeled Offsite Inventory Emissions

As described on page 2-3 of the CP Chukchi NO2 AQIA (CP 2010c) only emissions associated with the Shell Gulf of Mexico Inc. (Shell) OCS source were explicitly included in the 1-hour NO_2 cumulative impact analysis. The Shell OCS source was modeled using input files provided by Shell to USEPA as part of several May 2009 submittals (Shell 2009a, and Shell 2009b) with locations, emissions, and stack parameter data adjusted to match those presented in Attachment A to Shell's Comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c). The data are presented in the CP Chukchi AQIA (CP 2010b) Appendix L, Table L4-2 and L4-3. Modeled emissions are different than those documented in the Statement of Basis to the January 8, 2010 proposed permit for the Shell OCS source. The differences are documented in **Table 3-1** are largely the result of modeling emissions for units that operate less that 24-hours as 24-hour weighted emissions rather than 1-hour weighted emissions. Because the Shell OCS source mobile support vessel fleet was conservatively modeled as a single point source centered on the Frontier Discoverer, and the Shell OCS source is located more 25 kilometers from the CP OCS source, the differences will have negligible effect on cumulative model predicted short-term NO_2 impacts.

3.3 Description of OLM Implementation with OCD Model Predicted Impacts

This section describes how the Ozone Limiting Method (OLM) was implemented for NO_2 modeling conducted with the OCD dispersion model for the CP Chukchi NO2 AQIA (CP 2010c). The NO_2 concentration for each hour at each receptor was estimated using the following equation derived from the 40 CFR 51 Appendix W OLM reference (Cole and Summerhays 1979).

$$NO_2 = \{(T) \times [NO_x]_{predicted}\} + MIN\{((1-T) \times [NO_x]_{predicted}), \text{ OR } (46/48) \times [O_3]_{background})\}$$

Where:

NO_2	= The estimated hourly NO_2 concentration.
T	= The in-stack thermal conversion of NO_x to NO_2, which was set to 0.1 for this implementation.
MIN	= Means the minimum of the two quantities within the brackets.
$[NO_x]_{predicted}$	= The model predicted aggregate hourly NO_x concentration (i.e., summation of concentrations from all sources contributing to a particular receptor).
$[O_3]_{background}$	= The representative hourly ambient O_3 concentration discussed in section 3.6.

OCD does not contain an OLM algorithm; therefore, OLM was implemented using a post-processor operating on hourly receptor by receptor concentration files created by OCD. The post-processor source code, called

Table 3-1 Modeled 1-hour NO_x Emissions – Shell OCS Source

Modeled Stack #	Source ID	Source Name	1-hour NO_x emissions (g/s)		
			Modeled [1]	Permit SOB [2]	Difference (Modeled-SOB)
Stationary Sources					
1	FD1-7	Generator Engines	0.590	0.582	0.008
	FD8	E-Generator Engine	0.0340	0.411	-0.377
2	FD9-11	MLC Compressors	1.34	1.34	0
3	FD12-13	HPU Engines	1.36	0	1.36
5a	FD14	Port Deck Crane	7.8	0.78	0
5b	FD15	Starboard Deck Crane	7.8	0.78	0
4	FD16-18	Cementing Units	0.74	0.74	0
7	FD19-20	Logging Winches	0		
6	FD21-22	Heat Boilers	0.4	0.4	0
8	FD23	Incinerator	0.00	0.087	-0.087
9	FD31	Resupply Ship – Docked	0.57	1.136	-0.566
Mobile Sources					
MOBILE	Various	All Shell Mobile Sources [3]	170	214	-44

1 Base Operating Scenario – Maximum 24-hr NO_x emissions, Attachment A, page 2 of Shell's Comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c).

2 Base Case Scenario – 1-hour PTE, Appendix A of Statement of Basis to the January 8, 2010 proposed permit for the Shell exploratory activity (USEPA 2010a).

3 For modeled emissions, this includes Ice Management Fleet (Ice breaker and anchor handler), Resupply – transit, OSR Main Ship, and OSR Work Boats. For the Permit SOB, this includes Ice Breaker #1, Ice Breaker #2 - Worst-case Tor Viking or Hull 247 Scenario, Supply Ship – Generic, Oil Spill Response Main Ship – Nanuq, Oil Spill Response, Three Kvichak Work Boats.

"OLM4OCD_v2.0.f", was included with digital files accompanying the CP Chukchi NO2 AQIA (CP 2010c), and is included with this document in a file called "1-hour NO2 Modeling Archive.zip". With the exception that OLM was implemented using the aggregate model predicted hourly NO_x concentration at a particular receptor, OLM was implemented as described in draft OLM guidance for a Tier 2 screening level analysis available from USEPA (USEPA 1997), which included using an in-stack thermal conversion of NO_x to NO_2.(T) of 10 percent.

OLM was implemented using the aggregate model predicted hourly NO_x concentration at a particular receptor based on the belief that the plumes from project sources will combine shortly after release because they are in close proximity and strongly influenced by downwash. This situation will promote plume combining and scavenging of ozone by upwind plumes, both prohibit individual plumes from being exposed to the full oxidizing potential of the ambient ozone. Therefore, it would be overly conservative to implement OLM using a plume-by-plume approach which assumes that each plume is exposed to the full oxidizing potential of the ambient ozone and that plumes do not interact.

The choice to use an in-stack thermal conversion of NO_x to NO_2 (in-stack NO_2/NO_x ratio) of 10 percent was based on historical precedence and lack of data to the contrary. From the 1979 journal article referenced by 40 CFR 51 Appendix W (Cole and Summerhays 1979), to the draft OLM guidance available from USEPA (USEPA 1997), to the formal implementation of OLM in the ISCST3 dispersion model (ISC-OLM), the in-stack NO_2/NO_x ratio has always been set to 10 percent as evidenced by the hard-coding of this value into the

ISC-OLM model. More recently, OLM has been implemented in the guideline AMS/EPA regulatory dispersion model – AERMOD, and the addendum to the user's guide for that model (USEPA 2006), suggests using a default in-stack NO_2/NO_x ratio of 10 percent.

ConocoPhillips recently queried engine manufacturers, and reviewed available literature in order to understand the potential variability of the in-stack NO_2/NO_x ratio for engines. That evaluation found that no conclusive data could be identified to overturn a 10 percent ratio basis for diesel exhausts from stationary and/or marine diesel engines. Older published data and literature suggests typical in-stack NO_2/NO_x ratios of between 10 and 20 percent for uncontrolled diesel engines and more recent studies of on-road cleaner burning diesel engines suggest in-stack NO_2/NO_x ratios of between 5 and 10 percent.

Based on research conducted, which demonstrated a lack of definitive data, it was concluded that there is no compelling reason to break from precedent set by the USEPA and conduct NO_2 modeling with anything but an in-stack NO_2/NO_x ratio of 10 percent.

3.4 Description of the Ambient Boundary used for 1-Hour NO_2 Modeling

When predicting 1-hour NO_2 ambient air quality impacts, as described on page 2-2 of the CP Chukchi NO2 AQIA (CP 2010c), the ambient boundary was defined as a 500 meter radius circle centered on the jack-up drill rig. This ambient boundary is different from the one used in the CP Chukchi AQIA (CP 2010b) which was defined as the edge of the jack-up drill rig.

3.5 Derivation of the 1-Hour NO_2 Background Concentration

The CP Chukchi NO2 AQIA (CP 2010c) cumulative impact analysis was based on a regional 1-hour NO_2 background concentration of 21 $\mu g/m^3$ (11 ppb). This section details the development of the 1-hour NO_2 background concentration. The regional background NO_2 concentration has been derived based on hourly NO_2 measurements made at the Wainwright Near-Term Monitoring Station in 2009 during the drilling season (July through November).

In order to prepare the measured hourly NO_2 concentrations for evaluation, the July through November 2009 Wainwright Near-Term Monitoring Station data was placed into a spreadsheet and filtered so that only the hour with the highest concentration for each day remained. This filtering is consistent with the final form of the 1-hour NO_2 NAAQS which is compared to the three-year average of the 98th percentile of daily maximum one-hour average concentrations of NO_2. Once the hourly data was filtered to only include the maximum concentration for each day, the data was sorted by descending concentration, and the highest values were evaluated to determine if they were representative of a regional background concentration appropriate for predicting cumulative impacts in the project impact area.

Because of the proximity of the Wainwright Near-Term Monitoring Station to the community of Wainwright, and because it was operated from the Wainwright Search and Rescue Headquarters Building, the measured concentrations are known to be influenced by combustion sources used for building heat, mobile sources associated with activity at the building, and combustion sources within the community (i.e., mobile sources, residential heating, heating public buildings, heating the community water storage, and power generation). Based on correlating measured concentrations to wind direction and analyzing the transient nature of the highest measured concentrations, it will be shown below that the highest measured hourly concentrations are not representative of a regional background because the source of the measured concentrations were located within approximately 500 meters of the station. Therefore, the magnitude of NO_2 impacts from these sources are clearly not representative of the regional background offshore in the project area which is located more than 200 km from any onshore sources. Furthermore, because of their small magnitude, and distance from the proposed project, these sources will not produce a significant concentration gradient in the project impact area and should not be included in the cumulative impact analysis as nearby sources as would be the case if they remained part of the background concentration. It is thus appropriate to remove them from consideration. By analyzing data collected at the Wainwright Near-Term Monitoring Station, supplemented with data from the

Wainwright Permanent Monitoring Station when it became operational on September 12, 2010, the following days and associated concentrations were removed from the evaluation.

August 31, 2009

The maximum measured NO_2 concentration on this day was 34 ppb. This concentration occurred during hour ending 15:00. An examination of hourly concentrations occurring both before and after this measurement shows that it is likely the result of a near-field mobile or stationary source. This is because the concentrations measured in the hours leading up to and after the maximum reading are very low. Specifically, NO_2 was measured as 6 ppb the hour before and after with measured concentrations stable nearly all day at 0.0 ppb. Because of this large spike, it is assumed the measured concentration is the result of a source very close to or associated with the station. This is further supported by the fact that there were no stationary sources upwind of the station when the highest concentration was measured (i.e., winds were blowing from the southeast). Therefore, this value should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Table 3-2 presents a record of hourly NO_2 concentrations and meteorological conditions measured on August 31, 2009.

November 21, 2009

The maximum measured NO_2 concentration on this day from the Near-Term Station was 32 ppb during hour ending 11:00. However, elevated concentrations were measured from hour ending 10:00 through hour ending 16:00 when winds were light and blowing from the community (northwesterly through northerly winds). Earlier in the morning, winds were slightly stronger and blowing from the east-southeast and were associated with either 0.0 ppb NO_2 or otherwise very low concentrations. By late morning into early afternoon the winds shifted counterclockwise placing the station downwind of the community and NO_2 concentrations increased. As the day progressed, the winds slowly shifted counterclockwise to southerly directions and subsequently concentrations decreased to 0.0 ppb by the evening.

Measured NO_2 concentrations from the Wainwright Permanent Monitoring Station during this day were also evaluated to determine if the same pattern could be seen and support the conclusion that concentrations measured at the Near-Term Station were the result of the community. Data from this monitor, which is located northeast of the community of Wainwright, showed a similar, but delayed, increase and then decrease in measured NO_2 concentrations as winds placed it downwind of the community through the late afternoon. Consistent with what would be expected from measured concentrations attributed to the community; measured concentrations at the Permanent Station were lower than those measured at the Near-Term Station. This difference is likely related to the fact that the station closest to the community measures the highest concentrations since plumes have had less time to disperse.

Because both monitors measured notable increases in NO_2 concentrations once winds shifted to place the monitoring stations downwind of the community, and the site closest to the community measured the highest concentration, it is believed that the elevated NO_2 concentrations measured on this day are the result of combustion sources associated with the community of Wainwright. Therefore, values measured at the Near-Term Monitoring Station from hour ending 10:00 through hour ending 11:00 should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Table 3-3 presents a record of hourly NO_2 concentrations and meteorological conditions measured in Wainwright on November 21, 2009.

September 17, 2009

The maximum measured NO_2 concentration on this day was 26 ppb. This concentration occurred during hour ending 14:00. As with the maximum concentration measured on August 31, 2009, concentrations before and after the maximum concentration were at or below the instrument detection limit. Furthermore, concentrations measured at the Wainwright Permanent Monitoring Station were at or below the instrument detection limit during the whole day inconsistent with high hourly concentration measured at the Near-Term Monitoring Station.

Because the Wainwright Permanent Monitoring Station did not measure NO_2 concentrations above 1 ppb, it leads to the conclusion that the elevated concentration measured at the Wainwright Near-Term Monitoring Station is the result of a near-field source and not representative of regional concentrations. The fact that NO_2 concentrations measured before and after the 26 ppb measurement were much lower supports this conclusion. Therefore, this value should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Table 3-4 presents a record of hourly NO_2 concentrations and meteorological conditions measured in Wainwright on November 21, 2009.

<u>November 28 and 29, 2009</u>

All elevated impacts (i.e., those greater than 0.005 ppm) on these two days occurred when wind directions placed both the Wainwright Near-Term and Permanent monitoring stations downwind of the power plant. The power plant is directly upwind of the Near-Term Monitoring Station when winds blow from the north-northeast (i.e. 15 degrees). The power plant is directly upwind of the Permanent Monitoring Station when winds blow from the northwest (i.e. 300 degrees). Therefore, neither station will measure impacts from the power plant during the same wind directions.

Consistent with measuring NO_2 concentrations at the Near-Term Monitoring Station that are attributed to power plant, on November 28 from hour ending 8:00 to hour ending 12:00 1) winds were blowing steadily from the north-northeast, 2) measured concentrations at the station were elevated, and 3) measured concentrations at the Permanent Monitoring Station were at or below detection. Before and after this period, winds had a more westerly component, and measured concentrations were near 0 ppb. Elevated NO_2 measurements on this day were clearly a result of the power plant and not representative of regional concentrations; therefore, values measured between hour ending 8:00 and hour ending 12:00 should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

The only time of the day that elevated NO_2 concentrations were measured at the Wainwright Permanent Monitoring Station was late in the day when winds began blowing steadily from the northwest placing the station downwind of the power plant. Clearly, on this day dispersion conditions were well suited for keeping the power plant plume coherent.

On November 29, 2010, dispersion conditions and northwesterly winds persisted from the previous day through hour ending 9:00, and elevated NO_2 concentrations were only measured at the Permanent Monitoring Station and not the Near-Term Station. Once again this indicates that measured concentrations were from the power plant. As soon as winds began to rotate more northerly and the power plant was no longer upwind of the station, concentrations at the Permanent Station dropped to 0 ppb. By hour ending 20:00 winds were north-northeasterly placing the power plant upwind of the Wainwright Near-Term Station, and consistent with that, an elevated NO_2 concentration was measured at the Near-Term Station. Elevated NO_2 measurements on this day were clearly a result of the power plant and not representative of a regional concentration; therefore, values measured between hour ending 1:00 and hour ending 9:00 at the Permanent Station and hour ending 20:00 at the Near-Term Station should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Table 3-5 and **Table 3-6** present a record of hourly NO_2 concentrations and meteorological conditions measured in Wainwright on November 28, and 29, 2009; respectively.

October 28, 2009

The maximum measured NO_2 concentration on this day from the Wainwright Near-Term Station was 17 ppb. This concentration occurred during hour ending 14:00. An examination of hourly concentrations occurring both before and after this measurement shows that it is likely the result of a near-field mobile or stationary source. This is because the concentrations measured in the hours leading up to and after the maximum reading are very low. Specifically, NO_2 was measured as 6 ppb the hour before and 7 ppb the hour after with measured concentrations stable nearly all day below 2 ppb. Because of this spike, it is assumed the measured concentration is the result of a source very close to or associated with the station. Based on wind directions, it is likely that the measured NO_2 concentration is the due to the large boiler located near the community water storage tanks which was directly upwind of the station during hour ending 14:00 (i.e., winds were blowing from the northwest). Since the maximum concentration measured on this day is the result of a near-field stationary or mobile source, this value should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Table 3-7 presents a record of hourly NO_2 concentrations and meteorological conditions measured in Wainwright on October 28, 2009. Note that the data collection system at the Wainwright Permanent Station was offline on this day.

July 2, 5, 9, and 25 2009

The maximum measured NO_2 concentration on all of these days show a very similar pattern suggesting all are attributed to the same near-field source. The concentrations all have the following in common:

- Maximum measured NO_2 values on these days are all between 11 and 16 ppb.
- All maximum measured NO_2 values occur in the early afternoon.
- All maximum measured NO_2 values represent isolated elevated measurements with concentrations measured in the hours leading up to and after the maximum stable nearly all day at 0 ppb.
- All maximum measured NO_2 values occur during light winds from the north.

Because the parking area for the Wainwright Near-Term Station is on the north side of the building, these measurements could all be the result of mobile source activity associated with the Search and Rescue Headquarters Building. That activity could be routine or associated with building reconstruction that occurred during the summer of 2009. However, it is also worth noting that the Olgoonik Corporation maintenance and storage yard is also directly upwind of the Near-Term Station during northerly winds, and measured NO_2 concentrations could be associated with activities at that location. Either way, the transient nature of the maximum measured concentrations on these days would suggest they are the result of near-field sources and not representative of regional concentrations. Therefore, the values measured on July 2, 2009 hour ending 12:00, July 5, 2009 hour ending 14:00, July 9, 2009 hour ending 15:00, and July 25, 2009 hour ending 12:00 should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Table 3-8, **Table 3-9**, **Table 3-10**, and **Table 3-11** present a record of hourly NO_2 concentrations and meteorological conditions measured on July 2, 5, 9, and 25, 2009; respectively. Note that data collection had not begun at the Permanent Station in July 2009.

November 18, 2009

The maximum measured NO_2 concentrations on this day occurred over two separate periods as the winds shifted counterclockwise from north-northeasterly to southwesterly directions starting at hour ending 8:00.

During the first period, consistent with measuring NO_2 concentrations attributed to power plant emissions at the Wainwright Near-Term Monitoring Station, from hour ending 8:00 to hour ending 10:00 1) winds were blowing steady from the north-northeast, 2) measured concentrations at the station were elevated, and 3) measured concentrations at the Permanent Monitoring Station were at or below detection. Before this period, winds had a more westerly component, and measured concentrations were near zero. Immediately after this period, winds had a more easterly component, and measured concentrations were near 0 ppb. Elevated NO_2 measurements on this day during this first period were clearly the result of the power plant and not representative of regional concentrations. Therefore, values measured between hour ending 8:00 and hour ending 10:00 should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

The second period of elevated measurements occurred as the winds rotated counter-clockwise from northerly to southwesterly directions from hour ending 11:00 to hour ending 13:00. This entire time, the Near-Term Station was downwind of the community and measured concentrations were influenced by sources within the community. By hour ending 14:00, the winds were southwesterly, the station was no longer downwind of the community, and subsequently measured concentrations dropped to below 3 ppb where they remained until the winds shifted back counterclockwise placing the station downwind of the community once again. A similar yet much less pronounced pattern in elevated measured NO_2 concentrations occurred at the Wainwright Permanent Station as it was also downwind of the community. The difference in magnitude of the measured concentrations between the two stations is likely related to the fact that the station closest to the community measures the highest concentrations since plumes have had less time to disperse.

The strong correlation of measured concentrations to wind directions placing both monitoring stations downwind of the community would suggest that elevated measured concentrations during hour ending 12:00 and 13:00 at the Near-Term Station are the result of combustion sources located within the community and not representative of regional concentrations. Therefore they should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Table 3-12 presents a record of hourly NO_2 concentrations and meteorological conditions measured in Wainwright on November 18, 2009.

November 20, 2009

The maximum measured NO_2 concentration on this day from the Wainwright Near-Term Station was 15 ppb. This concentration occurred during hour ending 9:00; however, hour ending 10:00 was also likely elevated as a result of the same near field source. Winds on this day started out northerly and slowly rotated counterclockwise to southeasterly directions by the end of the day. Though the Near-Term station was downwind of the community through hour ending 10:00, elevated NO_2 concentrations were only measured at the Near-Term Station when it was downwind of the community school (i.e., westerly). An examination of hourly concentrations occurring both before and after this two hour period shows that the elevated measurements were likely the result of a near-field mobile or stationary source such as the boiler used for heating at the school. This is because the concentrations measured in the hours leading up to and after the maximum reading are very low. Therefore, concentrations measured during hour ending 9:00 and 10:00 are the result of a combustion sources within the community and should be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Note that on this day from hour ending 8:00 through hour ending 11:00, the Wainwright Permanent Station was downwind of the community and measured elevated concentrations the entire time. Because the elevated NO_2 measurements at the Permanent Station correlate only to wind directions placing it downwind of the community, it is clear that sources within the community contribute to the elevated NO_2 measurements. Therefore, concentrations measured from hour ending 8:00 to hour ending 11:00 at the Permanent Station are the result of combustion sources within the community and should also be removed from consideration when determining an appropriate regional background concentration for the cumulative impact analysis.

Table 3-13 presents a record of hourly NO_2 concentrations and meteorological conditions measured in Wainwright on November 20, 2009.

Table 3-2 August 31, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.010	0.000	0.001	0.006	**0.034**	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wind Direction	100	100	100	100	110	110	110	110	110	110	110	120	140	140	130	120	90	110	140	160	140	130	140	160
Wind Speed (m/s)	13	13	13	13	13	12	11	10	9	8	7	6	6	4	2	3	1	3	4	6	6	7	8	9

Table 3-3 November 21, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	**0.004**	**0.017**	**0.032**	**0.018**	**0.007**	**0.017**	**0.007**	**0.013**	**0.015**	**0.007**	**0.003**	**0.003**	**0.006**	0.000	0.000	0.001
Wind Direction	110	130	110	80	60	35	10	360	350	340	330	336	342	348	354	360	25	50	50	50	83	117	170	170
Wind Speed (m/s)	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	2
Wainwright Permanent Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	**0.002**	**0.018**	**0.010**	**0.016**	**0.015**	**0.025**	**0.011**	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000

Table 3-4 September 17, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.001**	**0.026**	**0.001**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wainwright Permanent Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.001	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wind Direction	45	40	37	39	40	37	33	30	34	36	37	35	32	32	31	35	34	35	35	39	42	43	42	44
Wind Speed (m/s)	9	9	9	9	9	9	10	11	10	10	10	10	11	11	11	11	10	10	10	9	8	8	8	8

Table 3-5 November 28, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.002	0.001	0.004	0.010	0.013	0.013	0.015	0.020	0.007	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000
Wainwright Permanent Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.000	0.000	0.005		0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.024	0.019
Wind Direction	111	93	48	16	43	318	343	17	17	13	15	5	353	349	348	344	339	341	333	319	315	307	303	300
Wind Speed (m/s)	3.4	2.1	1.4	1.7	0.8	0.6	2.3	6.3	5.7	5.1	5.1	5.2	5.6	6.3	7	7.6	7.6	7.6	7.3	7.7	7.5	7.2	6.5	5.7

Table 3-6 November 29, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.005	0.002	0.003	0.005	0.007	0.009	0.007	0.003	0.013	0.000	0.001	0.000	0.000
Wainwright Permanent Monitoring Station Measurements																								
NO_2 (ppm)	0.012	0.006	0.018	0.011	0.012			0.021	0.021	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wind Direction	302	309	300	304	303	293	295	301	308	323	323	317	321	321	314	329	353	1	356	19	31	40	49	35
Wind Speed (m/s)	5.6	6.1	6.2	5.9	5.9	5.6	5.7	5.1	5.0	4.7	4.8	3.9	4.7	4.4	3.4	3.6	3.7	3.1	3.2	2.6	2.5	2.4	2.8	3.4

Table 3-7 October 28, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.001	0.002	0.000	0.001	0.000	0.003	0.003	0.002			0.000	0.006	0.006	0.017	0.007	0.001	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000
Wind Direction	285	330	310	300	310	350	350	275	200	233	265	298	330	300	290	280	300	310	50	170	130	140	150	140
Wind Speed (m/s)	5	4	4	4	3	3	1	1	1	2	2	2	3	3	1	5	4	1	2	2	3	3	4	4

Table 3-8 July 2, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.012	0.008	0.001	0.000	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Wind Direction	40	40	40	40	40	40	70	70	90	70	100	360	10	40	40	40	40	40	40	50	50	80	70	60
Wind Speed (m/s)	3	3	4	4	4	3	4	3	4	4	4	3	6	6	7	7	7	8	7	7	6	7	5	4

Table 3-9 July 5, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.007	0.011	0.002	0.006	0.002	0.005	0.009	0.004	0.016	0.007	0.006	0.002
Wind Direction	280	300	300	230	30	240	310	290	330	330	300	340	10	360	360	350	350	10	360	10	360	10	360	360
Wind Speed (m/s)	4	3	1	2	1	3	3	1	3	3	3	3	4	4	4	4	4	6	4	5	4	4	4	4

Table 3-10 July 9, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.000	0.003	0.003	0.009	0.004	0.003	0.005	0.003	0.006	0.002	0.005	0.016	0.005	0.003	0.002	0.000	0.000	0.001	0.000	0.001	0.000
Wind Direction	280	260	310	340	10	340	340	340	340	340	340	335	330	340	10	310	300	280	280	280	265	250	220	190
Wind Speed (m/s)	4	3	3	1	1	1	2	2	2	2	2	2	2	3	1	2	2	1	1	2	2	1	1	1

Table 3-11 July 25, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.001	0.002	0.002	0.001	0.012	0.010	0.001	0.004	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000
Wind Direction	50	40	50	50	360	360	360	10	360	10	180	350	10	360	360	360	360	360	360	40	40	70	50	50
Wind Speed (m/s)	4	4	3	4	3	4	3	3	4	3	3	3	5	4	4	4	3	4	4	5	5	6	4	4

Table 3-12 November 18, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.004	0.003	0.004	0.003	0.000	0.005	0.006	0.009	0.016	0.010	0.004	0.016	0.011	0.002	0.003	0.001	0.001	0.002	0.002	0.001	0.002	0.001	0.004	0.006
Wainwright Permanent Monitoring Station Measurements																								
NO_2 (ppm)	0.001	0.000	0.001	0.003	0.000	0.000		0.000	0.000	0.000	0.001	0.006	0.004	0.001	0.001	0.000	0.000	0.000	0.003	0.001	0.003	0.006	0.007	0.007
Wind Direction	248	247	251	261	215	259	347	8	8	3	15	331	246	233	228	202	215	207	243	249	275	302	293	299
Wind Speed (m/s)	2.2	2.1	1.7	1.1	1.4	0.4	1.3	1.9	1.9	2.5	2.0	0.4	1.3	1.2	1.3	1.2	1.4	1.5	1.1	1.3	1.5	1.0	0.7	0.8

Table 3-13 November 20, 2009 NO_2 Concentrations Measured at Wainwright

Hour Ending	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Wainwright Near-Term Monitoring Station Measurements																								
NO_2 (ppm)	0.002	0.002		0.002	0.003	0.003	0.008	0.005	0.015	0.011	0.005	0.005	0.001	0.000	0.000	0.006	0.011	0.001	0.000	0.002	0.006	0.001	0.000	0.000
Wind Direction	360	340	320	360	310	330	310	290	269	247	226	204	183	161	140	138	135	133	130	135	140	125	110	110
Wind Speed (m/s)	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	3	2	3
Wainwright Permanent Monitoring Station Measurements																								
NO_2 (ppm)	0.000	0.000	0.000	0.000	0.002			0.026	0.025	0.020	0.013	0.000	0.000	0.001	0.000	0.000	0.012	0.001	0.000	0.001	0.001	0.000	0.000	0.000

After removing the concentrations measured on 12 days described above the Wainwright Near-Term Monitoring Station data was re-evaluated, and the highest remaining concentration was 11 ppb, which was measured on July 1, 2009 during hour ending 9:00 a.m. It was decided that this remaining maximum value, as opposed to the remaining highest-eighth-high value should be used as a representative regional background concentration for conducting cumulative modeling since USEPA has yet to issue guidance regarding the appropriate ranking for the measured concentration to be used in a cumulative 1-hour NO_2 impact analysis.

3.6 Background Ozone Data Used in NO_2 Modeling

Section 2.4 on page 2-4 of the CP Chukchi NO2 AQIA (CP 2010c) provided a summary of the ambient ozone data used as input to the NO_2 modeling. That summary indicated modeling was conducted using a diurnally varying ambient ozone input file, when in actuality; modeling was conducted with a constant value for each modeled month since data reviewed showed little diurnal or daily variation. Below is a description and justification for the ambient ozone input file used.

As discussed in Section 3.3, the estimation of hourly modeled NO_2 concentrations associated with the proposed project was conducted using the Ozone Limiting Method (OLM) in accordance with 40 CFR 51 Appendix W. In this method, hourly emissions of NO_x are modeled and then converted to NO_2. According to the OLM, the degree to which NO_x emissions are converted to NO_2 during plume transport is directly related to concurrent hourly concentrations of ambient ozone. Given the project is well off of the coast where there are no ozone measurement stations, an objective method was applied to estimate ambient ozone using land-based measurements.

A monitor at Wainwright, Alaska located approximately 200 km to the east-southeast of the project, provides the closest and most readily available source of representative ozone data. This location is particularly suitable because it is generally upwind of the project due to easterly winds that prevail during the drilling season. The Wainwright ozone monitor has hourly ozone measurements for the July-November drilling season during 2009, but it was not in operation during the historical 5-year dispersion modeling period. In order to determine how to use this data in an objective unbiased manner, the diurnal pattern of ozone was examined for each month during the drilling period. It was determined from these patterns that while there was little variation of the average concentration according to hour of the day, there was a substantial variation of the average concentration from month to month, increasing from July to November. Therefore the following average ozone concentrations measured for each month were applied in the OLM method:

- July 0.017 ppm (33 $\mu g/m^3$),
- August 0.019 ppm (37 $\mu g/m^3$),
- September 0.025 ppm (49 $\mu g/m^3$),
- October 0.025 ppm (49 $\mu g/m^3$),
- November 0.031 ppm (61 $\mu g/m^3$).

Given the available data, applying monthly varying values of ozone in OLM is expected to provide unbiased modeling estimates of hourly NO_2 from the project.

3.7 Revised Far-Field NO_2 Ambient Air Quality Impact Analysis

It was determined that a memory stack overrun which occurred when post-processing OCD predicted hourly NO_x concentrations into a domain of highest-eighth high (H8H) NO_2 impacts resulted in anomalously elevated impacts in the far-field of the modeling domain. After correcting the post-processing the model predicted impacts were reanalyzed and it was determined that previously reported maximum model predicted concentrations, which occurred in the near-field, remained unchanged. Therefore, the results of the cumulative impact analysis presented in Chapter 3 of the CP Chukchi NO2 AQIA (CP 2010c) are unaffected. However, the issue did affect the far-field isopleth plots of model predicted H8H 1-hour NO_2 cumulative impacts presented as Figures 3-2 and 3-3 on pages 3-3 and 3-4 of the CP Chukchi NO2 AQIA (CP 2010c). Therefore, the figures have been revised and should be replaced with **Figure 3-2** and **Figure 3-3** below. Though the near-field modeling was unaffected, for completeness, the near-field plot of model predicted H8H 1-hour NO_2 cumulative impacts presented as Figure 3-1 on page 3-1 of the CP Chukchi NO2 AQIA (CP 2010c) has been reproduced and is presented as **Figure 3-1** below. A complete digital record of the reprocessed NO_2 1-hour modeling is included with this document in a file called “1-hour NO2 Modeling Archive.zip”.

3.8 Discussion of Model Predicted 1-hour NO_2 Design Values used for Comparison to the NAAQS

Table 1 on page 3-1 of the CP Chukchi NO2 AQIA (CP 2010c) presents the 1-hour NO_2 cumulative impact analysis results. As described in the footnote to this table, the model predicted portion of the cumulative impact presented is the average across all modeled years of the 8^{th}-highest daily 1-hour maximum concentration from the annual distribution of daily 1-hour maximum concentrations. This design value is consistent with the latest guidance from USEPA regarding modeling for the new hourly NO_2 NAAQS (USEPA 2010b).

Figure 3-1 REVISED Near-Field Isopleth Plot of Predicted H8H 1-Hour NO_2 Cumulative Impacts

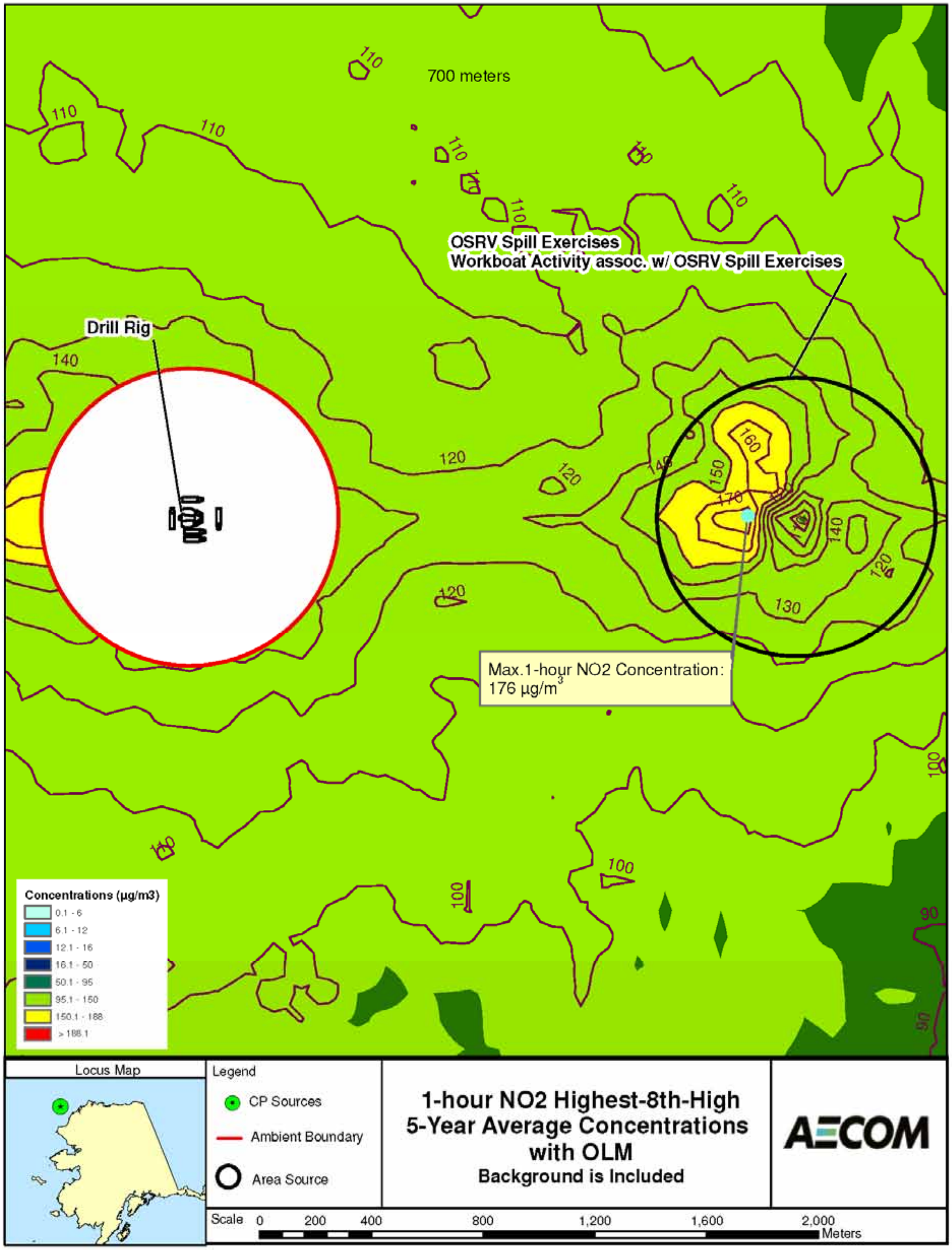


Figure 3-2 REVISED Far-Field Isopleth Plot of Predicted H8H 1-Hour NO_2 Cumulative Impacts

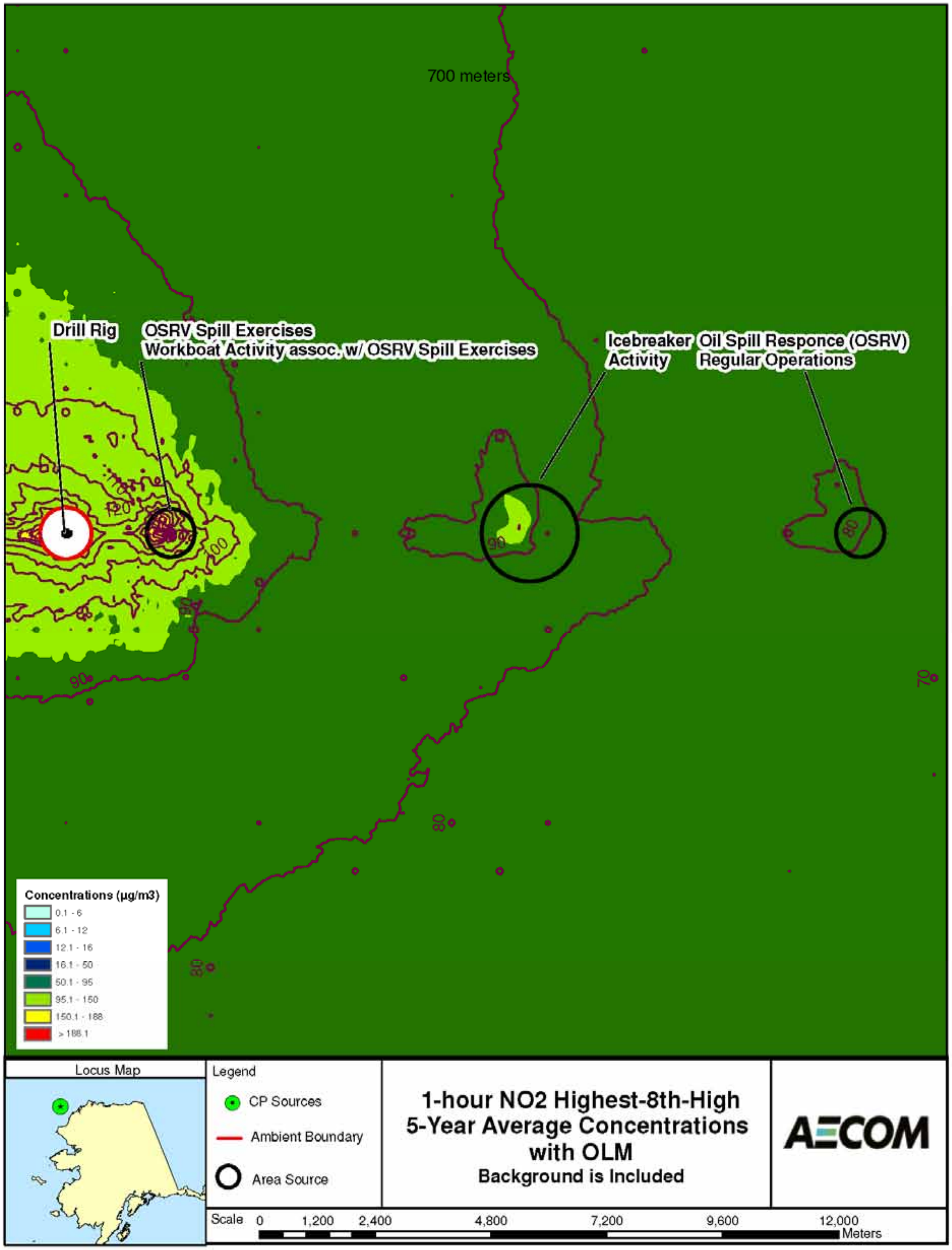
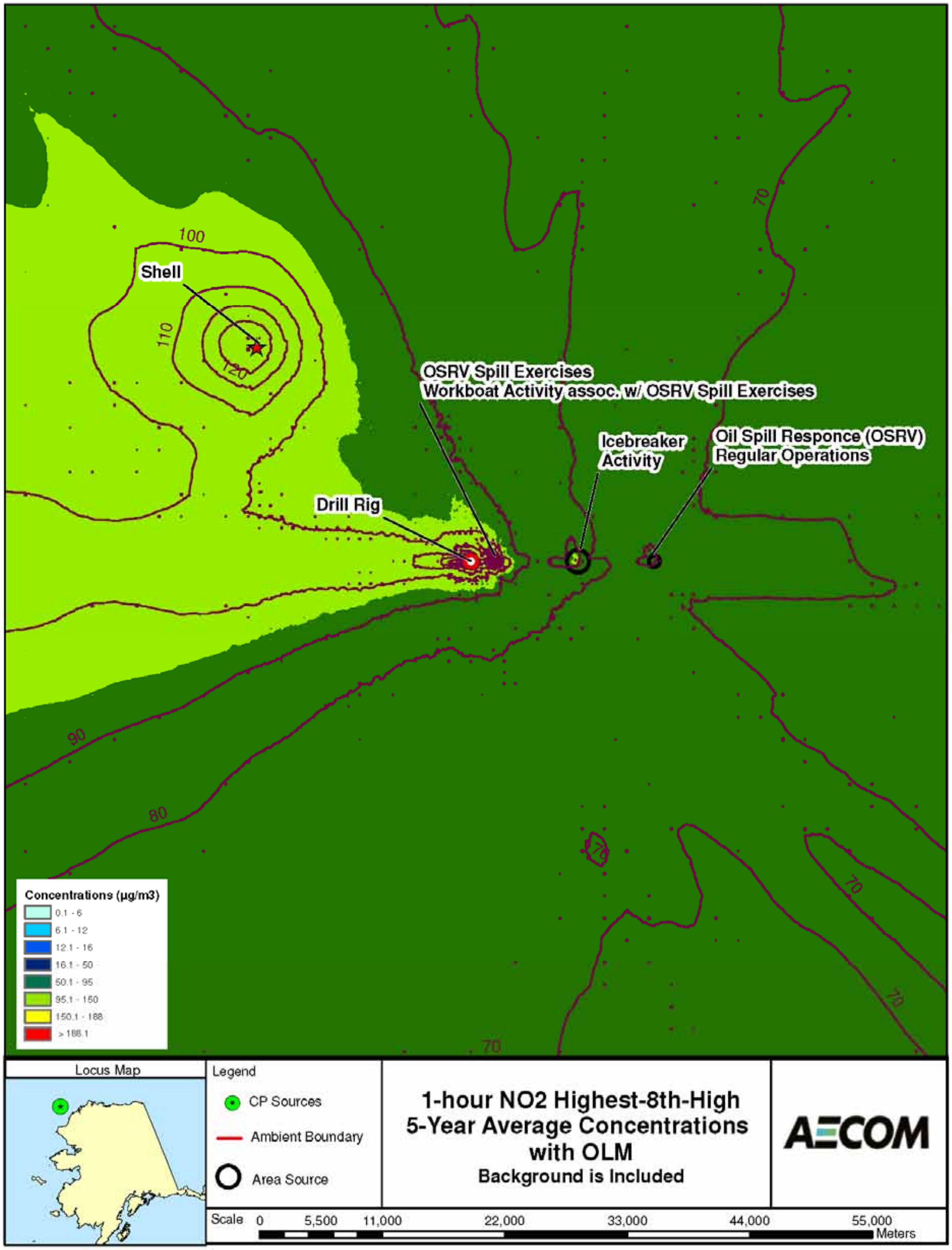


Figure 3-3 REVISED Isopleth Plot of Predicted H8H 1-Hour NO_2 Cumulative Impacts on the Entire Modeling Domain



4.0 Revised PM_{10} Cumulative Impact Analysis Supplemental Information

On April 26, ConocoPhillips (CP) submitted a short-term PM_{10} ambient air quality impact analysis that revised the one presented as part of the Part 71 permit application for its planned 2010 Chukchi Sea exploration project. (CP Chukchi PM10 AQIA – CP 2010d). The following sections supplements and revises information presented in that submittal.

4.1 Typographical Error and Minor Corrections

1. The maximum predicted cumulative impact across all years listed in the first paragraph of Section 4.0 on page 3 of the CP Chukchi PM10 AQIA should be 21.6 μg/m^3, and not 21.7 μg/m^3.

4.2 Shell Worst-Case Configuration

In order to maximize impacts from the Shell Gulf of Mexico Inc. (Shell) OCS source on the ConocoPhillips modeling domain, it was determined that the Shell OCS source should be located at an azimuth of 315 degrees from the ConocoPhillips OCS source. This location was chosen since it corresponded to the worst case location determined and used for cumulative modeling in described in the CP Chukchi AQIA (CP 2010b). As described on page 8-1 section 8.2.1 of the CP Chukchi AQIA (CP 2010b), of the five potential locations modeled with OCD, this location maximized impacts on the modeling domain. Though that analysis was carried out entirely with OCD, and the Revised CP Chukchi PM10 AQIA (CP 2010d) was carried out with a mix of ISC-Prime screen and OCD, the conclusions will not change since the ConocoPhillips OCS source was still modeled with OCD (i.e., the pattern of ConocoPhillips OCS source impacts that lead to maximum ConocoPhillips/Shell impact overlap remained the same), and the Shell OCS source, which was modeled with ISC-Prime screen, was modeled with meteorology always placing Shell upwind of the ConocoPhillips OCS source (i.e., modeling was tailored to maximize ConocoPhillips/Shell impact overlap given the selected Shell location).

4.3 Explicitly Modeled Offsite Inventory Emissions

As described in Section 8.2 starting on page 8-1 of the CP Chukchi AQIA (CP 2010b) only emissions associated with the Shell exploratory activity (Shell OCS source) were explicitly included the cumulative impact analysis. As described on page 2, Section 2.0 of the Revised CP Chukchi PM10 AQIA (CP 2010d), the Shell OCS source was modeled using input files provided by Shell to USEPA as part of several May 2009 submittals (Shell 2009a, and Shell 2009b) with locations, emissions, and stack parameter data adjusted to match those presented in Attachment A to Shell's Comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c). The data are presented in the CP Chukchi AQIA (CP 2010b) Appendix L, Table L4-2 and L4-3 and are reproduced in **Table 4-1** and **Table 4-2**. Modeled emissions are different than those documented in the Statement of Basis to the January 8, 2010 proposed permit for the Shell exploratory activity (USEPA 2010a). The differences are documented in **Table 4-1** and **Table 4-2** and are the result of changes to the mobile support vessel fleet and Frontier Discoverer incinerator characterization. Because the Shell OCS source mobile support vessel fleet was conservatively modeled as a single point source at the center of the Frontier Discoverer, and the Shell OCS source is located just over 25 kilometers from the ConocoPhillips OCS Source, the differences will have negligible effect on cumulative model predicted impacts.

4.4 Discussion of Model Predicted 24-hour PM_{10} Design Values used for Comparison to the NAAQS

Table 1 on page 6 of the Revised CP Chukchi PM10 AQIA (CP 2010d) presents the short-term PM_{10} cumulative impact analysis results. As described in the table footnote, the model predicted portion of the cumulative impact presented in this table is the sum of:

- highest-second-high model predicted impact from the ConocoPhillips OCS source, and
- highest-first-high model predicted impact from the Shell OCS source.

When comparing to the short-term PM_{10} NAAQS using model predicted impacts from the ConocoPhillips OCS source, it is appropriate to use the highest-second-high short term concentration over the entire receptor network for each year modeled according to 40 CFR 58 Appendix W Section 7.2.1.1b since modeling was conducted with five years of representative meteorology, and the five years were not treated as a single continuous period. If the five year dataset were treated as a single period, the highest-sixth-high would be appropriate. Meteorological data representativeness was thoroughly discussed in Chapter 4 of the CP Chukchi AQIA (CP 2010b).

When comparing to the short-term PM_{10} NAAQS using model predicted impacts from the Shell OCS source, it is appropriate to use the highest-first-high short-term concentration over the entire receptor network according to 40 CFR 58 Appendix W Section 7.2.11c since a screening technique was used to predict the impact.

Table 4-1 Modeled Annual PM_{10} and $PM_{2.5}$ Emissions – Shell OCS Source

Modeled Stack #	Source ID	Source Name	Annual PM_{10} and $PM_{2.5}$ emissions (g/s)		
			Modeled [1]	Permit SOB [2]	Difference (Modeled-SOB)
Stationary Sources					
1	FD1-7	Generator Engines	0.07	0.07	0
	FD8	E-Generator Engine			
2	FD9-11	MLC Compressors	0.008	0.004	0.004
3	FD12-13	HPU Engines	0.005	0.005	0
5a	FD14	Port Deck Crane	0.0009	0.002	0
5b	FD15	Starboard Deck Crane	0.0009		
4	FD16-18	Cementing Units	0.009	0.008	0.001
7	FD19-20	Logging Winches	0		
6	FD21-22	Heat Boilers	0.022	0.022	0
8	FD23	Incinerator	0.013	0.003	0.001
9	FD31	Resupply Ship – Docked	0.0009	0.0009	0
Mobile Sources					
MOBILE	Various	All Shell Mobile Sources [3]	3.19	1.55	1.64

1 Base Operating Scenario – Maximum ton per year $PM_{2.5}$ emissions, Attachment A, page 17 of Shell's Comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c).

2 Base Case Scenario – 24-hour PM_{10} PTE, Appendix A of Statement of Basis to the January 8, 2010 proposed permit for the Shell exploratory activity (USEPA 2010a).

3 For modeled emissions, this includes Ice Management Fleet (Ice breaker and anchor handler), Resupply – transit, OSR Main Ship, and OSR Work Boats. For the Permit SOB, this includes Ice Breaker #1, Ice Breaker #2 – Worst-case Tor Viking or Hull 247 Scenario, Supply Ship – Generic, Oil Spill Response Main Ship – Nanuq, Oil Spill Response, Three Kvichak Work Boats.

Table 4-2 Modeled 24-hour PM_{10} and $PM_{2.5}$ Emissions – Shell OCS Source

Modeled Stack #	Source ID	Source Name	24-Hour PM_{10} and $PM_{2.5}$ emissions (g/s)		
			Modeled[1]	Permit SOB[2]	Difference (Modeled-SOB)
Stationary Sources					
1	FD1-7	Generator Engines	0.15	0.15	0
	FD8	E-Generator Engine	0.007	0.007	0
2	FD9-11	MLC Compressors	0.07	0.04	0.03
3	FD12-13	HPU Engines	0.03	0	0.03
5a	FD14	Port Deck Crane	0.005	0.005	0
5b	FD15	Starboard Deck Crane	0.005	0.005	0
4	FD16-18	Cementing Units	0.02	0.02	0
7	FD19-20	Logging Winches	0		
6	FD21-22	Heat Boilers	0.05	0.05	0
8	FD23	Incinerator	0.01	0.03	-0.02
9	FD31	Resupply Ship – Docked	0.04	0.04	0
Mobile Sources					
MOBILE	Various	All Shell Mobile Sources[3]	7.26	7.87	-0.61

1 Base Operating Scenario – Maximum 24-hr $PM_{2.5}$ emissions, Attachment A, page 2 of Shell's Comments to the August 2009 EPA Permit R10OCS/PSD-AK-2009-01 submitted September 17, 2009 (Shell 2009c).

2 Base Case Scenario – 24-hour PM_{10} PTE, Appendix A of Statement of Basis to the January 8, 2010 proposed permit for the Shell exploratory activity (USEPA 2010a).

3 For modeled emissions, this includes Ice Management Fleet (Ice breaker and anchor handler), Resupply – transit, OSR Main Ship, and OSR Work Boats. For the Permit SOB, this includes Ice Breaker #1, Ice Breaker #2 – Worst-case Tor Viking or Hull 247 Scenario, Supply Ship – Generic, Oil Spill Response Main Ship – Nanuq, Oil Spill Response, Three Kvichak Work Boats.

5.0 SO_2 1-Hour Ambient Air Quality Impact Analysis

A final rule revising the National Ambient Air Quality Standards (NAAQS) for SO_2 was published in the Federal Register on June 22, 2010 and becomes effective on August 23, 2010. Because of the timing of the rule effective date relative to USEPA issuing a draft permit for public comment for this project, ConocoPhillips is anticipating a USEPA Region 10 request for a compliance demonstration with the revised SO_2 NAAQS. Therefore, ConocoPhillips is submitting the following information to address the revised standard.

The final rule establishes a new 1-hour SO_2 standard of 75 ppb (196 μg/m^3), and revokes the existing 24-hour and annual standards. The new 1-hour SO_2 standard is compared to the 3-year average of the 99^{th} percentile of the annual distribution of the daily maximum 1-hour average concentrations.

Though it will occur, it has yet to be determined when USEPA will issue guidance on conducting refined air quality dispersion modeling and implementing the new 1-hour SO_2 standard. Without this guidance, the following questions remain unanswered:

- How should modeling results and background concentrations be translated and combined into a form appropriate for comparison to the new standard?
- How should a permittee identify and appropriately assess the air quality impacts of SO_2 sources that may potentially cause of contribute to a violation of the new standard (i.e., what is considered a significant 1-hour SO_2 impact?)?

In light of these unanswered questions, to complete an analysis to demonstrate compliance with the new 1-hour SO_2 NAAQS for this project, the following conservative technical approach was used to predict cumulative air quality impacts for comparison to the new standard. Cumulative 1-hour SO_2 air quality impacts used to compare to the new standard were calculated as the sum of 1) maximum model predicted 1-hour SO_2 impacts from project sources, 2) maximum model predicted 1-hour SO_2 impacts from offsite sources, and 3) a maximum measured 1-hour SO_2 concentration. The results of the cumulative impact analysis are presented in **Table 5-1** and show compliance with the new standard.

Maximum model predicted 1-hour SO_2 project impacts were derived from a reanalysis of significant impact analysis modeling submitted with the CP Chukchi AQIA (CP 2010b). The significant impact analysis for the SO_2 3-hour averaging period was conducted with maximum 1-hour emission rates detailed in Appendix E of the CP Chukchi AQIA (CP 2010b). Therefore, all that was required to obtain 1-hour impacts was to reprocess the 3-hour averaging period model output submitted as part of the CP Chukchi AQIA (CP 2010b). Reference the attached file "1-hour SO2 Processing Files.zip" for a copy of the reprocessed SO_2 model output.

As discussed on Section 8.2 of the CP Chukchi AQIA (CP 2010b), the only offsite source explicitly modeled is the Shell OCS source. Maximum 1-hour SO_2 impacts from this offsite source were derived by scaling impacts presented in the Statement of Basis (SOB) for Permit No. R10OCS/PSD-AK-09-01 (USEPA 2010a). Model predicted 3-hour concentrations were converted to 1-hour concentrations using the same persistence factors used to calculate the 3-hour values. Since a scaling factor of 1.0 was used (reference page 104, Table 5-8 of the SOB), the maximum 3-hour impact presented on page 110, Table 5-12 of the SOB of 68.8 μg/m^3 is equivalent to the maximum 1-hour SO_2 impact.

The maximum measured 1-hour SO_2 concentration was derived from data recorded by the Wainwright Near-Term Monitoring Program. During the period November 2008 through October 2009, the maximum measured 1-hour SO_2 concentration was 0.008 ppm (21 μg/m^3) which occurred on November 19, 2008 hour ending 1000.

Table 5-1 1-hour SO_2 Cumulative Impact Analysis Results (Concentrations in $\mu g/m^3$)

Pollutant	Averaging Period	Impacts predicted with Wainwright NWS Meteorological Data[1]					Model Predicted Impact[2]	Background Concentration[3]	Total	NAAQS
		1999	2002	2004	2005	2006				
SO_2	1-hour	7.0	5.2	5.2	7.2	7.4	76	21	97	196

1 Highest-first-high model predicted impact from only the ConocoPhillips OCS source.

2 The total model predicted impact is the sum of the maximum highest-first-high impact from the ConocoPhillips OCS source, and the highest-first-high impact predicted for the Shell OCS source. The Shell contribution to the cumulative impacts is 68.8 $\mu g/m^3$.

3 Maximum 1-hour SO_2 concentration measured by the Wainwright Near-Term Monitoring Program from November 2008 through October 2009.

6.0 Comparison of Impacts Predicted with the Wainwright NWS Data Compared to Offshore Data Developed from the MM5 Mesoscale Meteorological Model

As discussed in Section 2.6, USEPA Region 10 requested that meteorological data predicted with the Fifth-Generation NCAR/Penn State Mesoscale Model (MM5) be used as input to guideline dispersion models provided the MM5 data has been approved for regulatory purposes. Fortunately, calendar year 2002 MM5 predicted meteorology for the Chukchi Sea has been developed and was approved for regulatory modeling as described in the CP Chukchi CALPUFF Evaluation (CP 2010e). This is significant because it provides a mechanism for conducting modeling with OCD using offshore meteorological and oceanographic data, and provides a significant basis for comparison of air quality impacts predicted with offshore data to impacts predicted with onshore data.

Therefore, the MM5 data was processed into an OCD meteorological input file and used to predict impacts for comparison to the NAAQS, and to impacts predicted by OCD using the Wainwright NWS station data. A report documenting the data processing, model execution, and model predicted impacts compared to the NAAQS and those predicted with the Wainwright NWS data are presented in Appendix A.

The cumulative ambient air quality impact analysis presented in Appendix A demonstrates compliance with the NAAQS using model predicted impacts generated by OCD using MM5 model predicted meteorological input data. Furthermore, it shows that impacts predicted with the Wainwright NWS station meteorological input data are very similar to those predicted with the MM5 model predicted meteorological input data. The correlation of model predicted impacts between these two datasets proves the equivalency of the data sets. Since the data sets are equivalent for predicting impacts with OCD, then an analysis conducted with the Wainwright NWS station data will result in the more robust compliance demonstration since it provides the longest data record which best accounts for interannual meteorological variations.

7.0 References

AECOM Environment (AECOM). 2010a. Wainwright Near-Term Ambient Air Quality Monitoring Program Monthly Preliminary Data Summary November and December 2009. Submitted to ConocoPhillips Alaska, Inc., Anchorage Alaska and USEPA Region 10. January 2010.

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CP 2010c. Addendum – ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Attachment C – NO_2 1-Hour Standard Modeling (Modeling Report – 1-Hour NO_2 Ambient Air Quality Impact Analysis for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea). Submitted to USEPA Region 10 (Doug Hardesty) on April 12, 2010.

CP 2010d. Addendum – ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Revised PM_{10} Analysis. Submitted to USEPA Region 10 (Herman Wong) on April 26, 2010.

CP 2010e. Addendum – ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Attachment D – CALPUFF Modeling (CALPUFF Overwater Modeling Evaluation for a Jack-up Drill Rig in the Chukchi Sea). Submitted to USEPA Region 10 (Doug Hardesty) on April 12, 2010.

CP 2010f. Addendum – ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Ambient Air Quality Impacts at Nearby Communities. Submitted to USEPA Region 10 (Herman Wong) on May 19, 2010.

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USEPA 2010a – Statement of Basis for Proposed Outer Continental Shelf Prevention of Significant Deterioration Permit No. R10OCS/PSD-AK-09-01. Frontier Discoverer Drillship – Chukchi Sea Exploration Drilling Program. Date of Proposed Permit: January 8, 2010.

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USEPA 2010c. Modeling Procedures for Demonstrating Compliance with the $PM_{2.5}$ NAAQS. Memorandum from Stephen D. Page Director of the USEPA Office of Air Quality Planning and Standards. March 23, 2010.

Appendix A

OCD Modeling Evaluation for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea Using MM5 Predicted Meteorology

Environment

Submitted to:
ConocoPhillips
Anchorage, AK

Submitted by:
AECOM
Fort Collins, CO
60136620
June 2010

OCD Modeling Evaluation for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea Using MM5 Predicted Meteorology

Final

AECOM Environment

Submitted to:
ConocoPhillips
Anchorage, AK

Submitted by:
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Fort Collins, CO
60136620
June 2010

OCD Modeling Evaluation for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea Using MM5 Predicted Meteorology

Final

Olga Kostrova

Prepared By
Olga Kostrova

TA Damiana

Reviewed By
Tom Damiana

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1.0 Introduction

1.1 Overview

On February 12, 2010, ConocoPhillips (CP) submitted an ambient air quality impact analysis for an exploratory drilling activity to be conducted within the Devil's Paw Prospect on the Chukchi Sea (CP Chukchi AQIA) (Ambient Air Quality Impact Analysis for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea – ConocoPhillips 2010a).

Subsequently, USEPA Region 10 requested ConocoPhillips conduct a supplemental OCD analysis using overwater meteorological input data created using calendar year 2002 data predicted using the Fifth-Generation NCAR/Penn State Mesoscale Model (MM5) and processed for use with 40 CFR 51 Appendix W approved dispersion models using the Mesoscale Model Interface (MMIF) program. The 2002 predicted MM5 meteorological data and methodologies used for processing it for use in dispersion models using MMIF is presented in the "CALPUFF Overwater Modeling Evaluation for a Jack-up Drill Rig in the Chukchi Sea", here after referred to as the CP Chukchi CALPUFF Evaluation (CP 2010c).

This report presents a cumulative impact analysis for the CP OCS source described in the CP Chukchi AQIA (CP 2010a) using impacts predicted with OCD using offshore MM5 predicted meteorological input data. The results of that analysis are also compared to the cumulative impact analysis results obtained previously using OCD with Wainwright NWS station input meteorological data.

1.2 Report Organization

Chapter 2.0 provides details regarding the meteorological data required for OCD. Chapter 3.0 documents the OCD modeling approach. Chapter 4.0 presents the model results. Chapter 5.0 contains all references.

2.0 OCD Meteorological Input Data

A detailed description of the 2002 MM5 predicted meteorological data, and how that data was processed using MMIF for use in dispersion models is presented in CP Chukchi CALPUFF Evaluation (CP 2010c). This Chapter describes how the meteorological data output from the MMIF processor was subsequently converted into an OCD-ready meteorological input file.

2.1 OCD Overwater Meteorological Input Data

An OCD overwater input file consists of six meteorological parameters: wind direction, wind speed, mixing height, relative humidity, air temperature, and water temperature. Wind direction, wind speed, mixing height, and, air temperature are contained in the 2002 MMIF data. Therefore, relative humidity and water temperature had to be extracted from the 2002 MM5 data directly. **Table 2-1** summarizes the parameters required as input to OCD, and the source of data.

The MMIF data set consists of gridded data in binary format making it difficult to extract data from a particular node. Therefore, the PRTMET utility of the CALPUFF modeling system was used to extract the required meteorological parameters from 2002 MMIF data set into a useable ASCII format for a single grid cell located over the project site. **Figure 2-1** shows the grid cell location relative to the modeled receptor domain.

Hourly relative humidity and water temperature values were extracted from the 2002 MM5 data for the same grid cell over the project site. The MM5 data also consists of gridded data in binary format; therefore, to extract data from a particular node, the node was identified and the data was extracted and converted into a useable ASCII format using the CALMM5 utility of the CALPUFF modeling system. Once extracted, this data was adjusted to local standard time.

The ASCII data extracted from the MMIF and MM5 data sets were combined and placed into a free-formatted ASCII text file required for input to OCD. The file was used as the overwater meteorological data input to the OCD model used for this evaluation.

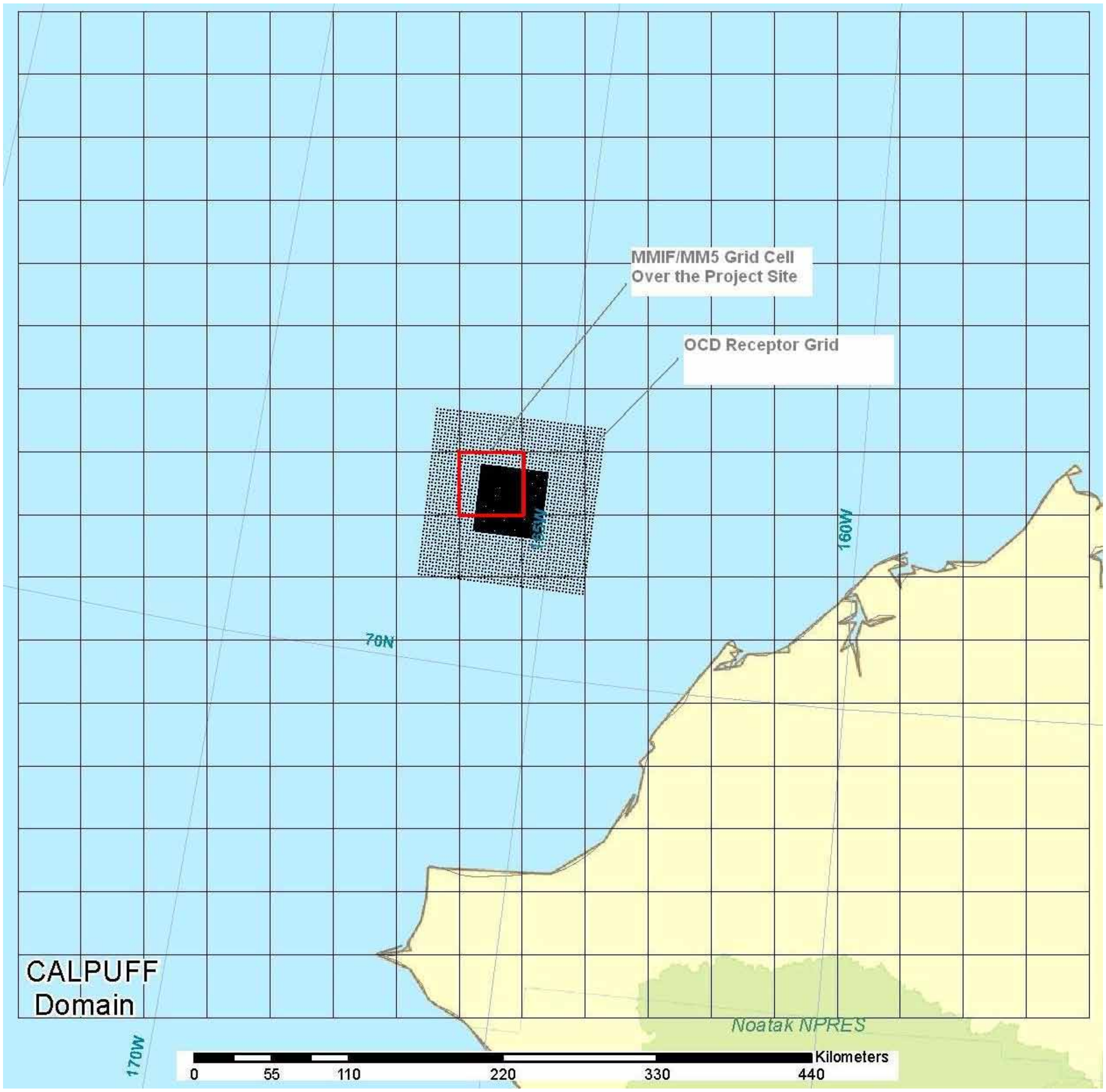
2.2 OCD Overland Meteorological Input Data

The OCD overland meteorological input data used for this evaluation is the same as that described and used for the dispersion modeling conducted in support of the CP Chukchi AQIA (CP 2010a). As described in Section 4.2 of the CP Chukchi AQIA (CP 2010a) that data set consists of hourly surface observations from the Wainwright NWS station with concurrent estimates of twice-daily mixing heights from the Barrow upper air station processed into an OCD-ready format using the PCRAMMET processor.

Table 2-1 Summary of the OCD-Required Meteorological Parameters

OCD-Required Overwater Meteorological Parameters	Data Source (MMIF/MM5)
Overwater wind direction (degrees)	Extracted from the MMIF grid cell over the project site using PRTMET program
Overwater wind speed (m/s)	Extracted from the MMIF grid cell over the project site using PRTMET program
Overwater mixing height (meters)	Extracted from the MMIF grid cell over the project site using PRTMET program
Overwater relative humidity (%)	Extracted from the MM5 grid cell over the project site using CALMM5 program
Overwater ambient temperature (degrees K)	Extracted from the MMIF grid cell over the project site using PRTMET program
Air minus water temperature (degrees K)	Extracted from the MM5 grid cell over the project site using CALMM5 program

Figure 2-1 MMIF/MM5 Grid Cell Used for Extracting Meteorological Parameters for OCD Model



3.0 OCD Dispersion Modeling Input Data

This report is an evaluation and comparison of the cumulative impact analyses determined for the CP OCS source using two different meteorological input files. Therefore, except for the meteorological input file, model input data is the same as that used in previously described analyses. With the exception of 1-hour model predicted NO_2 impacts, all information regarding modeled sources, source exit characteristics, source locations, source emission rates, receptor grids, and building information is presented in detail in the CP Chukchi AQIA (CP 2010a).

A complete description of the 1-hour NO_2 modeling is described in the document titled "Modeling Report – 1-Hour NO_2 Ambient Air Quality Impact Analysis for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea" CP Chukchi NO2 AQIA (CP 2010b).

4.0 Discussion of OCD Modeling Results

4.1 Cumulative Impact Analysis Using MM5 Predicted Input Meteorology

The results of the cumulative impact analysis conducted using impacts predicted by OCD using MM5 predicted offshore meteorological input data are presented in **Table 4-1** which lists all modeled concentrations, ambient background concentrations, as well as total concentrations for comparison to the NAAQS for those pollutants and averaging periods which either exceed the significant impact levels, or for which significant impact levels have not been established (i.e., 1-hour SO_2 and 24-hour $PM_{2.5}$). **Table 4-1** clearly demonstrates that model predicted cumulative air quality impacts for the project are less than the NAAQS for all pollutant and averaging periods evaluated.

Table 4-2 demonstrates that project impacts predicted by OCD using MM5 predicted offshore meteorological input data are below the significant impact levels for 3-hour, 24-hour, and annual SO_2. Therefore, no further analysis is required for these pollutants to demonstrate compliance with the.

For comparison, **Table 4-3** presents the results of the cumulative impact analysis conducted using impacts predicted by OCD using the Wainwright NWS station meteorological input data. Comparing the results presented in **Table 4-1** and **Table 4-3** shows that both approaches yield very similar results proving the equivalency of the data sets for predicting impacts with OCD. Since the data sets are equivalent for predicting impacts with OCD, then an analysis conducted with the Wainwright NWS station data will result in the more robust compliance demonstration since it provides the longest data record which best accounts for interannual meteorological variations.

A digital record containing the OCD/MM5 model input and output files used for the cumulative impact analysis presented in this section are transmitted electronically with this document. A document describing the contents of the digital record is included with the electronic submittal. Reference the files called "OCD-MM5_Modeling_Archive.zip" and "SO2 OCD-MM5_Modeling_Archive.zip".

4.2 Sensitivity of OCD Predicted Impacts to MM5 Predicted Input Meteorology Minimum Mixing Height Selection

In order to process MM5 generated meteorological data through the MMIF processor, MMIF requires the user to input a minimum value for the Planetary Boundary Layer (PBL) depth. For the analysis presented in Section 4.1 above, the minimum PBL depth was set to 100 meters following the settings detailed in Table 2-2 on page 2-4 of the CP Chukchi CALPUFF Evaluation (CP 2010c). 100 meters is conservative for this project based on the research presented in Appendix J of the CP Chukchi AQIA (CP 2010a) which indicates that the minimum value over the project area during the drilling season is not likely lower than 250 meters. Regardless, sensitivity modeling has been conducted to understand the effect of lowering this value to 50 meters. **Table 4-4** presents a comparison of maximum OCD modeled impacts predicted from July through November using a minimum PBL height of 50 meters to those predicted with a minimum PBL height of 100 meters. These results show that short-term impacts do show some sensitivity to minimum mixing height, but not for controlling pollutants and averaging periods such as 1-hour NO_2 and 24-hour $PM_{2.5}$. Maximum annual impacts are somewhat sensitive to the mixing height choice.

Because modeled stack heights range from less than 10 meters to just over 40 meters, the lack of sensitivity to minimum mixing height suggests that the maximum impacts for most averaging periods are likely controlled by sources which produce high impacts irrespective of meteorological conditions involving low mixing heights.

Table 4-1 Cumulative Impact Analysis Using Offshore MM5 Meteorological Input Data (Concentrations in µg/m^3)

Pollutant	Averaging Period	Overall Maximum Impact (Ranking) [1]	Background Concentration [2]	Total	NAAQS
CO	1-hour	2,468 (H2H)	1,050	3,518	40,000
CO	8-hour	1,521 (H2H)	945	2,466	10,000
NO_2 [3]	1-hour	148 (H8H) [4]	21	169	188
NO_2 [5]	Annual	7.5 (H1H)	2	9.5	100
$PM_{2.5}$	24-hour	10.6 (H8H)	10	20.6	35
$PM_{2.5}$	Annual	0.7 (H1H)	3	3.7	15
PM_{10}	24-hour	28.8 (H2H)	49	77.8	150
SO_2	1-hour	75 [6] (H1H)	21	96	196

1 H1H (highest-first-high), H2H (highest-second-high), and H8H (highest-eighth-high).

2 With the exception of 1-hour NO_2 and SO_2, reference Chapter 7 of the CP Chukchi AQIA (CP 2010a). For NO_2 1-hour, reference Chapter 2 of the CP Chukchi NO2 AQIA (CP 2010b). For 1-hour SO_2 reference the Wainwright Near-Term Monitoring Program data summary for the period November 2008 through October 2009 (AECOM 2010).

3 OLM applied.

4 Ranking based on a population of daily maximum 1-hour values.

5 Includes 75% ARM NO_x to NO_2 conversion.

6 The total model predicted impact is the sum of the maximum highest-first-high impact from CP sources, and the highest-first-high impact predicted for the Shell exploration activity. The Shell contribution to the cumulative impacts is 68.8 µg/m^3 (reference Chapter 5 of this document).

Table 4-2 Significance Analysis for SO_2 (Concentrations in µg/m^3)

Pollutant	Averaging Period (Ranking)	Total [1]	Significant Impact Level
SO_2	1-hour	5.41 (H1H)	1,300
SO_2	8-hour	2.69 (H1H)	365
SO_2	Annual	0.01 (H1H)	80

1 H1H (highest-first-high).

Table 4-3 Cumulative Impact Analysis Using Wainwright NWS Meteorological Input Data (Concentrations in µg/m^3)

Pollutant	Averaging Period	Overall Maximum Impact	Background Concentration	Total	NAAQS
CO	1-hour	2,075	1,050	3,125 [1]	40,000
CO	8-hour	1,094	945	2,039 [1]	10,000
NO_2 [2]	1-hour	155	21	176 [3]	188
NO_2 [4]	Annual	12.1	2	14.1 [1]	100
$PM_{2.5}$	24-hour	23.1	10	33.1 [5]	35
$PM_{2.5}$	Annual	2.3	3	5.3 [1]	15
PM_{10}	24-hour	21.6	49	70.6 [6]	150
SO_2	1-hour	76	21	97	196

1 Reference Table 8-1 on page 8-5 of the CP Chukchi AQIA (CP 2010a).

2 OLM applied.

3 Reference Table 3-1 on page 3-1 of the CP Chukchi NO2 AQIA (CP 2010b).

4 Includes 75% ARM NO_x to NO_2 conversion.

5 Reference Table 2-10 of this document.

6 Reference Table 1 on page 6 of the CP Chukchi PM10 AQIA (CP 2010d).

7 Reference Table 5-1 of this document.

Table 4-4 Comparison of Maximum Cumulative Modeled Predicted Concentrations using Different Minimum PBL Heights (Concentrations in µg/m^3)

Pollutant	Averaging Period	Minimum PBL Height used by MMIF	
		50 meter	100 meter
CO	1-hour	2,682	2,682
CO	8-hour	2,682	1,971
NO_2 [1]	1-hour	460	460
NO_2 [2]	Annual	5.6	7.5
$PM_{2.5}$	24-hour	53.1	53.1
$PM_{2.5}$	Annual	0.7	0.7
PM_{10}	24-hour	53.1	53.1
SO_2	1-hour	6.16	6.16
SO_2	3-hour	5.41	5.41
SO_2	24-hour	2.69	2.69
SO_2	Annual	0.01	0.01

1 OLM applied

2 Includes 75% ARM NO_x to NO_2 conversion

5.0 References

AECOM Environment (AECOM). 2010. Wainwright Near-Term Ambient Air Quality Monitoring Program Annual Data Report November 2008 through November 2009. Submitted to ConocoPhillips Alaska, Inc., Anchorage Alaska and USEPA Region 10. March 2010.

ConocoPhillips (CP). 2010a. ConocoPhillips Outer Continental Shelf Air Permit Application (Air Quality Modeling Analysis) – Chukchi Sea Devil's Paw Prospect - Volume 2. Submitted to USEPA Region 10 on February 12, 2010.

CP 2010b. Addendum – ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Attachment C – NO_2 1-Hour Standard Modeling (Modeling Report – 1-Hour NO_2 Ambient Air Quality Impact Analysis for Proposed Exploratory Drilling (Devil's Paw Prospect) in the Chukchi Sea). Submitted to USEPA Region 10 (Doug Hardesty) on April 12, 2010.

CP 2010c. Addendum – ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Attachment D – CALPUFF Modeling (CALPUFF Overwater Modeling Evaluation for a Jack-up Drill Rig in the Chukchi Sea). Submitted to USEPA Region 10 (Doug Hardesty) on April 12, 2010.

CP 2010d. Addendum – ConocoPhillips' Part 71 Chukchi Sea OCS Air Permit Application – Revised PM_{10} Analysis. Submitted to USEPA Region 10 (Herman Wong) on April 26, 2010.

Appendix B

Emission Rates used in the 1-Hour NO_2 Ambient Air Quality Impact Analysis

Modeled 1-Hour NO_x Emissions

- **Drill Rig**
- **Ware Vessel**
- **Offshore Supply Vessel (OSV)**
- **Oil Spill Response Vessels (OSRV) 1 & 2**
- **Other Sources – (Ice Breaker 1 & 2, Anchor Handling Tug, Work Boats, OSRV 1 & 2, Marine Research Vessel, and Spill Storage Tanker)**

Drill Rig Emission Rates

Drill Rig Emission Rates

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NO_x	Exhaust Gas Emissions (g/s) NO_x
Drill Rig Equipment					
Main Drill Rig Engine 1 Wärtsilä 8L26A2	24	per day	Short-term	10.0	1.26
	1500 [2]	per year	Annual		--
Main Drill Rig Engine 2 Wärtsilä 8L26A2	24	per day	Short-term	10.0	--
	1500 [2]	per year	Annual		--
Main Drill Rig Engine 3 Wärtsilä 8L26A3	24	per day	Short-term	10.0	1.26
	1500 [2]	per year	Annual		--
Main Drill Rig Engine 4 Wärtsilä 8L26A4	24	per day	Short-term	10.0	--
	1500 [2]	per year	Annual		--
Emergency Back-up Engine Caterpillar Diesel 3508 B	24	per day	Short-term	29.1	--
	75	per year	Annual		--
Cement Engine 1 Caterpillar 15	24	per day	Short-term	12.3	1.55
	131	per year	Annual		--
Cement Engine 2 Caterpillar 15	24	per day	Short-term	12.3	1.55
	131	per year	Annual		--
			[1] **Total Cement Engine Modeled Short-term (g/s) =**		**3.11**
Logging Winch Caterpillar C7 Acert Engine	24	per day	Short-term	5.7	--
	273	per year	Annual		--
Heater 1 To be determined	24	per day	Short-term	0.53	6.68E-02
	2400	per year	Annual		--
Heater 2 To be determined	24	per day	Short-term	0.53	6.68E-02
	2400	per year	Annual		--
[3] Incinerator To be determined	24	per day	Short-term	0.41	5.22E-02
	473.4	per year	Annual		--
			[3] **Total Ton per Year =**		**15.0**

NOTES:
1 - Drill Rig Cement Engines 1 & 2 modeled as a single source.
2 - Emission calculated based on 1500 hours per year controlled. This is equivalent to 4 engines operating 1200 hours per year controlled and 2 engines operating 125 hours per year uncontrolled.

3 – For the incinerator, annual hours/year based on 65 ton/year allowable waste consumption.

Double dash (--) signifies source was not modeled.

Ware Vessel Emission Rates (not modeled)

Ware Vessel Emission Rates

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr)	Exhaust Gas Emissions (g/s)
				NO_x	NO_x
Ware Vessel In Transit to Drill Rig (50 trips at 3 hours one-way = 150 hours one-way)					
Main Engine 1 - Propulsion / Cruising Caterpillar 3516C	3	per day	Short-term	19.4	--
	150	per year	Annual		--
Main Engine 2 - Propulsion / Cruising Caterpillar 3516C	3	per day	Short-term	19.4	--
	150	per year	Annual		--
Main Engine 3 - Dynamic Positioning / Idling Caterpillar 3516C	0	per day	Short-term	18.1	--
	0	per year	Annual		--
Main Engine 4 - Dynamic Positioning / Idling Caterpillar 3516C	0	per day	Short-term	18.1	--
	0	per year	Annual		--
Generator 1 Caterpillar C18	3	per day	Short-term	7.1	--
	150	per year	Annual		--
Generator 2 Caterpillar C18	0	per day	Short-term	7.1	--
	0	per year	Annual		--
Generator 3 Caterpillar C18	0	per day	Short-term	7.1	--
	0	per year	Annual		--
Emergency Generator Caterpillar 3306	0	per day	Short-term	5.17	--
	0	per year	Annual		--
		Ton per Year =			--
Ware Vessel Transferring Supplies at the Drill Rig (300 hours per year - maximum time next to rig is 6 hours)					
Main Engine 1 - Propulsion / Cruising Caterpillar 3516C	0	per day	Short-term	19.4	--
	0	per year	Annual		--
Main Engine 2 - Propulsion / Cruising Caterpillar 3516C	0	per day	Short-term	19.4	--
	0	per year	Annual		--
Main Engine 3 - Dynamic Positioning / Idling Caterpillar 3516C	6	per day	Short-term	18.1	--
	300	per year	Annual		--
Main Engine 4 - Dynamic Positioning / Idling Caterpillar 3516C	6	per day	Short-term	18.1	--
	300	per year	Annual		--
Generator 1 Caterpillar C18	6	per day	Short-term	7.1	--
	300	per year	Annual		--
Generator 2 Caterpillar C18	6	per day	Short-term	7.1	--
	100	per year	Annual		--
Generator 3 Caterpillar C18	0	per day	Short-term	7.1	--
	0	per year	Annual		--
Emergency Generator Caterpillar 3306	6	per day	Short-term	5.17	--
	30	per year	Annual		--
		Ton per Year =			--

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NO_x	Exhaust Gas Emissions (g/s) NO_x
Ware Vessel In Transit to Drill Rig (50 trips at 3 hours one-way = 150 hours one-way)					
Main Engine 1 - Propulsion / Cruising Caterpillar 3516C	3	per day	Short-term	19.4	--
	150	per year	Annual		--
Main Engine 2 - Propulsion / Cruising Caterpillar 3516C	3	per day	Short-term	19.4	--
	150	per year	Annual		--
Main Engine 3 - Dynamic Positioning / Idling Caterpillar 3516C	0	per day	Short-term	18.1	--
	0	per year	Annual		--
Main Engine 4 - Dynamic Positioning / Idling Caterpillar 3516C	0	per day	Short-term	18.1	--
	0	per year	Annual		--
Generator 1 Caterpillar C18	3	per day	Short-term	7.1	--
	150	per year	Annual		--
Generator 2 Caterpillar C18	0	per day	Short-term	7.1	--
	0	per year	Annual		--
Generator 3 Caterpillar C18	0	per day	Short-term	7.1	--
	0	per year	Annual		--
Emergency Generator Caterpillar 3306	0	per day	Short-term	5.17	--
	0	per year	Annual		--
		Ton per Year =			--
Ware Vessel Delayed by poor weather (maximum 100 hours per year)					
Main Engine 1 - Propulsion / Cruising Caterpillar 3516C	0	per day	Short-term	19.4	--
	0	per year	Annual		--
Main Engine 2 - Propulsion / Cruising Caterpillar 3516C	0	per day	Short-term	19.4	--
	0	per year	Annual		--
Main Engine 3 - Dynamic Positioning / Idling Caterpillar 3516C	24	per day	Short-term	18.1	--
	100	per year	Annual		--
Main Engine 4 - Dynamic Positioning / Idling Caterpillar 3516C	24	per day	Short-term	18.1	--
	100	per year	Annual		--
Generator 1 Caterpillar C18	24	per day	Short-term	7.1	--
	100	per year	Annual		--
Generator 2 Caterpillar C18	0	per day	Short-term	7.1	--
	0	per year	Annual		--
Generator 3 Caterpillar C18	0	per day	Short-term	7.1	--
	0	per year	Annual		--
Emergency Generator Caterpillar 3306	0	per day	Short-term	5.17	--
	0	per year	Annual		--
Total Ton per Year Across All Scenarios =					--

Double dash (--) signifies source was not modeled.

Offshore Supply Vessel (OSV) Emission Rates

Offshore Supply Vessel (OSV) Emission Rates

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr)	Exhaust Gas Emissions (g/s)
				NO_x	NO_x
[1]OSV In Transit to Drill Rig - 24 of 25 miles traveled to Drill Rig					
Main Engine 1 CAT 3516c Propulsion/Cruising	2.88	per day	Short-term	16.7	--
	172.8	per year	Annual		--
Main Engine 2 CAT 3516c Propulsion/Cruising	2.88	per day	Short-term	16.7	--
	172.8	per year	Annual		--
Thruster Engine 1 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 2 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 3 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Generator 1 CAT C18	2.88	per day	Short-term	6.0	--
	172.8	per year	Annual		--
Generator 2 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	0	per day	Short-term	1.79	--
	0	per year	Annual		--
		Total Ton per Year =			**--**
[2]OSV In Transit to Drill Rig - Last one mile of 25 traveled to Drill Rig					
Main Engine 1 CAT 3516c Propulsion/Cruising	0.12	per day	Short-term	16.7	--
	7.2	per year	Annual		--
Main Engine 2 CAT 3516c Propulsion/Cruising	0.12	per day	Short-term	16.7	--
	7.2	per year	Annual		--
Thruster Engine 1 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 2 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 3 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Generator 1 CAT C18	0.12	per day	Short-term	6.0	--
	7.2	per year	Annual		--
Generator 2 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	0	per day	Short-term	1.79	--
	0	per year	Annual		--
		Total Ton per Year =			**--**

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr)	Exhaust Gas Emissions (g/s)
				NO_x	NO_x
OSV Transferring Supplies at the Drill Rig (360 hours per year - maximum time next to rig is 6 hours)					
Main Engine 1 CAT 3516c Propulsion/Cruising	0	per day	Short-term	15.0	--
	0	per year	Annual		--
Main Engine 2 CAT 3516c Propulsion/Cruising	0	per day	Short-term	15.0	--
	0	per year	Annual		--
Thruster Engine 1 CAT C32 - Dynamic Positioning	6	per day	Short-term	12.9	1.63E+00
	360	per year	Annual		--
Thruster Engine 2 CAT C32 - Dynamic Positioning	6	per day	Short-term	12.9	1.63E+00
	360	per year	Annual		--
Thruster Engine 3 CAT C32 - Dynamic Positioning	6	per day	Short-term	12.9	1.63E+00
	360	per year	Annual		--
Generator 1 CAT C18	6	per day	Short-term	6.0	7.59E-01
	360	per year	Annual		--
Generator 2 CAT C18	6	per day	Short-term	6.0	7.59E-01
	120	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	6	per day	Short-term	1.79	--
	30	per year	Annual		--
			Total Ton per Year =		**8.44E+00**
[2]OSV In Transit from Drill Rig - Traveling from next to the Drill Rig (mile zero) to 1 mile distance from Drill Rig					
Main Engine 1 CAT 3516c Propulsion/Cruising	0.12	per day	Short-term	16.7	--
	7.2	per year	Annual		--
Main Engine 2 CAT 3516c Propulsion/Cruising	0.12	per day	Short-term	16.7	--
	7.2	per year	Annual		--
Thruster Engine 1 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 2 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 3 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Generator 1 CAT C18	0.12	per day	Short-term	6.0	--
	7.2	per year	Annual		--
Generator 2 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	0	per day	Short-term	1.79	--
	0	per year	Annual		--
			Total Ton per Year =		**--**

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NO_x	Exhaust Gas Emissions (g/s) NO_x
[1]OSV In Transit from Drill Rig - Beginning 1 mile distance from Drill Rig and traveling a 24 mile distance for a total of 25 mile distance from the Drill Rig					
Main Engine 1 CAT 3516c Propulsion/Cruising	2.88	per day	Short-term	16.7	--
	172.8	per year	Annual		--
Main Engine 2 CAT 3516c Propulsion/Cruising	2.88	per day	Short-term	16.7	--
	172.8	per year	Annual		--
Thruster Engine 1 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 2 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 3 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Generator 1 CAT C18	2.88	per day	Short-term	6.0	--
	172.8	per year	Annual		--
Generator 2 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	0	per day	Short-term	1.79	--
	0	per year	Annual		--
		Total Ton per Year =			**--**

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr)	Exhaust Gas Emissions (g/s)
				NO_x	NO_x
OSV Delayed by poor weather (100 hrs open water idling)					
Main Engine 1 CAT 3516c Propulsion/Idling	24	per day	Short-term	15.0	--
	100	per year	Annual		--
Main Engine 2 CAT 3516c Propulsion/Idling	24	per day	Short-term	15.0	--
	100	per year	Annual		--
Thruster Engine 1 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 2 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 3 CAT C32 Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Generator 1 CAT C18	24	per day	Short-term	6.0	--
	100	per year	Annual		--
Generator 2 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	0	per day	Short-term	1.79	--
	0	per year	Annual		--
	Total Ton per Year =				**--**
	Total OSV Ton per year =				**8.44E+00**

NOTES:

1 - OSV was modeled a distance of 1 mile from the Drill Rig and accounts for 24 miles traveled towards the Drill Rig

Short-term total hours = (3 hours one-way maximum)*(24/25) = 2.88 hours

Total one-way hours - 60 trips at 3.0 hours one-way = 180 hours one-way, then (180 hours)*(24/25) = 172.8 hours (time required to travel 24 of 25 miles)

2 - OSV was modeled next to the Drill Rig and accounts for the last mile traveled to the Drill Rig

Short-term total hours = (3 hours one-way maximum)*(1/25) = 0.12 hours

Total one-way hours = (180 hours)*(1/25) = 7.2 hours

Double dash (--) signifies source was not modeled.

Oil Spill Response Vessel (OSRV) Emission Rates

Oil Spill Response Vessel (OSRV) Emission Rates

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NO_x	Exhaust Gas Emissions (g/s) NO_x
Dedicated OSRV Anchored no Closer than 10 km to the Drill Rig (excludes time assisting with fuel transfer)					
Main Engine 1 CAT 3516c - Propulsion/Cruising	24	per day	Short-term	16.7	2.11E+00
	852	per year	Annual		--
Main Engine 2 CAT 3516c - Propulsion/Cruising	24	per day	Short-term	16.7	2.11E+00
	852	per year	Annual		--
Thruster Engine 1 CAT C32 - Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 2 CAT C32 - Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 3 CAT C32 - Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Generator 1 CAT C18	24	per day	Short-term	6.0	7.59E-01
	2352	per year	Annual		--
Generator 2 CAT C18	24	per day	Short-term	6.0	7.59E-01
	294	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	24	per day	Short-term	1.79	2.25E-01
	18	per year	Annual		--
			Modeled Short-term (g/s) =		5.96E+00
			Total Ton per Year =		**2.23E+01**
OSRV Laying Boom During Fuel Transfers (6 Fuel Transfers per year - 1 hour laying boom and 1 hour retrieving boom - 12 hours per year)					
Main Engine 1 CAT 3516c Propulsion/Cruising	2	per day	Short-term	16.7	2.11E+00
	12	per year	Annual		--
Main Engine 2 CAT 3516c Propulsion/Cruising	2	per day	Short-term	16.7	2.11E+00
	12	per year	Annual		--
Thruster Engine 1 CAT C32 - Dynamic Positioning	2	per day	Short-term	12.9	1.63E+00
	12	per year	Annual		--
Thruster Engine 2 CAT C32 - Dynamic Positioning	2	per day	Short-term	12.9	1.63E+00
	12	per year	Annual		--
Thruster Engine 3 CAT C32 - Dynamic Positioning	2	per day	Short-term	12.9	1.63E+00
	12	per year	Annual		--
Generator 1 CAT C18	2	per day	Short-term	6.0	7.59E-01
	12	per year	Annual		--
Generator 2 CAT C18	2	per day	Short-term	6.0	7.59E-01
	2	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	2	per day	Short-term	1.79	--
	12	per year	Annual		--
			Total Ton per Year =		**4.75E-01**

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NO_x	Exhaust Gas Emissions (g/s) NO_x
OSRV Anchored During Fuel Transfers (6 Transfers per Year - 6 hours to complete fuel transfer - 36 hours per year)					
Main Engine 1 CAT 3516c Propulsion/Cruising	6	per day	Short-term	16.7	--
	36	per year	Annual		--
Main Engine 2 CAT 3516c Propulsion/Cruising	6	per day	Short-term	16.7	--
	36	per year	Annual		--
Thruster Engine 1 CAT C32 - Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 2 CAT C32 - Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Thruster Engine 3 CAT C32 - Dynamic Positioning	0	per day	Short-term	12.9	--
	0	per year	Annual		--
Generator 1 CAT C18	6	per day	Short-term	6.0	--
	36	per year	Annual		--
Generator 2 CAT C18	5	per day	Short-term	6.0	--
	5	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	6.0	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	0	per day	Short-term	1.79	--
	0	per year	Annual		--
	Total OSRV Ton per Year =				**4.75E-01**

Double dash (--) signifies source was not modeled.

Other Sources Emission Rates

Other Sources Emission Rates

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NOx	Exhaust Gas Emissions (g/s) NOx
[1]Ice Breaker 1 - Operating within the 25 Mile					
Main Engine	24	per day	Short-term	38.3	4.83
Wärtsilä Vasa 16V32/6000 kW	700[1]	per year	Annual		--
Main Engine	24	per day	Short-term	38.3	4.83
Wärtsilä Vasa 16V32/6000 kW	700[1]	per year	Annual		--
Main Engine	24	per day	Short-term	28.8	3.62
Wärtsilä Vasa 12V32/4500 kW	700[1]	per year	Annual		--
Main Engine	24	per day	Short-term	28.8	3.62
Wärtsilä Vasa 12V32/4500 kW	700[1]	per year	Annual		--
Harbor Generator	24	per day	Short-term	21.7	2.74
Wärtsilä Vasa 4R22 – 710 kW	35	per year	Annual		--
Emergency Generator	24	per day	Short-term	9.19	1.16
Caterpillar 3412 – 300 kW	35	per year	Annual		--
Boiler 1 - Aquamaster Rauma Unex BH-2000	24	per day	Short-term	0.560	0.07
	700[1]	per year	Annual		--
Boiler 2 - Aquamaster Rauma Unex BH-2000	24	per day	Short-term	0.560	0.071
	700[1]	per year	Annual		--
Incinerator - Aquamaster Rauma Unex BH-2000	24	per day	Short-term	0.263	3.31E-02
	700[1]	per year	Annual		--
	Ice Breaker 1 Short-term (g/s) =				**21.0**
[1]Ice Breaker 2 - Operating within the 25 Mile Zone					
Main Engine	24	per day	Short-term	38.3	4.83
Wärtsilä Vasa 16V32/6000 kW	700[1]	per year	Annual		--
Main Engine	24	per day	Short-term	38.3	4.83
Wärtsilä Vasa 16V32/6000 kW	700[1]	per year	Annual		--
Main Engine	24	per day	Short-term	28.8	3.62
Wärtsilä Vasa 12V32/4500 kW	700[1]	per year	Annual		--
Main Engine	24	per day	Short-term	28.8	3.62
Wärtsilä Vasa 12V32/4500 kW	700[1]	per year	Annual		--
Harbor Generator	24	per day	Short-term	21.7	2.74
Wärtsilä Vasa 4R22 – 710 kW	35	per year	Annual		--
Emergency Generator	24	per day	Short-term	9.19	1.16
Caterpillar 3412 – 300 kW	35	per year	Annual		--
Boiler 1 - Aquamaster Rauma Unex BH-2000	24	per day	Short-term	0.560	0.071
	700[1]	per year	Annual		--
Boiler 2 - Aquamaster Rauma Unex BH-2000	24	per day	Short-term	0.560	0.071
	700[1]	per year	Annual		--
Incinerator - Aquamaster Rauma Unex BH-2000	24	per day	Short-term	0.263	3.31E-02
	700[1]	per year	Annual		--
Ice Breaker 2 Short-term (g/s) =					**21.0**
[1]Total Ice Breaker short-term emission rate (g/s) =					**42.0**
[1]Total Ton per Year =					**96.0**

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NO_x	Exhaust Gas Emissions (g/s) NO_x
Anchor Handling Supply Tug (AHST) - 20 hours per event for 3-movement events					
Main Engine 1	20	per day	Short-term	60.8	7.67
Cat 3608	60	per year	Annual		--
Main Engine 2	20	per day	Short-term	60.8	7.67
Cat 3608	60	per year	Annual		--
Generator 1	20	per day	Short-term	9.7	1.22
Cat 3406	60	per year	Annual		--
[2]Generator 2	24	per day	Short-term	9.7	1.22
Cat 3406	12	per year	Annual		--
Generator 3	0	per day	Short-term	9.7	--
Cat 3406	0	per year	Annual		--
[2]Emergency Generator	24	per day	Short-term	2.2	0.27
Cat 3306	6	per year	Annual		--
	[2]Total Modeled Short-term (g/s) =				**1.81E+01**
	Total Ton per Year =				**4.55E+00**
[3] 34' Work Boats - 4 boats for 48 hours exercise/season					
WB-1 Propulsion Engine 1	24	per day	Short-term	2.6	0.33
Cummins QSB5.9-305CD	48	per year	Annual		--
WB-1 Propulsion Engine 2	24	per day	Short-term	2.6	0.33
Cummins QSB5.9-305CD	48	per year	Annual		--
WB-2 Propulsion Engine 1	24	per day	Short-term	2.6	0.33
Cummins QSB5.9-305CD	48	per year	Annual		--
WB-2 Propulsion Engine 2	24	per day	Short-term	2.6	0.33
Cummins QSB5.9-305CD	48	per year	Annual		--
WB-3 Propulsion Engine 1	24	per day	Short-term	2.6	0.33
Cummins QSB5.9-305CD	48	per year	Annual		--
WB-3 Propulsion Engine 2	24	per day	Short-term	2.6	0.33
Cummins QSB5.9-305CD	48	per year	Annual		--
WB-4 Propulsion Engine 1	24	per day	Short-term	2.6	0.33
Cummins QSB5.9-305CD	48	per year	Annual		--
WB-4 Propulsion Engine 2	24	per day	Short-term	2.6	0.33
Cummins QSB5.9-305CD	48	per year	Annual		--
	[3] Total Modeled Short-term (g/s) =				**2.64E+00**
	Total Ton per Year =				**5.60E-01**

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NO_x	Exhaust Gas Emissions (g/s) NO_x
[4] OSRV 1 & 2 Spill Exercises (48 hours per year + 12 hrs travel time)					
Main Engine 1 CAT 3516c - Propulsion/Cruising	24	per day	Short-term	15.0	1.90E+00
	60	per year	Annual		--
Main Engine 2 CAT 3516c - Propulsion/Cruising	24	per day	Short-term	15.0	1.90E+00
	60	per year	Annual		--
Thruster Engine 1 CAT C32 - Dynamic Positioning	24	per day	Short-term	11.7	1.47E+00
	48	per year	Annual		--
Thruster Engine 2 CAT C32 - Dynamic Positioning	24	per day	Short-term	11.7	1.47E+00
	48	per year	Annual		--
Thruster Engine 3 CAT C32 - Dynamic Positioning	24	per day	Short-term	11.7	1.47E+00
	48	per year	Annual		--
Generator 1 CAT C18	24	per day	Short-term	5.43	6.84E-00
	60	per year	Annual		--
Generator 2 CAT C18	24	per day	Short-term	5.43	6.84E-00
	30	per year	Annual		--
Generator 3 CAT C18	0	per day	Short-term	5.43	--
	0	per year	Annual		--
Emergency Generator CAT C4.4	2	per day	Short-term	1.61	2.03E-01
	2	per year	Annual		--
[4]Total Modeled Short-term (g/s) =					**1.95E+01**
[4]Total Modeled Annual (g/s) =					--
Total Ton per Year =					**2.21E+00**
[5] Marine Research Vessel - 600 hours per year					
Main Engine	24	per day	Short-term	19.0	--
Caterpillar	600	per year	Annual		--
Generator	24	per day	Short-term	4.13	--
Caterpillar	600	per year	Annual		--
Generator	24	per day	Short-term	2.76	--
Caterpillar	600	per year	Annual		--
Generator	24	per day	Short-term	1.22	--
Caterpillar	600	per year	Annual		--
[5]Modeled Short-term (g/s) =					**--**
Total Ton per Year =					**--**

Equipment	Utilization per Unit (hours)		Averaging Period	Exhaust Gas Emissions (lb/hr) NOx	Exhaust Gas Emissions (g/s) NOx
[6] Spill Storage Tanker – 48 hours for spill exercises					
Main Engine 1	12	per day	Short-term	33.7	4.25
Panamax class sized	12	per year	Annual		--
Main Engine 2	12	per day	Short-term	33.7	4.25
Panamax class sized	12	per year	Annual		--
Generator 1	24	per day	Short-term	15.9	2.00
Panamax class sized	48	per year	Annual		--
Boiler 1	24	per day	Short-term	1.98	0.25
Panamax class sized	48	per year	Annual		--
			[6]Modeled Short-term (g/s) =		1.19E+01
			Total Ton per Year =		9.26E-01

NOTES:

1 Ice Breakers 1 & 2 modeled as single source; All emission sources are modeled at higher annual emission rates than what is listed in the application for conservatism. Note that the application limits ice breaker operation to 675 hours per year where as the modeling was conducted at 700 hours per year.

2 Anchor Handling Supply Tug Generator 2 and the emergency generator are scheduled to operate 12 hours and 6 hours per year respectively, however, each unit was modeled on a short-term basis at 24 hours for conservatism. Anchor Handling Supply Tug (AHST) modeled as single source.

3 Work Boats modeled as single source

4 OSRV 1 & 2 modeled as single source. Emissions presented represent a single OSRV, however, these emissions were doubled prior to input into the model

5 Marine Research Vessel modeled as single source

6 Spill Storage Tanker modeled as single source

Double dash (--) signifies source was not modeled.

Map 16. Sea surface temperature extremes (°C)

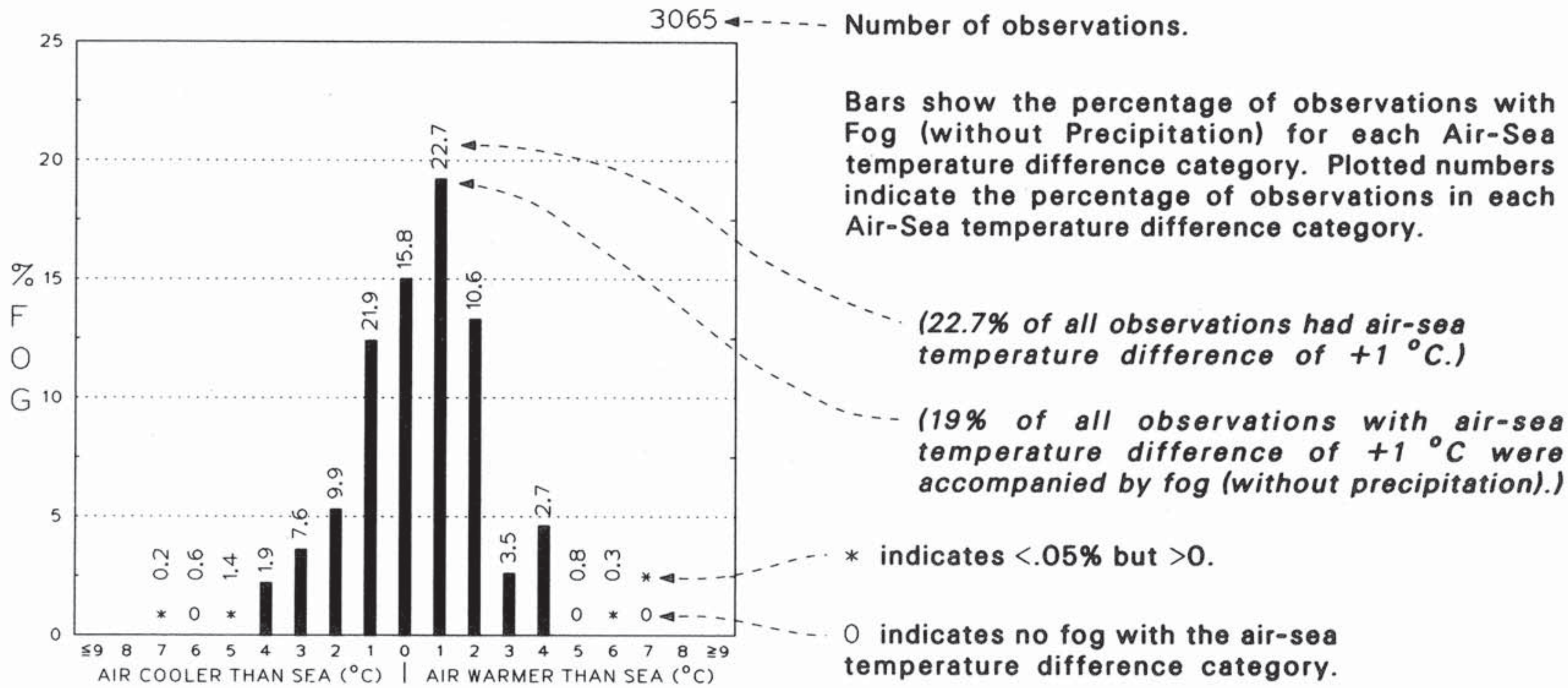
BLACK LINE – Maximum (99%) sea surface temperature (1% of the temperatures were greater than the given value).

BLUE LINE – Minimum (1%) sea surface temperature (1% of the temperatures were equal to or less than the given value).

Albers Equal–Area Conic Projection

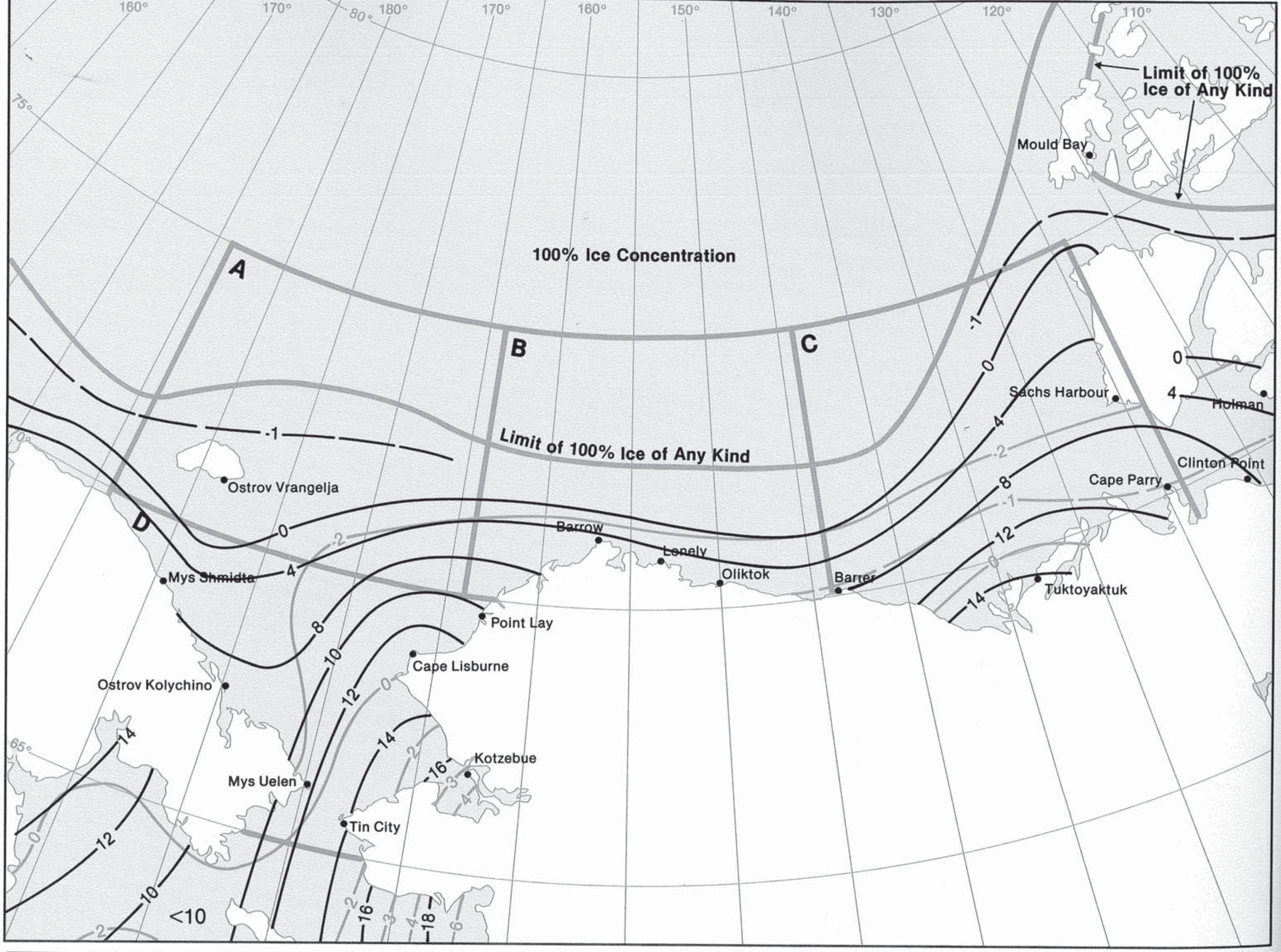
Graphs: Fog/air-sea temperature difference

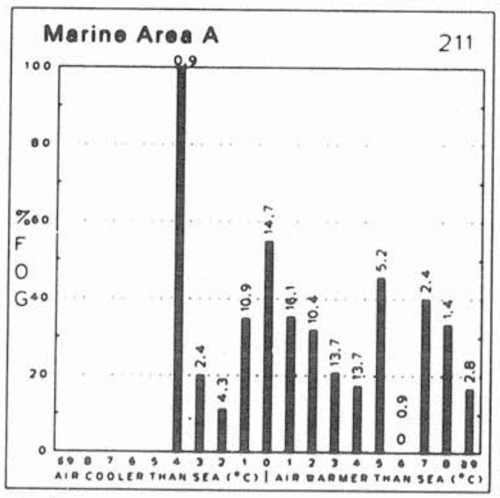
PERCENT FREQUENCY OF THE OCCURRENCE OF FOG (Without Precipitation) VERSUS AIR-SEA TEMPERATURE DIFFERENCE (°C)

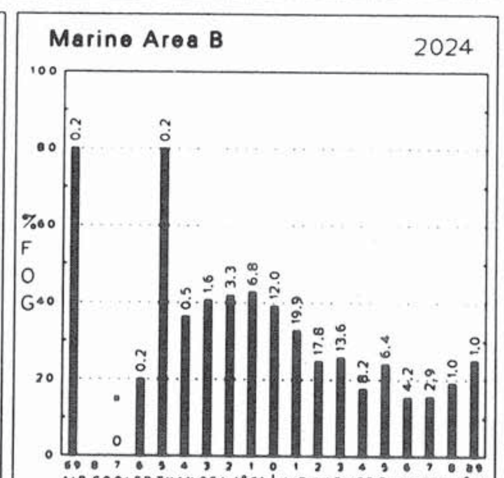


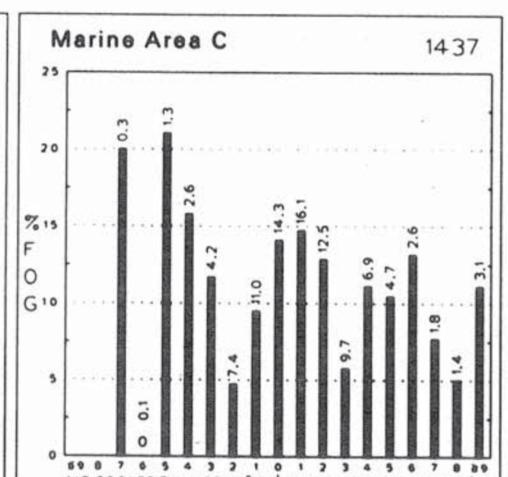
Sea surface temperatures are recorded with a fairly high frequency in marine observations. The principal methods for observing the temperature of the water surface on merchant ships are by either a fluid thermometer located in the condenser intake of the ship or a thermometer immersed in a freshly-drawn bucket of surface water. While the intake method is commonly used on most merchant ships today, the bucket method was the most common a half century ago. Injection temperatures are not considered as representative of the surface temperature as bucket readings because the injectors are commonly located well below the water surface at depths of 5 to 20 meters depending on the size of the ship. Injection temperatures are also subject to varying errors due to heating caused by the ship. Bucket temperatures can also be biased by the air temperature or the bucket itself.

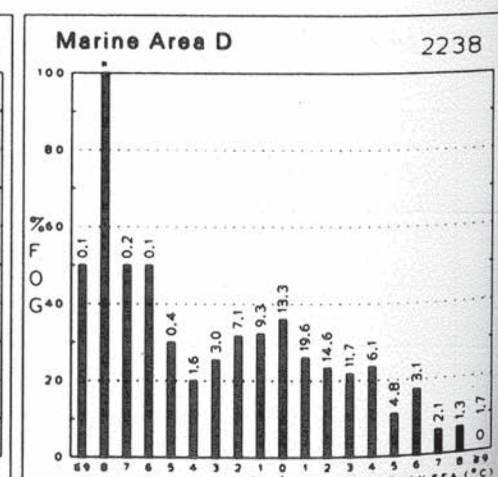
Even though the two methods produce slightly different results, the data can be used with considerable confidence. The isopleths representing extreme conditions show the maximum (99%) and the minimum (1%) levels of sea surface temperature. Gradients and relative values of the isopleths are considered reliable.





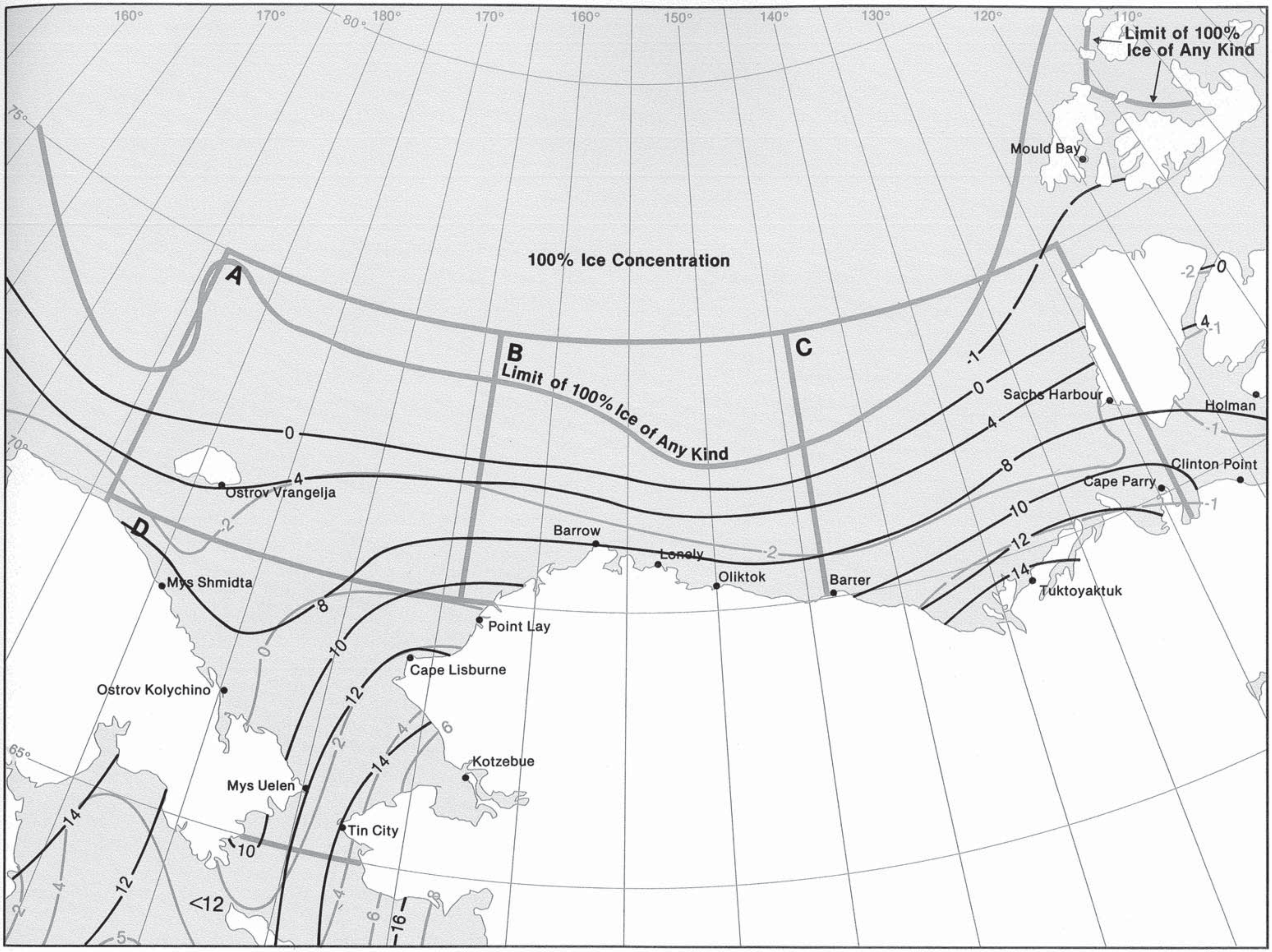


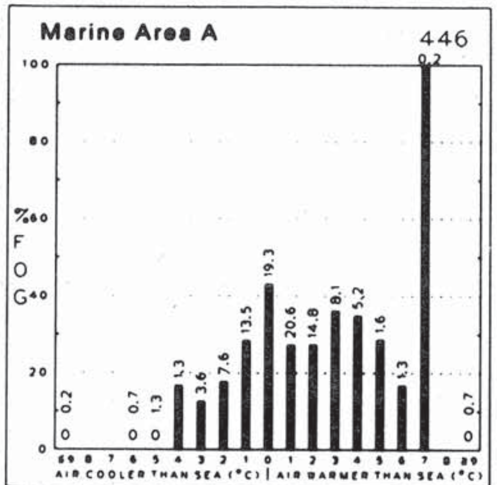


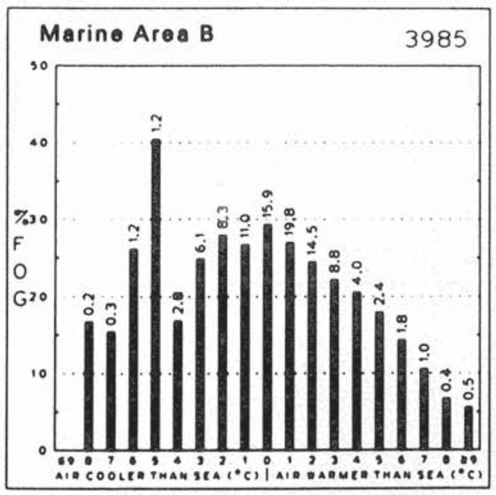


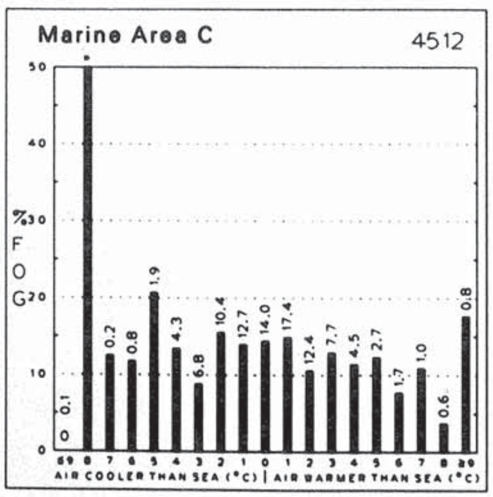
July

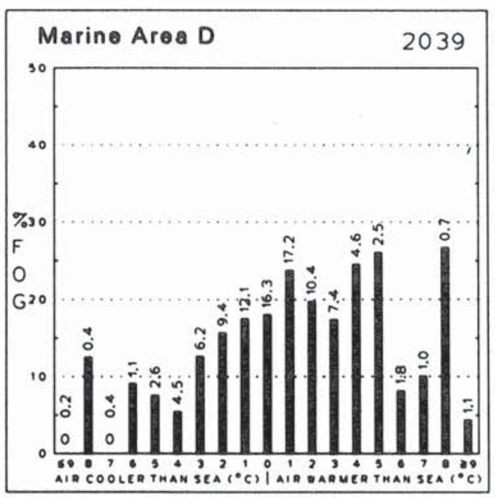
16 Fog and Air-Sea Temperature Difference
Sea Surface Temperature Extremes





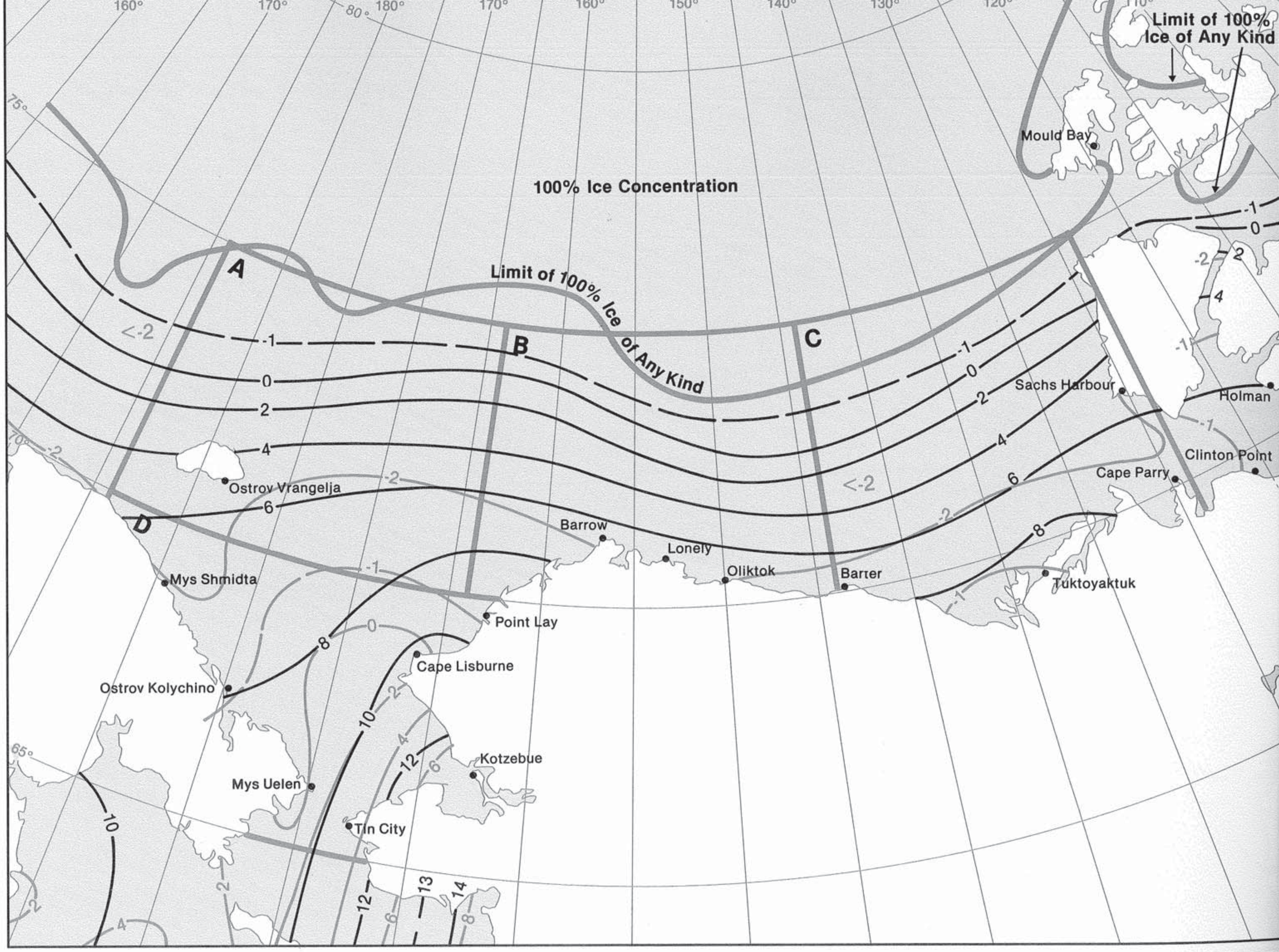


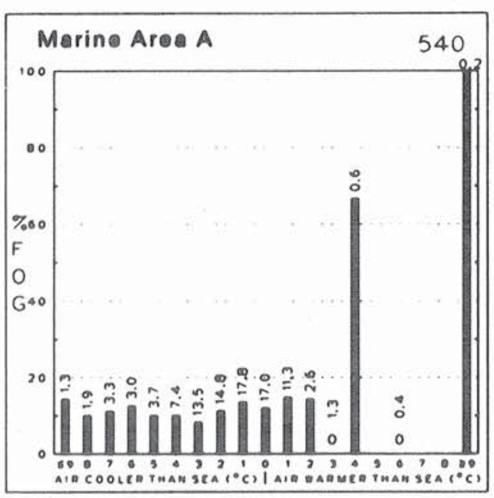


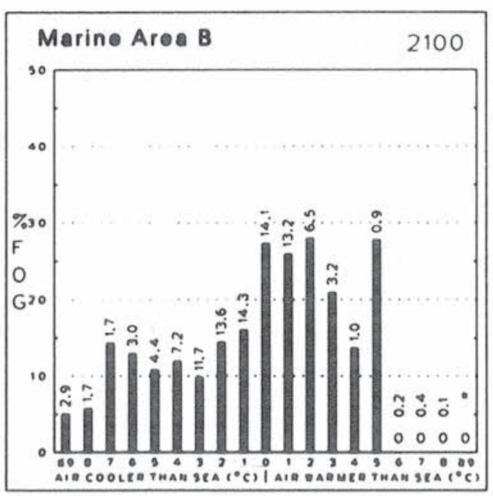


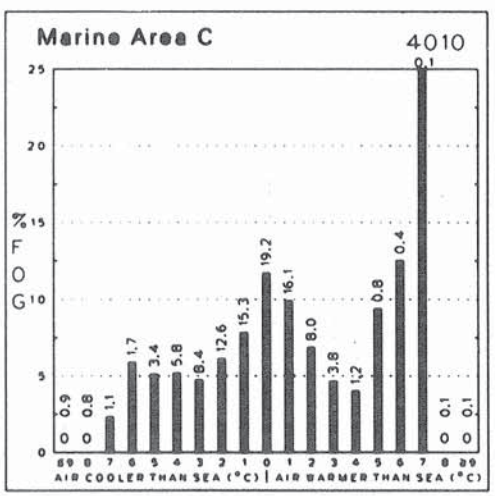
16 Fog and Air-Sea Temperature Difference **August**

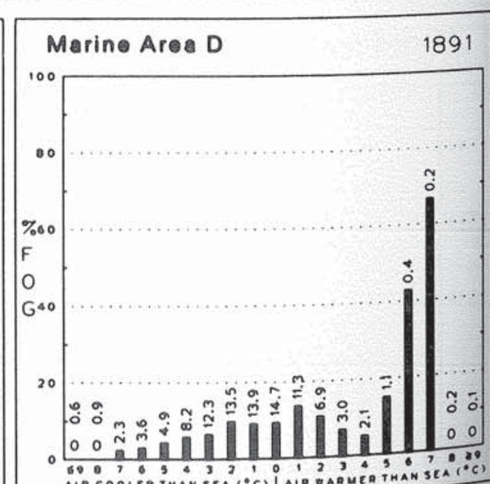
Sea Surface Temperature Extremes





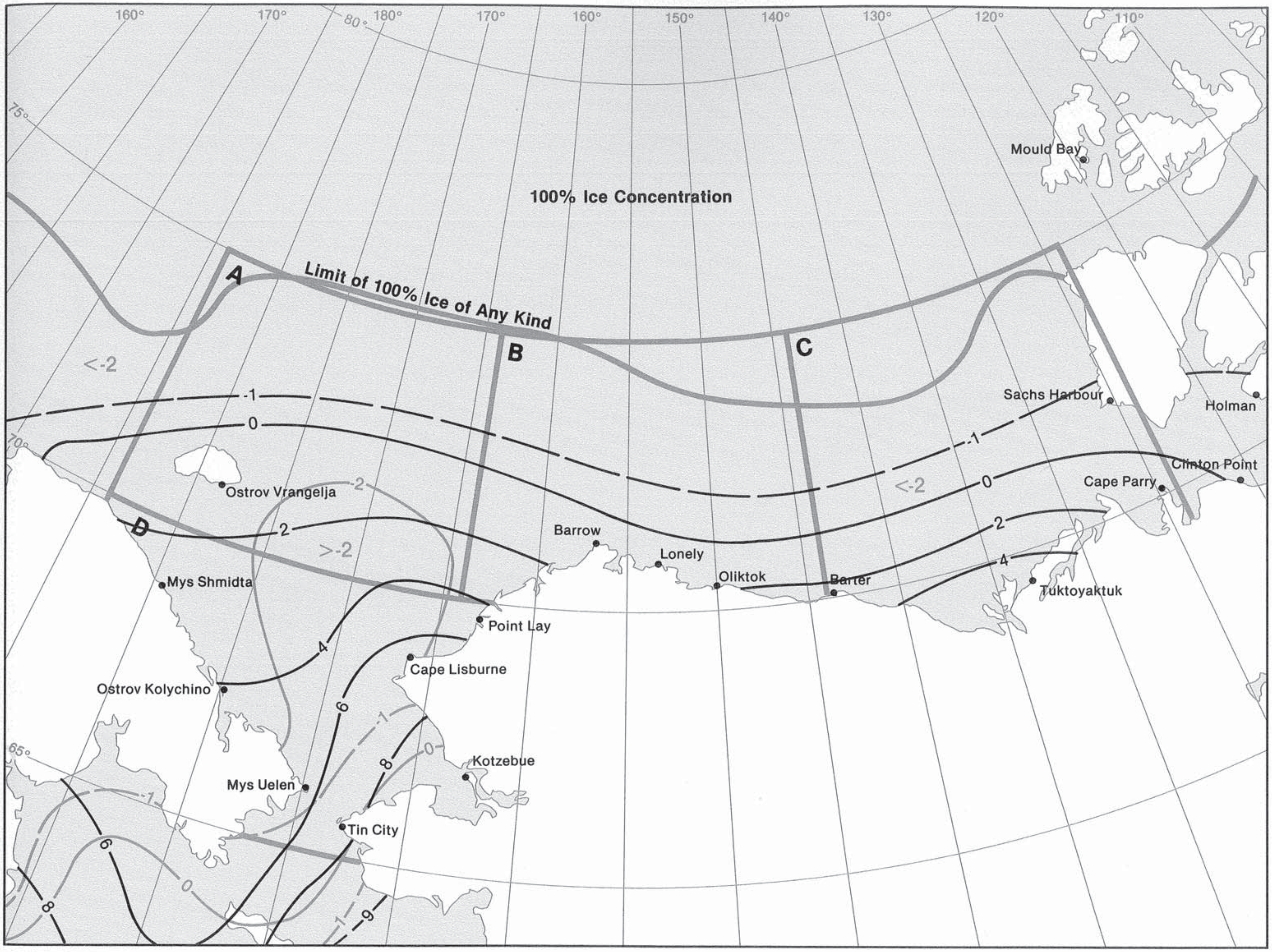


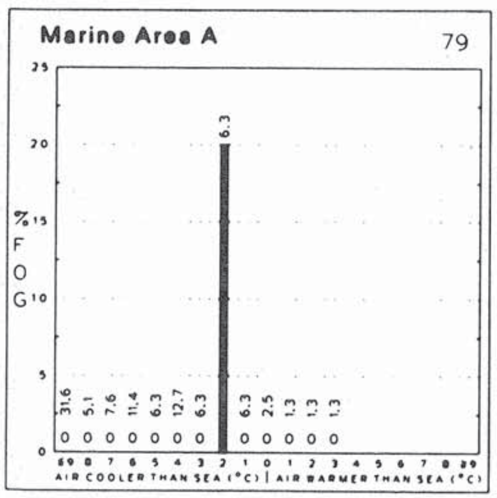


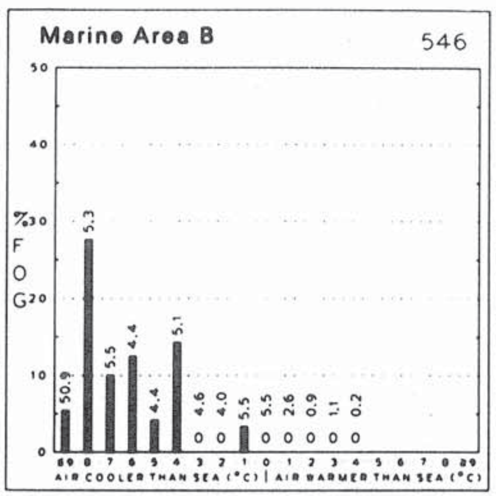


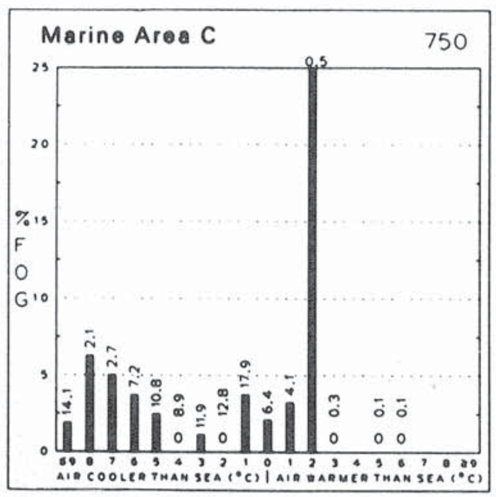
September

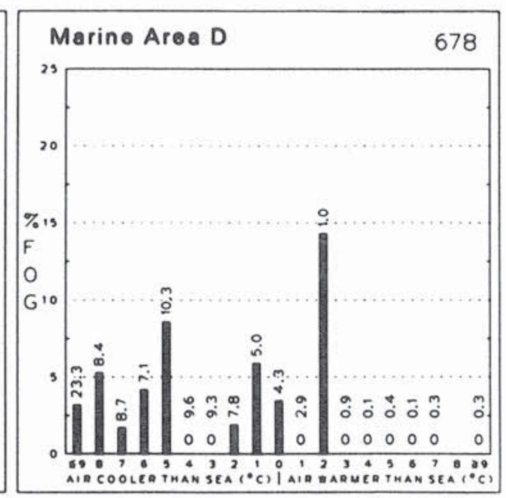
16 Fog and Air-Sea Temperature Difference
Sea Surface Temperature Extremes



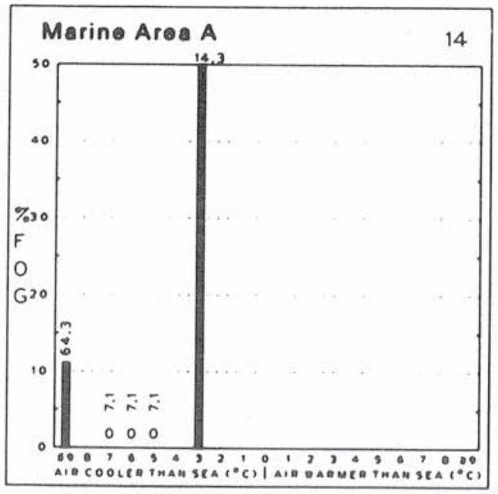


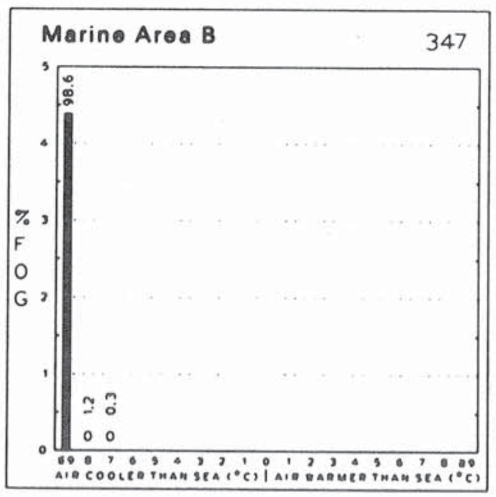


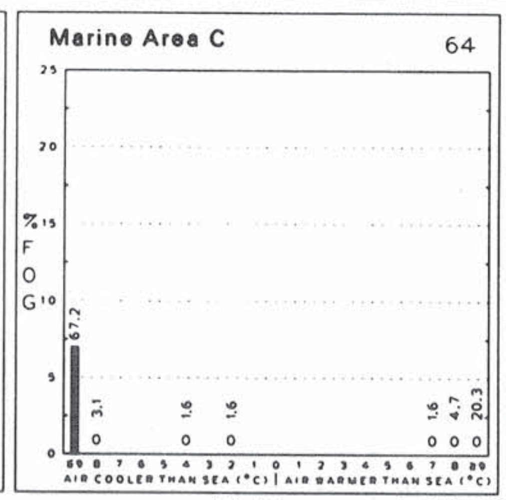


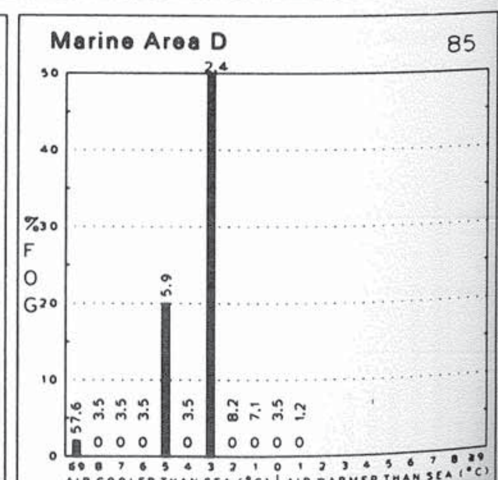


16 Fog and Air-Sea Temperature Difference **October**



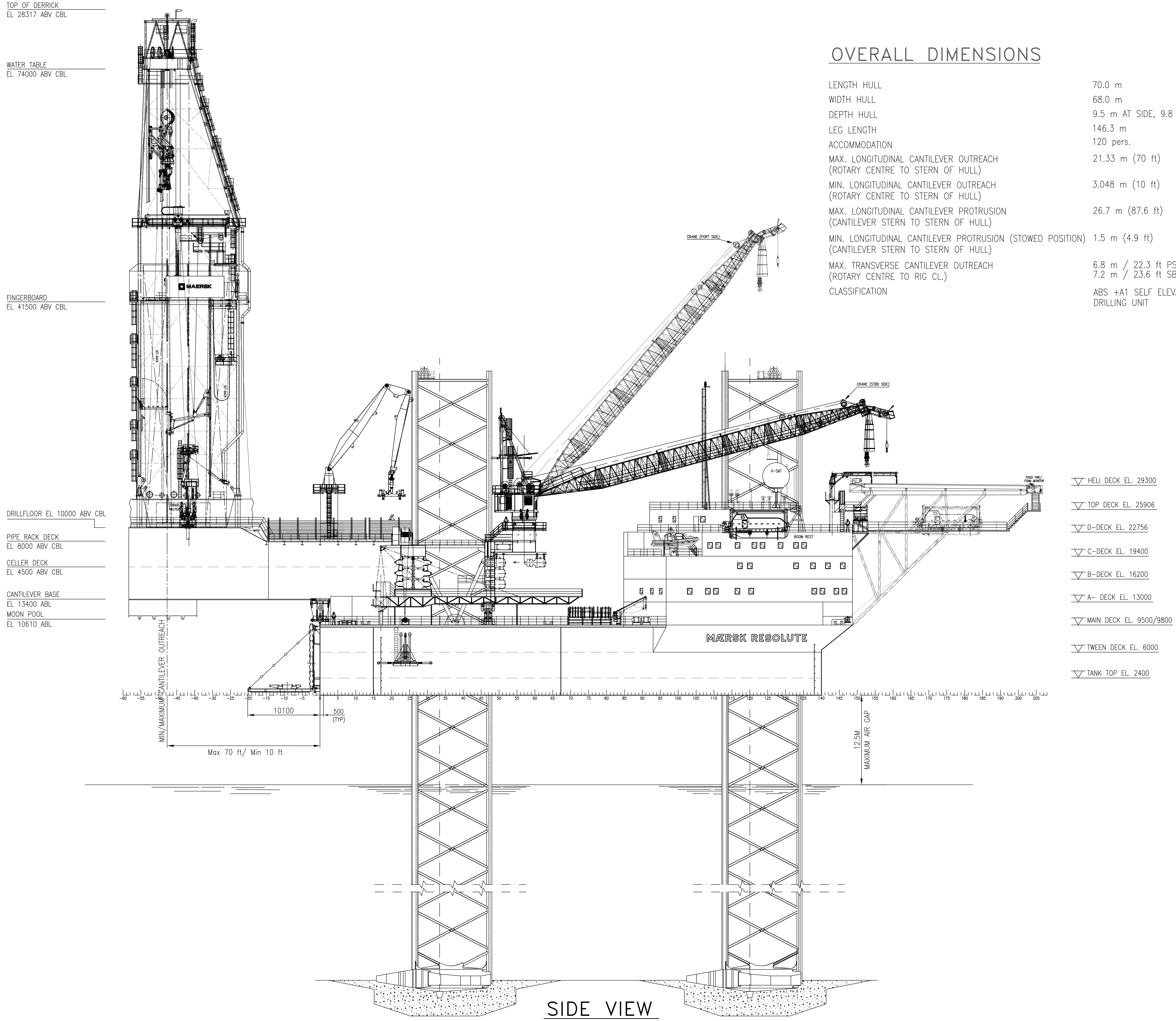






November

16 Fog and Air-Sea Temperature Difference
Sea Surface Temperature Extremes



SIDE VIEW

OVERALL DIMENSIONS

LENGTH HULL	70.0 m
WIDTH HULL	68.0 m
DEPTH HULL	9.5 m AT SIDE, 9.8 m AT ℄
LEG LENGTH	146.3 m
ACCOMMODATION	120 pers.
MAX. LONGITUDINAL CANTILEVER OUTREACH (ROTARY CENTRE TO STERN OF HULL)	21.33 m (70 ft)
MIN. LONGITUDINAL CANTILEVER OUTREACH (ROTARY CENTRE TO STERN OF HULL)	3.048 m (10 ft)
MAX. LONGITUDINAL CANTILEVER PROTRUSION (CANTILEVER STERN TO STERN OF HULL)	26.7 m (87.6 ft)
MIN. LONGITUDINAL CANTILEVER PROTRUSION (STOWED POSITION) (CANTILEVER STERN TO STERN OF HULL)	1.5 m (4.9 ft)
MAX. TRANSVERSE CANTILEVER OUTREACH (ROTARY CENTRE TO RIG CL.)	6.8 m / 22.3 ft PS & 7.2 m / 23.6 ft SB &
CLASSIFICATION	ABS +A1 SELF ELEVATING DRILLING UNIT

ALTERATIONS

NO	DESCRIPTION	AUTHORITY	BY	DATE	PCM CHECK

REFERENCE PLANS

NO	TITLE	PLAN NO	PLAN BY

REVISION RECORD

REVISION						
DATE						
REVISION						
DATE						

APPROVED BY:		DATE:
OWNER	MAERSK	19 JUL 05
	MAERSK	16 AUG 05
	MAERSK	13 DEC 06
	MAERSK	23 JUL 07
CLASS	ABS	04 AUG 05
	ABS	26 SEP 05

Keppel FELS
Keppel FELS Limited
50, Gul Road,
Singapore 629351.
Tel: (65) 6863 7200
Fax: (65) 6863 1739

MAERSK CONTRACTORS

DATE :	15 JUNE 2005	SCALE :	1 : 250
DESIGNED BY :	MSC	HULL/JOB No. :	B274
DRAWN :	LEE CHING	COST CODE No. :	–
CHECKED :	PRABHAT KUMAR	APPROVED :	ANIS HUSSAIN / PATRICK KUO

JOB : MAERSK RESOLUTE
HIGH EFFICIENCY JACK-UP

TITLE : GENERAL ARRANGEMENT
SIDE VIEW

SHT 1 OF 1 SHTS

K-FELS DRAWING No :	D001 (AS BUILT)	ALT. NO.
OWNER DRAWING No :	RSU.02.1001.000.101	0

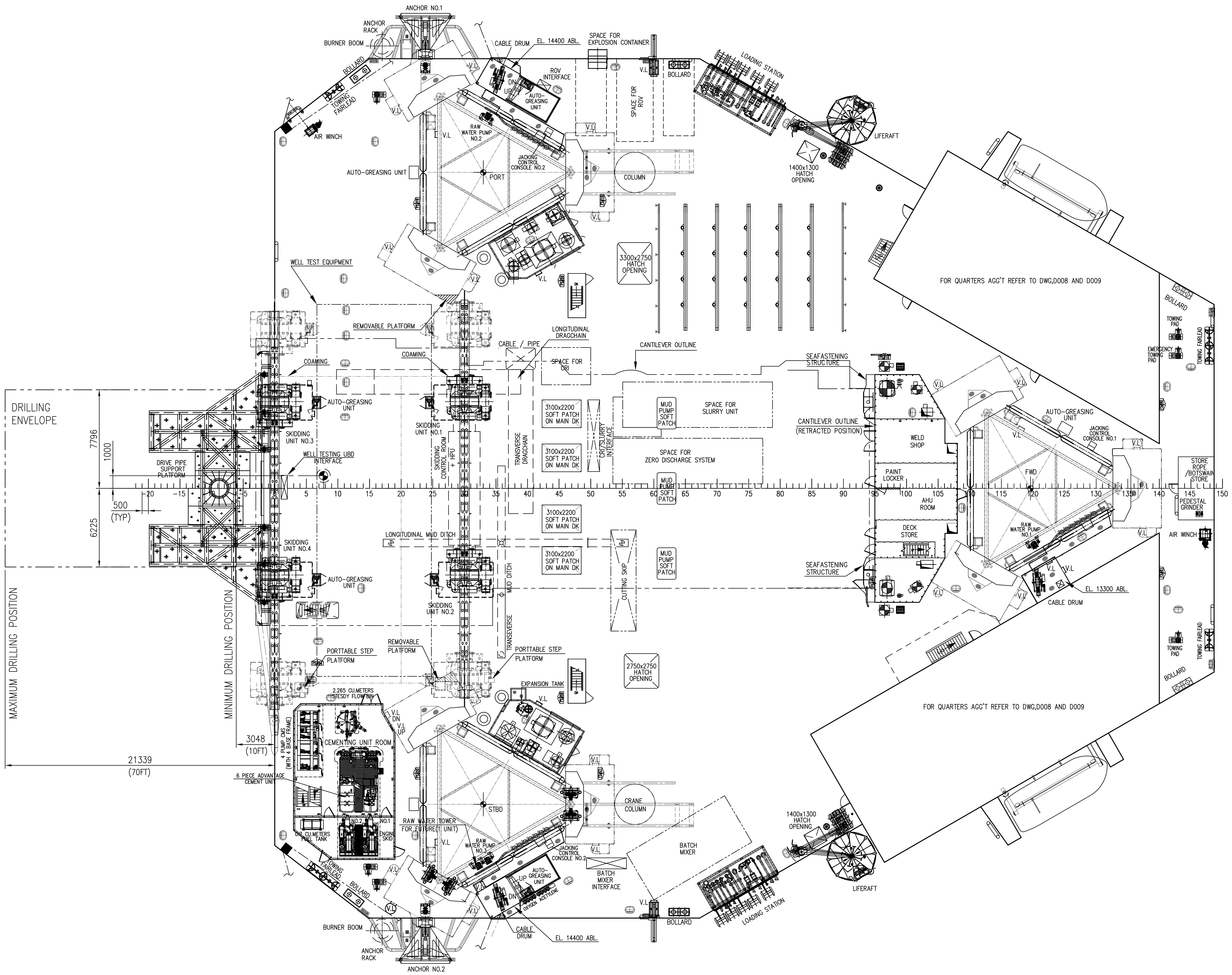
A1 (841mm X 594mm)

ALTERATIONS

NO	DESCRIPTION	AUTHORITY	BY	DATE	PCM / CHECK

REFERENCE PLANS

NO	TITLE	PLAN NO	PLAN BY
1.	MACHINERY ARRANGEMENT – CANTILEVER SKIDDING SYSTEM.	M102-10	KFELS



PLAN VIEW AT MAIN DECK

REVISION RECORD

REVISION						
DATE						
REVISION						
DATE						

APPROVED BY:		DATE:
OWNER		19 JUL 05
	MAERSK	16 AUG 05
	MAERSK	13 DEC 06
	MAERSK	23 JUL 07
CLASS	ABS	04 AUG 05
	ABS	26 SEP 05

Keppel FELS Limited
50, Gul Road,
Singapore 629351.
Tel: (65) 6863 7200
Fax: (65) 6863 1739

MAERSK CONTRACTORS

DATE :	15 JUNE 2005	SCALE :	1 : 200
DESIGNED BY :	MSC	HULL/JOB No. :	B274
DRAWN :	LEE CHING	COST CODE No. :	–
CHECKED :	PRABHAT KUMAR	APPROVED :	ANIS HUSSAIN / PATRICK KUO

JOB :

MAERSK RESOLUTE
HIGH EFFICIENCY JACK-UP

TITLE :

GENERAL ARRANGEMENT MAIN DECK

SHT 1 OF 1 SHTS

K-FELS DRAWING No :	D005 (AS BUILT)	ALT. NO.
OWNER DRAWING No :	RSU.02.1005.000.101	0

A1 (841mm X 594mm)