Technical Analysis Report
for
Minor General Permit 2

Issued to

Oil or Gas Drilling Rigs

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Air Permits Program

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1. INTRODUCTION

This Technical Analysis Report (TAR) provides the Alaska Department of Environmental Conservation's (Department's) basis for issuing minor general permit 2 (MG-2) for North Slope portable oil and gas operations (POGOs) classified under 18 AAC 50.502(c)(2)(A). The Department is issuing MG-2 under the provisions of 18 AAC 50.560.

2. BACKGROUND DISCUSSION

The Department developed MG-2 upon the recommendation of the *Workgroup for Global Air Permit Policy Development for Temporary Oil and Gas Drill Rigs* (Workgroup).[1] The Workgroup was organized by the Department and the Alaska Department of Natural Resources (DNR) to discuss air quality concerns and operational limitations for temporary oil and gas drill rig operations at existing oil and gas facilities. The Workgroup consisted of representatives from the following interested parties:

- The Department's Air Quality Division
- DNR's Division of Oil and Gas
- Alaska Oil and Gas Association (AOGA)
- Cook Inlet Regional Citizens Advisory Council (CIRCAC)
- Alaska Support Industry Alliance (ASIA)
- North Slope Borough (NSB)

The Workgroup was charged with developing recommendations for improving air permit program policies and procedures. They have been assessing the issue since spring 2013.

The Workgroup established two subcommittees in December 2013, a Technical Subgroup and an Options/Policy Subgroup, to work through the various details of the charge. The Technical Subgroup assessed the monitoring and modeling data available at the time to determine whether it was "sufficiently accurate, representative and complete to reasonably conclude" that drilling activity anywhere in the State is unlikely to cause ambient air concentrations greater than the Alaska Ambient Air Quality Standards (AAAQS) listed in 18 AAC 50.010.[2] They concluded that additional information was needed, which could best be met through air quality modeling.

Since it would be untenable to model the entire State in a single analysis, the Technical Subgroup limited their initial modeling analysis to just North Slope operations. They will likely assess other parts of Alaska in the future, at which point the Workgroup will decide whether they should recommend additional permitting/regulatory changes.

The Technical Subgroup addressed four portable oil and gas operation (POGO) categories, which they designated as:

- Routine infill drilling at an isolated well pad (RDi);
- Routine infill drilling at a collocated well pad (RDc):
- Developmental drilling at an isolated well pad (DDi); and

[1] Additional information regarding the Workgroup may be found on the Department's website at: http://dec.alaska.gov/air/air-permit/oil-gas-drill-workgroup

[2] *Meeting Notes Summary – Technical Subgroup of Workgroup for Global Air Permit Policy Development for Temporary Oil and Gas Drill Rigs* – January 9, 2014 Meeting

- Developmental drilling at a collocated well pad (DDc).

They also assumed: the POGO occurs at an onshore location; the POGO emissions units (EUs) are liquid-fired; and that all of the internal combustion units are reciprocating engines. The Technical Subgroup developed a Technical Report that describes in further detail the air quality modeling approach and assumptions used for the North Slope simulation. The Department sought public comment on the modeling analysis and Technical Report from September 13, 2017 through October 13, 2017. The Department only received editorial comments regarding the Technical Report. The Technical Subgroup finalized the Technical Report on October 17, 2017.[3]

As discussed in the Technical Report, the Technical Subgroup used the U.S. Environmental Protection Agency's (EPA's) AERMOD Modeling System (AERMOD) for the North Slope POGO simulation. This is the EPA approved dispersion model for conducting an onshore, near-field simulation. The Technical Report further notes that the modeling analysis is consistent with EPA's *Guideline on Air Quality Models* (Guideline), as required under 18 AAC 50.215(b).

The Technical Subgroup subsequently decided to also assess POGO activity at island developments within the Beaufort Sea. Emissions from island developments are typically modeled in a different manner than onshore emissions due to the unique dispersion conditions associated with overwater boundary layers. The EPA approved dispersion model for conducting overwater, near-field simulations is the Offshore and Coastal Dispersion (OCD) model. However, the modeling of offshore sources in northern latitudes requires additional consideration since the water bodies seasonally vary from open water to ice cover. OCD is EPA's preferred model for assessing the ambient impacts during the open water season, but AERMOD is better suited for assessing the winter-time impacts since ice cover leads to similar boundary layer conditions to that of land.

The Technical Subgroup conducted a sensitivity analysis of the potential impacts during open water conditions using OCD and AERMOD. Their findings are discussed in a January 10, 2018 technical memorandum from Isaac Bertschi (SLR International Corporation) to Alan Schuler (Department), which the Department is providing in Appendix B of this TAR. The Technical Subgroup compared the maximum POGO impacts during the typical Beaufort Sea open water season (July through October) for the following averaging periods and pollutants: 1-hour nitrogen dioxide (NO_2), period NO_2, 1-hour sulfur dioxide (SO_2), period SO_2, 24-hour particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$), and period $PM_{2.5}$. AERMOD estimated substantially greater impacts than OCD in all cases. The Department therefore concludes that the findings described in the Technical Report also apply to POGO activities at island developments within the Beaufort Sea.

The Department stated in the public notice of the North Slope modeling analysis that it "intends to use the results of the ambient demonstration in a future minor permit decision(s) issued under AS 46.14 and 18 AAC 50." The MG-2 permit falls under this statement. The modeling analysis demonstrates that operating a North Slope POGO within the constraints described in the report will not cause or contribute to a violation of the following AAAQS:

[3] *Ambient Demonstration for the North Slope Portable Oil and Gas Operation Simulation*; October 17, 2107.

- SO_2: 1-hour, 3-hour, 24-hour, and annual averaging periods.
- Carbon Monoxide (CO): 1-hour and 8-hour averaging periods.
- NO_2: 1-hour and annual averaging periods.
- Particulate matter having an aerodynamic diameter of 10 microns or less (PM_{10}): 24-hour averaging period.
- $PM_{2.5}$: 24-hour and annual averaging periods.

MG-2 includes the constraints described in the Technical Report, except for the onshore constraint. As previously noted, the Technical Report findings also apply to POGOs operating at Beaufort Sea islands. The Department developed the monitoring, recordkeeping, and reporting (MR&R) provisions needed to confirm compliance with the ambient air conditions.

3. DEFINITIONS

The term "portable oil and gas operation" is defined in 18 AAC 50.990(124) to mean: "an operation that moves from site to site to drill or test one or more oil or gas wells, and that uses drill rigs, equipment associated with drill rigs and drill operations, well test flares, equipment associated with well test flares, camps, or equipment associated with camps; 'portable oil and gas operation' does not include well servicing activities; for the purposes of this paragraph, 'test' means a test that involves the use of a flare".

The term "well servicing activities" is defined in 18 AAC 50.990(125) to mean: "the use of portable equipment for servicing existing oil and gas wells that only stays on site for short and varying periods of time; 'well servicing activities' includes the use of [coiled tubing units, well frac units, well slickline units, well hot oil units, and well wireline units]".

4. REGULATORY BASIS FOR A MINOR GENERAL PERMIT

The regulatory provisions for establishing a minor general permit are established in 18 AAC 50.560. Paragraph (a) states the Department "may issue a general minor permit to allow construction and operation of stationary sources or emission units" that require a minor permit, involved the same or similar types of operation, involve the same type of emissions, and are subject to similar air quality control requirements. MG-2 meets this requirement since POGOs are required to obtain a minor permit under 18 AAC 50.502(c)(2)(A), and they involve same types of operation, emissions, and control requirements.

18 AAC 50.560(c) requires the Department to develop an application or notification form with each minor general permit. 18 AAC 50.560(b) requires the Department to provide notice and opportunity for public comment on the proposed permit and of the proposed application or notification form. The Department therefore provided a public comment period from March 15, 2018 through April 16, 2018. The Department considered all comments received during this period in its final decision. The Department's response to these comments are in the Response to Comments document. The minor general permit applications are available on the Department's general permit web-site at: http://dec.alaska.gov/air/ap/genperm.htm.

18 AAC 50.560(d) allows the Department to specify whether the applicant must submit a complete notification form and operate in compliance with the general minor permit, or whether

the applicant must also obtain Department approval under 18 AAC 50.560(e) to operate under the general minor permit. The applicant does not need to obtain Department approval under 18 AAC 50.560(e) prior to operating under the general minor permit.

18 AAC 50.560(f) describes the required content of a minor general permit. MG-2 complies with these requirements, as further discussed in Section 7 of this TAR.

18 AAC 50.560(g) provides a process for relocating a portable stationary source. Condition **Error! Reference source not found.** requires the Permittee to notify the Department of POGO relocations by submitting a completed relocation notification described in Attachment 2.

There are no references to federal regulations because minor permits are not required to include New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAP). Equipment subject to federal regulations are still required to comply with any applicable rules.

5. EMISSIONS SUMMARY AND PERMIT APPLICABLITY

Table 1 shows the emissions summary and permit applicability from a POGO activity allowed under MG-2. Emission factors and detailed calculations are provided in Appendix A.

Table 1 - Emissions Summary and Permit Applicability, tons per year (tpy)

Parameter	NO_X	CO	VOC	PM-2.5	PM-10	SO_2
Potential to Emit	40.1	56.1	93.5	20.3	20.3	2.6
Title V Permit Threshold	100	100	100	100	100	100
Title V Permit Required?	No	No	No	No	No	No

6. DEPARTMENT FINDINGS

1. The ambient analysis conducted by the Technical Subgroup meets the ambient demonstration requirements in 18 AAC 50.540(c)(2)(B) for minor permits classified under 18 AAC 50.502(c)(2)(A). The ambient analysis also demonstrates compliance with the 1-hour NO_2 AAAQS.
2. The drill rig engines and portable engines operated as part of the POGO (EUs 1 and 4, respectively) are nonroad engines and therefore not classified as fuel burning equipment per 18 AAC 50.990(39). As such, they are not subject to the state emission standards and are not included in the assessable emissions total.
3. EUs 1 and 4 must remain nonroad engines in order for the Permittee to continue operating those engines under MG-2 (i.e., EUs 1 and 4 must not remain at the same location[4] for 12 consecutive months or more, per 40 C.F.R. 89.2). For purposes of this paragraph, periods of inactivity between operations count towards the 12 consecutive month limit, unless the POGO is placed into storage mode (also known as 'stacking'). When a POGO is placed into storage mode, its engines should not lose their nonroad status.

[4] See definition of 'nonroad engine' in 40 C.F.R. 89.2.

4. The MG-2 permit is structured to allow operators the flexibility to apply it to an entire oil and gas Unit as identified by the Alaska Department of Natural Resources Division of Oil and Gas on state land and by the Bureau of Land Management on federal lands. This allows a Permittee to operate multiple POGOs within a given oil and gas unit boundary. However, the daily fuel limits apply on a per pad basis.

7. PERMIT CONDITIONS

18 AAC 50.560(f)(3) requires a minor general permit to include the requirements established under 18 AAC 50.544. These requirements, and how the Department met them in MG-2, are summarized below. This section also discusses the basis for all other conditions as set forth in AS 46.14 and 18 AAC 50.

Cover Page

18 AAC 50.544(a)(1) requires the Department to identify the stationary source, Permittee, and contact information. MG-2 includes place-holders for this information.

Section 1: Emissions Unit Inventory

Table 1 lists emissions units at the source by EU #, EU description, make/model, fuel type, and rating/max capacity. Except as noted elsewhere in this permit, the information in Table 1 is for identification purposes only.

Section 2: Emission Fees

18 AAC 50.544(a)(2) requires the Department to include a requirement to pay fees in accordance with 18 AAC 50.400 – 18 AAC 50.499. MG-2 includes these requirements.

Section 3: State Emission Standards and MR&R

The visible and emission limits established in 18 AAC 50.055 apply to all fuel-burning equipment. The Department has therefore incorporated these limits as follows in MG-2 and for well test flares.

Condition 8: Visible Emissions

Condition 8 prohibits the Permittee from causing or allowing visible emissions in excess of the applicable standard in 18 AAC 50.055(a)(1).

For activities not subject to Title V permitting or for the provisions of this permit to be included in the operating permit as an administrative amendment or modification, the Department has included monitoring, recordkeeping and reporting requirement to ensure continued compliance with the VE standards. Diesel-fired heaters and boilers have the tendency to exceed the VE standards. As such, the Department has included a requirement to perform Method 9 testing, recordkeeping and reporting requirements to demonstrate continued compliance with the standard.

Condition 9, Particulate Matter (PM)

Condition 9 requires the Permittee to comply with the State PM (also called grain loading) standard in 18 AAC 50.055(b) applicable to fuel-burning equipment. The Permittee shall not cause or allow fuel-burning equipment to violate this standard. The Permittee is required to conduct PM source testing if threshold values for opacity are exceeded.

Condition 10, Sulfur Compound Emissions

Condition 10 requires the Permittee to comply with the sulfur compound emission standard in 18 AAC 50.055(c). Monitoring, recordkeeping, and reporting shall be conducted in accordance with the ambient air quality protection requirements listed in Conditions 11 and 12 to ensure compliance with the sulfur compound emission standard in 18 AAC 50.055(c).

Section 5: Ambient Air Quality Protection Requirements

Conditions 11 - Error! Reference source not found.**, Ambient Air Quality Protection Requirements**

18 AAC 50.544(a)(6) and 18 AAC 50.502(c)(1) require the Department to impose conditions as necessary to protect ambient air quality. The ambient analysis conducted by the Technical Subgroup indicates that restrictions are needed to protect the AAAQS. The Department therefore included these restrictions in MG-2. The restrictions include: daily fuel consumption limits for various POGO categories; limits on the fuel sulfur content; and exhaust stack requirements. MG-2 also prohibits concurrent drilling and fracing of an unconventional resource. The Department added monitoring, recordkeeping, and reporting for each ambient air quality protection requirement. For fuel consumption rates, the Department added flexibility for the applicant to follow four procedures or to propose a site-specific technique to track POGO fuel consumption.

Section 6: General Recordkeeping, Reporting, and Certification Requirements

Condition 15, Certification

18 AAC 50.205 states all reports or compliance certifications required under a permit be signed and certified by a responsible official. This requirement is reiterated as a standard permit condition in 18 AAC 50.345(j), which must be incorporated in all minor permits, per 18 AAC 50.544(a)(5). MG-2 uses the standard language, as required, but it also contains additional wording that allows the Permittee to provide electronic signatures.

Condition 16, Submittals

Condition 16 clarifies where and how the Permittee should send their reports, certifications, and other submittals required by this permit. The Department included this condition from a practical perspective rather than a regulatory obligation.

Condition 16, Information Requests

AS 46.14.020(b) allows the Department to request a wide variety of emissions, design and operational information from the owner and operator of a stationary source. This statutory provision is reiterated as a standard permit condition in 18 AAC 50.345(i), which must be incorporated in all air quality control minor permits, per 18 AAC 50.544(a)(5). The Department used the standard language in MG-2.

Condition 18, Recordkeeping Requirements

The condition restates the regulatory requirements for recordkeeping, and supplements the recordkeeping defined for specific conditions in the permit. The records being kept provide an evidence of compliance with this requirement.

Condition 19, Excess Emission and Permit Deviation Reports

This condition requires the Permittee to comply with the applicable requirement in

18 AAC 50.235(a)(2) and 18 AAC 50.240. Also, the Permittee is required to notify the Department when emissions or operations deviate from the requirements of the permit. The Department mostly used the Standard Condition III language, but with updated web-links.

Condition 20, Operating Reports

The Department mostly used the Standard Operating Permit Condition VII language for the operating report condition in MG-2. However, the Department modified or eliminated the Title V only aspects in order to make the language applicable for a minor permit.

Condition 21, Affirmation of Title V Avoidance

18 AAC 50.544(d) requires the Department to impose a periodic affirmation, in accordance with 18 AAC 50.205, of whether the POGO is still accurately described by the application and minor permit and whether the POGO activities become subject to other permits under 18 AAC 50. The requirement applies to stationary sources not subject to Title V permitting. The Department anticipates that some POGO activities under this minor general permit will not occur as part of a Title V stationary source. Condition 21 incorporates this requirement. The Permittee must provide the affirmation by March 31st of each year.

Section 7: Standard Permit Conditions

Conditions 22 - 26, Standard Permit Conditions

As previously discussed, 18 AAC 50.544(a)(5) requires each minor permit to contain the standard permit conditions in 18 AAC 50.345, as applicable. 18 AAC 50.345(a) clarifies that subparts (c)(1) and (2), and (d) through (o), may be applicable for a minor permit.

The Department included all of the minor permit-related standard conditions of 18 AAC 50.345 in MG-2. The Department incorporated these standard conditions as follows:

- 18 AAC 50.345(c)(1) and (2) is incorporated as Condition 22 of Section 7 (Standard Permit Conditions);
- 18 AAC 50.345(d) through (h) is incorporated as Conditions 23 through 27, respectively, of Section 7 (Standard Permit Conditions);
- As previously discussed, 18 AAC 50.345(i) is incorporated as Condition 16 and 18 AAC 50.345(j) is incorporated as Condition 15 of Section 6 (Recordkeeping, Reporting, and Certification Requirements); and
- 18 AAC 50.345(k) is incorporated as Condition 28, and 18 AAC 50.345(l) through (o) is incorporated as Conditions 31 through 34, respectively, of Section 8 (General Source Testing Requirements). See the following discussion.

Section 8: General Source Test Requirements

AS 46.14.180 states that monitoring requirements must be, "based on test methods, analytical procedures, and statistical conventions approved by the federal administrator or the department or otherwise generally accepted as scientifically competent." The Department incorporated this requirement as follows:

- Condition 29 requires the Permittee to conduct their source tests under conditions that reflects the actual discharge to ambient air; and

- Condition 30 requires the Permittee to use specific EPA reference methods when conducting a source test.

8. Permit Administration

The MG-2 permit could be redundant with the terms and conditions of a Title I or Title V permit. The Permittee may choose to revise their existing stationary source specific permit once the MG-2 permit becomes effective by submitting a permit specific request. Drill sites that are not physically adjacent to or contiguous with Title V major production facilities or production centers are considered isolated well pads for ambient air quality protection purposes. Drill sites that are physically adjacent to or contiguous with Title V major production facilities or production centers are considered collocated well pads for ambient air quality protection purposes. Emissions from these well pads should be reviewed in accordance with the applicable stationary source permit on a case-by-case basis. The MG-2 permit operates outside the scope of this discussion.

APPENDIX A: EMISSIONS CALCULATIONS

Table 2 presents details of the EUs, their characteristics, and emissions. Potential emissions are estimated using maximum annual operation for all fuel-burning equipment as defined in 18 AAC 50.990(39) based on full-time operation.

Table 2 - Emissions Summary, in Tons Per Year (TPY)

EU ID	Unit ID/Description	Maximum Rating or Capacity	NO_X		CO		VOC		PM-2.5 / PM-10 / PM		SO_2
			EF	PTE (tpy)	EF	PTE (tpy)	EF	PTE (tpy)	EF	PTE (tpy)	PTE (tpy)
1	Drill Rig Reciprocating Engines	15,435 gal/day	3.2 lb/MMBtu	769.6	0.85 lb/MMBtu	292.9	0.1 lb/MMBtu	34.5	0.0573 lb/MMBtu	3.63	0.43
2	Drill Rig Heaters and Boilers		20 lb/kgal	17.0	5 lb/kgal	14.1	0.34 lb/kgal	1.0	3.30 lb/kgal	9.30	19.90
3	Well Venting/Flow Backs	25 wells/yr						90.4			
4	Miscellaneous POGO Reciprocating Engines Not on Drill Rig	--	3.2 lb/MMBtu	769.6	0.85 lb/MMBtu	292.9	0.1 lb/MMBtu	34.5	0.0573 lb/MMBtu	3.63	0.43
5	Miscellaneous POGO Boilers and Heaters Not on Drill Rig	--	20 lb/kgal	17.0	5 lb/kgal	14.1	0.34 lb/kgal	1.0	3.30 lb/kgal	9.30	19.90
6	POGO Portable Flares	--	0.068 lb/MMBtu	6.1	0.31 lb/MMBtu	27.9	0.66 lb/MMBtu	1.2	11.02 lb/hr	1.72	2.19
Total Potential to Emit Emissions				**40.1**		**56.1**		**93.5**		**20.3**	**2.6**
Total Assessable Emissions				**252**							

Notes

a. EUs 1 and 2: Combined daily fuel consumption limit is 15,435 gallons (including 1.25 excursions 20 percent of the time). Assuming the heaters/boilers would consume 30.2% of this limit, which equals 4,661 gal/day. Assumed EU 1 burns the remaining 10,774 gal/day.

b. EUs 4 and 5: Combined daily fuel consumption limit is 15,435 gallons (including 1.25 excursions 20 percent of the time). Assuming the heaters/boilers would consume 30.2% of this limit, which equals 4,661 gal/day. Assumed EU 4 burns the remaining 10,774 gal/day.

c. EU 4: Emissions = (10,774 gal/day) * (365 days/yr) * (Emission Factors in AP-42, Tables 3.4-1 and 3.4-2). These emissions are not added to the PTE.

d. EU 5: Emissions = (4,661 gal/day) * (365 days/yr) * (Emission factors from AP-42, Tables 1.3-1, 1.3-2, and 1.3-7).

e. EU 6: Emissions = (assumed 130 MMscf/yr limit) * (Emission factors given in AP-42, Chapter 13-5).

f. SO_2 emissions for all units estimated by mass balance assuming heat contents in application, 6.76 lb/gal, 15 ppmw S (ULSD) for the engines and 0.15% S by weight (LEPD) for the boilers/heaters, and 200 ppmv H_2S, as applicable.

g. HAPs estimated to be 1.6 tpy to confirm the stationary source is not a major source for HAPs.

h. Emissions from New Well Flowbacks:

Volume of flowback total oil per well [18]	200	bbls/flowback
Gas-to-Oil Ratio (GOR) [19]	0.00189	MMscf/bbl
Lift gas volume [20]	0.06250	MMscf/flowback
Total Volume of Gas/flowback	0.441	MMscf/flowback
Total Gas emissions/flowback	12.8	tons/flowback
Potential number of new wells per year	25	wells
Total flashed gas including CO_2, N_2, non-VOC, and VOC	320	tons

Conversion factors:

Standard molar volume	385.3	scf/lb-mol	1 ft^3	28.316	Liters
F-Factor for natural gas	8,710	dscf/MMBtu (68 ^oF)	HHV_{ULSD}	19,500	Btu/lb
F-Factor for diesel	9,190	dscf/MMBtu (68 ^oF)	LHV_{ULSD}	18,400	Btu/lb
Temperature	60	^oF = 288.71 ^oK	HHV_{LEPD}	19,600	Btu/lb
Pressure	1	atmosphere	LHV_{LEPD}	18,500	Btu/lb
1 lb	453.592	grams	Mol. Wt. SO_2	64.0628	grams/mol

[18] The total volume of oil per flowback for a new well was provided by CPAI Drilling and Wells group. This value represents only the oil and does not include water and other drilling fluids which dominate the total fluids produced during a typical flowback.

[19] Gas-to-Oil Ratio (GOR) is the average of the GOR for CPF1, CPF2, and CPF3 as provided in Attachment F of the permit application.

[20] Lift gas volume per flowback is based on a representative flowback which flows gas at 0.25 MMscfd for 6 hours.

APPENDIX B:

AERMOD AND OCD INTERCOMPARISON ANALYSIS FOR ALASKA NORTH SLOPE POGOS LOCATED AT GRAVEL ISLANDS IN THE BEAUFORT SEA

Technical Memorandum

To: Alan Schuler, Alaska Department of Environmental Conservation

From: Isaac Bertschi, SLR International Corporation

Date: January 10, 2018

Subject: AERMOD and OCD Intercomparison Analysis for Alaska North Slope POGOs Located at Gravel Islands in the Beaufort Sea

1.0 Introduction

The Technical Subgroup of the Workgroup for Global Air Permit Policy Development for Temporary Oil and Gas Drill Rigs (Workgroup) was convened in 2013 to develop recommendations for streamlining the air permitting process for portable oil and gas operations (POGOs) within the state of Alaska. During September 2017, the Alaska Department of Environmental Conservation (ADEC) made available the Workgroup Draft Ambient Demonstration for the North Slope Portable Oil and Gas Operation Simulation (AECOM, 2017) (Draft North Slope POGO Simulation Report) for public comment and review. The ambient demonstration (i.e., dispersion modeling analysis) described in the Draft North Slope POGO Simulation Report is based on the AERMOD model system, which is recommended in 40 CFR 51, Appendix W for characterizing the dispersion of emissions over land at distances less than or equal to 50 km from the source. The ambient demonstration was used to show that operating a North Slope POGO within the constraints described in the Draft North Slope POGO Simulation Report will not cause or contribute to a violation of the Alaska Ambient Air Quality Standards for sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter having an aerodynamic diameter of 10 microns or less (PM_{10}), and particulate matter having an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$).

Per 40 CFR 51, Appendix W, the Offshore and Coastal Dispersion (OCD) model is the EPA-preferred model for characterizing the dispersion of emissions over water at distances less than or equal to 50 km from the source. Because the ambient demonstration described in the Draft North Slope POGO Simulation Report is based on the AERMOD model, the analysis is valid only for Alaska North Slope POGOs operating over land or at coastal and over water locations when the sea surface is covered with snow and ice, unless it can be shown that the AERMOD model estimates pollutant impacts that are comparable to or greater than the pollutant impacts estimated with the OCD model. Therefore, Hilcorp Alaska, LLC (HAK) contracted SLR International Corporation (SLR) to prepare an intercomparison analysis of the OCD and AERMOD models when used to characterize emissions from a POGO at a gravel island located in the Beaufort Sea during the open water season, defined as the period when total ice cover is less than ten percent, typically from July through October.

2.0 Modeling Approach

The dispersion model intercomparison analysis was conducted with the latest versions of OCD (Version 5.0) and AERMOD (Version 16216r). The approach to developing the meteorological modeling data for this analysis is similar to the approach that was used for the dispersion modeling analysis prepared as an element of the HAK Liberty Development Project (Liberty) Development and Production Plan (DPP) submitted to the Department of Interior Bureau of Ocean Energy Management (BOEM) during December 2014. Pursuant to BOEM's air quality regulations (30 CFR 550.249(e)), the modeling approach used for the Liberty DPP ambient air demonstration is consistent with the dispersion modeling guidelines in 40 CFR 51, Appendix W.

The meteorological data used for the OCD model are from both onshore and offshore locations and are described in Section 2.4. The latest version of AERMET (16216) was used to prepare meteorological data and atmospheric stability parameter inputs for the AERMOD model and the meteorological data used for the AERMOD model are described in Section 2.5. In addition, the most recent version of the Building Profile Input Program with Plume Rise Model Enhancements (BPIPPRM version 04274) was used to model the effects of building downwash on the dispersion of emissions for the AERMOD model analysis.

2.1 Emission Unit Descriptions and Locations

Table 1 provides the modeled emission unit (EU) physical parameters. With the exception of stack base elevations, the parameters in Table 1 are similar to those in Table 7 in the Draft North Slope POGO Simulation Report. The stack base elevations used in the ambient demonstration for the North Slope POGO simulation are 1.5 meters based on construction requirements on Alaska North Slope tundra. However, man-made gravel islands in the Beaufort Sea have an island pad grade equal to approximately 15 feet (4.5 m) above mean sea level and, therefore, the stack base elevations used for this analysis are equal to 4.5 m.

Table 2 provides the modeled emission rates, which are based on the emission rates and nominal emission scaling factors described in the Draft North Slope POGO Simulation Report. Specifically, the emission rates shown in Table 2 were derived by multiplying the emission rates in Table 5 of the Draft North Slope POGO Simulation Report with the average of the monthly emission scaling factors in Table 6 of the Draft North Slope POGO Simulation Report for the period from July through October.

Table 1. Modeled Exhaust Parameters

Model ID	Base Elevation (m)	Release Height (m)	Exit Temperature (K)	Velocity (m/s)	Exit Diameter (m)
RIG1_1	4.5	12.55	783	71.1	0.254
RIG1_2	4.5	12.55	783	71.1	0.254
GEN1_2	4.5	10.84	789	60.5	0.203
AUX1	4.5	8.00	872	77.5	0.152
ST1_1	4.5	11.32	505	9.1	0.305
ST1_2	4.5	11.32	505	9.1	0.305

[1] Exhaust parameters are based on information in Table 7. Stack Parameters during Nominal Operation, Draft Ambient Demonstration for the North Slope Portable Oil and Gas Operation Simulation (AECOM, 2017).

Table 2. Modeled Emission Rates (Grams per Second)

Model ID	NO_2		SO_2		$PM_{2.5}$	
	1-hour	Open Water Period	1-hour	Open Water Period	24-hour	Open Water Period
RIG1_1	7.57E+00	6.58E+00	4.51E-03	4.01E-03	5.24E-02	5.24E-02
RIG1_2	7.57E+00	6.58E+00	4.51E-03	4.01E-03	5.24E-02	5.24E-02
GEN1_2	2.05E+00	1.78E+00	1.38E-03	6.27E-04	2.58E-02	2.58E-02
AUX1	1.88E-01	1.63E-01	1.25E-04	1.25E-04	1.13E-03	1.13E-03
ST1_1	7.59E-02	6.59E-02	7.73E-02	6.72E-02	7.01E-03	7.01E-03
ST1_2	7.59E-02	6.59E-02	7.73E-02	6.72E-02	7.01E-03	7.01E-03

[1] Modeled emission rates are based on emission rates shown in Table 5 and the average values of the open water season monthly emission scaling factors in Table 6 in the Draft Ambient Demonstration for the North Slope Portable Oil and Gas Operation Simulation (AECOM, 2017).

2.2 Building Downwash Analysis

The OCD model has the ability to simulate effects of building downwash on the dispersion of emissions. The OCD model downwash algorithm is based on a single building height input and width input for each modeled emission source. According to the Department of Interior Mineral Management Services, which is the agency that developed the OCD model, OCD estimates lower concentrations with wider building widths (ADEC, 2016). Therefore, the building width inputs for the OCD analysis were set equal to the smaller of the length and width of the modeled modules.

For the AERMOD analyses, the BPIPPRM (version 04274) was used to model the effects of building downwash on the dispersion of emissions. Direction-specific building downwash dimensions for use as model inputs were calculated based on information provided in Figure 3 in the Draft North Slope POGO Simulation Report.

2.3 Model Receptors and Terrain

The same receptor field was used for the OCD and AERMOD analyses to allow for an adequate comparison of model results. The receptor grid was developed to capture maximum impacts and consists of receptors placed along the edge of a 100 m by 100 m pad, similar to that which is shown in Figure 3 of the Draft North Slope POGO Simulation Report. Additional receptors were placed outward from the pad edge with 50-meter spacing within a 2-km by 2-km area centered over the pad so that the receptor grid spans a sufficient distance to capture the modeled maximum impacts.

2.4 OCD Meteorological Data

The OCD meteorological data used for this analysis are similar to the data used for the ambient demonstration in the HAK Liberty DPP submitted to BOEM during December 2014. The OCD model requires hourly meteorological data from both onshore and offshore locations. The required land-based OCD meteorological inputs include ambient air temperature, horizontal wind speed, horizontal wind direction, and stability class. The mandatory OCD overwater meteorological inputs are relative humidity (RH), ambient air temperature, horizontal wind speed, horizontal wind direction, overwater mixing height, and sea surface temperature (SST).

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

The overwater meteorological input data for the OCD model were prepared using site-specific hourly air temperature, wind speed, and wind direction data collected from the Shell Endicott Main Production Island (MPI) Meteorological Monitoring Program station. SST data collected during the 2010 open water season at the NOAA National Data Buoy Center Prudhoe Bay Buoy (PRDA2) were used for the air dispersion model analysis. Hourly RH data were not collected during the Shell Endeavor Island Meteorological Monitoring Program during the 2010 open water season and, therefore, concurrent one-hour RH measurements from the NWS Deadhorse ASOS site were used in the OCD model.

2.5 AERMET Meteorological Data Analysis

The Liberty DPP ambient air demonstration used the AERMOD model to assess emission impacts during periods when the Alaska North Slope and Beaufort Sea experiences snow and ice-covered water conditions (November through June). At the time, the Liberty DPP dispersion modeling analysis used the latest version of AERMET (version 14134) to process hourly surface meteorological data collected at the Endicott MPI from May 2010 through April 2011, with corresponding upper air data collected at the Endicott MPI Temperature Profiler station. For this analysis, the latest version of AERMET (16216) was used to process the surface meteorological data and upper air data collected at the Endicott MPI during the 2010 open water season to allow for the use of concurrent OCD and AERMOD meteorological data sets.

AERMET requires inputs of hourly surface observations of wind speed and wind direction, ambient air temperature, solar radiation, and vertical ambient air temperature difference ("Delta T") and uses upper air and surface meteorological data with site-specific geophysical inputs to calculate the atmospheric boundary layer parameters supplied to AERMOD for use in the air dispersion model algorithms. The geophysical inputs are albedo, Bowen ratio, and surface roughness length. While AERMOD was not used to characterize the dispersion of emissions during the open water season for the HAK Liberty DPP ambient demonstration, AERMET geophysical parameters were developed for the North Slope summer and winter seasons at the Endicott MPI station.

Table 3 shows the Alaska North Slope geophysical input parameters that were used for the AERMOD analysis. The values shown in Table 3 are based on the procedures for determining geophysical input parameters outlined in the *Alaska Department of Environmental Conservation (ADEC) AERMET Geometric Means, How to Calculate the Geometric Mean Bowen Ratio and the Inverse-Distance Weighted Geometric Mean Surface Roughness Length in Alaska* (July 2009) and on Alaska North Slope geophysical parameter inputs the have been approved by ADEC for prior permit activities.

Table 3. Site-Specific AERMET Geophysical Parameters

Geophysical Parameter	Season[1]	
	Summer	Winter
Albedo	0.106	0.800
Bowen Ratio	0.118	1.954
Surface Roughness Length (m)	0.001	0.001

[1] The seasons are defined as: Summer = June through September, Winter = October through May.

3.0 Results

Table 4 provides a summary of the maximum modeled impacts for the OCD and AERMOD analyses, respectively. As shown, the maximum modeled pollutant impacts from the AERMOD analysis are approximately 1.5 to 2.8 times greater than the corresponding maximum modeled pollutant impacts from the OCD model analysis.

The results in Table 4 show that the ambient demonstration described in the Draft North Slope POGO Simulation Report provide a conservative estimate of the pollutant impacts from the operation of a POGO located at a gravel island in the Beaufort Sea. This conclusion is based on the fact that the ambient demonstration described in the Draft Alaska North Slope POGO Simulation Report uses the AERMOD modeling system, which has been shown here to predict greater maximum impacts than the OCD model, and demonstrates that a North Slope POGO will not cause or contribute to a violation of the AAAQS listed in 18 AAC 50.010 under the constraints described in the Draft Alaska North Slope POGO Simulation Report.

Table 4. Dispersion Modeling Results

Dispersion Model System	Maximum Modeled Impact					
	NO_2		SO_2		$PM_{2.5}$	
	1-hour	Open Water Period	1-hour	Open Water Period	24-hour	Open Water Period
AERMOD	1,388.3	57.2	67.0	2.5	5.0	0.8
OCD	812.4	27.4	44.4	0.9	3.1	0.3
Ratio of Maximum AERMOD Value to Maximum OCD Value	171%	209%	151%	278%	161%	267%

4.0 References

Alaska Department of Environmental Conservation, *re AERMET Geometric Means, How to Calculate the Geometric Mean Bowen Ratio and the Inverse-Distance Weighted Geometric Mean Surface Roughness Length in Alaska*, revision 2, June 2009.

Alaska Department of Environmental Conservation, *ADEC Modeling Review Procedures Manual*, May 12, 2016.

AECOM, *Ambient Demonstration for the North Slope Portable Oil and Gas Operation Simulation*, Draft, August 31, 2017.

Hilcorp Alaska, LLC, *Liberty Development Project Development and Production Plan, Revision 1* (Public), September 8, 2015.