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June 28, 2012

Re: Shell Gulf of Mexico Inc.
Noble *Discoverer* – Chukchi Sea
Application to Revise Outer Continental Shelf Prevention of Significant Deterioration Permit to Construct No. R10OCS/PSD-AK-09-01

Shell Gulf of Mexico, Inc. submits this application to revise Outer Continental Shelf Prevention of Significant Deterioration Permit to Construct No. R10OCS/PSD-AK-09-01. This application includes responses to the information requests made in a letter from Mr. Richard Albright to me on June 6, 2012.

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

Please contact Pauline Ruddy (907-771-7243) or Chris Lindsey (907-771-7262) if you have any questions.

Susan Childs

Alaska Venture Support Integrator, Manager

Cc:

Pauline Ruddy, Shell
Lance Tolson, Shell
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APPLICATION TO REVISE
OUTER CONTINENTAL SHELF
PREVENTION OF SIGNIFICANT DETERIORATION
PERMIT TO CONSTRUCT # R10OCS/PSD-AK-09-01

Prepared for:
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Date:
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Project Number:
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ENVIRON

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Introduction

Shell Gulf of Mexico, Inc. acquired a number of exploration leases in the Chukchi Sea. On September 19, 2011, EPA issued a Prevention of Significant Deterioration (PSD) air quality permit for offshore exploration by the drill ship Discoverer at these lease sites (R10CS/PSD-AK-09-01). Responding to appeals, the Environmental Appeals Board denied or dismissed all petitions for review of the permit on January 12, 2012 and the permit became final and effective on January 27, 2012.

Since then, Shell has conducted hundreds of source tests on emission units on the Discoverer and its associated fleet vessels. In the course of conducting these source tests and preparing for the drilling season, several issues have surfaced that warrant additional explanation and/or revisions to the permits. This document provides the basis for four revision requests:

1. Discoverer main generator NOx and ammonia limits. Testing of the Discoverer's D399 engines demonstrates that the current NOx and ammonia limits are not feasible for this particular situation. Shell requests that the NOx emission limit be revised to 1.2 gram/kW-hr for FD1, FD3, FD4, and FD5 and to 2 grams/kW-hr for FD2 and FD6. Shell requests removal of the ammonia limit.

2. Use of CDPF controls in place of oxidation catalysts. Shell requests permit revisions to reflect the fact that Shell installed more-costly and better-performing catalytic diesel particulate filters on some engines in place of oxidation catalysts, including revisions to require appropriate monitoring, record-keeping, and reporting requirements.

3. Requirement to test at rated capacity. The Discoverer generator engines and many of the engines on the Associated Fleet vessels are unable to operate at their rated capacity. For each such engine, Shell is identifying the maximum feasible operating rate and why the engine is limited.

4. OSR vessel PM limit. Shell requests that the PM10 and PM2.5 emission limits be revised for the oil spill response vessel. Testing shows that the vessel's PM emissions are higher than anticipated during the permit process. Shell asks that the limit be increased to 36 pounds per day.

The need for these revisions derives from the unique circumstances of this case and the long permitting history. First, applying the PSD permitting rules to what are essentially mobile sources presents unique and difficult challenges. Typically, PSD permitting applies to future construction, either of a new or modified stationary source. In contrast, the Discoverer and most all of the vessels in the associated fleet are existing mobile sources with existing engines built into the depths of each vessel's hull. Furthermore, the Discoverer and many of the associated fleet vessels are leased by Shell. At the time Shell prepared its application and BACT analysis, the Discoverer and other vessels were being leased and used by different companies. As a result, Shell's consultants had to rely on manufacturer literature and estimates in assessing emissions, the feasibility of control technologies, and the emission rates achievable by control technologies. In other words, the application, and thus the permit based on it, reflects what was theoretically achievable based on information available at the time. Now Shell has had the opportunity to test the emission units and controls that will actually be in use, and this testing has demonstrated what is actually achievable.

Second, it has been more than three years since Shell proposed PSD emission limits, and more than two years since EPA originally imposed PSD permit limits. In the interim, new and better emission unit information that would have supported revising some of those limits was developed. Shell submitted its initial Discoverer Chukchi Sea PSD application in December 2008, and submitted a replacement application in February 2009. EPA issued a Discoverer Chukchi Sea PSD permit in March 2010, and in December 2010, the Environmental Appeals Board remanded parts of the permit. In 2011, Shell submitted a number of application supplements addressing remand issues and in September 2011, EPA issued the revised PSD permit that is the subject of this revision request. Over these years there have been several changes, including use of a more refined and accurate model to demonstrate ambient air quality compliance, that provided a basis to revise limits. Shell acknowledges that the post-remand permit offered an opportunity to request emission limit revisions, but Shell was then and remains now committed to making every effort to meet the emission limits imposed by EPA. As noted above, Shell did not have actual emission factor data until only recently and as a result misjudged the emission limits that would be achievable while simultaneously meeting stringent limits for multiple pollutants.

Despite the difficulties arising from these circumstances and the stringency of the many conditions in the Discoverer Chukchi PSD permit, Shell’s source testing has demonstrated compliance with a vast majority of the limits, with only the four areas listed above needing revision.

Permit Revision Requests

1 Discoverer Main Generators: Revise Emission Limits for NOx and Remove Emission Limits for NH3

The Discoverer Chukchi Sea PSD permit requires extensive air pollutant emissions testing of emission units on the Discoverer and its associated fleet. Shell submitted a source test protocol for the Discoverer on February 22, 2012 and initiated testing of the Discoverer emission units in March 2012. Based on the results of the emission tests, Shell has determined that it is not technically feasible to consistently achieve compliance with the oxides of nitrogen (NOx) and ammonia (NH3) emission limits that apply to the main generator engines on the Discoverer.

This application provides the technical basis for revising the NOx and removal of the NH3 emission limits for those units. It documents why specific permit terms should be revised or rescinded and the effect of these changes on emissions, other permit terms, the underlying ambient demonstrations, and compliance monitoring.

1.1 Background

Six Caterpillar D399 generator sets (Emission Units FD-1 through FD-6) provide the primary systems power for drilling and ship utilities and operate at varying loads throughout the drilling process. The engines will burn ultra-low sulfur diesel (ULSD) fuel, and each is rated at 1,325 horsepower (hp). The normal ramping procedure is to operate the fewest number of engines needed to power the load; as load increases, operators add engines so that the operating engines are at 50 percent capacity or greater.

The PSD permit application for Discoverer operations in the Chukchi Sea provided a Best Available Control Technology (BACT) analysis for all the sources on the Discoverer. Because there was virtually no precedent for BACT analyses on off-shore drill rigs, the BACT analyses necessarily focused on emission control experience at on-shore facilities; as discussed later, we underestimated how critical this distinction is when determining the feasibility of BACT-related emission limits.

The review of available control technologies in the application concluded that selective catalytic reduction (SCR) was the best technology for NOx emissions and an oxidation catalyst was the best technology for particulate matter (PM), carbon monoxide (CO), and volatile organic compound (VOC) emissions from the D399 engines. SCR and oxidation catalysts are proven technologies for on-shore reciprocating engines, but we did not locate any examples of SCR and oxidation catalysts being retrofitted on older diesel engines located deep within a vessel. As discussed below, retrofitting SCR and oxidation catalysts on existing engines in a drill ship is extremely expensive (costing approximately $24 million initially), and is not cost-effective when typical cost effectiveness criteria are applied. However, Shell proposed to install SCR, and Shell's proposed BACT assessment was essentially an exercise in determining the degree of NOx emission control the technology was capable of achieving. Given the scale of the costs, the emission limit ultimately proposed could logically be considered the Lowest Achievable Emission Rate.[1]

SCR technology involves injecting urea into the exhaust stream in the presence of a catalyst to convert NO_x to nitrogen and water. Ideally, the urea will reduce NO_x at a 1:1 ratio. However, because mixing within the exhaust stack is not ideal, a small portion of ammonia passes through the system and is released to the atmosphere; this is commonly referred to as ammonia slip. Ammonia slip is minimized using instrumentation that adjusts urea injection to engine load and other operational factors. The instrumentation includes a continuous NO_x sensor that adjusts the load-based urea injection algorithm as needed.

The BACT analysis indicated the anticipated vendor was DEC Marine AB, a Swedish company that by 2008 had installed NO_x emission control systems on more ships than any other company. With the DEC controls, Shell anticipated emission reductions to 0.5 grams NOx per kilowatt-hr, an 80 percent reduction of CO emissions, and a 50 percent reduction of PM emissions.

1.2 PSD Permit Limits

EPA first issued the Discoverer Chukchi Sea PSD permit in March 2010. The permit was appealed to the Environmental Appeals Board and remanded in part to the EPA. EPA addressed the remand issues and re-issued the permit in September 2011. Both the draft 2010 and the final 2011 permits require the installation and use of SCR and oxidation catalysts to control emissions from the main generator engines, and established the following emission limits in Condition C.3:

- NOx - 0.50 grams (g) per kilowatt-hour (kW-hr), EPA Method 7E
- NH3 - 5 parts per million by volume (ppmv), CTM 027 or 038
- PM - 0.127 g/kW-hr, EPA Method 5
- PM10 - 0.127 g/kW-hr, EPA Methods 201A and 202
- PM2.5 - 0.127 g/kW-hr, EPA Methods 201A and 202
- CO - 0.1790 g/kW-hr, EPA Method 10
- VOC - 0.0230 g/kW-hr, EPA Method 25A
- Visible Emissions: 20 percent averaged over any six consecutive minutes, EPA Method 9

Attached as Appendix A is the September 2011 PSD permit authorizing Discoverer exploration in the Chukchi Sea.

1.3 Efforts to Achieve Emission Limits

As part of the process of preparing a permit application for the Discoverer, Shell solicited SCR quotations from DEC and Mustang Cat in August 2008. Both offered commercially viable

[1] Note that Shell is not suggesting that the limit is LAER in this case. For purposes of this application, Shell accepts that EPA is processing the limit as BACT. Refer to footnote 6 for further explanation.

solutions, but Shell deemed the DEC proposal better suited for marine installations because of their significant experience in such installations and because its units were sized smaller, a key concern given the lack of overhead space in the Discoverer engine room above the D399 engines on which they were to be installed. In March 2009, a purchase order was issued to DEC to procure six of their vertical SCRs.

1.3.1 DEC Marine Control Equipment

Shell arranged to install the DEC SCR and oxidation catalysts on the Discoverer generator engines in a Subic Bay (Philippines) shipyard. Installation of the control equipment took 120 days of shipyard time (from December 2009 through May 2010). Commissioning and air emissions testing started in May 2010, but the Discoverer was relocated to a Singapore shipyard in August to avoid typhoon season in the Philippines. Commissioning and testing continued in Singapore from September through November 2010. Although capital cost of the DEC emission control units was modest (approximately $750,000), the total cost procurement, engineering and design, installation, and commissioning was $23.5 million,

In three months of effort and nearly continuous involvement of engine and control technology specialists, the D399 engines with the DEC Marine SCR and oxidation catalysts were only occasionally able to meet the NOx limit and only once in more than 60 tests meet all the emission limits. And this was despite efforts by Shell to go beyond the manufacturer's design to achieve compliance, including procuring two different SCR catalysts other than those installed by DEC. Additional emissions testing performed with the new catalysts in place revealed the high temperature catalyst did not perform well; it was found to be very fragile and crumbled inside the DEC unit during stack testing. The medium temperature catalyst performed well and appeared promising for gaseous pollutants, but PM emissions were typically 50 percent higher than the emission limit. After going beyond the original DEC design and devoting several months to a research and development project aimed at achieving all the emission limits imposed by the spring 2010 draft permits, it was clear that the Discoverer D399 engines equipped with the DEC Marine SCR and catalytic oxidation units were not physically capable of achieving the limits, leading Shell to search for supplemental and alternative control technologies.

In addition to looking for alternatives for the DEC SCR system, a solution called ULTRA BURN was identified as having a potential benefit to the installed DEC SCRs. In fall 2010, the decision was made to procure an ULTRA BURN system to be installed and tested on a generator engine. The ULTRA BURN system did not improve emissions performance.

Although eventually proven infeasible, another alternative identified was CSNOx. Shell determined CSNOx was still in its Research & Development phase and not yet commercially tested, and therefore was not viewed as an alternative that could reliably reduce NOx to 0.5g/kW-hr.

The inability to consistently and simultaneously meet the NOx, NH3, and PM emission limits prompted the search for technologies that could complement the already installed DEC SCRs, particularly by further controlling PM because the oxidation catalysts were not achieving the level of control anticipated in the application concurrent with achieving the NOx emission limits.

Two critical considerations were the limited space available with the DEC systems already installed and the need to limit backpressure created by the control devices to no more than 22 inches of water.[2] The DEC units already contributed 17 inches of backpressure, leaving only 5 inches for an additional PM control device.

Neither Mustang nor DEC offered particulate control devices with efficiencies greater than 50 percent. Using internet searches, a U.S. Maritime Administration study, and industry contacts, two vendors were identified in the search for PM reducing technology: Johnson Matthey and CleanAIR Systems.

Johnson Matthey proposed two options for the particulate matter control: a passive regeneration solution and an active regeneration solution. Upon investigation, it was determined that the Johnson Matthey passive regeneration solution would have reached a point of PM saturation in approximately three hours and would thus require the engine to be removed from service to manually remove and clean the PM filter.

After consideration of the active regeneration option, Johnson Matthey declined to provide a PM reduction solution based on the following:

1. Johnson Matthey's active systems were almost always used on standby emergency engines that run a minimal amount and thus cannot achieve regeneration temperatures;
2. While marine applications were not anticipated to pose any special issues that compromise integrity of the system, there were no documented marine cases for their active systems,
3. Active systems are extremely complex and placing six on an ocean going vessel is riskier than a land based system that can be easily accessed for service.

CleanAIR Systems was unable to offer a PM-only solution that could meet the required PM emission reduction in the space available after the DEC SCR was installed.

There was no apparent retrofit system to the purchased DEC system available to meet the combination of NOx and PM emission limits, regardless of NH3 emissions.[3] Furthermore, to meet the NOx limit, the DEC system would have needed to be re-configured from a commercially available configuration.

Despite having spent nearly $24 million on procurement, installation, and testing of the DEC emission control system, Shell re-initiated its search for a commercially available control option that would allow the engines to meet all emissions limits and fit into the available constrained space in the Discoverer engine room. CleanAIR was the only vendor identified that offered an integrated package with better combination of emissions reductions than the DEC system. CleanAIR offered a recently developed control system integrating an SCR unit with a newly developed catalytic diesel particulate filter (CDPF). In the absence of alternatives, the decision

[2] Backpressure is the resistance to exhaust flow caused by downstream piping, silencers, and emissions control equipment. Engines are designed to operate with a certain range of acceptable backpressure.

[3] The feasibility of installing a CDPF downstream of the DEC SCR is addressed in sections 4.4.1 (pages 68-71) of the Statement of Basis for the January 2010 proposed PSD permit for Discoverer operations in the Chukchi Sea.

was made to replace the DEC SCRs with CleanAIR E-PODs. The cost of removing the DEC control equipment and procuring and installing E-PODs exceeded $7 million.

1.4 E-POD Technology

Caterpillar CleanAIR Systems is a worldwide leader in custom-designed exhaust after-treatment solutions, including oxidation catalyst, catalyzed diesel particulate filters, SCR systems, and a hybrid "E-POD" technology. The E-POD combines an oxidation catalyst or catalytic diesel particulate filter (CDPF) with an SCR system in a silenced housing, custom designed to fit existing installations with minimal site disruption or re-engineering. In 2010, Caterpillar acquired CleanAIR Systems and E-PODs are now commonly applied to Caterpillar engines.

Given the remoteness of the Arctic OCS lease areas, reliability is one of the primary considerations in design and acquisition of new equipment. Consequently, one of the primary reasons that Shell selected the CleanAIR Systems technology was that they had installed more than 300 custom-designed E-PODs worldwide. Given that the EPODs were sold by a Caterpillar Company, Shell also expected the CleanAIR staff would be more familiar with Caterpillar engines such as the D399 generator engines. Furthermore, CleanAIR designed the systems for up to 90% reduction of NOx, CO, and VOC emissions and 85 percent reduction of PM emissions. CleanAIR targeted 10 ppm ammonia slip.

Although Shell could have purchased E-PODs with an oxidation catalyst, the testing of the DEC oxidation catalyst indicated a higher degree of PM control was required. Consequently, Shell purchased E-PODs that use a CDPF with an electric heater to maintain exhaust temperatures high enough for the CDPF to regenerate during extended low load operation. Placing the CDPF before the SCR improves the SCR's efficiency by transforming the various NOx compounds to the most easily converted compound, NO2, and it also protects the SCR from performance-degrading soot build up. Substitution of the CDPF for the oxidation catalyst does not reduce space available for the mixing zone or for the SCR catalyst because the space devoted to CO and PM control is the same regardless of whether an oxidation catalyst or CDPF is installed inside the E-POD unit. While both options are guaranteed to provide 90 percent reduction in CO emissions, CleanAIR guarantees 85 percent control of PM emissions with a CDPF but only 20 percent control of PM emissions with an oxidation catalyst. The better PM control occurs because an oxidation catalyst only reduces the soluble organic fraction of PM, while a CDPF also traps particulate matter.

Caterpillar offers two configurations for the E-POD: horizontal and vertical flow. The horizontal configuration is typically used in land based applications because its lower overall height is easier to mount to container style structures used in the land-based market and easier to transport because of its lower height, but, its large footprint covers the top of the engine, hindering engine service access. The vertical configuration is better for marine markets because it fits well within traditional stack structures and maximizes access to the top of the engine for service.

SCR performance is affected by many parameters, of which the most critical are:

1. Urea/Ammonia Distribution at face of the catalyst
2. Residence Time, the time the urea has to transform to ammonia from the time it is injected to the time it enters the catalyst

Mixers must be carefully designed to achieve urea distribution targets without creating so much exhaust backpressure that the engine emits more pollution. Mixers improve urea distribution by:

1. Creating swirl and turbulence
2. Contracting and expanding the flow stream
3. Reducing urea droplet size when urea impinges on the mixer blade surfaces

Residence time for reactions to occur requires a certain minimum volume because the exhaust flow rate of the engine is fixed. In a vertical configuration, the cross-sectional area of the unit is set by the required space velocity for the catalyst, the permissible back pressure, and spatial constraints within the vessel. With the cross-section fixed, the length is chosen to provide the proper residence time. In cases where residence time is low because of length restraints, there is a relatively greater ammonia injection rate required to achieve the desired NOx reduction, and there is greater ammonia slip.

Designing and installing the best available control technology for the Discoverer generator engines was challenged by the fact that the Discoverer “stationary source” is not at all stationary – it works throughout the world; it is not owned but leased, and changes to the vessel require approval by the owner because it potentially affects suitability of the drill rig for other clients and projects; the engines are existing and may be expected to have higher exhaust concentration directed to the control device; and the engines are located two levels below deck, in a location where installing emission control equipment had never been anticipated.

Thus, in addition to reliability and emission control performance, a critical consideration in the design of the emission control system in this case was the limited space available for emission controls and the need for access to the catalysts. The generator engines are located two levels below deck, and there is very limited opportunity to install additional equipment. Noble retained Zentech Incorporated of Houston to prepare computer models of the Discoverer interior to assist in determining how large an E-POD could be fit below deck and how the E-PODs and associated exhaust ducts could be installed in the Discoverer engine room. Appendix B provides isometric “snapshots” of the computer model Zentech prepared. The engines are not shown in these figures, but the engines lie directly under the E-PODs and take up virtually the entire level below the mezzanine deck.

Spatial restrictions in the Discoverer’s engine room necessitated two E-POD designs. Engine location permitted a primary design (hereafter E-POD 1345) to be used for engines FD1, FD3, FD4, and FD5 and a secondary design (hereafter referred to as E-POD 26) for engines FD2 and FD6. Both designs are approximately 5 feet by 4 feet in cross section. The E-POD 1345 design is 19 feet tall; E-POD 26 design is about 32 inches shorter. The volume of catalyst is the same in both designs; the difference in length comes out of the urea mixing area because inlet and outlet sections must also be controlled to balance flow distribution to the CDPFs and backpressure. The E-POD 1345 units contain two mixers and the E-POD 26 units contain one mixer. Computational Fluid Dynamics studies revealed that two mixers in the E-POD 26 unit are too close to allow the flow to expand and contract between them. Because this reduced the effective residence time and degraded performance, only one mixer is used in the E-POD 26 units.

CleanAIR acknowledges that it has designed E-POD systems that can perform better than those installed on the Discoverer. However, the Discoverer E-PODs are custom-designed for the space that is available, and CleanAIR affirms that their design targets are the best that one can hope to achieve with current technology in the space available.

Electronic controls for the E-PODs adjust the quantity of urea injected based on a NOx reduction target and measured NOx emissions downstream of the SCR. CleanAIR recommends establishing a NOx reduction target of 90 percent for the E-POD 1345 and 86 percent for the E-POD 26 for the best long-term performance and system stability, but more aggressive NOx reduction (to 93 percent for E-POD 1345 and 88 percent for E-POD 26) are also acceptable.[4] CleanAIR explains that attempting too high a NOx reduction is counterproductive, because the controller attempts to inject greater and greater quantities of urea. The downstream sensor cannot distinguish between NOx and NH3, so it reads the increasing NH3 slip as NOx and injects still more urea. Eventually the controller will reach its limit and reset itself. CleanAIR suggests a target no greater than 93 percent to ensure stable operation.

Appendix C provides a cut-away drawing of the vertical E-POD designed and constructed for the Discoverer. The drawing indicates exhaust from the engine enters from the bottom of the E-POD and passes through heated diesel particulate filters. The partially cleaned exhaust then enters a mid-section where urea is injected and mixed into the exhaust air before passing through the SCR catalyst blocks. Cleaned exhaust exits the E-POD at the top of the control device.

Appendix C also provides dimensional drawings of the E-PODs. The E-POD 1345 units have the same exterior dimensions but the E-POD inlet port is off-center on the design for engines 4 and 5. The E-POD 26 design is required for generator engines 2 and 6 because of overhead space constraints. Above FD-2, there is an old and relatively delicate electrical cable tray that would be extremely difficult to relocate. Above FD-6, there is reduced headroom, necessitating a shorter E-POD.

1.5 Shell Testing and Efforts to Achieve Emission Limits

1.5.1 Engineering Tests at NC Machinery

Given the challenges experienced in source testing the Discoverer generator engines in 2010 and without access to the vessel, Shell elected to conduct preliminary engineering tests at NC Machinery in Tukwila during the Spring of 2012, with the objective of determining engine and

[4] Email from Brian Huffman, Caterpillar Emissions Solutions. June 28, 2012.

control settings to achieve compliance during formal emissions tests on the Discoverer. As discussed below, Shell spent several months and more than a million dollars in an unsuccessful effort to meet all the permit emission limits.

Shell purchased a Caterpillar D399 1325 hp industrial engine identical to the Discoverer engines and retained NC Machinery to overhaul the engine to the manufacturer's specifications. In addition, a generator of the same make and model as those on the Discoverer was located and refurbished. Other permit equipment requirements, such as the closed crankcase ventilation system, were also installed on the engine.

Shell directed CleanAIR to ship one E-POD 1345 and one E-POD 26 to NC Machinery. A substantial steel frame nearly 50 feet tall was designed and fabricated to support the E-POD above the engine. A CleanAIR technician and a number of Caterpillar staff were involved in preparing the engine and E-PODs for the tests and efforts to demonstrate compliance during the tests.

Shell retained the Avogadro Group to conduct emission tests of the D399 engine with the E-PODs. The initial tests of the E-POD 1345 unit indicated compliance with CO, VOC, and particulate matter emission limits, but NOx and ammonia slip exceeded permit limits. A series of engine loads were selected in which to measure emissions across the likely operating spectrum. Testing took place at 100 percent load (which ranged between 924 kw and 910 kw, depending on the engine timing); at intermediate loads (875 kw, 825 kw, 775 kw, 700 kw); and at 50 percent load (455-462 kw). The fuel injection timing was varied between Top Dead Center (TDC) and 4 degrees retarded and NOx reduction targets were varied from 91 to 97 percent in an effort to comply with both NOx and ammonia emission limits. Eventually, Shell determined that the highest level of NOx reduction was obtained by retarding the engine timing 2 degrees and selecting a NOx reduction target of 97 percent. This combination enabled compliance with the NOx emission limit but ammonia slip remained relatively high.[5] Furthermore, wide variations in concentrations were noted, indicating instability of the control system. Subsequent commissioning work noted instability at control levels higher than about 93%.

In an effort to reduce ammonia slip, a layer of AMOX© catalyst bricks were installed in the E-POD 1345 and the tests were repeated. The addition of these catalyst bricks resulted in a slightly lower ammonia slip, but emissions still exceeded 5 ppm. However, the NH3 reduction was accompanied by a slight increase in NOx emissions.

CleanAIR technicians hypothesized that the persistent ammonia slip level was the result of exhaust 'blow-by' that was occurring in the spaces between the catalyst bricks (i.e., some of the exhaust was traveling through these spaces rather than through the catalyst where it could be converted). CleanAIR suggested sealing the spaces between the bricks with ceramic rope. A design was engineered and sent to NC Machinery. Subsequent testing with the ceramic rope installed revealed an increase in both ammonia slip and NOx emissions.

[5] Note that Avogadro employed FTIR to obtain real-time ammonia emissions information. The PSD permit requires a wet chemistry method that takes more than a week to process.

Over the course of three weeks between March 30 and April 20, 59 reference method source tests were performed in an attempt to find the combination of engine parameters and catalyst configurations that would achieve compliance with NOx and NH3 emission limits. None of the tests were entirely successful. Using a NOx reduction target of 97 percent, which is well outside the manufacturer's recommendations, NOx emissions of less than 0.4 g/kW-hr were obtained, with concurrent NH3 emissions of 10-26 ppm.

Given that ammonia slip was well above the permit limit with the E-POD 1345, there was concern that the E-POD 26 would show even higher ammonia slip because its reduced length did not allow for as much urea/exhaust mixing. In order to reduce the anticipated ammonia slip, the design of EPOD 26 included a layer of AMOX bricks. These bricks are essentially oxidation catalysts designed to oxidize NH3 to nitrogen.

Testing commenced on April 13 with the engine timing (and fuel injection) 2 degrees retarded and an aggressive NOx reduction target of 97 percent. From the outset, the ammonia slip was higher than with the E-POD 1345. Because both NOx and ammonia emissions exceeded the permit limits, engine timing was adjusted to 4 degrees retarded and retested at 700 kw with negligible improvement.

Because NOx emissions were higher than anticipated, it was posited that the row of AMOX bricks was converting excess ammonia into NOx. Accordingly, a second series of tests was performed with two changes: the AMOX bricks were removed, and the cooling capacity of the inlet air was doubled. By cooling the inlet air, it was hoped that the NOx level would be reduced.

The second round of tests resulted in higher NOx concentrations and higher ammonia slip than the first round of tests. In all, 10 tests were conducted with the E-POD 26 between April 13 and April 20. Using a NOx reduction target of 97 percent, which is well outside the manufacturer's recommendations, NOx emissions of 0.7 to 0.83 g/kW-hr were obtained, with concurrent NH3 emissions of 12-32 ppm.

In summary, Shell invested several months and more than a million dollars at NC Machinery in an effort to achieve the PSD permit emission limits for the Discoverer D399 engines. While BACT is intended to reflect emission limits and control equipment that is proven and commercially available, in Tukwila Shell conducted a second research program to try to achieve all the emission limits required by the PSD permits. This reflects an extraordinary level of effort, especially when one considers that the annual emissions from the diesel generators are on the order of 10 tons.

Despite this effort, the engineering tests indicated the E-PODs could not achieve the ammonia limit with either the E-POD 26 or the E-POD 1345 design, and could not achieve the NOx limit with the E-POD 26 design. The tests showed that EPOD 1345 could meet the NOx limit if the controller was forced to attempt a 97 percent NOx reduction, but this is well outside the manufacturer's recommending operating condition and significant instability in the measured concentrations was observed. While the engineering tests at aggressive NOx reduction targets demonstrates Shell's efforts to achieve compliance with all permit limits, compliance with both

NOx and NH3 limits was still not achieved. Shell concluded that actual tests of the D399 engines on the Discoverer would be conducted with E-PODs targeting NOx reductions within the range of operating conditions recommended by the manufacturer to ensure proper long-term operation of the control systems.

1.5.2 Emission Testing at Vigor Shipyard

In late April, Shell moved the two E-PODs it used in Tukwila to Vigor Shipyard in Seattle for installation on the Discoverer with four other E-PODs. Altogether, Shell spent more than $2 million to acquire six E-PODs and deliver them to the Discoverer and another $5 million for installation.

Shell retained the Avogadro Group to conduct emission tests of the actual D399 engines that power the main generators on the Discoverer. The engines were tuned by Caterpillar technicians and set up to match the fuel injection setting determined at NC Machinery to produce the lowest NOx emissions. The E-PODs were commissioned by a CleanAIR technician, with the controller set to achieve 93 percent NOx reduction. The target NOx reduction was reduced from the 97 percent target during testing at NC Machinery to be more consistent with the manufacturer’s recommended operating practice. Although reduced from a 97 percent NOx reduction target, the E-PODs were set up to achieve as much NOx reduction as possible within the manufacturer’s recommended operating range.

Avogadro began testing the D399 generator engines installed on the Discoverer on May 28 and finished the testing June 8. As initially proposed in a January 11, 2012 letter from Shell’s Susan Childs to Natasha Greaves at EPA, during the tests the engines were operated at less than the engines’ rated capacity. The D399’s were tested at 800 kw rather than the name plate rating of 980 kw because Noble Corporation, the owner of the Discoverer, has established 800 kW as the maximum operating rate for the generators and has installed an electrical distribution system with controls that limit the engines’ operating rate accordingly. Consequently, the engines were tested at 800 kw to represent full load and at 600 kw and 400 kW to represent 75 percent and 50 percent load, respectively.

The test results presented in Table 1 indicate compliance with CO, PM10, PM2.5, and VOC emission limits by comfortable margins. However, NOx emissions and NH3 emissions exceed their respective emission limits. Additional detail on the NOx and NH3 tests is provided in Appendix D.

Shell downloaded data collected by the E-POD control system during each engine test and sent the data to CleanAIR technicians to confirm the engines and E-PODs were operating properly during the tests. CleanAIR reviewed the data and concluded that the systems “are operating within acceptable performance specifications.” CleanAIR acknowledged the variability in emission test results, and suggested the variability can be attributed to:

1. Variations between the E-POD's themselves
2. Testing data accuracy and/or procedure accuracy

3. Engine out emissions levels - This is the biggest variable as D399 are unregulated engines and can have significant differences in emissions out levels. This can be due to many factors including engine age, wear, injector performance, etc.

Table 1: Summary of Source Test Results								
Source	**Load (%)**	**Oxides of Nitrogen**		**Ammonia**	**Carbon Monoxide**	**Total PM**		**VOC**
		lbs/hr	**g/kW-hr**	**ppmv**	**g/kW-hr**	**lbs/day**	**g/kW-hr**	**g/kW-hr**
FD-1	100	0.31	0.17	91	0.0208	3.132	0.0703	0.0076
	75	0.27	0.19	81	0.0067	1.201	0.0359	0.0081
	50	0.30	0.32	38	0.0097	0.251	0.0113	0.0097
FD-2	100	2.34	1.26	6	0.0037	1.376	0.0309	0.0075
	75	1.91	1.37	5	0.0034	0.832	0.0249	0.0082
	50	1.44	1.55	5	0.0046	1.027	0.0461	0.0097
FD-3	100	0.64	0.34	26	0.0367	1.469	0.0330	0.0075
	75	0.72	0.52	8	0.0203	0.604	0.0181	0.0080
	50	0.54	0.57	6	0.0906	0.966	0.0428	0.0097
FD-4	100	0.81	0.43	21	0.0189	2.111	0.0471	0.0069
	75	0.45	0.33	28	0.0089	0.486	0.0146	0.0075
	50	0.69	0.75	10	0.0162	0.363	0.0163	0.0095
FD-5	100	1.43	0.77	16	0.0181	0.876	0.0197	0.0069
	75	0.90	0.65	19	0.0065	0.848	0.0254	0.0076
	50	0.75	0.81	14	0.0148	0.859	0.0385	0.0094
FD-6	100	2.11	1.14	10	0.0089	1.010	0.023	0.0076
	75	1.47	1.06	13	0.0086	1.492	0.045	0.0079
	50	1.05	1.13	8	0.0042	0.430	0.019	0.0095
BACT Limit			**0.50**	**5**	**0.1790**		**0.127**	**0.0230**
Mass Limit		**4.64**				**28.3**		

1.6 BACT Reevaluation

EPA has a five-step process for determining Best Available Control Technology for a given emission unit. Shell's PSD permit application followed that "top down" analysis using five steps:

1. Identify all control technologies
2. Eliminate Technically Infeasible Options
3. Rank remaining control technologies by control effectiveness
4. Evaluate most cost effective controls
5. Identify the most effective option not rejected based on energy, environmental, and economic impacts

In its application, Shell identified SCR as the most effective technology for controlling NOx emissions from reciprocating engines. Shell proposed to meet a 0.5 g/kW-hour NOx emission limit based on commitments by DEC Marine.[6] Shell did not propose an ammonia limit because ammonia is not a pollutant regulated by EPA and because DEC had not guaranteed an ammonia emission rate. The application discussed both oxidation catalysts and CDPF for PM control, but indicated CDPFs were not cost effective because of the small incremental reduction in annual mass emissions. As discussed above, however, the oxidation catalyst provided by DEC was not able to assure compliance with PM emission limits while simultaneously achieving the NOx emission limits.

Although the NC Machinery tests, the tests of FD1 on the Discoverer, and tests of other generator engines at some loads indicate it is possible to meet the 0.5 g/kW-hr NOx emission limit, not all engine/E-POD combinations are able to meet this limit and none of the tests at either location simultaneously met NOx and NH3 emission limits. Although not all tests revealed compliance with the permit limit, a review of the BACT limits in Tables 2 and 3 confirm that the NOx emissions measured at NC Machinery and on the Discoverer are very low compared with typical permit limits. When one considers all the challenges Shell faced in designing and installing the control equipment on a leased ship, this is a noteworthy achievement.

In hind sight, our BACT analysis erred in Step 3 of the Top Down process by misunderstanding the “real world” effectiveness of SCR in controlling NOx when there are spatial restrictions to the size of the SCR while simultaneously meeting pressure drop limitations imposed by controls for other pollutants. Had we better understood the spatial and engine back pressure limitations, we would have proposed higher NOx limits.

While not required by guidelines on determining BACT, Shell spent millions of dollars and months of effort in engineering tests in the Philippines, Singapore, and in Tukwila that were essentially research and development studies. BACT is a case-by-case determination, and the conclusion of Shell’s efforts is that achieving 0.5 g NOx/kW-hr on a continuous long-term basis is not feasible on the D399 engines in this application.

To provide a basis for comparison, Table 2 presents the transitional Tier 4 emission limits for nonroad engines, which do not apply to marine diesel engines. Table 2 also provides the emission limits imposed on large, stationary, non-emergency diesel engines in several recently-issued PSD permits and draft permits. Table 3 expands on Table 2 and provides details on the control devices and NOx emission limits determined to be BACT for those recently-issued PSD

[6] As noted above, Shell proposed limits based on SCR even though it could have demonstrated that installing SCR units in these existing vessels would not be cost effective. Shell’s commitments to North Slope communities included using the best control technology it could employ and there was no top-down BACT “cost-effectiveness” criterion built into that commitment. Shell, therefore, presented the use of those controls as BACT in its application. Shell acknowledges that EPA, in turn, processed Shell’s proposals as BACT limits and will treat the requested revised limits as BACT. Shell believes that it is important, however, at least for precedent purposes, that the record reflect the uniqueness of Shell’s application. Given the fact that Shell has spent in excess of $30 million getting to the point of being able to meet the requested revised limits, it is likely that those limits would be deemed well-beyond – that is, much more stringent than – BACT in other similar circumstances.

Table 2: Comparison of Current D399 Limits to Transitional Tier 4 Limits, and Similar Source Permit Limits

Source	Permit Issue Date	# Engines & Rated hp	NO_X g/kW-hr	PM g/kW-hr	CO g/kW-hr	VOC g/kW-hr	SO_2 ppmw S in fuel	NH_3 ppmv
Discoverer	9/19/2011	6 x 1,325	0.5	0.127[1]	0.179	0.23	15	5
Transitional Tier 4	--	1,207 to 3,000	0.67	0.1	3.5	0.4	--	--
C.R. Luigs[2]	3/30/2012	8 x 5,875	18.1	0.24[1]	2.42	0.39	15	--
Development Driller 1[2]	3/30/2012	8 x 5,096	12.1	0.24[1]	1.98	0.39	15	--
Ocean Confidence[3]	2/29/2012	8 x 4,439	12.1	--	--	--	500	--
Deepwater Nautilus[4]	11/28/2011	4 x 4,929	12.7	--	--	--	500	--
Noble Bully (I and II)[4]	11/28/2011	8 x 4,027	5.5	--	--	--	500	--
Pathfinder[5]	10/27/2011	3 x 9,910 3 x 6,610	12.7	0.24[1]	3.3		15	--
DHPP[6]	7/14/2011	1 x 4,400	9.8	0.5[7]	--	--	--	--
Discoverer Spirit[8]	6/13/2011	4 x 9,910 2 x 6,610	12.7	--	--	--	500	--
Flopam[9]	4/26/2011	11 x 591, 6 x 1,175	6.4[10]	0.2[11]	3.5	--	--	--
BPXA[12]	6/15/2009	1 x 1,041	4.7	--	2.6	--	15	--
USAF - Eareckson[13]	9/29/2003	2 x 3,000 kW	--[14]		0.67			15

1 PM, PM10, and PM2.5 emission limits are all the same.

2 The ultra-deepwater drillship C.R. Luigs and the semisubmersible drilling vessel Development Driller 1 are both included in a draft OCS permit issued for operations at multiple sites within the DeSoto Canyon lease block in the Gulf of Mexico. Draft Permit No. OCS-EPA-R4008, issued by USEPA Region 4.

3 The semisubmersible drilling vessel Ocean Confidence is in a draft OCS permit issued for operations within the Lloyd Ridge lease block 317 in the Gulf of Mexico. Draft Permit No. OCS-EPA-R4009, issued by USEPA Region 4.

4 The Deepwater Nautilus, Noble Bully I, and Noble Bully II are all included in an OCS permit issued for operations at multiple sites within the DeSoto Canyon and Lloyd Ridge lease blocks in the Gulf of Mexico. Permit No. OCS-EPA-R4006, issued by USEPA Region 4.

5 The drillship Pathfinder is in an OCS permit issued for operations within the Lloyd Ridge lease block 411 in the Gulf of Mexico. Permit No. OCS-EPA-R4007, issued by USEPA Region 4.

6 Permit No. AQ0215CPT03, issued to the Dutch Harbor Power Plant by Alaska Department of Environmental Conservation (ADEC).

7 Permit limit is on PM2.5 emissions.

8 The drillship Discoverer Spirit is in an OCS permit issued for operations within the Lloyd Ridge lease block 410 in the Gulf of Mexico. Permit No. OCS-EPA-R4005, issued by USEPA Region 4.

9 Permit No. PSD-LA-747(M1) issued by Louisiana Department of Environmental Quality (LDEQ).

10 Permit limit (which represents the lowest achievable emission rate – LAER) is on the combined emission rates of NOX and Non-Methane Hydrocarbons (NMHC).

11 Permit limit is on PM10 emissions.

12 Permit No. AQ0181CPT06, Rev. 2, issued to British Petroleum Exploration Alaska (BPXA) by ADEC.

13 Permit No. 307CP01, issued to US Air Force Eareckson Air Station, by ADEC.

14 This BACT determination (to use SCR) was reversed by their operating permit, which required using good combustion practices, no numerical limit in their permit.

Table 3: Comparison of Current D399 Limit to Transitional Tier 4 Limits, and Other Relevant BACT Determinations

Source	Permit Issue Date	Emission Unit Description	Emission Unit	BACT Limit NOx g/kW-hr	NOx % Reduction	Vendor - Model	Control Device
Discoverer	9/19/2011	Drill rig power	FD-1-6	0.5	--	D. E. C. Marine, AB	SCR
Transitional Tier 4	--	--	--	0.67	--	--	--
C.R. Luigs[1]	3/30/2012	Main power plant engines	EU-001 - 008	18.1	--	MAN B&W 9L32/40-47	Positive crankcase ventilation, turbocharger, high-pressure fuel injection with aftercooler
Development Driller 1[1]	3/30/2012	Main power plant engines	EU-001 - 008	12.1	--	Caterpillar 3612 DITA	Direct Injection, turbocharger/aftercooler
Ocean Confidence[2]	2/29/2012	Main propulsion generator	DR-GE-01 - 08	12.1	--	Wärtsilä F316A	Turbocharger/aftercooler, enhanced work practive power management and Nox emissions maintenance system. Good combustion and maintenance practices
Deepwater Nautilus[3]	11/28/2011	Drill rig generators	GEN-1 - 4	12.7	--	Wärtsilä 12V32 LNE	Low NOx Engine (LNE) design, turbocharger/aftercooler, injection timing retard, high injection pressure, and good combustion practices
Noble Bully (I and II)[3]	11/28/2011	Drill rig generators	GEN-1 - 8	5.5	--	Electro-Motive 20-710G7C-T2	Use of certified EPA Tier 2 engines with Low NOx Engine design (including ignition timing retard, turbo charger/after cooler, and high injection pressure), intake air cooling, and good

Table 3: Comparison of Current D399 Limit to Transitional Tier 4 Limits, and Other Relevant BACT Determinations

Source	Permit Issue Date	Emission Unit Description	Emission Unit	BACT Limit NOx g/kW-hr	NOx % Reduction	Vendor - Model	Control Device
							combustion practices
Pathfinder[4]	10/27/2011	Main propulsion diesel electric generators	DR-GE-01 - 6	12.7	--	Wärtsilä Vasa 18V32, 12V32 LNE	Low NOx Engine (LNE) design, turbocharger/aftercooler, injection timing retard, high injection pressure, and good combustion practices, enhanced with a Power Management System and NOx Concentration Maintenance System.
DHPP[5]	7/14/2011	Power plant	EU 15	9.8	35	Caterpillar C-280-16	Turbocharger/aftercooler
Discoverer Spirit[6]	6/13/2011	Workboat propulsion	DR-GE-01 - 06	12.7	--	Wärtsilä 18V32, 12V32 LNE	Low NOx Engine (LNE) design, turbocharger/aftercooler, injection timing retard, high injection pressure, and good combustion practices, enhanced with a Power Management and NOx Concentration Maintenance System.
Flopam[7]	4/26/2011	Chem plant under const.	Large Generator Engines	6.4[8]	--	None	None
BPXA[9]	6/15/2009	Oil/gas processing	EU IDS 49 - 56	4.7	15	--	Turbocharger/aftercooler, and good combustion practices

Table 3: Comparison of Current D399 Limit to Transitional Tier 4 Limits, and Other Relevant BACT Determinations

Source	Permit Issue Date	Emission Unit Description	Emission Unit	BACT Limit NOx g/kW-hr	NOx % Reduction	Vendor - Model	Control Device
DHPP[10]	1/31/2007	Power plant	Unit 15	9.8	--	Caterpillar C-280	Turbocharger/aftercooler
DHPP[10]	1/31/2007	Power plant	Unit 14	13.6	0	Wärtsilä 12V32C	Fuel injection timing retard and aftercooler
BPXA[11]	8/19/2005	Generator	Cummins IC Generator	--	--	Cummins	--
Nome Joint Utilities System[12]	11/5/2004	Generator	Diesel Electric Generator	134 (lb/hr)	--	WARTSILA 12V32B	Fuel injection timing retard (three gasses retard) and separate low temperature cooling water system/aftercooler
Westward Seafoods[13]	10/10/2003	Generator	IC Generator	8.65	--	Wartsila Model 6R32D	Water injection, low Nox design
USAF - Eareckson[14]	9/29/2003	Generator Engines	IC Engines units 5,6	--	--	Cooper Bessemer diesel engine	Good combustion practices

1 The ultra-deepwater drillship C.R. Luigs and the semisubmersible drilling vessel Development Driller 1 are both included in a draft OCS permit issued for operations at multiple sites within the DeSoto Canyon lease block in the Gulf of Mexico. Draft Permit No. OCS-EPA-R4008, issued by USEPA Region 4.

2 The semisubmersible drilling vessel Ocean Confidence is in a draft OCS permit issued for operations within the Lloyd Ridge lease block 317 in the Gulf of Mexico. Draft Permit No. OCS-EPA-R4009, issued by USEPA Region 4.

3 The Deepwater Nautilus, Noble Bully I, and Noble Bully II are all included in an OCS permit issued for operations at multiple sites within the DeSoto Canyon and Lloyd Ridge lease blocks in the Gulf of Mexico. Permit No. OCS-EPA-R4006, issued by USEPA Region 4.

4 The drillship Pathfinder is in an OCS permit issued for operations within the Lloyd Ridge lease block 411 in the Gulf of Mexico. Permit No. OCS-EPA-R4007, issued by USEPA Region 4.

5 Permit No. AQ0215CPT03, issued to the Dutch Harbor Power Plant by Alaska Department of Environmental Conservation (ADEC).

6 The drillship Discoverer Spirit is in an OCS permit issued for operations within the Lloyd Ridge lease block 410 in the Gulf of Mexico. Permit No. OCS-EPA-R4005, issued by USEPA Region 4.

7 Permit No. PSD-LA-747(M1) issued by Louisiana Department of Environmental Quality (LDEQ).

8 Permit limit (which represents the lowest achievable emission rate – LAER) is on the combined emission rates of NOX and Non-Methane Hydrocarbons (NMHC).

9 Permit No. AQ0181CPT06, Rev. 2, issued to British Petroleum Exploration Alaska (BPXA) by ADEC.
10 Permit No. AQ0215CPT02 Rev. 2, issued to Dutch Harbor Power Plant by ADEC
11 Permit No. AQ0417CPT05, Rev. 1, issued to British Petroleum Exploration Alaska (BPXA) by ADEC
12 Permit No. AQ0210TVP02P, issued to Nome Joint Utility System by ADEC
13 Permit No. AQ0433TVP02P, issued to Westward Seafoods, Inc. by ADEC
14 Permit No. 307CP01, issued to US Air Force Eareckson Air Station, by ADEC.

permits and draft permits. In most cases, EPA determined that engine design, e.g. use of turbochargers and aftercoolers, along with good combustion practices constitute BACT.

Table 2 shows that the NOx emission limits of recently-issued PSD and draft permits are more than ten times less stringent that than the limit in the Discoverer's permit. It is clear that a modest increase in NOx emissions would still represent BACT.

Ammonia (NH3) is not a federally regulated criteria pollutant, and is therefore not subject to BACT requirements under PSD review. An ammonia slip level of 10 ppmv was used in the Discoverer PSD permit application to estimate mass emissions of ammonia but this level was not intended to represent BACT. Indeed, no BACT analysis for ammonia was required. Shell is not aware of any ammonia limits in permits resulting from federal regulation.

There are permits that include ammonia limits but they are permits issued by states that have chosen to regulate ammonia, and are typically associated with ammonia slip from SCR units applied to combustion turbines and boilers. As indicated in Tables 2 and 3, Alaska Department of Environmental Conservation (ADEC) issued a permit in 2003 for two diesel-fired generator engines with a NOx limit of 1.46 g/kW-hr; this limit was to be achieved using an SCR system and an ammonia slip limit of 15 ppmv but the requirement to employ SCR was later reversed.

1.7 Proposed Permit Limit Revisions

BACT is defined in 40 C.F.R. §52.21(b)(12) in part as

> *an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant*.

The preceding sections have documented the unique circumstances that affect Shell's ability to install and operate control equipment on the Discoverer D399 generator engines. These sections also document the extensive efforts Shell expended to achieve the current limits. Shell has determined that the existing NOx limit is not technically feasible for this particular case, and requests that EPA revise the BACT limits for NOx emissions from the D399 engines accordingly.

Table 4 provides a statistical assessment of the emission test results for the two E-POD designs applied to the D399 engines. To allow for the variation acknowledged by CleanAIR in its review of the test results (discussed above), Shell proposes a revised NOx BACT limit based on the mean of the low load tests (which have the highest emission factors but the lowest mass emissions) plus two standard deviations and a small margin for deterioration over time. For FD1, FD3, FD4, and FD5, the proposed NOx emission limit is 1.2 g/kW-hr. For FD2 and FD6, the proposed NOx emission limit is 2 g/kW-hr.

Table 4: Analysis of NOx Emissions Testing							
NOx Emissions from E-POD 1345							
Load	**Max (g/kW-hr)**	**Mean (g/kW-hr)**	**Std. Dev. (g/kW-hr)**	**Mean + 1 Std. Dev. (g/kW-hr)**	**Mean + 2 Std. Dev. (g/kW-hr)**	**Max + 1 Std. Dev. (g/kW-hr)**	**Max + 2 Std. Dev. (g/kW-hr)**
Low	0.99	0.61	0.22	0.84	1.06	1.21	1.44
Medium	0.68	0.42	0.19	0.61	0.79	0.87	1.05
High	0.78	0.43	0.25	0.67	0.92	1.03	1.28
Composite	0.99	0.49	0.23	0.72	0.95	1.22	1.45
NOx Emissions from E-POD 26							
Load	**Max (g/kW-hr)**	**Mean (g/kW-hr)**	**Std. Dev. (g/kW-hr)**	**Mean + 1 Std. Dev. (g/kW-hr)**	**Mean + 2 Std. Dev. (g/kW-hr)**	**Max + 1 Std. Dev. (g/kW-hr)**	**Max + 2 Std. Dev. (g/kW-hr)**
Low	1.86	1.34	0.29	1.63	1.93	2.15	2.45
Medium	1.40	1.21	0.17	1.39	1.56	1.58	1.75
High	1.28	1.20	0.07	1.27	1.34	1.35	1.42
Composite	1.86	1.25	0.20	1.45	1.65	2.06	2.26

Shell elected to conduct additional emissions tests of the D399 engines after the official source tests were completed. Shell measured NOx and NH3 emissions with FD3 operating at 75 percent load (600 kW) and its E-POD 1345 targeting 90 percent NOx reduction. The average of two hour-long runs was 1.19 g NOx/kW-hr and 6 ppm NH3.

Similarly, Shell measured NOx and NH3 emissions with FD2 operating at 75 percent load (600 kW) and its E-POD 26 targeting 86 percent NOx reduction. The average of three hour-long runs was 1.40 g NOx/kW-hr and 5 ppm NH3.

Shell submits that the E-PODs designed for and installed on the Discoverer and the proposed NOx emission limits are BACT, and that compliance is assured by operating within the manufacturer's recommended NOx reduction range (90-93 percent). The tradeoff within this range appears to be the potential for higher NH3 slip when operating at the higher end of this range.

Table 5 identifies the mass emissions of NOx authorized by the current permit (at 0.5 g/kW-hr) and the NOx emissions that would result if the BACT limit is increased to 1.2 g/kW-hr for engines FD1, FD3, FD4, and FD5 and increased to 2 g/kW-hr for engines FD2 and FD6. Table 5 indicates the increases in annual potential emissions attributable to the change in BACT limits would be 11.3 tons per year. This is well below the 40 ton per year increase that is considered a major modification in EPA's PSD permit program.

Table 5: NOx Mass Emission Increases

BACT Limit	Emissions per Engine		Emissions all 6 Engines	
g/kW-hr	lb/hr	tons/year	lb/hr	tons/year
0.5	0.77	0.97	4.64	5.8
1.2	1.86	2.33		
2.0	3.10	3.89		
Composite (4 at 1.2 and 2 at 2 g/kW-hr):			13.6	17.1

The ammonia limit that was imposed by EPA cannot be achieved while simultaneously meeting the very low NOx limit. Given that EPA regulates NOx emissions and ambient NO2 concentrations, but regulates neither ammonia emissions nor ammonia ambient concentrations, Shell suggests that the focus of the permit should be on NOx emissions, not ammonia. In its permit applications, Shell identified anticipated ammonia emissions of 10 ppmv but did not propose an ammonia emission limit.

Furthermore, despite the placement of the ammonia limit in the BACT section of the permit, the permitting history indicates that an ammonia limit was originally intended to act as parametric monitoring for NOx. But in the permit's later iteration, periodic monitoring is required for NOx, making an NH3 limit unnecessary for confirming proper operation of the emission controls. The sequence of permit conditions related to ammonia follows:

- In 2009, the proposed permit included an NH3 BACT limit of 5 ppmv and NH3 monitoring requirements at each SCR. The Statement of Basis (SOB) for 2009 permit provides documentation on pages 47-48 that NH3 was to represent good performance of the SCR and oxidation catalyst system. Emissions of NH3, ammonia slip, can occur when the catalyst temperature is not in the optimum range for the reaction between NOx and ammonia. In order to ensure that the ammonia slip is maintained at the minimum level commensurate with achieving the NOx emission limit of 0.5 g/kW-hr, EPA proposed an emission limit for ammonia as part of the BACT emission limit for NOx from the generator engines. However, ammonia is not a federally regulated criteria pollutant and therefore should not be subject to a BACT limit.
- In 2010 reissuance of the permit and supplemental SOB, the permit removed the NH3 monitoring requirement but retained the NH3 emission limit of 5 ppmv. On Page 5 of the 2010 permit SOB, EPA states that the monitoring was changed to one-time stack testing and EPA made a conscious decision to remove ongoing monitoring.
- In 2011, additional on-going parametric monitoring requirements were added to the permit to ensure continuing performance of the SCR and oxidation catalyst systems. The 2011 permit requires monitoring and recording of the inlet temperature and urea flow. To ensure each catalyst is still active, the permit requires weekly measurements of NOx and CO concentrations downstream of the SCR and oxygen catalyst units with a portable monitoring device. At this time, it appears that EPA should have removed the NH3 limit because the additional parametric monitoring requirements adequately confirm proper operation of the SCR systems.

Shell proposes that EPA rescind the ammonia emission limit.

The proposed NOx emission limit revisions require three sections of the permit to be revised. The changes occur in Condition C.3, C.4, and C.5, as follows:

> 3. BACT Limits. Emissions from each generator engine (Units FD-1 – 6) shall not exceed the emission limits specified for each of the pollutants below:
>
> > 3.1. For F-D 1, FD-3, FD-4, and FD-5, nitrogen oxides (NOX): ~~0.50~~ 1.2 grams (g) per kilowatt-hour (kW-hr).
> >
> > 3.2 For F-D 2 and FD-6, nitrogen oxides (NOX): ~~0.50~~ 2.0 grams (g) per kilowatt-hour (kW-hr).
> >
> > 3.~~1.1~~3. For compliance with Condition C.3.1 and C3.2, measurement of NOX shall be determined using EPA Method 7E.
> >
> > ~~3.2. Ammonia (NH3): 5 parts per million by volume (ppmv) at actual stack gas conditions~~
> >
> > ~~3.2.1. For compliance with Condition C.3.2, measurement of NH3 shall be determined using EPA Conditional Test Method 027 or 038.~~
>
> 4. Annual Emission Limits. Emissions from all six generator engines in aggregate (Units FD-1 – 6) shall not exceed the emission limits specified for each of the pollutants below:
>
> > 4.1. Nitrogen oxides (NOX): ~~5.83~~ 17.1 tons/rolling 12-month period
> >
> > > 4.1.1. For compliance with Condition C.4.1, measurement of NOX shall be determined using EPA Method 7E.

5. Hourly Emission Limit. Emissions from all six generation engines in aggregate (Units FD-1 –6) shall not exceed the emission limits specified for each of the pollutants below:

5.1. Nitrogen oxides (NOX): ~~4.64~~ 13.6 lb/hr

5.1.1. For compliance with Condition C.5.1, measurement of NOX shall be determined using EPA Method 7E.

The compliance monitoring, record-keeping, and reporting requirements remain unchanged.

1.8 Ambient Air Quality Implications of Increased Emissions

To ensure the proposed increase in generator engine NOx emissions does not compromise compliance with ambient air quality standards, the AERMOD dispersion model was applied assuming all six generator engines emit 2.0 g/kW-hr NOx. Thus, the modeling assumes hourly and annual generator engine NOx emissions that are 37% higher than proposed.

The modeling was conducted using the same approach as used in the permit application. The modeling analysis demonstrating continued compliance with the one hour and annual NOx ambient air quality standard is summarized in a Technical Memorandum by Air Sciences that is provided in Appendix E.

1.9 Secondary Aerosol Formation

ENVIRON simulated fleet emissions at the Burger prospect in the Chukchi Sea in a previous regional modeling analysis to assess potential impacts of primary emitted pollutants and secondary aerosols to Native villages on the North Slope.[7] The results of these simulations suggest likely concentrations for all criteria pollutants and averaging periods will be small fractions of the NAAQS at the villages. The village with the highest predicted secondary aerosol concentrations was Point Lay where the 98th percentile 24-hour PM2.5 concentration was 0.29 $\mu g/m^3$ or less than one percent of the NAAQS.

Recent source testing suggests ammonia slip may be about four times higher for some of the engines. If all the PM2.5 at Point Lay is ammonium nitrate and aerosol formation is limited by available ammonia, then a factor-of-four increase in ammonia could cause a potential increase in PM2.5 to 1.16 $\mu g/m^3$ or about three percent of the 24-hour PM2.5 NAAQS. This increase would be offset by the very large reduction in total fleet NOx emissions that Shell has implemented since the previous modeling was conducted. The previous regional simulations conservatively assumed the entire fleet emitted at the maximum short-term rate of 1,500 lb/hr of NOx for 153 days. Current total fleet NOx emissions are limited to about 640 lb/hr, less than half of the NOx emissions assumed in the previous simulations.

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[7] ENVIRON 2011. *CALPUFF Simulations to Assess Pollutant Concentrations in North Slope Villages from Shell Exploratory Drilling Operations ion the Beaufort and Chukchi Seas with the Frontier Discover.* Memorandum from Ken Richmond, ENVIRON, to Gene Pavia, UMIAQ, April 18, 2011. ftp://ftp.epa.gov/reg10ftp/alaska/ocs/shell_discoverer_2011_supplemental_application/June10_submittal_compilation/4_08_11_submittals/memo_calpuff.pdf

2 Catalytic Diesel Particulate Filters in Place of Oxidation Catalyst Units

The Discoverer Chukchi Sea PSD permit identifies technologies and emissions limits in conditions stemming from the BACT determination for Discoverer emission units. For particulate matter, carbon monoxide, and VOC emissions, the permits specify either oxidation catalysts or catalytic diesel particulate filters, depending on the engine. An oxidation catalyst is a flow-through device that achieves significant CO and VOC reductions and a modest reduction of the soluble organic fraction of PM. A diesel particulate filter (DPF) is a wall flow device used to trap particulate matter; it can be catalyzed to achieve additional reductions identical to an oxidation catalyst, and is then referred to as a catalytic diesel particulate filter (CDPF). A DPF or CDPF burns off trapped particulate matter through a process known as thermal regeneration which, as the name suggests, depends upon exhaust temperature. In general, CDPFs cost more and achieve greater PM reduction than oxidation catalysts.

The determination of which control option is required by the permit depended in part on cost effectiveness information provided in Shell's application. This revision request is necessary because Shell chose to accept the additional cost associated with CDPFs on some engines even though an oxidation catalyst had been deemed BACT in the permit.

2.1 Emission Units with CDPFs substituted for Oxidation catalysts

During the process of modifying the Discoverer and associated fleet to meet its permit requirements, Shell purchased and installed CDPFs rather than oxidation catalysts on several of the emission sources. The emission units on which CDPFs were substituted are listed in Table 6.

Table 6: Discoverer Emission Units with CDPFs substituted for Oxidation catalysts

Emission Unit	Emission Unit ID	Permit-required Emission Controls	As-built Emission Controls
Primary Generator Engine	FD-1, FD-2, FD-3 FD-4, FD-5, FD-6	SCR, oxidation catalyst, CCV	E-POD (SCR, CDPF), CCV
MLC Air Compressor	FD-9	Oxidation catalyst	CDPF

2.2 Catalyzed Diesel Particulate Filters Control Efficiency

The CDPFs contain an oxidation catalyst and a filter membrane for more efficient removal of particulate matter than an oxidation catalyst alone, therefore satisfying the requirement of installing an oxidation catalyst, but with better particulate control. As confirmation that the CDPFs have better control efficiencies than oxidation catalysts, the control efficiencies for the three criteria pollutants affected by these types of controls, PM, CO and VOCs, that were used in the permit applications are provided in Table 7. For all three pollutants the control efficiencies are either equal to or better with the CDPFs so the substitution is an improvement. CleanAIR provided the CDPF control efficiencies seen in Table 7 in their manufacturer's data sheet (Appendix F).

Table 7: Control Effectiveness Used for Oxidation Catalysts and CDPFs			
Device	**$PM_{2.5}$**	**CO**	**VOC**
Oxidation catalyst	50%	47% / 80%*	70%
CDPF	85%	80%	90%

* 47% control assumed for MLC air compressor; 80 percent control assumed for D399 generator engines.

2.3 Location and Configuration of CDPF

The substituted CDPFs are installed in the same locations and configurations permitted for the oxidation catalyst units. The application did not specify dimensions or internal diagrams of the oxidation catalysts. The internal layout and catalyst formulation of the CDPFs are not included because CleanAIR Systems considers the information proprietary and was unwilling to provide it to Shell. However, Appendix C provides a schematic of the E-POD system installed on the D399 generator engines.

2.4 Oxidation Catalyst Monitoring, Record-keeping and Reporting Requirements

The monitoring, record-keeping, and reporting requirements for the permitted oxidation catalyst units are presented below. Units that are installed with continuous monitoring systems (CMS) are subject to additional monitoring requirements as detailed below. The permit condition numbers are listed for reference purposes.

2.4.1 Generator Engine Oxidation Catalyst Monitoring

B.15 **Oxidation Catalyst Control Device Monitoring**. For any emission unit that is required by this permit to be controlled by an oxidation catalyst control device, the permittee shall install, calibrate, operate, and maintain (in accordance with manufacturer specifications) CMS to measure and record inlet temperature (ºF), and catalyst activity (CO ppm concentration) as follows:

15.1 (Prepare and submit 60 days before the first drilling season a site-specific monitoring plan that addresses the monitoring system design, data collection, quality assurance, and quality control elements outlined in this condition. Install, calibrate, operate, and maintain each CMS according to the procedures in the approved site-specific monitoring plan. The plan shall address the performance criteria and design specifications for the monitoring system equipment, including the sample interface, detector signal analyzer, sensor tolerance and sensitivity, and data acquisition and calculations; sampling interface (e.g., thermocouple) location such that the monitoring system will provide representative measurements; equipment performance checks, system accuracy audits, or other audit procedures; ongoing operation and maintenance procedures; and ongoing reporting and recordkeeping procedures.

15.2 The temperature CMS shall collect data at least once every 15 minutes.

15.3 Conduct the CMS equipment performance checks, system accuracy audits, or other audit procedures specified in the site-specific monitoring plan within 60 days prior to each drilling season and at least once every 3 months for the duration of the drilling season.

15.4 Conduct a performance evaluation of each CMS in accordance with the site-specific monitoring plan.

15.5 Except for periods of monitoring system malfunctions, repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, system accuracy audits and required zero and span adjustments), operate the CMS at all times the affected source is operating. A monitoring system malfunction is any sudden, infrequent, not reasonably preventable failure of the monitoring system to provide valid data. Monitoring system failures that are caused in part by poor maintenance or careless operation are not malfunctions. Complete monitoring system repairs in response to monitoring system malfunctions and return the monitoring system to operation as expeditiously as practicable.

15.6 Monitor and record CO emissions (ppm) from the exhaust of each oxidation catalyst unit once per week using a portable CO monitor that meets the requirements of EPA OTM 13 found at http://www.epa.gov/ttn/emc/prelim/otm13.pdf.

15.7 Report as a permit deviation under Condition A.17.3 any periods during which the inlet temperature is less than 300^{o}C, or the CO concentration is 120% or more than the CO concentration measured during the most recent previous source test that produced compliance data or emission factors for this permit.

Condition C.2 is a requirement for Discoverer Generator Engines FD-1-6.

C.2 **Operation of Oxidation Catalyst**. At all times that any of Units FD-1 – 6 are in operation, the exhaust from each emission unit shall be directed to an operating oxidation catalyst.

2.4.2 Mud Line Cellar Engine Oxidation Catalyst Monitoring

Condition F.1 is a requirement for Mud Line Cellar Compressor Engines FD-9-11. Engines FD-10-11 have permitted Oxidation catalyst units installed for control of emissions.

F.1 **Operation of Oxidation Catalyst**. At all times that any of Units FD-9 – 11 are in operation, the exhaust from each emission unit shall be directed to an operating oxidation catalyst.

2.5 Identification of Monitoring Equipment Installed on CDPF

The CDPFs controlling emissions from units FD-1-6 are installed in CleanAIR E-POD control systems. E-POD units combine CDPF with SCR to control emissions, and are required to measure and monitor the parameters listed in Table 8. These are the same parameters required by each permit to be measured and monitored if using oxidation catalyst control devices. Monitoring Equipment installed on engines FD-1-6 control devices are provided in Table 9.

The CDPF installed on engine FD-9 is identical to those installed on engines FD-1-6, however, it is not combined with SCR in an E-POD control system. Instead, like other Discoverer engines controlled through CDPF, it is attached to a CleanAIR HiBACK USB unit certified by California Air Resources Board as a reliable means of reducing PM by 85 percent. The same HiBACK unit is required by the PSD permit for other CDPF-equipped engines for demonstrating the proper functioning of a CDPF. The HiBACK USB is a microprocessor-based data logger and alarm system designed to record and monitor exhaust backpressure and temperature. CleanAIR's product specification for HiBACK USB units is provided as Appendix G.

Table 8: Measurements Included in the CMS with Thresholds

Parameter	Limit	Sampling Frequency	Permit Condition	Affected Emission Units
SCR Inlet temperature	> 250^{O} C	At least every 15 minutes	B.14 (B.28)	Discoverer FD1 – 6 IB1 propulsion and generation IB2 propulsion and generation
SCR Urea flow	Flow must exist	At least every 15 minutes	B.14 (B.28)	Discoverer FD1 – 6 IB1 propulsion and generation IB2 propulsion and generation
SCR NOx emission concentration	< 150% of most recent stack test (in ppm)	Once per week	B.14 (B.28)	Discoverer FD1 – 6 IB1 propulsion and generation IB2 propulsion and generation
Oxidation catalyst/CDPF inlet temperature	> 300^{O} C	At least every 15 minutes	B.15 (B.29)	Discoverer FD1 – 6 Discoverer FD10 – 11 IB1 propulsion and generation IB2 propulsion and generation
Oxidation catalyst/CDPF CO emission concentration	< 120% of most recent stack test (in ppm)	Once per week	B.15 (B.29)	Discoverer FD1 – 6 Discoverer FD10 – 11 IB1 propulsion and generation IB2 propulsion and generation

Table 9: Sensor Specifications, Signal Processing and Transmittal

Vessel / Emission Unit	Parameter	Model Number	Performance Criteria	Specification	Signal Processing and Transmittal
Discoverer / FD1 – 6 SCR & Oxidation catalyst/CDPF	Inlet temperature	Tempco P/N TTM00015. K type thermocouple	Range: 100 – 400C Precision: +/- 7C*	Range: 0 – 1260 C Transmitter accuracy: 0.2% of span which is 2.5C**	Signal from SCR processor to ADM. Then interrogated by AQ computer & sent to office by internet daily.
Discoverer / FD1 – 6 SCR	Urea Flow on/off	Grundfoss DME 60 metering pumps	Differentiate between flow and no flow	Accuracy: 1% No-flow defined as < 5% of max which is < 3 l/hr	Signal from SCR processor to ADM. Then interrogated by AQ computer & sent to office by internet daily.
Discoverer / FD1 – 6 SCR	NOx and CO conc.	Testo 350	Provided in ASTM 6522-00		Manual recording, scan sent to office by internet weekly.

*From Stack Test Method 2A and 2% of minimum absolute temperature
** http://www.tempco.com/sensors/Style_TTM.htm

ADM – TASC data logger / processor
AQ – air quality

2.6 Proposed Permit Term Revisions

Substitution of the better performing CDPF for oxidation catalysts requires the following permit conditions to be edited, added or replaced.

CleanAIR E-POD systems installed on FD-1 through FD-6 are designed to combine SCR with either oxidation catalysts or CDPFs. The E-POD units are designed with a comprehensive system to monitor operational parameters regardless if an oxidation catalyst or a CDPF is installed in the unit. Therefore Shell elects to not use the HiBACK unit, but to monitor these catalyst also using the E-POD CMS. As there is no change to the CMS as a result of substitution of CDPF in place of an oxidation catalyst, the Monitoring, Recordkeeping, and Reporting requirements for these emission units are not affected. Therefore, these units continue to be subject to permit condition B.15, which describes requirements for CMS.

The monitoring, recordkeeping, and reporting for emission unit FD-9 are addressed with the HiBACK pre-programmed data interrogation sensors, algorithms and data records. Therefore FD-9 should not be subject to the CMS requirements of condition B.15. Condition B.15 should read as follows to account for the different control device (edits are underlined):

B.15 **Oxidation Catalyst <u>and Combined Catalytic Diesel Particulate Filter</u> Control Device Monitoring**. For any emission unit that is required by this permit to be controlled by an oxidation catalyst control device <u>or a CDPF combined with SCR control system</u>, the permittee shall install, calibrate, operate, and maintain (in accordance with manufacturer specifications) CMS to measure and record inlet temperature (ºF), and catalyst activity (CO ppm concentration) as follows:

15.1 Prepare and submit 60 days before the first drilling season a site-specific monitoring plan that addresses the monitoring system design, data collection, quality assurance, and quality control elements outlined in this condition. Install, calibrate, operate, and maintain each CMS according to the procedures in the approved site-specific monitoring plan. The plan shall address the performance criteria and design specifications for the monitoring system equipment, including the sample interface, detector signal analyzer, sensor tolerance and sensitivity, and data acquisition and calculations; sampling interface (e.g., thermocouple) location such that the monitoring system will provide representative measurements; equipment performance checks, system accuracy audits, or other audit procedures; ongoing operation and maintenance procedures; and ongoing reporting and recordkeeping procedures.

15.2 The temperature CMS shall collect data at least once every 15 minutes.

15.3 Conduct the CMS equipment performance checks, system accuracy audits, or other audit procedures specified in the site-specific monitoring plan within 60 days prior to each drilling season and at least once every 3 months for the duration of the drilling season.

15.4 Conduct a performance evaluation of each CMS in accordance with the site-specific monitoring plan.

15.5 Except for periods of monitoring system malfunctions, repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, system accuracy audits and required zero and span adjustments), operate the CMS at all times the affected source is operating. A monitoring system malfunction is any sudden, infrequent, not reasonably preventable failure of the monitoring system to provide valid data. Monitoring system failures that are caused in part by poor maintenance or careless operation are not malfunctions. Complete monitoring system repairs in response to monitoring system malfunctions and return the monitoring system to operation as expeditiously as practicable.

15.6 Monitor and record CO emissions (ppm) from the exhaust of each oxidation catalyst unit or combined CDPF and SCR system once per week using a portable CO monitor that meets the requirements of EPA OTM 13 found at http://www.epa.gov/ttn/emc/prelim/otm13.pdf.

15.7 Report as a permit deviation under Condition A.17.3 any periods during which the inlet temperature is less than 300^{o}C, or the CO concentration is 120% or more than the CO concentration measured during the most recent previous source test that produced compliance data or emission factors for this permit.

Replace the condition that requires operation of an oxidation catalyst on FD-1-6, C.2, with:

C.2 **Operation of Catalyzed Diesel Particulate Filter (CDPF).** At all times that any of Units FD-1– 6 are in operation, the exhaust from each emission unit shall be directed to an operating CDPF.

2.1 The CDPF shall be equipped with an operating monitor and alarm unit, that records exhaust pressure and temperature.

2.2 During each day that each of Units FD-1-6 is operated, the exhaust temperature shall be above 300^{o}C, or 572^{o}F, for at least 30 percent of the time.

Of the three Mud Line Cellar Compressor Engines FD-9-11, only FD-9 is installed with a CDPF rather than an oxidation catalyst. Therefore, the condition requiring use of an oxygen catalyst should be revised as follows (edits are underlined):

F.1 **Operation of Oxidation Catalyst.** At all times that either of Units FD-10 – 11 are in operation, the exhaust from each emission unit shall be directed to an operating oxidation catalyst.

We suggest a condition that requires use of CDPF for unit FD-9 be inserted as Condition F.2, with adjustments to numbering of subsequent conditions

F.2 **Operation of Catalyzed Diesel Particulate Filter (CDPF).** At all times that Unit FD-9 is in operation, the exhaust shall be directed to an operating CDPF.

2.1. The CDPF shall be equipped with an operating HiBACK monitor and alarm unit, that records exhaust pressure and temperature.

2.2. During each day that Unit FD-9 is operated, the exhaust temperature shall be above 300^{o}C, or 572^{o}F for at least 30 percent of the time.

In addition, Shell suggests that the following two conditions be added to the Monitoring, Recordkeeping, and Reporting condition section, F.8, for Mud Line Cellar Engines FD-9-11.

F.8 ****

8.5. Monitor the exhaust temperature of FD-9 by use of the HiBACK monitor and alarm unit, whenever the engine is in operation.

8.6. Each day, calculate and record for the previous calendar day, the percent of operational time for FD-9 that the exhaust temperature was above 300^{o}C (572^{o}F).

8.7 Monitor and record CO emissions (ppm) from the exhaust of each oxidation catalyst unit or CDPF once per week using a portable CO monitor that meets the requirements of EPA OTM 13 found at http://www.epa.gov/ttn/emc/prelim/otm13.pdf.

No other changes are necessary to implement this revision request.

As required by the permit conditions a CMS plan has already been submitted that addresses the requirements for CDPFs installed in place of oxygen catalysts.

3 Rated Capacity for Emission Units

3.1 Introduction

Shell conducted each of several hundred emissions test with the intent to test all emission sources per permit requirements. In some cases, however, due to physical limitations or requirements of the vessel owner, Shell had to test units at an operating rate below the rate implied by the permit. In these instances, the maximum permissible load that the engine could be operated was deemed the 100% load case.

Maximum continuous power ratings of marine engines are often 10-20% below “name plate” power ratings. Owners employ controllers and mechanical stops to limit the amount of fuel that can be consumed by the engine to stay within the maximum continuous ratings of each engine. (See attached example of Cummins KTA 19 performance data as an example which de-rates engine 20% for continuous duty.)

It should be noted that neither the Discoverer nor the vessels comprising its Associated Fleet are owned by Shell. Shell charters the vessels from companies that desire to protect their assets from damage. Unlike power plants and on-road diesel vehicles, engines in vessels are built into the hull and cannot be economically replaced in total. Vessel owners sometimes take additional steps to limit the operating level of their engines to extend their useful life.

3.2 Noble Discoverer

1. *Identification of each emission unit for which Shell is proposing to define the maximum operating capacity at a level below that identified in the permit.*

   Emission units FD-1-6 (main generators) which are Caterpillar D 399’s rated at 988 kW each.

2. *Identification of the proposed de-rated maximum operating rate.*

   Caterpillar D 399’s de-rated to maximum operating rate of 800 kW.

3. *Description of the physical or operational limitation which forms the basis for the de-rating request.*

   Noble, the owner of the Discoverer, has established 800 kW as the maximum operating rate for the generators, and has installed an electrical distribution system with controls that limit the engines’ operating rate accordingly. This operating rate is nearly 20 percent lower than the 988 kW nameplate rating on the engine. With this contractual and operational restriction in place, Shell submits that an engine operating rate that results in 800 kW output reflects the true 100 percent engine load to be encountered during our OCS drilling operations, and that the “100% load” source tests should take place at this restricted engine operating rate. Similarly, source tests at 75% and 50% load should be conducted at engine operating rates that generate 600 and 400 kW, respectively. (From Jan 11, 2012 letter from Susan Childs to EPA’s Natasha Greaves)

Several of the engines were unable to maintain a stable load at levels higher than 800 kW on the dynamometer. In addition, Noble Corporation, the owner of the Discoverer, has established 800 kW as the maximum operating rate for the main generators, FD-1-6, and has installed an electrical distribution system with controls that limit the engines' operating rate accordingly. This operating rate is nearly 20 percent lower than the 988 kW nameplate rating on the engine.

4. *Description of any engineering or administrative controls which will be put in place to ensure each emission unit cannot operate above the proposed de-rated maximum, if appropriate.*

   The vessel owner installed a power distribution system which limits the load on any engine to 800 kW. No changes will be made to the control software for the duration of the season.

5. *Proposed monitoring, record keeping, and reporting to be used to verify compliance with the proposed de-rated maximum operating rate.*

   The CMS system will monitor load (in kW) for each engine. Any 15 minute interval where power exceeds 105% of 800 kW will be reported as a variance.

3.3 Fennica (Icebreaker #1)

1. *Identification of each emission unit for which Shell is proposing to define the maximum operating capacity at a level below that identified in the permit.*

   The four main propulsion engines are to be de-rated. The Fennica is a diesel electric vessel powered by 4 Wartsila diesel engines—2 x Wärtsilä-Vaasa 16V32D's rated 6,000 kW and 2 x Wärtsilä-Vaasa 12V32D's rated 4,500 kW. The vessel is designed to work on both heavy fuel oil (HFO) and marine diesel oil MGO.

2. *Identification of the proposed de-rated maximum operating rate:*

   Proposed de-rated maximum engine capacity:

   Wärtsilä-Vaasa 16V32D's de-rated to 4,920 kW

   Wärtsilä-Vaasa 12V32D's de-rated to 3,690 kW

3. *Description of the physical or operational limitation which forms the basis for the de-rating request.*

   The Main Engine fuel rack position on Fennica is limited by mechanical stops which are adjusted to 95% maximum continuous rating when consuming HFO. This is a condition placed on the vessel by the vessel owner for its protection. ULSD fuel oil contains less energy content per volume than HFO, and has a lower viscosity resulting in lower performance of the fuel injection pumps. The combined affect is a reduction in maximum power available to approximately 82% maximum continuous rating. The mechanical stops could be adjusted to compensate for the reduction in caloric value of the fuel, but this was discouraged by the owner as it could result in the engine exceeding permit limits if the fuel was changed back to one with a higher caloric value or viscosity.

In their present configuration of rack stop and ULSD fuel, these engines cannot be physically run at a higher load.

The Permit specifies the top end of the test range at 95% of maximum load. For the 12V32D's, this calculates to be 4,500 kW x 82% x 95% = 3,506 kW. Shell tested the engines at an average load of 3,513 kW. For the 16V32D's, this calculates to be 6,000 kW x 82% x 95% = 4,674 kW. Shell tested the engines at an average load of 4,648 kW.

4. *Description of any engineering or administrative controls which will be put in place to ensure each emission unit cannot operate above the proposed de-rated maximum, if appropriate.*

   The vessel owner insists that fuel rack stops be left in place. Shell requires re-fueling with ULSD while operating under this permit. This combination limits engine to 82% of nameplate power levels.

5. *Proposed monitoring, record keeping, and reporting to be used to verify compliance with the proposed de-rated maximum operating rate.*

   The CMS system will monitor load (in kW) for each engine. Any 15 minute interval where power exceeds 105% of de-rated limits will be reported as a variance.

   The CMS system will monitor fuel use at 15 minute intervals. Any 15 minute interval where fuel exceeds 105% of the maximum fuel consumed during stack testing will be reported as a variance.

3.4 Tor Viking II (Icebreaker #2)

1. *Identification of each emission unit for which Shell is proposing to define the maximum operating capacity at a level below that identified in the permit.*

   No engines are to be de-rated.

   The permit requires a maximum test level of 80%, which is within both the physical limitations and vessel owner limitations of the vessel. Shell does not anticipate running engines at loads higher than tested. The Tor Viking II has four main propulsion engines which are coupled in pairs of one larger engine and one smaller engine per drive shaft. Either engine or both can be clutched into the drive shaft to provide a wide range of efficient operation. The larger of the engines, TV-1 and TV-2, are MaK 8M32's rated at 3,840 kW. The smaller size engines, TV-3 and TV-4 are the MaK 6M32's rated at 2,880 kW.

   These engines are designed to burn marine diesel fuel oil so de-rating of engines due to heat content of fuel is not necessary. The CMS system records fuel use and engine rack position (as % of total) and can demonstrate compliance with Permit.

3.5 Nanuq (OSR Vessel)

1. *Identification of each emission unit for which Shell is proposing to define the maximum operating capacity at a level below that identified in the permit.*

    The two main propulsion engines are to be de-rated. The Nanuq's main engines are Caterpillar 3608's rated at 2,710 kW.

2. *Identification of the proposed de-rated maximum operating rate:*

    Proposed de-rated maximum engine capacity:

    Caterpillar 3608's de-rated to 1927 kW

3. *Description of the physical or operational limitation which forms the basis for the de-rating request.*

    The main propulsion engines are controlled by a Power Management System (PMS) developed by Marine Technologies which limits power that can be applied to main engines to approximately 80% of maximum continuous power. This PMS system cannot be overridden on the bridge. It was installed by the vessel owner to prevent vessel master from damaging main propulsion engines. Moving the main engine throttles to full (e.g. 100% scale) one at a time or in tandem translates to a maximum measured fuel consumption of 134 gal / hr. Using attached power / fuel consumption curve, this fuel consumption translates to 1927 kW or 71% of maximum power.

4. *Description of any engineering or administrative controls which will be put in place to ensure each emission unit cannot operate above the proposed de-rated maximum, if appropriate.*

    The vessel owner will not adjust the power management system for the duration of this season.

5. *Proposed monitoring, record keeping, and reporting to be used to verify compliance with the proposed de-rated maximum operating rate.*

    The CMS system records fuel use at 15 minute intervals. Shell will review data for any periods of time when fuel levels exceed 105% of the maximum fuel consumed during stack testing (134[8] gal/hr) and notify the EPA as a variance.

[8] Per stack testing completed 6-27-2012

4 Nanuq Emission Limits

For emission units not subject to BACT, such as those on associated fleet vessels, Shell's permit application proposed limits based on various estimates, assumptions, and information sources, including data from engine manufacturers and control equipment vendors. Shell's consultants used this information to propose as stringent emission limits as the available facts and assumptions appeared to allow. Shell has now found that assumptions made to estimate particulate matter (PM) emissions from the primary oil spill response vessel (OSRV), the Nanuq, were flawed. This resulted in underestimating PM emissions and proposing daily PM limits for the Nanuq that the CDPF-controlled engines on the vessel cannot meet. The following section explains how Shell underestimated Nanuq PM emissions in its application, proposes revised daily PM limits, provides the technical basis for the revised limits, and provides modeling to demonstrate that revising the limits will not affect compliance with ambient air quality standards.

4.1 Background

The Nanuq is powered by two propulsion engines (N-1 and N-2) and two generator engines (N-3 and N-4). The propulsion engines are Caterpillar 3608 engines rated at 2,710 kW. The generators are powered by Caterpillar 3508B engines rated at 1,285 kW. The engines are required to combust only ultra-low sulfur distillate fuel. Exhaust from each engine is controlled by a CDPF designed to reduce PM emissions by 85 percent.

Serving as an OSRV, the Nanuq propulsion and generation engines are governed by an aggregate hourly NOx emission limit, aggregate daily PM10 and PM2.5 (hereafter, collectively, PM) emission limits, and an aggregate daily fuel consumption limit.[9] Shell is asking EPA to revise the 3.03 lbs/day limits in Conditions 4.1.1 and 4.1.2, which read as follows:

Q.4. Daily Emission Limits: At all times while the Discoverer is an OCS source and the Oil Spill Response fleet is within 25 miles of the Discoverer, emissions from the Oil Spill Response Fleet shall not exceed the emission limits specified:

4.1. Nanuq propulsion engines and generators in aggregate (Units N-1 – 4):

4.1.1. PM10: 3.03 lbs/day

4.1.1.1. For compliance with Condition Q.4.1.1, measurement of PM10 shall be determined using EPA Method s 201A and 202.

4.1.2. PM2.5: 3.03 lbs/day

4.1.2.1. For compliance with Condition Q.4.1.2, measurement of PM2.5 shall be determined using EPA Methods 201A and 202.

[9] The PM10 and PM2.5 emission limits are the same because it is assumed that all PM emissions are less than 2.5 microns in diameter. Therefore, the discussion in this section does not differentiate between $PM_{2.5}$ and PM_{10}.

4.2 PM Emission Assumptions

4.2.1 Basis for Existing Emission Limits

The current permit limits were derived by using manufacturer provided information, operational information, average brake-horsepower specific fuel consumption, and the heating value of diesel fuel, as follows:

- The daily fuel limit was determined by:
    - Calculating the product of the aggregate rated engine power (9,838 horsepower), the average brake HP-specific fuel consumption (7,000 Btu/hp-hr, as provided in AP-42 Table 3.3-1 footnote a), and the load factor (the power anticipated to be used divided by the power available, 30%).
    - Dividing the calculated value from above by the diesel heating value (133,100 Btu/gallon of fuel) to determine the daily fuel limit (rounded 3,725 up to 3,800 gallons per day).
- The daily PM limit is coupled to the fuel limit, and was determined by:
    - Identifying a PM emission factor from Caterpillar's Model 3608 data sheet, while operating at 100% load (0.17 g/kW-hr), see Appendix H.
    - Using the Caterpillar emission factor to determine an emission factor in pounds of PM emissions per gallon of fuel combusted, as follows:
        - Converting the emission factor to lb/hp-hr and dividing by the average horsepower-specific fuel consumption (7,000 Btu/hp-hr), to determine the emission factor in lb/MMBtu.
        - Calculating the product of the above emission factor and the diesel heating value (133,100 Btu/gallon of fuel) to determine the uncontrolled emission factor.
        - Applying the efficiency of the control device, in this case catalytic diesel particulate filter (CDPF) (85% control efficiency), to determine the controlled emission factor (0.000798 lb/gal).
    - Applying the emission factor to the daily fuel limit results in a daily PM limit of 3.03 lb/day.

4.2.2 Application Assumption Flaws

After source tests showed that Nanuq engine PM emissions were higher than anticipated, Shell reevaluated the basis for the PM limits, determining that an important contributing factor to low predicted PM emissions was the failure to recognize that PM emissions are not proportional to engine load. Based on actual fuel consumption data for the Nanuq operations in the Gulf of Mexico, Shell determined that typical power demands were approximately 30 percent of the ship's total power capacity. Based on that finding, PM emissions determined using a 100 percent load emission factor were multiplied by 30 percent. In fact, PM emissions are not linearly proportional to engine load. PM emissions are substantially higher at low load than at high load. The Caterpillar model 3608 data sheet (Appendix H) lists information for three load rates: 100, 75, and 50%. The PM emission factor for operation at 50% load is 50% higher than that for operation at 100% load.

In addition, Shell determined the PM emission permit limit using an industrial engine emission rate rather than the correct marine engine emission rate for the Caterpillar model 3608 (see Appendix H). The marine rating PM emission rate is over three times higher than that for the industrial engine.

Shell also now finds that the CDPFs will increase the power demands to a greater extent than anticipated. In order to ensure proper operation of the CDPFs and compliance with the PSD permit, Shell installed electric heaters in the CDPF that maintain temperatures high enough to burn off the collected PM.[10] When operating at low load, the heaters, which have high energy utility, are activated. This increases the operating load of one of the generators to approximately 80-90% of its maximum power.

Finally, Shell now anticipates that ocean conditions and the need to generate more heat in the cooler arctic temperature will require average loads greater than 30 percent on some days. While it is possible that season-average loads may be 30 percent of rated capacity, it is likely that significantly higher loads may be necessary on any given day to allow for oil spill response drills or adverse weather conditions. The permit does not allow the Nanuq to accrue unused daily allotments of fuel or PM to use in situations where it would need to operate at higher loads for a day.

4.3 PM Source Test Results and Efforts to Reduce PM Emissions

4.3.1 Nanuq PM Source Test Results

Source tests conducted by TRC Environmental Corporation in March 2012 on the Nanuq engines showed that the 3.03 lbs/day limits were too stringent. Using EPA Reference Methods 5 and 202, TRC measured PM from N-1 at 100% and 25% loads, N-2 at 100% load, and N-4 at 90% and 50% loads. Table 10 summarizes the results of the testing. As indicated in Table 10, the March test results revealed PM emissions from engine N-2 that were almost five times higher than those for the identical N-1.

[10] Condition Q.1.2: During each day that each of Units N-1 - 4 is operated, the exhaust temperature shall be above 300^{o}C, or 572^{o}F, for at least 30 percent of the time.

Table 10: Emission Source Test Results - Nanuq				
Unit	**Load (%)**	**Run**	**Total PM (lbs/hr)**	**Average (lbs/hr)**
N-1	100	1	0.295	0.273
		2	0.215	
		3	0.308	
	25	1	0.125	0.146
		2	0.089	
		3	0.226	
N-2	100	1	0.424	1.266
		2	2.758	
		3	0.6166	
N-4	90	1	0.2202	0.193
		2	0.2666	
		3	0.0926	
	50	1	0.1219	0.129
		2	0.1257	
		3	0.1381	
Aggregate (lb/hr)*				5.4
Emission Limit (lb/day)				3.03
* Based on highest emission rate per engine and assumes N-3 PM is the same as N-4				

A single 1-hour test run on engine N-2 resulted in PM emissions that are approximately 90 percent of the allowable daily PM limit. Shell's actions to address that single high run are discussed below. But even if the single high PM test result is discounted, the measured emissions rates are too high to allow operation of the Nanuq while still complying with the daily PM emission limits.

4.3.2 Improvements to Nanuq Engines and CDPFs

The presumed cause of the high PM during the second test run of N-2 was that a combination of low exhaust temperatures upstream of the catalysts and a potential wrong set of injectors on the engine led to poor catalyst performance and a build-up up of soot in the stack. As temperatures reached ignition temperature, the soot was released. A possible contributing factor was that back pressure built up so high that internal baffles flexed and soot leaked around filters. Indeed, more recent investigations have revealed cracks in the internal baffles that would allow soot to pass through uncontrolled.

The high PM measured on the second test run of N-2 prompted Shell to reevaluate each of the four engines and each CDPF on the Nanuq. The following components have since been replaced or repaired:

- Thermocouple on N-4 was defective, which lead to incorrect pre-heater performance which affects catalyst performance.
- Heating unit wires melted on two units and needed to be replaced.
- Circuit breakers for port main and starboard main heater units were tripped. Circuit breakers have been reset. Maintenance check list now includes checking heater circuits.
- HiBACK systems for N-2, N-3, and N-4 were replaced.
- Fuel injectors on N-2 were replaced and timing was checked on all engines. The injectors were an old part number that had different valve clearance specifications. Now all engines have current fuel injector series and are set to factory specifications.
- One additional filter was installed in the N-3 and N-4 CDPFs for a total of 6 filters per CDPF unit. Four additional filters were installed in the N-1 and N-2 CDPFs for a total of 20 filters per CDPF unit. This reduced backpressure because they were installed where the stack was previously blocked off.
- Routine maintenance and valves checks and replacements were performed, and Caterpillar and CleanAIR support staff validated that engines and filters were operating correctly.

In addition to these mechanical adjustments, the following operational improvements have been or will be implemented before commencing operation:

- Additional operator training on proper maintenance of units was conducted.
- The HiBACK system has status lights that indicate proper operation but a laptop is required to interrogate unit for historical temperatures and back pressures. Shell has added a laptop with appropriate software to interrogate the HiBACK systems which are indicators of CDPF performance.
- Shell will install analogue air pressure gages (manometers with about 1% error) upstream of catalysts to provide visible, real time indication of CDPF back pressure
- Shell will add audible alarms to HiBACK units to monitor backpressure.

4.3.3 Follow-up Source Tests

At the time of this submittal, Shell has just completed a second complete set of test runs at 25, 50, 75 and 100% load capacity for the main engines (N-1, N-2) and at 50 and 100 percent load for the generator engines (N-3, N-4). Because the new Method 202 requires significant time to dry the condensable fraction, PM results are not expected before early August.

The test results are expected to provide Shell with a more realistic basis for monitoring compliance during operation. Due to the improvements and repairs since the March tests, and a qualitative assessment of the filters, Shell anticipates that PM measurements will be more consistent and may be lower than those conducted in March. Nonetheless, Shell does not anticipate that PM emission rates will be low enough to achieve the existing 3.03 lbs/day PM emission limits.

4.4 Proposed Revised Particulate Matter Limits

The Nanuq engine source test results indicate that the CDPF-controlled Nanuq engines cannot meet the 3.03 lbs/day PM emission limits. We now realize that the emission estimates submitted in the application were not realistic for this vessel, the type of engine, and the manner in which it operates, and this resulted in emission limits that are too stringent. We note too that the limits are excessively low when compared with PM limits in similar contexts. The allowable aggregate PM emissions from the Nanuq are approximately five percent of those for other primary OSRVs in similar permits and permit applications in the Arctic OCS. For example, the daily primary OSRV limit in Shell Offshore Inc.'s permit for offshore exploration by the Kulluk Drillship in the Beaufort Sea (R10-OCS030000) is 64.6 lb per day for $PM_{2.5}$ and 68.2 lb/day for PM_{10}. When it submitted an application for an OCS permit (now withdrawn), ConocoPhillips proposed primary daily PM emissions of approximately 62 lb per day for their OSRV. Furthermore, the OSRVs described these other cases are smaller that the Nanuq in terms of maximum power capacity.

4.4.1 Requested Limits

In order to account for higher operating loads and higher emission rates, Shell requests that the PM10 and PM2.5 emission limits be revised to 36 pounds per day, which is approximately half the daily PM emission limits in the other two cases described above. Increasing the allowable daily aggregate PM emissions limits from 3.03 lbs/day to 36 lbs/day would result in a 2 ton increase in potential annual emissions. This is well below the 10 ton PM2.5 significant emissions increase and the 15 ton PM10 significant emissions increase that constitute major modifications under the PSD permit program. Furthermore, there is no BACT requirement for emission units on the Associated Fleet vessels. The only applicable regulatory requirement is that the exploration operations continue to comply with ambient air quality standards; that issue is addressed in Section 4.5.

As well as revising the PM emission limits, Shell proposes that EPA add monitoring, recordkeeping, and reporting conditions so that daily emissions of PM may be calculated to the greatest accuracy that the collected data allows. Shell has chosen to measure fuel consumption on each engine individually and at a greater frequency than is required by the permit. For Units N-1-4, fuel consumption will be measured every 15 minute. For emission units aboard the Discoverer, Shell is permitted to use tested emission factor as a function of power level, and Shell requests that the same be allowed for N-1, N-2, N-3, and N-4.

4.4.2 Proposed Permit Text Revisions

In order to implement the requested revisions, Shell proposes the following specific permit condition revisions:

Q.4 Daily Emission Limits: ****

4.1. Nanuq propulsion engines and generators in aggregate (Units N-1 – 4):

4.1.1. PM10: ~~3.03~~ 36.0 lbs/day

4.1.1.1. For compliance with Condition Q.4.1.1, measurement of PM_{10} shall be determined using EPA Method s 201A and 202.

4.1.2. PM2.5: ~~3.03~~ <u>36.0</u> lbs/day

4.1.2.1. For compliance with Condition Q.4.1.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

Q.9. Monitoring, Recordkeeping and Reporting. ****

9.4. Monitor and record fuel usage for each propulsion and generator engine (Units N-1-4) at least hourly.

9.7. Each day, calculate and record for the previous calendar day, the emissions of NOX, $PM_{2.5}$ and PM_{10}, in pounds per hour and pounds per day using the highest emission factor for each tested engine collected under Condition Q.8.5 and fuel usage data collected under Condition Q.9.4, <u>unless power level is monitored on at least a 15-minute frequency, in which case an appropriate load-based emission factor collected under Condition Q.8.5 can be used</u>.

No other changes to the PSD permit are required to implement these requested revisions.

4.5 Compliance with Ambient Air Quality Standards

To ensure the proposed increase in PM emissions does not compromise compliance with ambient air quality standards, the AERMOD dispersion model was applied to evaluate an aggregate emission rate of 36 pounds per day from the OSRV. The modeling was conducted using the same approach as used in the permit application. The modeling analysis demonstrates continued compliance with the 24-hour and annual PM2.5 ambient air quality standards, the 24-hour PM10 ambient air quality standard, and the 24-hour and annual PM10 PSD increments. Additional information on the modeling analysis is provided in a Technical Memorandum by Air Sciences that is provided in Appendix I.

Appendix A

September 2011 PSD Permit

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140

OUTER CONTINENTAL SHELF PREVENTION OF SIGNIFICANT DETERIORATION PERMIT TO CONSTRUCT

Permit Number: R10OCS/PSD-AK-09-01 Issuance Date: September 19, 2011

In accordance with the provisions of Clean Air Act (CAA) Section 328 and Code of Federal Regulations (CFR) Title 40, Part 55, and the provisions of Part C to Title I of the CAA and 40 CFR § 52.21,

Shell Gulf of Mexico Inc.
3601 C Street, Suite 1000
Anchorage, AK 99503

is authorized to construct and operate the Noble Discoverer (Discoverer) drillship and its air emission units and to conduct other air pollutant emitting activities in accordance with the permit conditions listed in this permit, and only at the following lease blocks from the Chukchi Sea lease sale 193:

<u>NR02-02:</u> 6819 6820 6821 6822 6868 6869 6870 6871 6872 6918 6919 6920 6921 6922 6968 6969 6970 6971 6972 7018 7019 7020 7021 7022 7023 7068 7069 7072

<u>NR03-01:</u> 6105 6106 6155 6156 6161 6162 6211 6212 6261 6363 6364 6413 6414 6415 6418 6419 6462 6463 6464 6465 6467 6468 6469 6512 6513 6514 6515 6516 6517 6518 6519 6562 6563 6564 6565 6567 6568 6569 6612 6613 6614 6615 6616 6617 6618 6665 6666 6667 6668 6705 6706 6712 6715 6716 6717 6753 6754 6755 6756 6761 6762 6765 6766 6767 6803 6804 6805 6810 6811 6812 6813 6814 6815 6816 6817 6853 6854 6855 6860 6861 6862 6863 6864 6865 6866 6903 6904 6905 6908 6909 6910 6911 6912 6913 6914 6915 6916 6953 6954 6955 6956 6957 6958 6959 6960 6961 6962 6963 6964 6965 7006 7007 7008 7009 7010 7011 7012 7013 7014 7056 7057 7058 7059 7060 7061 7062 7063 7106 7107 7108 7109 7110 7119

<u>NR03-02:</u> 6114 6115 6161 6163 6164 6165 6213 6214 6215 6220 6259 6261 6263 6264 6265 6270 6271 6321 6322 6359 6360 6371 6372 6409 6410 6422 6423 6459 6508 6558 6608 6658 6671 6672 6708 6713 6714 6715 6721 6722 6757 6761 6762 6763 6764 6765 6766 6771 6807 6811 6812 6813 6814 6815 6816 6817 6856 6862 6863 6864 6865 6866 6905 6912 6913 6914 6915 6916 6962 6963 6964 6965

<u>NR04-01:</u> 6352 6401 6402 6452 6453 6503 6504 6554 6604

<u>NR03-03:</u> 6007 6008 6009 6010 6017 6018 6020 6056 6057 6058 6059 6067 6068 6070 6108 6219 6560 6561 6609 6610 6611 6658 6659 6660 6709 6721 6722 6723 6759 6771 6772 6773 6823

Terms not otherwise defined in this permit have the meaning assigned to them in the referenced statutes and regulations. All terms and conditions of the permit are enforceable by the United States Environmental Protection Agency (EPA) and citizens under the CAA.

_____/s/___________ ______9/19/2011_______
Richard Albright Date
Director, Office of Air, Waste and Toxics

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ABBREVATIONS AND ACRONMYS

BACT............................Best Available Control Technology
CAA..............................Clean Air Act
CDPF............................Catalyzed Diesel Particulate Filter
CFR..............................Code of Federal Regulations
CGA..............................Cylinder Gas Audit
CMS..............................Continuous Monitoring Systems
CTM..............................Conditional Test Method
COA..............................Corresponding Onshore Area
EPA..............................United States Environmental Protection Agency
HPU..............................Hydraulic Power Unit
MLC..............................Mud Line Cellar
NA.................................Not applicable
OCS..............................Outer Continental Shelf
PSD..............................Prevention of Significant Deterioration
PTE..............................Potential to Emit
PDF..............................Portable Document Format
QA.................................Quality Assurance
QC.................................Quality Control
SCR..............................Selective Catalytic Reduction
USCG............................United States Coast Guard

UNITS AND MEASUREMENTS

Btu................................British thermal units
^{o}C..................................degree Celsius
dscf...............................dry standard cubic foot
^{o}F..................................degree Fahrenheit
g....................................grams
hp..................................brake horsepower
hr...................................hour
kW.................................kiloWatts (mechanical)
kWe...............................kiloWatts electrical
lb...................................pounds
MMBtu/hr.....................Million British thermal units per hour
ppm...............................parts per million
ppmv.............................parts per million by volume
scf.................................standard cubic foot
tpy.................................tons per year

POLLUTANTS

CO ....Carbon Monoxide
CO_2e..............................Carbon Dioxide Equivalent
GHG or GHGs ....Greenhouse Gas or Greenhouse Gases
NH_3 ....Ammonia
NMHC...........................Non-Methane Hydrocarbons
NO_X...............................Oxides of Nitrogen
NO_2 ....Nitrogen Dioxide
PM.................................Particulate Matter
$PM_{2.5}$ ....Particulate Matter with an Aerodynamic Diameter less than 2.5 microns
PM_{10}..............................Particulate Matter with an Aerodynamic Diameter less than 10 microns
SO_2................................Sulfur Dioxide
VOC ....Volatile Organic Compound

AUTHORITY

The United States Environmental Protection Agency (EPA) is issuing this outer continental shelf (OCS)/prevention of significant deterioration (PSD) permit pursuant to Section 328 of the CAA, 42 U.S.C. § 7627, and the implementing OCS regulations at 40 CFR Part 55, and pursuant to Part C to Title I of the CAA, 42 USC §§ 7470 to 7492, and the implementing PSD air quality regulations at 40 CFR § 52.21. This proposed action is based upon the application initially submitted by Shell Offshore Inc. (Shell or permittee) on December 19, 2008, supplemental submittals identified in the administrative record for this permit action, and upon the technical analysis performed by the EPA.

FINDINGS

On the basis of the information in the administrative record, the EPA has determined that:

1. The permittee will meet all of the applicable requirements of the 40 CFR Part 55.
2. The permittee will meet all of the applicable requirements of the 40 CFR § 52.21.

APPROVAL CONDITIONS

Shell is authorized to construct and operate the vessels and emission units listed in Tables 1 through 5, at any of the lease blocks identified on Page 1 of this permit, and consistent with the representations in the permit application and subject to the conditions in this permit.

Coast Guard Safety Zone. The permit does not authorize operation unless:

a. The Discoverer is subject to a currently effective safety zone established by the United Sates Coast Guard (USCG) which encompasses an area within at least 500 meters from the center point of the Discoverer and which prohibits members of the public from entering this area except for attending vessels or vessels authorized by the USGC (such area shall be referred to as the “Safety Zone”); and

b. Shell has developed in writing and is implementing a public access control program to:

   - locate, identify, and intercept the general public by radio, physical contact, or other reasonable measures to inform the public that they are prohibited by Coast Guard regulations from entering the Safety Zone; and
   - communicate to the North Slope communities on a periodic basis when exploration activities are expected to begin and end at a drill site, the location of the drill site, and any restrictions on activities in the vicinity of Shell’s exploration operations.

Table 1 – Noble Discoverer Emission Units

ID	Description	Make and Model	Rating[a]
FD-1 – 6	Generator Engines	Caterpillar D399 SCAC 1200 rpm	1,325 hp
FD-7	Propulsion Engine	Mitsubishi 6UEC65	7,200 hp
FD-8	Emergency Generator Seldom Used Sources	Caterpillar 3412 Various	639 hp Various[b]
FD-9 – 11	MLC Compressor Engines	Caterpillar C-15	540 hp
FD-12 – 13	HPU Engines	To be determined	250 hp
FD-14	Port Deck Crane Engine	Caterpillar D343	365 hp
FD-15	Starboard Deck Crane Engine	Caterpillar D343	365 hp
FD-16 – 17	Cementing Unit Engines	Detroit 8V-71N	335 hp
FD-18	Cementing Unit Engine	GM 3-71	147 hp
FD-19	Logging Winch Engine	Caterpillar C7	250 hp
FD-20	Logging Winch Engine	John Deere PE4020TF270D	35 hp
FD-21 – 22	Heat Boilers	Clayton 200	7.97 MMBtu/hr
FD-23	Incinerator	TeamTec GS500C	276 lb/hr
FD-24 -30	Fuel Tanks	Not applicable (NA)	Various
FD-31	Supply Ship Generator Engine(s) [c]	Generic	584 hp
FD-32	Drilling Mud System	NA	NA
FD-33	Shallow Gas Diverter System[d]	NA	NA

[a] Permit conditions may limit operation to less than rated capacity.
[b] See Condition E.3 for the Discoverer Emergency Generator and Seldom Used Sources (Unit FD-8) aggregate fuel use limit.
[c] Only when attached to the Discoverer.
[d] Permit condition prohibits the shallow gas diverter system from emitting any air pollutants.

Table 2 – Icebreaker #1

Description	Make and Model	Maximum Aggregate Rating[a]
Aggregate of Propulsion Engines and Generator Engines	Various	31,200 hp
Generator Engine(s)	Various	2,800 hp
Heat Boiler(s)	Various	10 MMBtu/hr
Incinerator	Various	154 lbs/hr
Seldom Used Sources	Various	Various[b]

[a] Permit conditions may limit operation to less than rated capacity.
[b] See Condition N.9.3 for the Icebreaker #1 Seldom Used Sources aggregate fuel use limit.

Table 3 – Icebreaker #2

ID	Description	Make and Model	Rating[a]
Tor Viking			
TV-1 - 2	Main Propulsion Engines	Caterpillar MaK 8M32	5,046 hp
TV-3 - 4	Main Propulsion Engines	Caterpillar MaK 6M32	3,784 hp
TV-5 – 6	Non-propulsion Generator Engines	Caterpillar 3412	1,168 hp
TV-7	Heat Boiler	NA	1.37 MMBtu/hr
TV-8	Incinerator	NA	151 lb/hr
	Seldom Uses Sources	Various	Various[b]
Hull 247[c]			
	Main Engines	NA	24 MW[d]
	Heat Boiler	NA	4 MMBtu/hr
	Incinerator	NA	151 lb/hr
	Seldom Uses Sources	Various	Various[b]

[a] Permit conditions may limit operation to less than rated capacity.
[b] See Condition O.9.5 for the Icebreaker #2 Seldom Used Sources aggregate fuel use limit.
[c] Hull 247 is the shipbuilder's (Edison Chouest) designation for a vessel to be built under contract to Shell. The final name for the vessel may be different than this temporary designation.
[d] This represents an aggregate rating of all engines on board Hull 247.

Table 4 – Supply Ship

Description	Make and Model	Maximum Aggregate Rating[a]
Propulsion Engines and Non-Propulsion Generator Engine(s), Excluding Emergency Engine	Various	Various[b]
Emergency Engine	Various	Various[b]

[a] Permit conditions may limit operation to less than rated capacity.
[a] See Condition P.1 for the Supply Ship/Barge and Tug aggregate fuel use limit.

Table 5 – Oil Spill Response Fleet

ID	Description	Make and Model	Rating[a]
Oil Spill Response Main Ship - Nanuq			
N-1 – 2	Propulsion Engines	Caterpillar 3608	2,710 kW
N-3 – 4	Electrical Generators	Caterpillar 3508	1,285 hp
N-5	Emergency Generator	John Deere	166 kW
N-6	Incinerator	ASC/CP100	125 lbs/hr
	Seldom Used Sources	Various	Various[b]
Oil Spill Response Work Boat - Kvichak 34-foot No. 1			
K-1 – 2	Propulsion Engines	Cummins QSB	300 hp
K-3	Generator Engines	Various	12 hp
Oil Spill Response Work Boat - Kvichak 34-foot No. 2			
K-4 – 5	Propulsion Engines	Cummins QSB	300 hp
K-6	Generator Engines	Various	12 hp
Oil Spill Response Work Boat - Kvichak 34-foot No. 3			
K-7 – 8	Propulsion Engines	Cummins QSB	300 hp
K-9	Generator Engines	Various	12 hp

[a] Permit conditions may limit operation to less than rated capacity.
[b] See Condition Q.5 for the Nanuq Seldom Used Sources aggregate fuel use limit.

Effective Date**.** This permit becomes effective 30 days after the service of notice of the final permit decision, unless review of the permit decision is requested pursuant to 40 CFR § 124.19.

OCS Source. Permit conditions contained in Sections B through Q, except for those conditions addressing notification, reporting and testing, apply only during the time that the Discoverer drillship is an OCS Source. Permit conditions in Sections A and R as well as permit conditions contained in Sections B through Q addressing notification, reporting and testing apply at all times as specified.

For the purpose of this permit:

a. The Discoverer is an "OCS Source" at any time the Discoverer is attached to the seabed at a drill site by at least a one anchor; and

b. A drill site is any location at which Shell is authorized to operate under this permit and for which Shell has received from the Bureau of Ocean, Energy, Management and Regulatory Enforcement (BOEMRE) an authorization to drill.

A. GENERALLY APPLICABLE REQUIREMENTS

1 **Construction and Operation.** The permittee shall construct and operate the OCS Source and the Associated Fleet in accordance with the application and supporting materials submitted by the permittee as identified in the Statement of Basis and Supplemental Statement of Basis for this permit action and in accordance with this permit. For purposes of this permit, Icebreaker #1, Icebreaker #2, the supply ship, the Nanuq and Kvichaks No. 1-3 shall collectively be referred to as the "Associated Fleet."

2 **Compliance Required.** The permittee shall comply with all requirements of 40 CFR § 52.21, Part 55, and this permit. Failure to do so shall be considered a violation of Section 111(e) and 165 of the CAA. All enforcement provisions of the CAA, including but not limited to, Section 113, 114, 120, 167, 303, and 304 apply to the permittee.

3 **Compliance with Other Requirements.** This permit does not relieve the permittee of the responsibility to comply fully with applicable provisions of any other requirements under federal law.

4 **Notification to Owners, Operators, and Contractors.** The permittee must notify all other owners or operators, contractors, and the subsequent owners or operators associated with emissions from the source of the conditions of this permit.

5 **Expiration of Approval to Construct.** As provided in 40 CFR § 52.21(f)(4), this approval shall become invalid if construction is not commenced within 18 months after the effective date of this permit, construction is discontinued for a period of 18 months, or construction is not completed within a reasonable time. The EPA may extend the 18-month period upon a satisfactory showing that an extension is justified.

6 **Permit Revision, Termination and Reissuance.** This permit may be revised, terminated, or revoked and reissued by the EPA for cause. Cause exists to revise, terminate, or revoke and reissue this permit under the following circumstances:

6.1 This permit contains a material mistake;

6.2 Materially inaccurate statements were made in establishing the terms or conditions of this permit;

6.3 The permittee fails to comply with any material condition of this permit; or

6.4 This permit must be revised, terminated, or revoked and reissued to assure compliance with CAA requirements.

A request by the permittee for modification, revocation and reissuance, or termination or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

7 **Credible Evidence.** For the purpose of establishing whether or not the permittee has violated or is in violation of any requirement of this permit, nothing in this permit shall preclude the use, including the exclusive use, of any credible evidence or information relevant to whether the permittee would have been in compliance with applicable

requirements if the appropriate performance or reference test or procedure had been performed.

8 **Inspection and Entry.** Upon presentation of credentials and other documents as may be required by law, the permittee shall allow the EPA or an authorized representative to perform the following:

8.1 Enter upon the Discoverer, any support vessel, any location where emissions-related activity is conducted, or any location where records must be kept under the conditions of the permit;

8.2 Have access to and copy, at reasonable times, any records that must be kept under the conditions of the permit;

8.3 Inspect at reasonable times any facilities, equipment (including monitoring and air pollution control equipment), practices, or operations regulated or required under the permit; and

8.4 As authorized by the CAA, sample or monitor at reasonable times substances or parameters for the purpose of assuring compliance with the permit or applicable requirements.

9 **Recordkeeping Requirements.** In addition to the specific recordkeeping requirements contained in the source-wide and emission unit sections of this permit, the permittee shall keep records of required monitoring information that include the following:

9.1 The date, place, and time of sampling or measurements;

9.2 The date(s) analyses were performed;

9.3 The company or entity that performed the analyses;

9.4 The analytical techniques or methods used;

9.5 The results of such analyses;

9.6 The operating conditions as existing at the time of sampling or measurement;

9.7 Copies of all reports and certifications submitted pursuant to this permit; and

9.8 The locations where samples were taken.

The permittee shall retain records of all required monitoring data and support information for a period of at least 5 years from the date of the monitoring sample, measurement, report, or application. Support information includes all calibration and maintenance records, all original strip-chart recordings for continuous monitoring instrumentation, and copies of all reports required by this permit.

10 **Agency Notifications.** Unless otherwise specified in this permit, any documents required to be submitted under this permit, including reports, test data, monitoring data, notifications, and applications for renewals and permit modifications shall be submitted to:

OCS/PSD Air Quality Permits
U.S. EPA - Region 10, AWT-107
1200 Sixth Avenue, Suite 900
Seattle, WA 98101
Facsimile no. 206-553-0110
Email: R10OCSAirPermits_Reports@epa.gov

11 **Certification.** Any document required to be submitted under this permit shall be certified by a responsible official, as that term is defined in 40 CFR § 71.2, of the permittee as to truth, accuracy, and completeness. Such certification shall state that based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate and complete.

12 **Severability.** The provisions of this permit are severable, and in the event of any challenge to any portion of this permit, or if any portion is held invalid, the remaining permit conditions shall remain valid and in force.

13 **Property Rights.** This permit does not convey any property rights of any sort, or any exclusive privilege.

14 **Information Request.** The permittee shall furnish the EPA, within a reasonable time, any information the EPA requests in writing to determine whether cause exists to modify, revoke and reissue, or terminate the permit or to determine compliance with the permit. Upon request, the permittee shall furnish the EPA with copies of records required to be kept by the permit.

15 **Excess Emission and Permit Deviation Reports.** Except as otherwise provided in this permit , the permittee shall report via fax and email, all emissions or operations that exceed or deviate from the requirements of this permit as follows:

15.1 As soon as possible after the event commences or is discovered, report:

15.1.1 Emissions that present a potential threat to human health or safety; and

15.1.2 Excess emissions that the permittee believes to be unavoidable.

15.2 Within two working days after the event commenced or was discovered, report an unavoidable emergency, malfunction, or non-routine repair that causes emissions in excess of a technology based emission standard; any other exceedance of an emission limit; or any exceedance of a throughput limit.

15.3 Report all other excess emissions and permit deviations:

15.3.1 Within 30 days after the end of the month during with the emissions or deviation occurred;

15.3.2 If a continuous or recurring excess emissions is not corrected within 48 hours of discovery, within 72 hours of discovery; and

15.3.3 For failure to monitor, as required in other applicable conditions of this permit.

15.4 When reporting excess emissions or permit deviations, the permittee must report using the form contained in Attachment A to this permit. The permittee must provide all information called for by the form.

15.5 If requested by the EPA, the permittee shall provide a more detailed written report as requested to follow up on an excess emissions report.

16 **Operating Reports.** During the life of this permit[1], the permittee shall submit an original and two copies of an Operating Report by March 31 for the preceding calendar year.

16.1 The Operating Report must include all information required to be in Operating Reports by other conditions of this permit.

16.2 If excess emissions or permit deviations that occurred during the reporting period are not reported under Condition A.15, either:

16.2.1 The permittee shall identify:

16.2.1.1 The date of the deviation;

16.2.1.2 The equipment involved;

16.2.1.3 The permit condition affected;

16.2.1.4 A description of the excess emissions or permit deviation; and

16.2.1.5 Any corrective action or preventive measures taken and the date or dates of such actions; or

16.2.2 When excess emissions or permit deviations have already been reported under Condition A.15, the permittee shall cite the date or dates of those reports.

16.3 The Operating Report must include a listing of emissions monitored which trigger additional testing or monitoring, whether or not the emissions monitored exceed an emission standard. The permittee shall include in the report:

16.3.1 The date of the emissions;

16.3.2 The equipment involved;

16.3.3 The permit condition affected; and

[1] "Life of this permit" is defined as the permit effective date, including any periods of reporting obligations that extend beyond the permit effective date. For example, if a permit expires prior to the end of a calendar year, there is still a reporting obligation to provide operating reports for the periods when the permit was in effect.

16.3.4 The monitoring result which triggered the additional monitoring.

16.4 The Operating Report must include reports of any required monitoring, including all emission calculations required by the permit.

B. SOURCE WIDE REQUIREMETNS

1. **Drill Site Notification.** At least 6 months prior to the Discoverer becoming an OCS Source, the permittee shall notify the EPA via facsimile of the following information:

1.1. The location of the proposed drill site, using coordinates in the following formats:

1.1.1. Latitude and longitude, and

1.1.2. Universal Transverse Mercator grid system.

1.2. The lease block within the Chukchi Sea lease sale 193 where the drill site is located;

1.3. The proposed date that the Discoverer will become an OCS Source at that drill site;

1.4. Confirmation that emissions from the source would impact no Class I area. The confirmation shall include a description of the legal and factual basis for this determination; and

1.5. Confirmation that emissions from the source would impact no area where an applicable increment was known to be violated. The confirmation shall include a description of the legal and factual basis for this determination.

2. **Duration of Exploration Operations.** The permittee shall only conduct exploration drilling operations in the Chukchi Sea between July 1 and November 30 each year (referred to hereafter as the "drilling season").

2.1. During any drilling season, the permittee shall not operate the Discoverer as an OCS Source in excess of 120 calendar days. Each partial day the Discoverer is operated as an OCS source shall be counted as a calendar day.

2.2. During any drilling season, the permittee shall not conduct any drilling activity in excess of 1,632 hours. Drilling activity is defined as any time when the top drive is engaged and turning the conventional rotary bit and any time when conducting mud line cellar (MLC) activity as defined in Condition B.2.3.

2.3. During any drilling season, the permittee shall not conduct any MLC activity in excess of 480 hours. MLC activity is defined as any time when any MLC compressor engine (Units FD-9 – 11) or HPU engine (Units FD-12 – 13) is operating.

2.4. For each drill site at which the Discoverer operates, the permittee shall record the following:

2.4.1. The location of each drill site, using a modern global positioning system to determine the location. Location shall be recorded by providing coordinates in the following formats:

2.4.1.1. Latitude and longitude, and

2.4.1.2. Universal Transverse Mercator grid system.

2.4.2. The lease block within the Chukchi Sea lease sale 193 where the drill site is located.

2.4.3. The date and hour that the Discoverer became an OCS Source at that drill site.

2.4.4. The date and hour that the Discoverer ceased to be an OCS Source at that drill site.

2.4.5. For each period of drilling activity except for periods of MLC activity, the permittee shall record the following:

2.4.5.1. The date and hour at which the top drive is first engaged and turning the conventional rotary bit; and

2.4.5.2. The date and hour at which the top drive is disengaged and no longer turning the conventional rotary bit.

2.4.6. For each period of MLC activity the permittee shall record the following:

2.4.6.1. The earlier of the following two points in time; the date and hour in which the first MLC compressor engine (Units FD-9 – 11) begins operation and the date and hour in which the first HPU engine (Units FD-12 – 13) begins operation; and

2.4.6.2. The later of the following two points in time: the date and hour in which the last MLC compressor engine (Units FD-9 – 11) ceases operation and the date and hour in which the last HPU engine (Units FD-12 – 13) ceases operation.

2.5. Any time spent drilling a relief well shall be included in the time recorded in Condition B.2.1.

2.6. By the 10th of each month, the permittee shall calculate and record the following operating parameters for the previous month and a running total for the current drill season or 12-month period, based upon recordkeeping performed pursuant to Conditions B.2.1, B.2.2, and B.2.3:

2.6.1. The number of days the Discoverer operated as an OCS source;

2.6.2. The number of hours of drilling activity; and

2.6.3. The number of hours of MLC activity.

3. **Drilling Season Notification.** Each drilling season, the permittee shall report to the EPA via facsimile the information below, within 3 days of occurrence:

3.1. The date and hour that the Discoverer became an OCS Source at the first drill site of that drilling season; and

3.2. The date and hour that the Discoverer ceased to be an OCS Source at the last drill site of that drilling season.

4. **Global Positioning System.** The permittee shall use a modern global positioning system on the Discoverer and Associated Fleet (except for the Kvichaks Nos. 1-3) as follows:

4.1. Monitor and record the date, time and location of the Discoverer and Associated Fleet when the Discoverer becomes and ceases to be an OCS source.

4.2. Monitor and record the date, time and location when each vessel in the Associated Fleet enters or leaves the 25 mile radius area around the Discoverer.

4.3. Once each hour, monitor and record the date, time, and location of the Discoverer and Associated Fleet.

4.4. Once each hour, monitor and record the date, time, direction the bow of the Discoverer is pointed, and wind direction at the Discoverer.

5. **Best Available Control Technology (BACT) for Sulfur Dioxide (SO_2) Emissions from Discoverer Emission Units.** The permittee shall not combust any liquid fuel with sulfur content greater than 0.0015 percent by weight, as determined by Condition B.5.1, in any emission unit on the Discoverer (except for Unit FD-7).

5.1. Representative fuel samples shall be obtained using one of the methods in 40 CFR § 80.330(b). The sulfur content of the fuel shall be determined using ASTM D 5453-08b.

5.2. Monitoring, Recordkeeping and Reporting. The permittee shall:

5.2.1. Prior to mobilizing the Discoverer for the first time at the beginning of a drilling season, determine the sulfur content in each fuel oil storage tank on the Discoverer. The permittee shall obtain a representative sample of the fuel and analyze the sample for sulfur content using the procedures in Condition B.5.1.

5.2.2. Thereafter, determine and record the sulfur content upon receiving each fuel shipment, as follows:

5.2.2.1. Obtain a representative sample of the fuel delivered and analyze the sample for sulfur content using the procedures in Condition B.5.1; or

5.2.2.2. Obtain a single certification of sulfur content for each shipment of fuel from the fuel supplier based on an analysis of the fuel, providing that the certification indicates that the sulfur content has been determined by the ASTM method listed in Condition B.5.1.

5.3. Within 3 business days of identification, report to the EPA any instance of a liquid fuel with sulfur content greater than 0.0015 percent by weight being combusted in any emission unit on the Discoverer (except Unit FD-7).

6. **Greenhouse Gas Potential to Emit Owner Requested Limit for Discoverer and Associated Fleet**

6.1. At all times while the Discoverer is an OCS Source, greenhouse gas (GHG) emissions as defined in 40 CFR § 52.21(b)(49) from the Discoverer and Associated

Fleet, when within 25 miles of the Discoverer, shall not exceed 70,000 tons carbon dioxide equivalent (CO_2e) as determined on a rolling 12-month basis by calculating the emissions (tons) for each month and adding the emissions (tons) calculated for the previous 11 months.

6.1.1. For emission units that combust fuel, monthly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions (tons) shall be determined by multiplying the appropriate emission factors for distillate oil in 40 CFR Part 98, Subpart C, Tables C-1 and C-2, by the recorded monthly fuel usage (gallons/month) and dividing by 2000 lb/ton.

6.1.2. For emission units that incinerate waste, monthly CO_2 emissions (tons) shall be determined by multiplying the CO_2 emission factor for incinerators in AP42 Table 2.1-7 (10/96) by the recorded monthly quantities of waste incinerated (tons/month) and dividing by 2000 lb/ton.

6.1.3. To account for mud off-gassing, monthly CH_4 emissions from the drilling mud shall be assumed to be 0.798 tons/month.

6.1.4. Monthly CO_2e emissions (tons) shall be determined by multiplying the calculated monthly emissions for CO_2, CH_4, and N_2O from all emission units and activities by the applicable global warming potential factors from 40 CFR Part 98, Subpart A, Table A-1, and summing the products.

6.2. At all times while the Discoverer is an OCS Source, the total amount of fuel combusted in engines and boilers on the Discoverer and Associated Fleet, when within 25 miles of the Discoverer, shall not exceed 6,346,493 gallons during any rolling 12-month period.

6.3. At all times while the Discoverer is an OCS Source, the total amount of waste combusted in incinerators on the Discoverer and Associated Fleet, when within 25 miles of the Discoverer, shall not exceed 1,657,440 pounds during any rolling 12-month period.

6.4. Monitoring, Recordkeeping and Reporting. The permittee shall monitor and record monthly fuel consumption and waste incineration as follows:

6.4.1. Equip each fuel combustion source on the Discoverer and Associated Fleet, except for seldom used sources, with a diesel fuel flow meter to continuously measure and record the fuel flow rate:

6.4.1.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the engine(s) being served by the meter.

6.4.1.2. Each fuel flow meter shall be totalizing and non-resettable.

6.4.1.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value.

6.4.1.4. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

6.4.1.5. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

6.4.2. Measure the fuel combusted in each seldom used fuel combustion source on the Discoverer and Associated Fleet by recording the quantity of fuel in each engine's fuel tank before and after periodic operation of each seldom used source:

6.4.2.1. Fuel tank content measurement may take the form of sight glass, use of a graduated dip stick, or tank instrumentation.

6.4.3. Calculate and record monthly fuel consumption for each fuel combustion source on the Discoverer and Associated Fleet in gallons. Determine the 12-month rolling fuel consumption by adding the gallons for each month to the gallons recorded for the previous 11 months.

6.4.4. For each batch of waste charged to an incinerator:

6.4.4.1. Record the date and time that each batch of waste was charged to the incinerator;

6.4.4.2. Weigh the batch of waste by using a weigh scale used that shall be accurate to within 0.5 lbs; and

6.4.4.3. Record the weight of each batch of waste charged to the incinerator.

6.4.5. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of the weigh scale to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

6.4.6. Maintain the accuracy of the weigh scale in accordance with manufacturer's recommendations.

6.4.7. Calculate and record monthly waste combusted in each incinerator on the Discoverer and Associated Fleet in pounds. Determine the 12-month rolling waste combusted by adding the waste combusted for each month to the waste combusted for the previous 11 months.

7. **Sulfuric Acid Mist Potential to Emit Owner Requested Limit for Associated Fleet.** The permittee shall not combust any liquid fuel with sulfur content greater than 0.0015 percent by weight, as determined by Condition B.7.1, in any emission unit on any vessel in the Associated Fleet.

7.1. Representative fuel samples shall be obtained using one of the methods in 40 CFR § 80.330(b). The sulfur content of the fuel shall be determined using ASTM D 5453-08b.

7.2. Monitoring, Recordkeeping and Reporting. The permittee shall:

7.2.1. Prior to mobilizing the Discoverer for the first time at the beginning of a drilling season, determine the sulfur content in each fuel oil storage tank on the vessels comprising the Associated Fleet. The permittee shall obtain a representative sample of the fuel and analyze the sample for sulfur content using the procedures in Condition B.7.1.

7.2.2. Thereafter, determine and record the sulfur content upon receiving each fuel shipment, as follows:

7.2.2.1. Obtain a representative sample of the fuel delivered and analyze the sample for sulfur content using the procedures in Condition B.7.1; or

7.2.2.2. Obtain a single certification of sulfur content for each shipment of fuel from the fuel supplier based on an analysis of the fuel, providing that the certification indicates that the sulfur content has been determined by the ASTM method listed in Condition B.7.1.

7.3. Within 3 business days of identification, report to the EPA any instance of a liquid fuel with sulfur content greater than 0.0015 percent by weight being combusted in any emission unit on any vessel in the Associated Fleet.

8. **BACT for Particulate Matter Emissions (PM, PM_{10}, and $PM_{2.5}$) from Discoverer Diesel IC Engine Crankcase Ventilation.** Except for the MLC Diesel Compressor Engines (FD-9 - 11) and the Caterpillar C7 Logging Winch Engine (FD-19), each diesel IC engine on the Discoverer shall be equipped with a closed crankcase ventilation system.

9. **General Testing Requirements.** Whenever conducting a stack test required by this permit, and unless specifically stated otherwise in this permit, the permittee shall comply with the following testing requirements in addition to the specific testing requirements contained in the emission unit sections of this permit:

9.1. The permittee shall provide the EPA at least 30 days prior notice of any stack test. If after 30 days notice for an initially scheduled stack test, there is a delay in conducting the scheduled stack test, the permittee shall notify the EPA as soon as possible of any delay in the original test date, either by providing at least 7 days prior notice of the rescheduled date of the stack test, or by arranging a rescheduled date with the EPA by mutual agreement.

9.2. The permittee shall submit to the EPA a complete stack test plan within 60 days after receiving a request by the EPA and at least 30 days prior to any required testing unless the EPA agrees in writing to some other time period. Retesting may be done without resubmitting the plan provided it is conducted in accordance with the previously submitted plan. The permittee shall follow the submitted test plan except as otherwise agreed to in writing by EPA prior to the testing. The source test plan shall include and address the following elements:

9.2.1. Purpose and scope of testing;

9.2.2. Source description, including a description of the operating scenarios and mode of operation during testing and including fuel sampling and analysis procedures;

9.2.3. Schedule/dates of testing;

9.2.4. Process data to be collected during the test and reported with the results, including source-specific data identified in the emission unit sections of this permit;

9.2.5. Sampling and analysis procedures, specifically requesting approval for any proposed alternatives to the reference test methods, and addressing minimum test length (e.g., one hour, 8 hours, 24 hours, etc.) and minimum sample volume;

9.2.6. Sampling location description and compliance with the reference test methods;

9.2.7. Analysis procedures and laboratory identification;

9.2.8. Quality assurance plan;

9.2.9. Calibration procedures and frequency;

9.2.10. Sample recovery and field documentation;

9.2.11. Chain of custody procedures;

9.2.12. Quality Assurance (QA)/Quality Control (QC) project flow chart;

9.2.13. Data processing and reporting;

9.2.14. Description of data handling and QC procedures; and

9.2.15. Report content and timing.

9.3. Unless otherwise specified in this permit, or the EPA determines in writing that other operating conditions are representative of normal operations or unless specified in the emission unit sections of this permit, the source shall be operated at a capacity of at least 90 percent but no more than 100 percent of maximum during all tests.

9.4. Unless otherwise specified by an applicable requirement or test method, the permittee shall conduct source testing at a point or points that characterize the actual discharge into the ambient air.

9.5. Only regular operating staff may adjust the processes or emission control devices during or within 2 hours prior to the start of a source test. Any operating adjustments made during a source test, that are a result of consultation during the tests with source testing personnel, equipment vendors, or consultants, may render the source test invalid.

9.6. For the duration of each test run (unless otherwise specified), the permittee shall record the following information:

9.6.1. All data which is required to be monitored during the test in the emission unit sections of this permit; and

9.6.2. All continuous monitoring system data which is required to be routinely monitored in the emission unit sections of this permit for the emission unit being tested.

9.7. Each source test shall follow the reference test methods specified by this permit and consist of at least three (3) valid test runs. For purposes of this permit:

9.7.1. EPA Test Methods 1, 2, 3A, 4, 5, 6C, 7E, 9, 10, 19, and 25A are set forth in 40 CFR Part 60, Appendix A;

9.7.2. EPA Test Methods 201A and 202 are set forth in 40 CFR Part 51, Subpart M;

9.7.3. Conditional Test Method 027 (CTM-027), "Procedure for Collection and Analysis of Ammonia in Stationary Sources," is set forth at http://www.epa.gov/ttn/emc/ctm.html;

9.7.4. Conditional Test Method 038 (CTM-038), "Measurement of Ammonia Emissions from Highway, Nonroad, and Stationary Use Diesel Engines by Extractive Fourier Transform Infrared (FTIR) Spectroscopy," is set forth at http://www.epa.gov/ttn/emc/ctm.html;

9.7.5. Other Test Method 27 (OTM 27), "Determination of PM_{10} and $PM_{2.5}$ Emissions from Stationary Sources (Constant Sampling Rate Procedure)," is set forth at http://www.epa.gov/ttn/emc/prelim.html; and

9.7.6. ASTM D 5453-09 is set forth at http://www.astm.org/Standards/D5453.htm.

9.8. Facilities for performing and observing the emission testing shall be provided that meet the requirements of 40 CFR § 60.8(e) and EPA Method 1.

9.9. Emission test reports shall be submitted to the EPA within 45 days of completing any emission test required by this permit along with items required to be recorded in Condition B.9.6 above.

9.10. EPA Methods 1, 2, 3A, 3B, 4, and 19 shall be used as necessary to convert the measured NO_X, PM, PM_{10}, $PM_{2.5}$, and CO emissions into units of the emission limits in the permit.

9.11. Source test emission data shall be reported as the arithmetic average of all valid test runs and in the terms of any applicable emission limit, unless otherwise specified in the emission unit sections of this permit.

9.12. An alternative test method or a deviation from a test method identified in this permit may be approved as follows:

9.12.1. The permittee must submit a written request to the EPA at least 60 days before the stack test is scheduled to begin which includes the reasons why the alternative or deviation is needed and the rationale and data to demonstrate that the alternative test method or deviation from the reference test method:

9.12.1.1. Provides equal or improved accuracy and precision as compared to the specified reference test method; and

9.12.1.2. Does not decrease the stringency of the standard as compared to the specified reference test method.

9.12.2. If requested by the EPA, the demonstration referred to in Condition B.9.12.1 must use Method 301 in 40 CFR Part 63, Appendix A, to validate the alternative test method or deviation.

9.12.3. The EPA must approve the request in writing.

9.12.4. Until the EPA has given written approval to use an alternative test method or to deviate from the test method specified in this permit, the permittee is required to use the test method specified in this permit when conducting a source test under this permit.

9.13. The permittee may request an extension to a source test deadline established by the EPA. The permittee may delay a source test beyond the original deadline only if the extension is approved in writing by the EPA.

9.14. In addition to any source testing explicitly required by this permit, the permittee shall conduct source testing as requested by the EPA to determine compliance with applicable permit requirements.

9.15. For any source test requiring the use of Method 201A, the permittee may substitute the use of Method 5. In either case, Method 202 shall also be employed for condensable PM, and the test results shall consider all PM to be $PM_{2.5}$.

10. **Prohibited Activities.** The permittee shall not:

10.1. Flow test wells,

10.2. Flare gas,

10.3. Store liquid hydrocarbons recovered during well testing,

10.4. Refuel any vessel (including the Discoverer, and excluding the Kvichak workboats) within 25 miles of the Discoverer, while the Discoverer is an OCS Source, or

10.5. Allow any vessel associated with this project, and that is not authorized by Tables 1 through 5 of this permit, to approach within 25 miles of the Discoverer, while the Discoverer is an OCS Source.

11. **Monthly Emissions Calculations.** By the tenth of each month, the permittee shall, using monitoring data collected pursuant to the requirements of this permit, calculate and record the monthly emissions of CO, NO_X, $PM_{2.5}$, PM_{10}, SO_2, VOC, and GHG emissions for the preceding month. For NO_X, the permittee shall also calculate and record the monthly emissions for the preceding month for each engine, boiler, or incinerator (or groups of engines or boilers) that are subject to an annual NO_X emission limit in this permit.

12. **Rolling 12-Month Emissions Calculations.** By the tenth of each month, the permittee shall calculate and record the rolling 12-month emissions of CO, NO_X, $PM_{2.5}$, PM_{10}, SO_2, VOC, and GHG emissions by using the monthly emissions calculated for the previous 12 months pursuant to Condition B.11. For NO_X, the permittee shall also calculate and record the rolling 12-month emissions for each engine, boiler, or incinerator (or groups of engines or boilers) that are subject to an annual NO_X emission limit in this permit.

13. **Good Operating and Maintenance Requirements.** At all times, including periods of startup, shutdown, and malfunction, the permittee shall, to the extent practicable, maintain and operate each emission unit, including any associated air pollution control equipment, in a manner consistent with good air pollution control practices for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the EPA which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures, and inspection of the source. The permittee shall keep records of any maintenance that would have a significant effect on emissions (the records may be kept in electronic format) and keep a copy of either the manufacturer's or the operator's maintenance procedures.

14. **Selective Catalytic Reduction (SCR) Control Device Monitoring.** For any emission unit that is required by this permit to be controlled by an SCR control device, the permittee shall install, calibrate, operate, and maintain (in accordance with manufacturer specifications) continuous monitoring systems (CMS) to measure and record inlet temperature in degrees Fahrenheit (ºF), urea feed rate (gallons/min), and catalyst activity (NO_X ppm concentration) as follows:

14.1. Prepare and submit 60 days before the first drilling season a site-specific monitoring plan that addresses the monitoring system design, data collection, quality assurance, and quality control elements outlined in this condition. Install, calibrate, operate, and maintain each CMS according to the procedures in the approved site-specific monitoring plan. The plan shall address the performance criteria and design specifications for the monitoring system equipment, including the sample interface, detector signal analyzer, sensor tolerance sensitivity, and data acquisition and calculations; sampling interface (e.g., thermocouple, flow meter) location such that the monitoring system will provide representative measurements; equipment performance checks, system accuracy audits, or other audit procedures; ongoing operation and maintenance procedures; and ongoing reporting and recordkeeping procedures.

14.2. The temperature and urea CMS shall collect data at least once every 15 minutes.

14.3. Conduct the CMS equipment performance checks, system accuracy audits, or other audit procedures specified in the site-specific monitoring plan within 60 days prior to each drilling season and at least once every 3 months for the duration of the drilling season.

14.4. Conduct a performance evaluation of each CMS in accordance with the site-specific monitoring plan.

14.5. Except for periods of monitoring system malfunctions, repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, system accuracy audits and required zero and span adjustments), operate the CMS at all times the affected source is operating. A monitoring system malfunction is any sudden, infrequent, not reasonably preventable failure of the monitoring system to provide valid data. Monitoring system failures that are caused in part by poor maintenance or careless operation are not malfunctions. Complete monitoring system repairs in response to monitoring system malfunctions and return the monitoring system to operation as expeditiously as practicable.

14.6. Monitor and record NO_X emissions (ppm) from the exhaust of each SCR unit once per week using a portable NO_X monitor that meets the requirements of EPA OTM 13 found at http://www.epa.gov/ttn/emc/prelim/otm13.pdf.

14.7. Report as a deviation under Condition A.0 any periods during which the urea pump is not operating, the inlet temperature is less than 250°C, or the NO_X concentration is 150 percent or more than the NO_X concentration measured during the most recent previous source test that produced compliance data or emission factors for this permit.

15. **Oxidation Catalyst Control Device Monitoring.** For any emission unit that is required by this permit to be controlled by an oxidation catalyst control device, the permittee shall install, calibrate, operate, and maintain (in accordance with manufacturer specifications) CMS to measure and record inlet temperature (ºF), and catalyst activity (CO ppm concentration) as follows:

15.1. Prepare and submit 60 days before the first drilling season a site-specific monitoring plan that addresses the monitoring system design, data collection, quality assurance, and quality control elements outlined in this condition. Install, calibrate, operate, and maintain each CMS according to the procedures in the approved site-specific monitoring plan. The plan shall address the performance criteria and design specifications for the monitoring system equipment, including the sample interface, detector signal analyzer, sensor tolerance and sensitivity, and data acquisition and calculations; sampling interface (e.g., thermocouple) location such that the monitoring system will provide representative measurements; equipment performance checks, system accuracy audits, or other audit procedures; ongoing operation and maintenance procedures; and ongoing reporting and recordkeeping procedures.

15.2. The temperature CMS shall collect data at least once every 15 minutes.

15.3. Conduct the CMS equipment performance checks, system accuracy audits, or other audit procedures specified in the site-specific monitoring plan within 60 days prior to each drilling season and at least once every 3 months for the duration of the drilling season.

15.4. Conduct a performance evaluation of each CMS in accordance with the site-specific monitoring plan.

15.5. Except for periods of monitoring system malfunctions, repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, system accuracy audits and required zero and span adjustments), operate the CMS at all times the affected source is operating. A monitoring system malfunction is any sudden, infrequent, not reasonably preventable failure of the monitoring system to provide valid data. Monitoring system failures that are caused in part by poor maintenance or careless operation are not malfunctions. Complete monitoring system repairs in response to monitoring system malfunctions and return the monitoring system to operation as expeditiously as practicable.

15.6. Monitor and record CO emissions (ppm) from the exhaust of each oxidation catalyst unit once per week using a portable CO monitor that meets the requirements of EPA OTM 13 found at http://www.epa.gov/ttn/emc/prelim/otm13.pdf.

15.7. Report as a permit deviation under Condition A.0 any periods during which the inlet temperature is less than 300°C, or the CO concentration is 120 percent or more than the CO concentration measured during the most recent previous source test that produced compliance data or emission factors for this permit.

C. DISCOVERER GENERATOR ENGINES (FD-1 – 6)

1. **Operation of Selective Catalytic Reduction (SCR) Unit.** At all times that any of Units FD-1 – 6 are in operation, the exhaust from each emission unit shall be directed to an operating SCR unit.

2. **Operation of Oxidation Catalyst.** At all times that any of Units FD-1 – 6 are in operation, the exhaust from each emission unit shall be directed to an operating oxidation catalyst.

3. **BACT Limits.** Emissions from each generator engine (Units FD-1 – 6) shall not exceed the emission limits specified for each of the pollutants below:

3.1. **Nitrogen oxides (NO_X):** 0.50 grams (g) per kilowatt-hour (kW-hr)

3.1.1. For compliance with Condition C.3.1, measurement of NO_X shall be determined using EPA Method 7E.

3.2. **Ammonia (NH_3):** 5 parts per million by volume (ppmv) at actual stack gas conditions

3.2.1. For compliance with Condition C.3.2, measurement of NH_3 shall be determined using EPA Conditional Test Method 027 or 038.

3.3. **Particulate Matter (PM):** 0.127 g/kW-hr

3.3.1. For compliance with Condition C.3.3, measurement of PM shall be determined using EPA Method 5.

3.4. **Particulate Matter with an aerodynamic diameter less than 10 microns (PM_{10}):** 0.127 g/kW-hr

3.4.1. For compliance with Condition C.3.4, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

3.5. **Particle** Matter with an aerodynamic diameter **less than 2.5 microns ($PM_{2.5}$):** 0.127 g/kW-hr

3.5.1. For compliance with Condition C.3.5, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

3.6. **Visible Emissions:** Visible emissions, excluding condensed water vapor, shall not reduce visibility through the exhaust effluent more than 20 percent averaged over any six consecutive minutes.

3.6.1. For compliance with Condition C.3.6, measurement of visible emissions shall be determined using EPA Method 9.

3.7. **Carbon Monoxide (CO):** 0.1790 g/kW-hr

3.7.1. For compliance with Condition C.3.7, measurement of CO shall be determined using EPA Method 10.

3.8. **Volatile Organic Compounds (VOC):** 0.0230 g/kW-hr

3.8.1. For compliance with Condition C.3.8, measurement of VOC shall be determined using EPA Method 25A.

4. **Annual Emission Limits.** Emissions from all six generator engines in aggregate (Units FD-1 – 6) shall not exceed the emission limits specified for each of the pollutants below:

4.1. **Nitrogen oxides (NO_X):** 5.83 tons/rolling 12-month period

4.1.1. For compliance with Condition C.4.1, measurement of NO_X shall be determined using EPA Method 7E.

5. **Hourly Emission Limit.** Emissions from all six generation engines in aggregate (Units FD-1 –6) shall not exceed the emission limits specified for each of the pollutants below:

5.1. **Nitrogen oxides (NO_X):** 4.64 lb/hr

5.1.1. For compliance with Condition C.5.1, measurement of NO_X shall be determined using EPA Method 7E.

6. **Daily Emission Limits.** Emissions from all six generator engines in aggregate (Units FD-1 – 6) shall not exceed the emission limits specified for each of the pollutants below:

6.1. **Particulate Matter with an aerodynamic diameter less than 10 microns (PM_{10}):** 28.3 lbs/day

6.1.1. For compliance with Condition C.6.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

6.2. **Particulate Matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$):** 28.3 lbs/day

6.2.1. For compliance with Condition C.6.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

7. **Electrical Power Output Limit.** The permittee shall not operate Units FD-1 – 6 such that aggregate electrical power from the attached generators is in excess of 3,872 kWe for any hour that these units are operated.

8. **Stack Test Requirements.** The permittee shall stack test all of Units FD-1 – 6 as follows:

8.1. At the start of the first drilling season that the Discoverer operates under this permit in the Chukchi Sea, all six of Units FD-1 – 6 shall have been stack tested under the requirements of this section.

8.2. Each stack test shall be conducted at three different loads: 50 percent, 75 percent and 100 percent.

8.3. Each stack test run shall test for emissions of CO, NO_X, NO_2, $PM_{2.5}$, PM_{10}, VOC, ammonia and visible emissions.

8.4. During each test run, the permittee shall monitor and record the following information:

8.4.1. Quantity of fuel used (in gallons);

8.4.2. Density of the fuel used (in lbs/gallon);

8.4.3. Heat content of the fuel used (in Btu/gallon);

8.4.4. Electrical power produced (in kWe-hr);

8.4.5. The stack temperature upstream of the SCR catalysis in ºC or ºF;

8.4.6. The quantity of urea reagent (in gallons) and the concentration of the urea reagent (in weight percent) introduced into the SCR control system; and

8.4.7. The NO_X concentration (ppm) indicated by the periodic NO_X monitor used for the SCR control system.

8.5. For each engine, each load, and each pollutant, the permittee shall determine emission factors in the following units: g/kW-hr, g/kWe-hr, lbs/kW-hr, lbs/kWe-hr and lbs/gallon.

9. **Monitoring, Recordkeeping, and Reporting.** The permittee shall:

9.1. Equip each of the generator engines (Units FD-1 – 6) on board the Discoverer with a electrical output monitoring device:

9.1.1. Each electrical output monitoring device shall measure the electrical output of the generator attached to each engine with an accuracy equal to or better than 2 percent of the engine's maximum output (in kWe);

9.1.2. Each electrical output monitoring device shall measure the electrical output of the generator attached to each engine at least once every 10 minutes; and

9.1.3. Each electrical output monitoring device shall be equipped to record each reading taken as well as provide and record average loads for each hour.

9.2. Maintain the accuracy of each electrical output monitoring device in accordance with manufacturer's recommendations.

9.3. Monitor and record the power output, in kWe, resulting from the operation of each of Units FD-1 – 6 at least once every 10 minutes.

9.4. Each month, calculate and record NO_X emissions in g/kW-hr from each engine for each hour during the month, using the emission factors collected under Condition

C.8.5, and power output data collected under Condition C.9.3, and converted to kW (mechanical).

9.5. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and the emissions of $PM_{2.5}$ and PM_{10} in pounds per day from each engine by using the emission factors for each tested engine collected under Condition C.8.5 and electrical load data collected under Condition C.9.3, to determine emissions from that source. Emissions shall be calculated for each ten-minute load reading for each engine.

9.6. For the purposes of Conditions C.9.4 and C.9.5, if a specific emission unit has not been tested yet, the permittee shall use the highest emission factor for the corresponding load from the test results for any of the generator engines that have already been tested.

9.7. For the purposes of Condition C.9.5, if a specific load reading is missing, the permittee shall calculate the emissions for that missing load reading by using the emission factor and load combination that results in the highest emissions rate for that emissions unit. If the engine in question has not been tested yet, the permittee shall use the emission factor as provided for in Condition C.9.6.

9.8. For the purpose of Condition C.9.5, if either the urea pump is not operating or if the catalyst inlet temperature, measured in Condition B.14, is less than $250^{o}C$, calculate emissions of NO_X for the affected time period by using an uncontrolled emission factor obtained by applying a 95 percent NO_X reduction efficiency to the emission factor determined pursuant to Condition C.8.5.

D. DISCOVERER PROPULSION ENGINE (FD-7)

1. The permittee shall not operate Unit FD-7 for any reason when operating the Discoverer as an OCS Source.

2. The permittee shall report to the EPA via facsimile or email any deviation from Condition D.1 within 3 business days of identification.

E. DISCOVERER EMERGENCY GENERATOR AND SELDOM USED SOURCES (FD-8)

1. **Discoverer Seldom Used Sources.** For purposes of this permit, Discoverer seldom used sources means any fuel burning unit on the Discoverer except for the emergency generator and Units FD 1 – 7 and FD 9 – 22.

2. **Emergency Generator Reliability Testing Limits.** The permittee shall operate the emergency generator:

   2.1. For no more than120 minutes during any one day;

   2.2. For no more than 10 hours during any drilling season; and

   2.3. The emergency generator shall only operate during the period of 12 pm to 2 pm.

3. **Fuel Usage Limit**. The permittee shall not use in excess of 150 gallons of fuel in aggregate in the Discoverer emergency generator and all Discoverer seldom used sources in any rolling 7-day period.

4. **Emergency Generator Hourly Emission Limits.** Emissions from the emergency generator shall not exceed the emission limits specified for each of the pollutants below:

    4.1. **Nitrogen oxides (NO_X):** 19.73 lb/hr

        4.1.1. For compliance with Condition E.4.1 measurement of NO_X shall be determined using EPA Method 7E.

5. **Emergency Generator Daily Emission Limits.** Emissions from the emergency generator shall not exceed the emission limits specified for each of the pollutants below:

    5.1. **PM_{10}:** 2.77 lbs/day

        5.1.1. For compliance with Condition E.5.1, measurement of PM_{10} shall be determined using EPA Method s 201A and 202.

    5.2. **$PM_{2.5}$:** 2.77 lbs/day

        5.2.1. For compliance with Condition E.5.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

6. **Monitoring, Recordkeeping, and Reporting.** For each instance in which the Discoverer emergency generator or each Discoverer seldom used source is operated while the Discoverer is an OCS Source, the permittee shall:

    6.1. Record the duration of the episode for the Discoverer emergency generator and each Discoverer seldom used source;

    6.2. Record the daily fuel consumption of the Discoverer emergency generator and each Discoverer seldom used source as provided in condition B.6.4.2;

    6.3. Calculate and record for the previous 6 calendar days the rolling 7- day fuel consumption for the Discoverer emergency generator and all Discoverer seldom used sources in aggregate by adding each day's fuel consumption to the total fuel consumed in the previous 6-calendar days;

    6.4. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and the emissions of $PM_{2.5}$ and PM_{10} in pounds per day from the emergency generator by multiplying an emission factor (0.587 lbs/gal for NO_X and 0.022 lbs/gal for $PM_{2.5}$ and PM_{10}) and recorded fuel use; and

    6.5. The permittee shall report to the EPA via facsimile or email, any deviation from Conditions E.2 and E.3 within 3 business days of identification.

7. **BACT Good Combustion Practices for NO_X, PM_{10}, $PM_{2.5}$, VOC, and CO (Carbon Monoxide)**. The permittee shall:

    7.1. Ensure that a full-time equipment maintenance specialist shall be on board at all times during operation as an OCS Source;

7.2. Train operating personnel to identify signs of improper operation and maintenance, including visible plumes, and to report these events to the maintenance specialist as soon as possible, but no later than within three hours of identification;

7.3. Have the maintenance specialist inspect, at least once each week, each emission unit for proper operation and maintenance consistent with the manufacturer's recommendations;

7.4. Ensure that the operation and maintenance manual provided by the manufacturer for each emission unit shall be kept on board the Discoverer at all times;

7.5. Follow the manufacturer's recommended operation and maintenance procedures for each emission unit;

7.6. Maintain, on board the Discoverer, a log detailing when reporting, inspections and maintenance are conducted pursuant to Conditions E.7.2, E.7.3, and E.7.5, respectively; and

7.7. No less than 30 days prior to each deployment of the Discoverer to the Chukchi Sea, the permittee shall provide notice to the EPA on how the permittee shall comply with the requirements of Conditions E.7.1 and E.7.2 for the upcoming drilling season.

F. MLC COMPRESSOR ENGINES (FD-9 - 11)

1. **Operation of Oxidation Catalyst.** At all times that any of Units FD-9 – 11 are in operation, the exhaust from each emission unit shall be directed to an operating oxidation catalyst.

2. **BACT Limits.** Emissions from each MLC compressor engine (Units FD-9 – 11) shall not exceed the emission limits specified for each of the pollutants below:

2.1. **NO_X and Non-Methane Hydrocarbons (NMHC), in aggregate:** 4.0 g/kW-hr

2.1.1. For compliance with Condition F.2.1, measurement of NO_X shall be determined using EPA Method 7E.

2.1.2. For compliance with Condition F.2.1, measurement of NMHC shall be determined using EPA Method 25A.

2.2. **PM:** 0.10 g/kW-hr

2.2.1. For compliance with Condition F.2.2, measurement of PM shall be determined using EPA Method 5.

2.3. **PM_{10}:** 0.10 g/kW-hr

2.3.1. For compliance with Condition F.2.3, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

2.4. **$PM_{2.5}$:** 0.10 g/kW-hr

2.4.1. For compliance with Condition F.2.4, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

2.5. **Visible Emissions:** Visible emissions, excluding condensed water vapor, shall not reduce visibility through the exhaust effluent more than 20 percent averaged over any six consecutive minutes.

2.5.1. For compliance with Condition F.2.5, measurement of visible emissions shall be determined using EPA Method 9.

2.6. **CO:** 1.86 g/kW-hr

2.6.1. For compliance with Condition F.2.6, measurement of CO shall be determined using EPA Method 10.

3. **Annual Emission Limits**. Emissions from all three MLC compressor engine (Units FD-9 – 11) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

3.1. **NO_X:** 1.71 tons/rolling 12-month period

3.1.1. For compliance with Condition F.3.1, measurement of NO_X shall be determined using EPA Method 7E.

4. **Hourly Emission Limits.** Emissions from all three MLC compressor engines (Units FD-9 – 11) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

4.1. **NO_X:** 7.11 lbs/hour

4.1.1. For compliance with Condition F.4.1, measurement of NO_X shall be determined using EPA Method 7E.

5. **Daily Emission Limits**. Emissions from all three MLC compressor engine (Units FD-9 – 11) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

5.1. **PM_{10}:** 4.26 lbs/day

5.1.1. For compliance with Condition F.5.1, measurement of PM_{10} shall be determined using EPA Methods 201A and202.

5.2. **$PM_{2.5}$:** 4.26 lbs/day

5.2.1. For compliance with Condition F.5.1, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

6. **Fuel Usage Limit.** The permittee shall not use in excess of 81,346 gallons of fuel in all three of Units FD-9 – 11 in aggregate during any rolling 12-month period.

7. **Stack Test Requirements.** The permittee shall stack test all of Units FD-9 – 11 as follows:

7.1. At the start of the first drilling season that the Discoverer operates under this permit in the Chukchi Sea, all three of Units FD-9 – 11 shall have been stack tested under the requirements of this section.

7.2. Each stack test shall be conducted for the following pollutants, and at the different loads specified:

7.2.1. **CO** at one load between 50 and 70% load;

7.2.2. **NO_X** at two loads – between 50 and 70% and between 80 and 100% loads;

7.2.3. **NO_2** at two loads – between 50 and 70% and between 80 and 100% loads;

7.2.4. **NMHC** at one load between 50 and 70% load;

7.2.5. **$PM_{2.5}$** at two loads – between 50 and 70% and between 80 and 100% loads;

7.2.6. **PM_{10}** at two loads – between 50 and 70% and between 80 and 100% loads; and

7.2.7. **Visible emissions** at one load between 50 and 70% load.

7.3. During each test run, the permittee shall monitor and record the following information:

7.3.1. Quantity of fuel used (in gallons);

7.3.2. Density of the fuel used (in lbs/gallon);

7.3.3. Heat content of the fuel used (in Btu/gallon); and

7.3.4. Mechanical power output (in kW).

7.4. For each engine, each load range, and each pollutant, the permittee shall determine emission factors in the following units: g/kW-hr, lbs/kW-hr, and lbs/gallon.

8. **Monitoring, Recordkeeping and Reporting:** The permittee shall:

8.1. Equip each of Units FD-9 -11 with a diesel fuel flow meter, or install a single fuel meter for all of Units FD-9 -11:

8.1.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the engine(s) or engine group being served by the meter;

8.1.2. Each fuel flow meter shall be totalizing and non-resettable; and

8.1.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value.

8.2. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

8.3. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

8.4. Monitor and record fuel usage for each engine on a hourly basis.

8.5. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and the emissions of $PM_{2.5}$ and PM_{10} in pounds per day using the highest emission factor collected under Condition F.7.4 and fuel usage data collected under Condition F.8.4.

G. HPU ENGINES (FD-12 - 13)

1. **Operation of Catalyzed Diesel Particulate Filter (CDPF).** At all times that any of Units FD-12 – 13 are in operation, the exhaust from each emission unit shall be directed to an operating CleanAIR Systems CDPF, Part No. FDA300.

1.1. Each CDPF shall be equipped with an operating HiBACK monitor and alarm unit, that records exhaust pressure and temperature.

1.2. During each day that each of Units FD-12 -13 is operated, the exhaust temperature shall be above 300°C, or 572°F for at least 30 percent of the time.

2. **BACT Limits.** Emissions from each HPU engine (Units FD-12 – 13) shall not exceed the emission limits specified for each of the pollutants below:

2.1. **NO_X and NMHC, in aggregate:** 4.0 g/kW-hr

2.1.1. For compliance with Condition G.2.1, measurement of NOX shall be determined using EPA Method 7E.

2.2. **PM:** 0.030 g/kW-hr

2.2.1. For compliance with Condition G.2.2, measurement of PM shall be determined using EPA Method 5.

2.3. **PM_{10}:** 0.030 g/kW-hr

2.3.1. For compliance with Condition G.2.3, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

2.4. **$PM_{2.5}$:** 0.030 g/kW-hr

2.4.1. For compliance with Condition G.2.4, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

2.5. **Visible Emissions:** Visible emissions, excluding condensed water vapor, shall not reduce visibility through the exhaust effluent more than 20 percent averaged over any six consecutive minutes.

2.5.1. For compliance with Condition G.2.6, measurement of visible emissions shall be determined using EPA Method 9.

2.6. **CO:** 0.70 g/kW-hr

2.6.1. For compliance with Condition G.2.6, measurement of CO shall be determined using EPA Method 10.

3. **BACT Good Combustion Practices for NO_X.** The permittee shall:

3.1. Ensure that a full-time equipment maintenance specialist shall be on board at all times during operation as an OCS Source;

3.2. Train operating personnel to identify signs of improper operation and maintenance, including visible plumes, and to report these events to the maintenance specialist as soon as possible, but no later than within three hours of identification;

3.3. Have the maintenance specialist inspect, at least once each week, each of Units FD-12 – 13 for proper operation and maintenance consistent with the manufacturer's recommendations;

3.4. Ensure that the operation and maintenance manual provided by the manufacturer for each of Units FD-12 – 13 shall be kept on board the Discoverer at all times;

3.5. Follow the manufacturer's recommended operation and maintenance procedures for each of Units FD-12 – 13;

3.6. Maintain, on board the Discoverer, a log detailing when reporting, inspections and maintenance are conducted pursuant to Conditions G.3.2, G.3.3, and G.3.5 respectively; and

3.7. No less than 30 days prior to each deployment of the Discoverer to the Chukchi Sea, the permittee shall provide notice to the EPA on how the permittee shall comply with the requirements of Conditions G.3.1 and G.3.2, for the upcoming drilling season.

4. **Annual Emission Limits.** Emissions from both HPU engines (Units FD-12 – 13) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

4.1. **NO_X:** 0.79 tons/rolling 12-month period

4.1.1. For compliance with Condition G.4.1, measurement of NO_X shall be determined using EPA Method 7E.

5. **Hourly Emission Limits.** Emissions from both HPU engines (Units FD-12 – 13) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

5.1. **NO_X:** 3.29 lbs/hour

5.1.1. For compliance with Condition G.5.1, measurement of NO_X shall be determined using EPA Method 7E.

6. **Daily Emission Limits.** Emissions from both HPU engines (Units FD-12 – 13) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

6.1. **PM_{10}:** 0.59 lbs/day

6.1.1. For compliance with Condition G.0, measurement of PM_{10} shall be determined using EPA Methods 201A and202.

6.2. **$PM_{2.5}$:** 0.59 lbs/day

6.2.1. For compliance with Condition G.6.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

7. **Annual Fuel Usage Limit.** The permittee shall not use in excess of 44,338 gallons of fuel in both of Units FD-12 – 13 in aggregate during any rolling 12-month period.

8. **Daily Fuel Usage Limits/Alternative Operating Scenarios.** Units FD-12, FD-13 and FD-23 shall be operated under one of three operating scenarios: Base Operating Scenario, Alternative Operating Scenario #1 or Alternative Operating Scenario #2. The permittee shall not use fuel in excess of the following limits while operating under the operating scenarios:

8.1. Under Base Operating Scenario, the permittee shall not operate either of Units FD-12 - 13;

8.2. Under Alternative Operating Scenario #1, the permittee shall not use in excess of 352 gallons of fuel in both of Units FD-12 – 13 in aggregate during any calendar day;

8.3. Under Alternative Operating Scenario #2, the permittee shall not use in excess of 704 gallons of fuel in both of Units FD-12 – 13 in aggregate during any calendar day; and

8.4. For each calendar day that the permittee intends to operate under either of Alternative Operating Scenarios #1 or 2, the permittee shall record in a log, at the beginning of the calendar day, which scenario it will be operating under for the day. In the absence of a log entry, the permittee shall comply with the requirements applicable to the Base Operating Scenario.

9. **Stack Test Requirements.** The permittee shall stack test both of Units FD-12 – 13 as follows:

9.1. At the start of the first drilling season that the Discoverer operates under this permit in the Chukchi Sea, both of Units FD-12 – 13 shall have been stack tested under the requirements of this section.

9.2. Each stack test shall be conducted for the following pollutants, and at the different loads specified:

9.2.1. **CO** at one load between 50 and 70% load;

9.2.2. **NO_X** at two loads – between 50 and 70% and between 80 and 100% loads;

9.2.3. **NO_2** at two loads – between 50 and 70% and between 80 and 100% loads;

9.2.4. **$PM_{2.5}$** at two loads – between 50 and 70% and between 80 and 100% loads;

9.2.5. **PM_{10}** at two loads – between 50 and 70% and between 80 and 100% loads;

9.2.6. **VOC** at one load between 50 and 70% load; and

9.2.7. **Visible emissions** at one load between 50 and 70% load.

9.3. During each test run, the permittee shall monitor and record the following information:

9.3.1. Quantity of fuel used (in gallons);

9.3.2. Density of the fuel used (in lbs/gallon);

9.3.3. Heat content of the fuel used (in Btu/gallon); and

9.3.4. Mechanical power output (in kW).

9.4. For each engine, each load range, and each pollutant, the permittee shall determine emission factors in the following units: g/kW-hr, lbs/kW-hr and lbs/gallon.

10. **Monitoring, Recordkeeping and Reporting.** The permittee shall:

10.1. Equip each of Units FD-12 -13 with a diesel fuel flow meter, or install a single fuel meter for both of Units FD-12 -13:

10.1.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the engine(s) or engine group being served by the meter;

10.1.2. Each fuel flow meter shall be totalizing and non-resettable; and

10.1.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value.

10.2. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

10.3. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

10.4. Monitor and record fuel usage for each engine on a hourly basis.

10.5. Monitor the exhaust temperature of each engine by use of the HiBACK monitor and alarm unit, whenever the engine is in operation.

10.6. Each day, calculate and record for the previous calendar day, the percent of operational time for each engine that the exhaust temperature was above 300^{o}C (572^{o}F).

10.7. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and the emissions of $PM_{2.5}$ and PM_{10} in pounds per day using the highest emission factor collected under Condition G.9.4 and fuel usage data collected under Condition G.10.4.

H. DECK CRANES (FD-14 - 15)

1. **Operation of Catalyzed Diesel Particulate Filter (CDPF).** At all times that any of Units FD-14 – 15 in operation, the exhaust from each Unit shall be directed to an operating CleanAIR Systems CDPF, Part No. 07040401AF.

   1.1. Each CDPF shall be equipped with an operating HiBACK monitor and alarm unit, that records exhaust pressure and temperature.

   1.2. During each day that each of Units FD-14 -15 is operated, the exhaust temperature shall be above 300^{o}C, or 572^{o}F, for at least 30 percent of the time.

2. **BACT Limits**. Emissions from each deck crane engine (Units FD-14 – 15) shall not exceed the emission limits specified for each of the pollutants below:

   2.1. **NO_X:** 10.327 g/kW-hr

      2.1.1. For compliance with Condition H.2.1, measurement of NO_X shall be determined using EPA Method 7E.

   2.2. **PM:** 0.0715 g/kW-hr

      2.2.1. For compliance with Condition H.2.2, measurement of PM shall be determined using EPA Method 5.

   2.3. **PM_{10}:** 0.0715 g/kW-hr

      2.3.1. For compliance with Condition H.2.3, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

   2.4. **$PM_{2.5}$:** 0.0715 g/kW-hr

      2.4.1. For compliance with Condition H.2.4, measurement of $PM_{2.5}$ shall be determined using EPA Methods201A and 202.

   2.5. **Visible Emissions:** Visible emissions, excluding condensed water vapor, shall not reduce visibility through the exhaust effluent more than 20 percent averaged over any six consecutive minutes.

      2.5.1. For compliance with Condition H.2.5, measurement of visible emissions shall be determined using EPA Method 9.

   2.6. **CO:** 0.220 g/kW-hr

      2.6.1. For compliance with Condition H.2.6, measurement of CO shall be determined using EPA Method 10.

   2.7. **VOC:** 0.0640 g/kW-hr

      2.7.1. For compliance with Condition H.2.7, measurement of VOC shall be determined using EPA Method 25A.

3. **BACT Good Combustion Practices for NO_X.** The permittee shall:

3.1. Ensure that a full-time equipment maintenance specialist shall be on board at all times during operation as an OCS Source;

3.2. Train operating personnel to identify signs of improper operation and maintenance, including visible plumes, and to report these events to the maintenance specialist as soon as possible, but no later than within three hours of identification;

3.3. Have the maintenance specialist inspect, at least once each week, each of Units FD-14 – 15 for proper operation and maintenance consistent with the manufacturer's recommendations;

3.4. Ensure that the operation and maintenance manual provided by the manufacturer for each of Units FD-14 – 15 shall be kept on board the Discoverer at all times;

3.5. Follow the manufacturer's recommended operation and maintenance procedures for each of Units FD-14 – 15;

3.6. Maintain, on board the Discoverer, a log detailing when reporting, inspections and maintenance are conducted pursuant to Conditions H.3.2, H.3.3, and H.3.5, respectively; and

3.7. No less than 30 days prior to initial deployment of the Discoverer to the Chukchi Sea, the permittee shall provide notice to the EPA on how the permittee shall comply with the requirements of Conditions H.3.1 and H.3.2 for the upcoming drilling season.

4. **Annual Emission Limits.** Emissions from both deck crane engines (Units FD-14 – 15) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

4.1. **NO_X:** 2.76 tons/rolling 12-month period

4.1.1. For compliance with Condition H.4.1, measurement of NO_X shall be determined using EPA Method 7E.

5. **Hourly Emission Limits.** Emissions from both deck cranes engines (Units FD-14 – 15) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

5.1. **NO_X:** 2.48 lbs/hour

5.1.1. For compliance with Condition H.5.1 measurement of NO_X shall be determined using EPA Method 7E.

6. **Daily Emission Limits.** Emissions from both deck crane engines (Units FD-14 – 15) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

6.1. **PM_{10}:** 0.41 lbs/day

6.1.1. For compliance with Condition H.6.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

6.2. **$PM_{2.5}$:** 0.41 lbs/day

6.2.1. For compliance with Condition H.6.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

7. **Fuel Usage Limit.** The permittee shall not use in excess of 63,661 gallons of fuel in both of Units FD-14 – 15 in aggregate during any rolling 12-month period.

8. **Stack Test Requirements.** The permittee shall stack test both of Units FD-14 – 15 as follows:

   8.1. At the start of the first drilling season that the Discoverer operates under this permit in the Chukchi Sea, both of Units FD-14 – 15 shall have been stack tested under the requirements of this section.

   8.2. Each stack test shall be conducted for the following pollutants, and at the different loads specified:

   8.2.1. **CO** at one load between 60 and 80% load;

   8.2.2. **NO_X** at two loads – between 60 and 80% and between 80 and 100% loads;

   8.2.3. **NO_2** at two loads – between 60 and 80% and between 80 and 100% loads;

   8.2.4. **$PM_{2.5}$** at two loads – between 60 and 80% and between 80 and 100% loads;

   8.2.5. **PM_{10}** at two loads – between 60 and 80% and between 80 and 100% loads;

   8.2.6. **VOC** at one load between 60 and 80% load; and

   8.2.7. **Visible emissions** at one load between 60 and 80% load.

   8.3. During each test run, the permittee shall monitor and record the following information:

   8.3.1. Quantity of fuel used (in gallons);

   8.3.2. Density of the fuel used (in lbs/gallon);

   8.3.3. Heat content of the fuel used (in Btu/gallon); and

   8.3.4. Mechanical power output (in kW).

   8.4. For each engine, each load range, and each pollutant, the permittee shall determine emission factors in the following units: g/kW-hr, lbs/kW-hr and lbs/gallon.

9. **Monitoring, Recordkeeping, and Reporting.** The permittee shall:

   9.1. Equip each of Units FD-14 -15 with a diesel fuel flow meter, or install a single fuel meter for both of Units FD-14 -15:

   9.1.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the engine(s) or engine group being served by the meter;

   9.1.2. Each fuel flow meter shall be totalizing and non resettable; and

   9.1.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter’s upper range value.

9.2. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

9.3. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

9.4. Monitor and record fuel usage for each engine on a hourly basis.

9.5. Monitor and record the exhaust temperature of each engine by use of the HiBACK monitor and alarm unit, while the engine is in operation.

9.6. Each day, calculate and record for the previous calendar day, the percent of operational time for each engine that the exhaust temperature was above 300^{o}C (572^{o}F).

9.7. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and the emissions of $PM_{2.5}$ and PM_{10} in pounds per day using the highest emission factor collected under Condition H.8.4and fuel usage data collected under Condition H.9.4.

I. CEMENTING UNIT AND LOGGING WINCH ENGINES (FD-16 - 20)

1. **Operation of Catalyzed Diesel Particulate Filter (CDPF).** At all times that any of the cementing unit and logging winch engines (Units FD-16 – 20) are in operation, the exhaust from each emission unit shall be directed to operating CleanAIR Systems CDPF, Part No. FDA300 for Units FD-16 and 17, Part No. FDA225 for Unit FD-18, and as specified by CleanAIR Systems for Units FD-19 - 20.

1.1. Each CDPF shall be equipped with an operating HiBACK monitor and alarm unit, that records exhaust pressure and temperature.

1.2. During each day that each of Units FD-16 – 20 is operated, the exhaust temperature shall be above 300^{o}C, or 572^{o}F, for at least 30 percent of the time.

2. **BACT Limits**. Emissions from each of Units FD-16 – 20 shall not exceed the emission limits specified for each of the pollutants below:

2.1. **NO_X:**

FD-16	13.155 g/kW-hr
FD-17	13.155 g/kW-hr
FD-18	15.717 g/kW-hr
FD-19	4.0 g/kW-hr
FD-20	7.50 g/kW-hr

2.1.1. For compliance with Condition I.2.1, measurement of NO_X shall be determined using EPA Method 7E.

2.2. **PM:**

FD-16	0.253	g/kW-hr
FD-17	0.253	g/kW-hr
FD-18	0.386	g/kW-hr
FD-19	0.03	g/kW-hr
FD-20	0.090	g/kW-hr

2.2.1. For compliance with Condition I.2.2, measurement of PM shall be determined using EPA Method 5.

2.3. **PM_{10}:**

FD-16	0.253	g/kW-hr
FD-17	0.253	g/kW-hr
FD-18	0.386	g/kW-hr
FD-19	0.03	g/kW-hr
FD-20	0.090	g/kW-hr

2.3.1. For compliance with Condition I.2.3, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

2.4. **$PM_{2.5}$:**

FD-16	0.253	g/kW-hr
FD-17	0.253	g/kW-hr
FD-18	0.386	g/kW-hr
FD-19	0.03	g/kW-hr
FD-20	0.090	g/kW-hr

2.4.1. For compliance with Condition I.2.4, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

2.5. **Visible Emissions:** Visible emissions, excluding condensed water vapor, shall not reduce visibility through the exhaust effluent more than 20 percent averaged over any six consecutive minutes.

2.5.1. For compliance with Condition I.2.5, measurement of visible emissions shall be determined using EPA Method 9.

2.6. **CO:**

FD-16	0.40	g/kW-hr
FD-17	0.40	g/kW-hr
FD-18	0.880	g/kW-hr
FD-19	0.70	g/kW-hr
FD-20	0.550	g/kW-hr

2.6.1. For compliance with Condition I.2.6, measurement of CO shall be determined using EPA Method 10.

2.7. VOC:

FD-16	0.20	g/kW-hr
FD-17	0.20	g/kW-hr
FD-18	0.270	g/kW-hr
FD-19	4.0	g/kW-hr
FD-20	0.750	g/kW-hr

2.7.1. For compliance with Condition I.2.7, measurement of VOC shall be determined using EPA Method 25A.

3. **BACT Good Combustion Practices for NO_X.** The permittee shall:

3.1. Ensure that a full-time equipment maintenance specialist shall be on board at all times during operation as an OCS Source;

3.2. Train operating personnel to identify signs of improper operation and maintenance, including visible plumes, and to report these events to the maintenance specialist as soon as possible, but no later than within three hours of identification;

3.3. Have the maintenance specialist inspect, at least once each week, each of Units FD-16 – 20 for proper operation and maintenance consistent with the manufacturer's recommendations;

3.4. Ensure that the operation and maintenance manual provided by the manufacturer for each of Units FD-16 – 20 shall be kept on board the Discoverer at all times;

3.5. Follow the manufacturer's recommended operation and maintenance procedures for each of Units FD-16 – 20;

3.6. Maintain, on board the Discoverer, a log detailing when reporting, inspections and maintenance are conducted pursuant to Conditions I.3.2, I.3.3, and I.3.5 respectively; and

3.7. No less than 30 days prior to initial deployment of the Discoverer to the Chukchi Sea, the permittee shall provide notice to the EPA on how the permittee shall comply with the requirements of Conditions I.3.1and I.3.2 for the upcoming drilling season.

4. **Annual Emission Limits.** Emissions from all cementing unit and logging winch engines (Units FD-16 – 20) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

4.1. **NO_X:** 4.09 tons/rolling 12-month period

4.1.1. For compliance with Condition I.4.1, measurement of NO_X shall be determined using EPA Method 7E.

5. **Hourly Emission Limits.** Emissions from all cementing unit and logging winch engines (Units FD-16 - 20) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

5.1. **NO_X:** 6.56 lbs/hour

5.1.1. For compliance with Condition I.5.1, measurement of NO_X shall be determined using EPA Method 7E.

6. **Daily Emission Limits.** Emissions from all cementing unit and logging winch engines (Units FD-16 – 20) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

6.1. **PM_{10}:** 3.87 lbs/day

6.1.1. For compliance with Condition I.6.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

6.2. **$PM_{2.5}$:** 3.87 lbs/day

6.2.1. For compliance with Condition I.6.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

7. **Fuel Usage Limit.** The permittee shall not use in excess of:

7.1. 53,760 gallons of fuel in all Units FD-16 – 20 in aggregate during any rolling 12-month period; and

7.2. 320 gallons of fuel in all Units FD-16 – 20 in aggregate during any calendar day.

8. **Operational Limit.** The permittee shall not operate any cementing unit or engine (Units FD-16 – 20) while conducting MLC activities as defined in Condition B.2.3.

9. **Stack Test Requirements.** The permittee shall stack test all of Units FD-16 – 20 as follows:

9.1. At the start of the first drilling season that the Discoverer operates under this permit in the Chukchi Sea, all of Units FD-16 – 20 shall have been stack tested under the requirements of this section.

9.2. Each stack test shall be conducted for the following pollutants, and at the different loads specified:

9.2.1. **CO** at one load between 50 and 70% load;

9.2.2. **NO_X** at two loads – between 50 and 70% and between 80 and 100% loads;

9.2.3. **NO_2** at two loads – between 50 and 70% and between 80 and 100% loads;

9.2.4. **$PM_{2.5}$** at two loads – between 50 and 70% and between 80 and 100% loads;

9.2.5. **PM_{10}** at two loads – between 50 and 70% and between 80 and 100% loads;

9.2.6. **VOC** at one load between 50 and 70% load; and

9.2.7. **Visible emissions** at one load between 50 and 70% load.

9.3. During each test run, the permittee shall monitor and record the following information:

9.3.1. Quantity of fuel used (in gallons);

9.3.2. Density of the fuel used (in lbs/gallon);

9.3.3. Heat content of the fuel used (in Btu/gallon); and

9.3.4. Mechanical power output (in kW).

9.4. For each engine, each load range, and each pollutant, the permittee shall determine emission factors in the following units: g/kW-hr, lbs/kW-hr, and lbs/gallon.

10. **Monitoring, Recordkeeping and Reporting.** The permittee shall:

10.1. Equip each of Units FD-16 - 20 with a diesel fuel flow meter, or install a single fuel meter for all of Units FD-16 - 20:

10.1.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the engine(s) or engine group being served by the meter;

10.1.2. Each fuel flow meter shall be totalizing and non-resettable; and

10.1.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value.

10.2. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

10.3. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

10.4. Monitor and record fuel usage for each engine on a hourly basis.

10.5. Monitor and record the exhaust temperature of each of engines FD-16 - 20 by use of the HiBACK monitor and alarm unit, while the engine is in operation.

10.6. Each day, for each of engines FD-16 - 20, calculate and record for the previous calendar day, the percent of operational time for each engine that the exhaust temperature was above $300^{o}C$ ($572^{o}F$).

10.7. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and the emissions from $PM_{2.5}$ and PM_{10} in pounds per day, using the highest emission factor collected under Condition I.9.4and fuel usage data collected under Condition I.10.4.

J. HEAT BOILERS (FD-21 - 22)

1. **BACT Limits.** Emissions from each of the heat boilers (Units FD-21 – 22) shall not exceed the emission limits specified for each of the pollutants below:

1.1. **NO_X:** 0.20 lbs/MMBtu

1.1.1. For compliance with Condition J.1.1, measurement of NO_X shall be determined using EPA Method 7E.

1.2. **PM:** 0.0235 lbs/MMBtu

1.2.1. For compliance with Condition J.1.2, measurement of PM shall be determined using EPA Method 5.

1.3. **PM_{10}:** 0.0235 lbs/MMBtu

1.3.1. For compliance with Condition J.1.3, measurement of PM_{10} shall be determined using EPA Methods 201A and Method 202.

1.4. **$PM_{2.5}$:** 0.0235 lbs/MMBtu

1.4.1. For compliance with Condition J.1.4, measurement of PM2.5 shall be determined using EPA Methods 201A and Method 202.

1.5. **Visible Emissions:** Visible emissions, excluding condensed water vapor, shall not reduce visibility through the exhaust effluent more than 20 percent averaged over any six consecutive minutes.

1.5.1. For compliance with Condition J.1.5, measurement of visible emissions shall be determined using EPA Method 9.

1.6. **CO:** 0.0770 lbs/MMBtu

1.6.1. For compliance with Condition J.1.6, measurement of CO shall be determined using EPA Method 10.

1.7. **VOC:** 0.00140 lbs/MMBtu

1.7.1. For compliance with Condition J.1.7, measurement of VOC shall be determined using EPA Method 25A.

2. **BACT Good Combustion Practices for NO_X, PM, $PM_{2.5}$, PM_{10}, CO and VOC.** The permittee shall:

2.1. Ensure that a full-time equipment maintenance specialist shall be on board at all times during operation as an OCS Source;

2.2. Train operating personnel to identify signs of improper operation and maintenance, including visible plumes, and to report these events to the maintenance specialist as soon as possible, but no later than within three hours of identification;

2.3. Have the maintenance specialist inspect, at least once each week, each of Units FD-21 – 22 for proper operation and maintenance consistent with the manufacturer’s recommendations;

2.4. Ensure that the operation and maintenance manual provided by the manufacturer for each of Units FD-21 – 22 shall be kept on board the Discoverer at all times;

2.5. Follow the manufacturer’s recommended operation and maintenance procedures for each of Units FD-21 – 22;

2.6. Maintain, on board the Discoverer, a log detailing when reporting, inspections and maintenance are conducted pursuant to Conditions J.2.2, J.2.3, and J.2.5, respectively; and

2.7. No less than 30 days prior to initial deployment of the Discoverer to the Chukchi Sea, the permittee shall provide notice to the EPA on how the permittee shall comply with the requirements of Conditions J.2.1and J.2.2 for the upcoming drilling season.

3. **Annual Emission Limits**. Emissions from all heat boilers (Units FD-21 – 22) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

3.1. **NO_X:** 4.59 tons/rolling 12-month period

3.1.1. For compliance with Condition J.3.1, measurement of NO_X shall be determined using EPA Method 7E.

4. **Hourly Emission Limits.** Emissions from all heat boilers (Units FD-21 – 22) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

4.1. **NO_X:** 3.19 lbs/hour

4.1.1. For compliance with Condition J.4.1, measurement of NO_X shall be determined using EPA Method 7E.

5. **Daily Emission Limits.** Emissions from all heat boilers (Units FD-21 – 22) in aggregate shall not exceed the emission limits specified for each of the pollutants below:

5.1. **PM_{10}:** 8.99 lbs/day

5.1.1. For compliance with Condition J.5.1, measurement of PM_{10} shall be determined using EPA Methods 201A and202.

5.2. **$PM_{2.5}$:** 8.99 lbs/day

5.2.1. For compliance with Condition J.5.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

6. **Stack Test Requirements.** The permittee shall stack test both of Units FD-21 – 22 as follows:

6.1. At the start of the first drilling season that the Discoverer operates under this permit in the Chukchi Sea, both of Units FD-21 – 22 shall have been stack tested under the requirements of this section.

6.2. Each stack test shall be conducted for the following pollutants, and at the different loads specified:

6.2.1. **CO** at 100% load;

6.2.2. **NO_X** at 50% and 100% loads;

6.2.3. **NO_2** at 50% and 100% loads;

6.2.4. **$PM_{2.5}$** at 50% and 100% loads;

6.2.5. **PM_{10}** at 50% and 100% loads;

6.2.6. **VOC** at 100% load; and

6.2.7. **Visible emissions** at 100% load.

6.3. During each test run, the permittee shall monitor and record the following information:

6.3.1. Quantity of fuel used (in gallons);

6.3.2. Density of the fuel used (in lbs/gallon); and

6.3.3. Heat content of the fuel used (in Btu/gallon).

6.4. For each boiler, each load range and each pollutant, the permittee shall determine emission factors in the following units: lbs/MMBtu and lbs/gallon.

7. **Monitoring, Recordkeeping and Reporting.** The permittee shall:

7.1. Equip each of Units FD-21 - 22 with a diesel fuel flow meter, or install a single fuel meter for both of Units FD-21 - 22:

7.1.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the boiler(s) or boiler group being served by the meter;

7.1.2. Each fuel flow meter shall be totalizing and nonresettable; and

7.1.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value.

7.2. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

7.3. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

7.4. Monitor and record fuel usage for each boiler on a hourly basis.

7.5. Each day, calculate and record for the previous calendar day, the emissions of NO_X $PM_{2.5}$, and PM_{10} using the highest emission factor collected under Condition J.6.4 and fuel usage data collected under Condition J.7.4.

K. INCINERATOR (FD-23)

1. **BACT Limits.** Emissions from the incinerator (Unit FD-23) shall not exceed the emission limits specified for each of the pollutants below:

1.1. **NO_X:** 5.0 lbs/ton of waste incinerated

1.1.1. For compliance with Condition K.1.1, measurement of NO_X shall be determined using EPA Method 7E.

1.2. **PM:** 8.20 lbs/ ton of waste incinerated

1.2.1. For compliance with Condition K.1.2, measurement of PM shall be determined using EPA Method 5.

1.3. **PM_{10}:** 8.20 lbs/ton of waste incinerated

1.3.1. For compliance with Condition K.0, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

1.4. **$PM_{2.5}$:** 7.00 lbs/ton of waste incinerated

1.4.1. For compliance with Condition K.1.4, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

1.5. **CO:** 31.0 lbs/ton of waste incinerated

1.5.1. For compliance with Condition K.1.5, measurement of CO shall be determined using EPA Method 10.

1.6. **VOC:** 3.0 lbs/ton of waste incinerated

1.6.1. For compliance with Condition K.1.6, measurement of VOC shall be determined using EPA Method 25A.

2. **BACT Good Combustion Practices for NO_X, PM, $PM_{2.5}$, PM_{10}, CO, and VOC.** The permittee shall:

2.1. Ensure that a full-time equipment maintenance specialist shall be on board at all times during operation as an OCS Source;

2.2. Train operating personnel to identify signs of improper operation and maintenance, including visible plumes, and to report these events to the maintenance specialist as soon as possible, but no later than within three hour of identification;

2.3. Have the maintenance specialist inspect, at least once each week, Unit FD-23 for proper operation and maintenance consistent with the manufacturer's recommendations;

2.4. Ensure that the operation and maintenance manual provided by the manufacturer for Unit FD-23 shall be kept on board the Discoverer at all times;

2.5. Follow the manufacturer's recommended operation and maintenance procedures for Unit FD-23;

2.6. Maintain, on board the Discoverer, a log detailing when reporting, inspections and maintenance are conducted pursuant to Conditions K.2.2, K.2.3, and K.2.5, respectively; and

2.7. No less than 30 days prior to initial deployment of the Discoverer to the Chukchi Sea, the permittee shall provide notice to the EPA on how the permittee shall comply with the requirements of Conditions K.2.1and K.2.2 for the upcoming drilling season.

3. **Annual Emission Limits.** Emissions from the incinerator (Unit FD-23) shall not exceed the emission limits specified for each of the pollutants below:

3.1. **NO_X:** 0.20 tons/rolling 12-month period

3.1.1. For compliance with Condition K.3.1, measurement of NO_X shall be determined using EPA Method 7E.

4. **Hourly Emission Limits.** Emissions from the incinerator (Unit FD-23) shall not exceed the emission limits specified for each of the pollutants below:

4.1. **Nitrogen oxides (NO_X):** 0.65 lb/hr

4.1.1. For compliance with Condition K.4.1, measurement of NO_X shall be determined using EPA Method 7E.

5. **Daily Emission Limits.** Emissions from the incinerator (Unit FD-23) shall not exceed the emission limits specified for each of the pollutants below:

5.1. **PM_{10}:** 5.33 lbs/day

5.1.1. For compliance with Condition K.5.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

5.2. **$PM_{2.5}$:** 4.55 lbs/day

5.2.1. For compliance with Condition K.5.2, measurement of PM2.5 shall be determined using EPA Methods 201A and 202.

6. **Throughput-Based Emission Limits.** Emissions from the incinerator (Unit FD-23) shall not exceed the emission limits specified for each of the pollutants below:

6.1. **PM_{10}:** 8.20 lbs/ton of waste incinerated

6.1.1. For compliance with Condition K.6.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

6.2. **$PM_{2.5}$:** 7.00 lbs//ton of waste incinerated

6.2.1. For compliance with Condition K.6.2, measurement of PM2.5 shall be determined using EPA Methods 201A and 202.

6.3. **SO_2:** 2.50 lbs//ton of waste incinerated

6.3.1. For compliance with Condition K.6.3, measurement of SO2 shall be determined using EPA Method 6C.

7. **Annual Waste Throughput Limit.** The permittee shall not incinerate in excess of 50,400 lbs of all types of waste in Unit FD-23 during any rolling 12-month period.

8. **Daily Fuel Usage Limits/Alternative Operating Scenarios.** Units FD-12, FD-13 and FD-23 shall be operated under one of three operating scenarios: Base Operating Scenario, Alternative Operating Scenario #1 or Alternative Operating Scenario #2. The permittee shall not incinerate waste in excess of the following limits while operating under the operating scenarios:

8.1. Under Base Operating Scenario, the permittee shall not incinerate in excess of 1300 lbs of waste during any calendar day;

8.2. Under Alternative Operating Scenario #1, the permittee shall not incinerate in excess of 800 lbs of waste during any calendar day;

8.3. Under Alternative Operating Scenario #2, the permittee shall not incinerate in excess of 300 lbs of waste during any calendar day; and

8.4. For each calendar day that the permittee intends to operate under either of Alternative Operating Scenarios #1 or 2, the permittee shall record as specified in Condition G.8.4.

9. **Waste Segregation Work Practice.** The permittee shall develop and implement a written waste segregation work practice plan to ensure that non-combustible items containing heavy metals that could be volatilized and emitted from the incinerator as PM are not introduced into the incinerator. The plan shall be submitted to the EPA Region 10 at least 30 days prior to initial deployment of the Discoverer to the Chukchi Sea.

10. **Stack Test Requirements.** Prior to each of the first three drilling seasons that the Discoverer operates under this permit in the Chukchi Sea, the permittee shall stack test the incinerator (Unit FD-23) as follows:

10.1. Each stack test shall be conducted at full rated capacity.

10.2. For the first drilling season, each stack test run shall test for emissions of CO, NO_X, NO_2, $PM_{2.5}$, PM_{10}, SO_2, and VOC.

10.3. For subsequent drilling seasons, each stack test run shall test for emissions of NO_X, NO_2, $PM_{2.5}$, PM_{10}, and SO_2.

10.4. During each test run, the permittee shall monitor and record the following information:

10.4.1. Quantity of fuel used (in gallons);

10.4.2. Density of the fuel used (in lbs/gallon);

10.4.3. Heat content of the fuel used (in Btu/gallon);

10.4.4. Quantity of waste incinerated (tons); and

10.4.5. Type of waste incinerated.

10.5. For each pollutant, the permittee shall determine emission factors in the following units: lbs/ton of waste incinerated.

11. **Monitoring, Recordkeeping, and Reporting.** The permittee shall:

11.1. For each batch of waste charged to the incinerator:

11.1.1. Record the date and time that each batch of waste was charged to the incinerator;

11.1.2. Weigh the batch of waste by using a weigh scale used that shall be accurate to within 0.5 lbs; and

11.1.3. Record the weight of each batch of waste charged to the incinerator.

11.2. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of the weigh scale to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

11.3. Maintain the accuracy of the weigh scale in accordance with manufacturer's recommendations.

11.4. Monitor and record the exhaust temperature of the incinerator at least every 15 minutes.

11.5. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and emissions of $PM_{2.5}$ and PM_{10} in pounds per day using the highest emission factor collected under Condition K.10.5 and waste material incinerated throughput collected under Condition K.11.1.

L. SUPPLY SHIP GENERATOR ENGINE (FD-31)

1. **Operational Limits.** For events where the supply ship is attached to the Discoverer, the permittee shall:

1.1. Not use in excess of 184.0 gallons of fuel per day in the non-propulsion generators (not including the emergency engine), in aggregate; and

1.2. Not use in excess of 1472.0 gallons of fuel during any rolling 12-month period in the non-propulsion generators (not including the emergency engine), in aggregate.

2. **Annual Emission Limits.** For events where the supply ship is attached to the Discoverer, emissions from operation of the supply ship generator engine (Unit FD-31) shall not exceed the emission limits specified for each of the pollutants below:

2.1. **NO_X:** 0.43 tons/rolling 12-month period

2.1.1. For compliance with Condition L.2.1, measurement of NOX shall be determined using EPA Method 7E.

3. **Daily Emission Limits.** For events where the supply ship is attached to the Discoverer, emissions from operation of the supply ship generator engine (Unit FD-31) shall not exceed the emission limits specified for each of the pollutants below:

3.1. **PM_{10}:** 7.60 lbs/day

3.1.1. For compliance with Condition L.3.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

3.2. **$PM_{2.5}$:** 7.60 lbs/day

3.2.1. For compliance with Condition L.3.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

4. **Stack Test Requirements.** Prior to the first supply ship trip of each drilling season to resupply the Discoverer while the Discoverer is operating under this permit in the Chukchi Sea, the permittee shall stack test the supply ship generator engine (Unit FD-31) as follows:

4.1. If the generator from the intended supply ship has already been tested pursuant to Conditions L.4.2 through L.4.5 during the past 5 years, no additional stack testing is required.

4.2. Each stack test shall be conducted at 100 percent load.

4.3. Each stack test run shall test for emissions of NO_X, NO_2, $PM_{2.5}$, and PM_{10}.

4.4. During each test run, the permittee shall monitor and record the following information:

4.4.1. Manufacturer and model no. of the engine;

4.4.2. The rated capacity of the engine (in hp);

4.4.3. Quantity of fuel used (in gallons);

4.4.4. Density of the fuel used (in lbs/gallon);

4.4.5. Heat content of the fuel used (in Btu/gallon); and

4.4.6. Electrical power output (in kWe).

4.5. For each engine, each load range, and each pollutant, the permittee shall determine emission factors in the following units: lbs/kWe-hr and lbs/gallon.

5. **Monitoring, Recordkeeping and Reporting.** The permittee shall:

5.1. Equip each of the non-propulsion generator engines (not including the emergency engine) with a diesel fuel flow meter, or install a single fuel meter for all of these engines:

5.1.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the engine(s) or engine group being served by the meter;

5.1.2. Each fuel flow meter shall be totalizing and non-resettable; and

5.1.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value

5.2. No less than 60 days before the first deployment to the Chukchi Sea of a vessel as the supply ship, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to departure of the supply vessel to the Chukchi Sea.

5.3. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

5.4. Monitor and record fuel usage for the non-propulsion generators on a hourly basis while the supply vessel is attached to the Discoverer.

5.5. For each event, record the date and time that the supply ship attaches to the Discoverer.

5.6. For each event, record the date and time that the supply ship detaches from the Discoverer.

5.7. For each event, record the manufacturer, model no. and rated capacity (in hp) of the supply ship generator engine.

5.8. For each event, calculate daily emissions of NO_X, $PM_{2.5}$, and PM_{10} using the using the highest emission factor collected under Condition L.4.5and fuel usage data collected under Condition L.5.4.

6. **Supply Ship Events.** The total number of events during which the supply ship transits to and from the Discoverer and either attaches to the Discoverer or operates in dynamic positioning mode shall not exceed 8 in any drilling season.

M. SHALLOW GAS DIVERTER SYSTEM (FD-33)

1. **Shallow Gas Diverter System.** There shall be no emissions of any regulated NSR pollutants or GHGs from the shallow gas diverter system.
2. **Shallow Gas Diversions.** The permittee shall:
   - 2.1. Record the frequency and duration of each shallow gas diversion.
   - 2.2. Report the frequency and duration of each shallow gas diversion no later than February 1st for the time period beginning January 1st and ending December 31st of the preceding year.

N. ICEBREAKER #1

1. **Operation of SCR Unit.** At all times that any of the propulsion or generator engines on board Icebreaker #1 are in operation, the exhaust from each engine shall be directed to an operating SCR emission unit.
2. **Operation of Oxidation Catalyst.** At all times that any of the propulsion or generator engines on board Icebreaker #1 are in operation, the exhaust from each engine shall be directed to an operating oxidation catalyst emission unit.
3. **Aggregate Capacity Limits.** For a given drilling season, the permittee may select any vessel as Icebreaker #1, subject to the following conditions:
   - 3.1. The total capacity of all propulsion engines on Icebreaker #1 shall not exceed 28,400 hp.
   - 3.2. The total capacity of all generator engines on Icebreaker #1 shall not exceed 2,800 hp.
   - 3.3. The total capacity of all boilers on Icebreaker #1 shall not exceed 10 MMBtu/hr.
   - 3.4. The total capacity of all incinerators on Icebreaker #1 shall not exceed 154 lbs/hr.
   - 3.5. Total uncontrolled emissions of $PM_{2.5}$ from all emission sources on board Icebreaker #1 shall not exceed 42.20 lbs/hour.
     - 3.5.1. For compliance with Condition N.3.5, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.
     - 3.5.2. For the purposes of Condition N.3.5, emissions from each emission unit shall be based on operation of that emission unit at 100 percent of rated capacity, except for the propulsion engines, for which emissions shall be based on operation of that emission unit at 80 percent of rated capacity.
   - 3.6. Total uncontrolled emissions of PM_{10} from all emission sources on board Icebreaker #1 shall not exceed 48.0 lbs/hour.

3.6.1. For compliance with Condition N.3.6, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

3.6.2. For the purposes of Condition N.3.6, emissions from each emission unit shall be based on operation of that emission unit at 100 percent of rated capacity, except for the propulsion engines, for which emissions shall be based on operation of that emission unit at 80 percent of rated capacity.

3.7. No later than 45 days prior to deployment to the Chukchi Sea each drilling season, the permittee shall provide notification to the EPA of the vessel selected as Icebreaker #1. The notification shall include a list of all emission sources on board the vessel as well as manufacturer, model and rated capacity of each such emission source, and the conversion efficiency (mechanical to electrical) of each generator on board.

4. **Capacity Limit on Icebreaker #1 Propulsion Engines.** At all times while the Discoverer is an OCS Source and Icebreaker #1 is within 25 miles of the Discoverer, the permittee shall limit operation of the propulsion engines in Icebreaker #1 to no greater than 80 percent of rated capacity.

5. **Annual Emission Limits.** At all times while the Discoverer is an OCS Source and Icebreaker #1 is within 25 miles of the Discoverer, emissions from all emission sources on Icebreaker #1 in aggregate shall not exceed the emission limits specified for each of the pollutants below:

5.1. **NO_X:** 41.59 tons/rolling 12-month period

5.1.1. For compliance with Condition N.5.1, measurement of NOX shall be determined using EPA Method 7E.

6. **Hourly Emission Limits.** Emissions from all emission sources on Icebreaker #1 in aggregate shall not exceed the emission limits specified for each of the pollutants below:

6.1. **NO_X:** 67.96 lbs/hour

6.1.1. For compliance with Condition N.6.1, measurement of NO_X shall be determined using EPA Method 7E.

7. **Daily Emission Limits.** At all times while the Discoverer is an OCS Source and Icebreaker #1 is within 25 miles of the Discoverer, emissions from all emission sources on Icebreaker #1 in aggregate shall not exceed the emission limits specified for each of the pollutants below:

7.1. **PM_{10}:** 277.47 lbs/day

7.1.1. For compliance with Condition N.7.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

7.2. **$PM_{2.5}$:** 269.66 lbs/day

7.3. For compliance with Condition N.7.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

8. **Electrical Power Output Limit.** At all times while the Discoverer is an OCS Source and Icebreaker #1 is within 25 miles of the Discoverer, the permittee shall not operate the internal combustion engines in excess of:

   8.1. 28,233,704 kWe-hr from all of the generators on board Icebreaker #1 in aggregate during any rolling 12-month period; or

   8.2. 420,188 kWe-hr from all of the generators on board Icebreaker #1 in aggregate during any calendar day;

9. **Fuel Usage Limit.** At all times while the Discoverer is an OCS Source and Icebreaker #1 is within 25 miles of the Discoverer, the permittee shall not use fuel in excess of:

   9.1. 302,400 gallons in all heat boilers on board Icebreaker #1 in aggregate during any rolling 12-month period; or

   9.2. 1,800 gallons in all heat boilers on board Icebreaker #1 in aggregate during any calendar day; or

   9.3. 100 gallons in Icebreaker #1 seldom used sources in aggregate during any rolling 7-day period. Icebreaker #1 seldom used sources include engines on Icebreaker #1, that are not otherwise identified in the permit as emission units or categories of emission units on Icebreaker #1.

10. **Attachment to Discoverer.** At no time shall Icebreaker #1 be attached to the Discoverer.

11. **Stack Height Limit for Icebreaker #1.** The permittee shall ensure that the stack height of Icebreaker #1 is no less than 24.38 meters. For the purposes of this condition, the permittee shall obtain the stack height information for each vessel to be used as Icebreaker #1.

12. **Stack Test Requirements.** Prior to each of the first two drilling seasons that a vessel is used as Icebreaker #1, and while the Discoverer is operating under this permit in the Chukchi Sea, the permittee shall stack test each propulsion engine, non-propulsion generator engine, boiler and incinerator on Icebreaker #1 as follows:

    12.1. Each stack test on the propulsion engines shall be conducted at three different loads: 30 percent, 60 percent and 80 percent.

    12.2. Each stack test on the non-propulsion generator engines shall be conducted at two different load ranges: 50 – 60 percent and 90 – 100 percent.

    12.3. Each stack test on the boilers shall be conducted at full loads.

    12.4. Each stack test on the incinerator shall be conducted at full load.

    12.5. Each stack test run shall test for emissions of NO_X, NO_2, $PM_{2.5}$, and PM_{10}.

    12.6. During each test run for the propulsion engines, generator engines, and boilers, the permittee shall monitor and record the following information:

    12.6.1. Quantity of fuel used (in gallons);

    12.6.2. Density of the fuel used (in lbs/gallon);

    12.6.3. Heat content of the fuel used (in Btu/gallon);

12.6.4. For the engines, electrical power output (in kWe);

12.6.5. The stack temperature upstream of the SCR catalysis ºC or ºF;

12.6.6. The quantity of urea reagent (in gallons) and the concentration of the urea reagent (in weight percent) introduced into the SCR control system; and

12.6.7. The NO_X concentration (ppm) indicated by the periodic NO_X monitor used for the SCR control system.

12.7. During each test run for the incinerator, the permittee shall monitor and record the quantity of waste material incinerated (in lbs).

12.8. For each engine, each load range, and each pollutant, the permittee shall determine emission factors in the following units: lbs/kWe-hr and lbs/gallon.

12.9. For each boiler, and each pollutant, the permittee shall determine emission factors in the following units: lbs/MMBtu and lbs/gallon.

12.10. For each incinerator, and each pollutant, the permittee shall determine emission factors in the following units: lbs/ton of waste combusted.

13. **Monitoring, Recordkeeping, and Reporting.** The permittee shall:

13.1. Equip each of the propulsion engines and generator engines on board Icebreaker #1 with an electrical output monitoring device:

13.1.1. Each electrical output monitoring device shall measure the electrical output of the generator attached to each engine with an accuracy equal to or better than 2 percent of the engine's maximum output (in kWe);

13.1.2. Each electrical output monitoring device shall measure the electrical output of the generator attached to each engine at least once every 10 minutes; and

13.1.3. Each electrical output monitoring device shall be equipped to record each reading taken as well as provide and record average loads for each hour.

13.2. Maintain the accuracy of each electrical output monitoring device in accordance with manufacturer's recommendations.

13.3. Monitor and record the electrical load for each engine at least once every ten minutes, and record the average hourly load for each hour.

13.4. Equip each of the boilers on board Icebreaker #1 with a diesel fuel flow meter, or install a single fuel meter for all of the boilers:

13.4.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the boiler(s) or boiler group being served by the meter;

13.4.2. Each fuel flow meter shall be totalizing and nonresettable; and

13.4.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value.

13.5. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

13.6. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

13.7. Monitor and record the hourly fuel usage for each boiler.

13.8. For each instance in which an Icebreaker #1 seldom used source is operated while the Discoverer is an OCS Source, the permittee shall:

13.8.1. Record the duration of the episode for each such seldom used source;

13.8.2. Record the fuel consumption on a daily basis for each such seldom used source as provided in Condition B.6.4.2; and

13.8.3. Calculate and record for the previous 6 calendar days the rolling 7-day fuel consumption of Icebreaker #1 seldom used sources in aggregate by adding each day's fuel consumption to the total fuel consumed in the previous 6-calendar days.

13.9. At least 45 days before deployment to the Discoverer each drilling season, the permittee shall notify the EPA of the stack height of Icebreaker #1.

13.10. Record any instance that Icebreaker #1 attaches to the Discoverer.

13.11. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and emissions of $PM_{2.5}$ and PM_{10} in pounds per day from the boilers and incinerator by using the highest emission factor for each tested boiler or incinerator collected under Conditions N.12.9 and N.12.10 and fuel usage data collected under Condition N.13.7, to determine emissions from that source. For the purposes of this condition, the permittee shall assume that the incinerator has been operated continuously at the maximum operating rate, and shall use the highest emission factor collected under Condition N.12.10.

13.12. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and emissions of $PM_{2.5}$ and PM_{10} in pounds per day from each engine by using the emission factors for each tested engine collected under Conditions N.12.8 and electrical load data collected under Condition N.13.3, to determine emissions from that source. Emissions shall be calculated for each ten-minute load reading for each engine.

13.13. For the purposes of Conditions N.13.11 and N.13.3, if a specific emission unit has not been tested yet, the permittee shall use the highest emission factor for the corresponding load from the test results for any equivalent emission unit in equivalent service that has already been tested.

13.14. For the purposes of Conditions N.13.11 and N.13.3, if a specific load reading is missing, the permittee shall calculate the emissions for that missing load reading by using the emission factor and load combination that results in the highest emissions rate for that emissions unit. If the engine in question has not been tested yet, the permittee shall use the emission factor as provided for in Condition N.13.13.

13.15. For the purpose of Condition P.13.12, if either the urea pump is not operating or if the catalyst inlet temperature, measured in Condition B.14, is less than 250^{o}C, calculate emissions of NO_X for the affected time period by using an uncontrolled emission factor obtained by applying a 95 percent NO_X reduction efficiency to the emission factor determined pursuant to Condition P.12.8

O. ICEBREAKER #2

1. **Operation of SCR Unit.** At all times that any of the propulsion or generator engines on board Icebreaker #2 are in operation, the exhaust from each engine shall be directed to an operating SCR emission unit.

2. **Operation of Oxidation Catalyst.** At all times that any of the propulsion or generator engines on board Icebreaker #2 are in operation, the exhaust from each engine shall be directed to an operating oxidation catalyst emission unit.

3. **Icebreaker #2 Vessel Alternatives.** For a given drilling season, the permittee may use either the Tor Viking or Hull 247 as Icebreaker #2, subject to the conditions in Section O of this permit. Hull 247 is a temporary vessel name assigned by the shipbuilder, Edison Chouest. This permit is intended to apply to this vessel even when renamed with its permanent name.

3.1 The total capacity of all propulsion engines on Icebreaker #2 shall not exceed 17,660 hp for the Tor Viking and 24,000 kW for Hull247.

3.2 The total capacity of all non-propulsion generator engines on Icebreaker #2 shall not exceed 2,336 hp for the Tor Viking and Hull 247 shall not have electrical generation capacity in addition to the engines specified in Condition O.3.1.

3.3 The total capacity of all boilers on Icebreaker #2 shall not exceed 1.37 MMBtu/hr for the Tor Viking and 4.00 MMBtu/hr for Hull 247.

3.4 The total capacity of all incinerators on Icebreaker #2 shall not exceed 151.23 lbs/hr.

3.5 Total uncontrolled emissions of $PM_{2.5}$ from all emission sources on board Icebreaker #2 shall not exceed 11.4 lbs/hour.

3.5.1 For compliance with Condition O.3.5, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

3.5.2 For the purposes of Condition O.3.5, emissions from each emission unit shall be based on operation of that emission unit at 100 percent of rated capacity, except for the propulsion engines, for which emissions shall be based on operation of that emission unit at 80 percent of rated capacity.

3.6 Total uncontrolled emissions of PM_{10} from all emission sources on board Icebreaker #2 shall not exceed 11.7 lbs/hour.

3.6.1 For compliance with Condition O.3.6, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

3.6.2 For the purposes of Condition O.3.6, emissions from each emission unit shall be based on operation of that emission unit at 100 percent of rated capacity, except for the propulsion engines, for which emissions shall be based on operation of that emission unit at 80 percent of rated capacity.

3.7 No later than 45 days prior to deployment to the Chukchi Sea each drilling season, the permittee shall provide notification to the EPA of the vessel selected as Icebreaker #2. The notification shall include a list of all emission sources on board the vessel as well as manufacturer, model and rated capacity of each emission source.

4. **Capacity Limit on Icebreaker #2 Propulsion Engines.** At all times while the Discoverer is an OCS Source and Icebreaker #2 is within 25 miles of the Discoverer, the permittee shall limit operation of the propulsion engines in Icebreaker #2 to 80 percent of rated capacity.

5. **Annual Emission Limits.** At all times while the Discoverer is an OCS Source and Icebreaker #2 is within 25 miles of the Discoverer, emissions from all emission sources on Icebreaker #2 in aggregate shall not exceed the emission limits specified for each of the pollutants below:

5.1 **NO_X:** 99.45 tons/rolling 12-month period

5.1.1 For compliance with Condition O.5.1, measurement of NOX shall be determined using EPA Method 7E.

6. **Hourly Emission Limits.** Emissions from all emission sources on Icebreaker #2 in aggregate shall not exceed the emission limits specified for each of the pollutants below:

6.1 **NO_X:** 69.06 lbs/hour

6.1.1 For compliance with Condition O.6.1, measurement of NOX shall be determined using EPA Method 7E.

7. **Daily Emission Limits.** At all times while the Discoverer is an OCS Source and Icebreaker #2 is within 25 miles of the Discoverer, emissions from all emission sources on Icebreaker #2 in aggregate shall not exceed the emission limits specified for each of the pollutants below:

7.1 **PM_{10}:** 281.46 lbs/day

7.1.1 For compliance with Condition O.7.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

7.2 **$PM_{2.5}$:** 273.82 lbs/day

7.2.1 For compliance with Condition O.7.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and202.

8. **Electrical Power Output Limit.** At all times while the Discoverer is an OCS Source and Icebreaker #2 is within 25 miles of the Discoverer, the permittee shall not operate the internal combustion engines in excess of:

8.1 25,223,168 kWe-hr from all of the generators on board the Tor Viking in aggregate during any rolling 12-month period.

8.2 44,562,643 kWe-hr from all of the generators on board Hull 247 in aggregate during any rolling 12-month period.

8.3 395,100 kWe-hr from all of the generators on board the Tor Viking in aggregate during any calendar day.

8.4 592,141 kWe-hr from all of the generators on board Hull 247 in aggregate during any calendar day.

9. **Fuel Usage Limit.** At all times while the Discoverer is an OCS Source and Icebreaker #2 is within 25 miles of the Discoverer, the permittee shall not use fuel in excess of:

9.1 40,320 gallons in all heat boilers on board the Tor Viking in aggregate during any rolling 12-month period.

9.2 120,960 gallons in all heat boilers on board Hull 247 in aggregate during any rolling 12-month period.

9.3 240 gallons in all heat boilers on board the Tor Viking in aggregate during any calendar day.

9.4 720 gallons in all heat boilers on board Hull 247 in aggregate during any calendar day.

9.5 100 gallons in Icebreaker #2 seldom used sources in aggregate during any rolling 7-day period. Icebreaker #2 seldom used sources include engines on Icebreaker # 2, that are not otherwise identified in the permit as emission units or categories of emission units on Icebreaker #2.

10. **Attachment to Discoverer.** At no time shall Icebreaker #2 be attached to the Discoverer.

11. **Stack Height Limit for Icebreaker #2.** The permittee shall ensure that the stack height of Icebreaker #2 is no less than 24.38 meters. For the purposes of this condition, the permittee shall obtain the stack height information for each vessel to be used as Icebreaker #2.

12. **Stack Test Requirements.** Prior to each of the first two drilling seasons that a vessel is used as Icebreaker #2, and while the Discoverer is operating under this permit in the Chukchi Sea, the permittee shall stack test each propulsion engine, non-propulsion generator engine, boiler and incinerator on Icebreaker #2 as follows:

12.1 Each stack test on the propulsion engines shall be conducted at four different loads: 20 percent, 40 percent, 60 percent, and 80 percent.

12.2 Each stack test on the non-propulsion generator engines shall be conducted at two different load ranges: 50 – 60 percent and 90 - 100 percent.

12.3 Each stack test on the boilers shall be conducted at full loads.

12.4 Each stack test on the incinerator shall be conducted at full load.

12.5 Each stack test run shall test for emissions of NO_X, NO_2, $PM_{2.5}$, and PM_{10}.

12.6 During each test run for the propulsion engines, generator engines, and boilers, the permittee shall monitor and record the following information:

12.6.1 Quantity of fuel used (in gallons);

12.6.2 Density of the fuel used (in lbs/gallon);

12.6.3 Heat content of the fuel used (in Btu/gallon);

12.6.4 For the engines, electrical power output (in kWe);

12.6.5 The stack temperature upstream of the SCR catalysis ºC or ºF;

12.6.6 The quantity of urea reagent (in gallons) and the concentration of the urea reagent (in weight percent) introduced into the SCR control system; and

12.6.7 The NO_X concentration (ppm) indicated by the periodic NO_X monitor used for the SCR control system.

12.7 During each test run for the incinerator, the permittee shall monitor and record the quantity of waste material incinerated (in lbs).

12.8 For each engine, each load range, and each pollutant, the permittee shall determine emission factors in the following units: lbs/kWe-hr and lbs/gallon.

12.9 For each boiler, and each pollutant, the permittee shall determine emission factors in the following units: lbs/MMBtu and lbs/gallon.

12.10 For each incinerator, and each pollutant, the permittee shall determine emission factors in the following units: lbs/ton of waste combusted.

13. **Monitoring, Recordkeeping, and Reporting.** The permittee shall:

13.1 Equip each of the propulsion engines and generator engines on board Icebreaker #2 with an electrical output monitoring device:

13.1.1 Each electrical output monitoring device shall measure the electrical output of the generator attached to each engine with an accuracy equal to or better than 2 percent of the engine’s maximum output (in kWe).

13.1.2 Each electrical output monitoring device shall measure the electrical output of the generator attached to each engine at least once every 10 minutes; and

13.1.3 Each electrical output monitoring device shall be equipped to record each reading taken as well as provide and record average loads for each hour.

13.2 Maintain the accuracy of each electrical output monitoring device in accordance with manufacturer’s recommendations.

13.3 Monitor and record the electrical load for each engine at least once every ten minutes, and record the average hourly load for each hour.

13.4 Equip each of the boilers on board Icebreaker #2 with a diesel fuel flow meter, or install a single fuel meter for all of the boilers:

13.4.1 Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the boiler(s) or boiler group being served by the meter;

13.4.2 Each fuel flow meter shall be totalizing and non-resettable; and

13.4.3 Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter’s upper range value.

13.5 No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

13.6 Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

13.7 Monitor and record the hourly fuel usage for each boiler.

13.8 For each instance in which an Icebreaker #2 seldom used source is operated while the Discoverer is an OCS Source, the permittee shall:

13.8.1 Record the duration of the episode for each such seldom used source;

13.8.2 Record the fuel consumption on a daily basis for each seldom used source as provided in Condition B.6.4.2; and

13.8.3 Calculate and record for the previous 6 calendar days the rolling 7-day fuel consumption of such seldom used sources in aggregate by adding each day's fuel consumption to the total fuel consumed in the previous 6-calendar days.

13.9 At least 45 days before deployment to the Discoverer each drilling season, the permittee shall notify the EPA of the stack height of Icebreaker #2.

13.10 Record any instance that Icebreaker #2 attaches to the Discoverer.

13.11 Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and emissions of $PM_{2.5}$ and PM_{10} in pounds per day from the boilers and incinerator by using the highest emission factor for each tested boiler or incinerator collected under Conditions O.12.9 and O.12.10 and fuel usage data collected under Condition O.13.7, to determine emissions from that source. For the purposes of this condition, the permittee shall assume that the incinerator has been operated continuously at the maximum operating rate, and shall use the highest emission factor collected under Condition O.12.10.

13.12 Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and emissions of $PM_{2.5}$ and PM_{10} in pounds per day from each engine by using the emission factors for each tested engine collected under Conditions O.12.8 and electrical load data collected under Condition O.13.3, to determine emissions from that source. Emissions shall be calculated for each ten-minute load reading for each engine.

13.13 For the purposes of Conditions O.13.11 and O.13.12, if a specific emission unit has not been tested yet, the permittee shall use the highest emission factor for the corresponding load from the test results from an equivalent emission unit in equivalent service that has already been tested.

13.14 For the purposes of Conditions O.13.11 and O.13.12, if a specific load reading is missing, the permittee shall calculate the emissions for that missing load reading by using the emission factor and load combination that results in the highest emissions rate for that emissions unit. If the engine in question has not been tested yet, the permittee shall use the emission factor as provided for in Condition O.13.13.

13.15 For the purpose of Condition O.13.12 if either the urea pump is not operating or if the catalyst inlet temperature, measured in Condition B.14, is less than 250^{o}C, calculate emissions of NO_X for the affected time period by using an uncontrolled emission factor obtained by applying a 95 percent NO_X reduction efficiency to the emission factor determined pursuant to Condition O.12.8.

P. SUPPLY SHIP

1. **Operational Limits on Supply Ship Engines.** At all times while the Discoverer is an OCS Source and the supply ship is within 25 miles of the Discoverer, the permittee shall:

1.1. Not operate the emergency engine on the supply ship.

1.2. Not use fuel in excess of 1,200 gallons in the Supply Ship propulsion engines and non-propulsion engines in aggregate during any calendar day when in transit to and from the Discoverer.

1.3. Not use fuel in excess of 4,800 gallons in the supply ship propulsion engines and non-propulsion engines in aggregate during any calendar day when operating in dynamic positioning mode.

2. **Hourly Emission Limits on Supply Ship in Dynamic Positioning Mode.** Emissions from all generator and propulsion engines in aggregate on the supply ship shall not exceed the emission limits specified for each of the pollutants below:

2.1. **Nitrogen oxides (NO_X):** 117.39 lb/hr

2.1.1. For compliance with Condition P.2.1, measurement of NO_X shall be determined using EPA Method 7E.

3. **Daily Emission Limits on Supply Ship in Dynamic Positioning Mode.** Emissions from all generator and propulsion engines in aggregate on the supply ship shall not exceed the emission limits specified for each of the pollutants below:

3.1. **PM_{10}:** 75.09 lbs/day

3.1.1. For compliance with Condition P.3.1, measurement of PM_{10} shall be determined using EPA Method s 201A and 202.

3.2. **$PM_{2.5}$:** 75.09 lbs/day

3.2.1. For compliance with Condition P.3.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

4. **Stack Test Requirements.** Prior to each of the first two drilling seasons that the supply ship is used and while the Discoverer is operating under this permit in the Chukchi Sea, the permittee shall stack test each propulsion engine and non-propulsion generator engine on the supply ship as follows:

4.1. Each stack test on the propulsion engines shall be conducted at four different loads: 20 percent, 40 percent, 60 percent, and 80 percent.

4.2. Each stack test on the non-propulsion generator engines shall be conducted at two different load ranges: 50 - 60 percent and 90 - 100 percent.

4.3. Each stack test run shall test for emissions of NO_X, NO_2, $PM_{2.5}$, and PM_{10}.

4.4. During each test run for the propulsion engines and generator engines the permittee shall monitor and record the following information:

4.4.1. Quantity of fuel used (in gallons);

4.4.2. Density of the fuel used (in lbs/gallon);

4.4.3. Heat content of the fuel used (in Btu/gallon);

4.4.4. For the engines, electrical power output (in kWe);

4.5. For each engine, each load range, and each pollutant, the permittee shall determine emission factors in the following units: lbs/kWe-hr and lbs/gallon.

5. **Monitoring, Recordkeeping and, Reporting**. The permittee shall:

5.1. At all times while the Discoverer is an OCS Source and the supply ship is within 25 miles of the Discoverer, monitor the power output of each propulsion engine on the supply ship at least once every 15 minutes.

5.1.1. The monitored power output shall be recorded as a direct readout value as well as a percentage of the rated capacity of each engine.

5.2. Equip each of the propulsion and non-propulsion engines on the Supply Ship with a diesel fuel flow meter or install a single fuel meter for all of the engines:

5.2.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the engine(s) or engine group being served by the meter;

5.2.2. Each fuel flow meter shall be totalizing and non-resettable; and

5.2.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value.

5.3. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

5.4. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

5.5. Monitor and record the hourly fuel usage for the supply ship.

5.6. For each trip to the Discoverer while the Discoverer is an OCS Source, the permittee shall record the following:

5.6.1. The date and time the supply ship came within 25 miles of the Discoverer; and

5.6.2. After the delivery to the Discoverer, the date and time that the supply ship was no longer within 25 miles of the Discoverer.

5.7. Each day, calculate and record for the previous calendar day, the emissions of NO_X in pounds per hour and pounds per day and the emissions of $PM_{2.5}$, and PM_{10} in pounds per day from each engine by using the emission factors for each tested engine collected under Condition P.4.5and recorded fuel use under Condition P.5.5.

5.8. Record the date and time the supply ship ceases operation in dynamic positioning mode.

5.9. Record the date and time the supply ship ceases operation in dynamic positioning mode.

6. **Supply Ship Events.** The total number of events during which the supply ship transits to and from the Discoverer and either attaches to the Discoverer or operates in dynamic positioning mode shall not exceed 8 in any drilling season. Each 24-hour period of operation in dynamic positioning mode is considered a separate supply ship event.

Q. OIL SPILL RESPONSE FLEET

1. **Operation of Catalyzed Diesel Particulate Filter (CDPF).** At all times while the Discoverer is an OCS Source and the Nanuq is within 25 miles of the Discoverer, and any of the Nanuq propulsion engines (Units N-1 - 2) or non-propulsion generator engines (Units N-3 -4) are in operation, the exhaust from each emission unit shall be directed to operating CleanAIR Systems CDPF, as specified by CleanAIR Systems.

1.1. Each CDPF shall be equipped with an operating HiBACK monitor and alarm unit, that records exhaust pressure and temperature.

1.2. During each day that each of Units N-1 - 4 is operated, the exhaust temperature shall be above 300^{o}C, or 572^{o}F, for at least 30 percent of the time.

2. **Annual Emission Limits.** At all times while the Discoverer is an OCS source and the Oil Spill Response fleet is within 25 miles of the Discoverer, emissions of NO_X from the Oil Spill Response Fleet shall not exceed the emission limits specified below:

2.1. **Nanuq propulsion engines and generators in aggregate (Units N-1 – 4):** 97.11 tons/rolling 12-month period

2.2. **Kvichak Nos. 1-3 propulsion engines in aggregate (Units K1-2, K4-5, and K7-8):** 19.07 tons/rolling 12-month period

2.2.1. For compliance with Conditions Q.2.1and Q.2.2, measurement of NO_X shall be determined using EPA Method 7E.

3. **Hourly Emission Limits:** At all times while the Discoverer is an OCS source and the Oil Spill Response fleet is within 25 miles of the Discoverer, emissions of NO_X from the Oil Spill Response Fleet shall not exceed the emission limits specified below:

3.1. Nanuq propulsion engines and generators in aggregate (Units N-1 – 4):

3.1.1. **NO_X:** 67.44 lbs/hour

3.1.1.1. For compliance with Condition Q.3.1.1, measurement of NO_X shall be determined using EPA Method 7E.

3.2. Kvichak Nos. 1-3 propulsion engines in aggregate (Units K1-2, K4-5, and K7-8):

3.2.1. **NO_X:** 13.24 lb/hr

3.2.1.1. For compliance with Condition Q.3.2.1, measurement of NO_X shall be determined using EPA Method 7E.

4. **Daily Emission Limits:** At all times while the Discoverer is an OCS source and the Oil Spill Response fleet is within 25 miles of the Discoverer, emissions from the Oil Spill Response Fleet shall not exceed the emission limits specified:

4.1. Nanuq propulsion engines and generators in aggregate (Units N-1 – 4):

4.1.1. **PM_{10}:** 3.03 lbs/day

4.1.1.1. For compliance with Condition Q.4.1.1, measurement of PM_{10} shall be determined using EPA Method s 201A and 202.

4.1.2. **$PM_{2.5}$:** 3.03 lbs/day

4.1.2.1. For compliance with Condition Q.4.1.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

4.2. Kvichak Nos. 1-3 in aggregate (Units K1-2, K4-5, and K7-8):

4.2.1. **PM_{10}:** 24.34 lbs/day

4.2.1.1. For compliance with Condition Q.4.2.1, measurement of PM_{10} shall be determined using EPA Methods 201A and 202.

4.2.2. **$PM_{2.5}$:** 24.34 lbs/day

4.2.2.1. For compliance with Condition Q.4.2.2, measurement of $PM_{2.5}$ shall be determined using EPA Methods 201A and 202.

5. **Fuel Usage Limit.** At all times while the Discoverer is an OCS Source and the Nanuq is within 25 miles of the Discoverer, the permittee shall not use in excess of:

5.1. 456,000 gallons of fuel in the Nanuq propulsion engines (Units N-1 – 2) and non-propulsion electrical generators (Units N-3 – 4) in aggregate during any rolling 12-month period.

5.2. 3,800 gallons of fuel in the Nanuq propulsion engines (Units N-1 – 2) and non-propulsion electrical generators (Units N-3 – 4) in aggregate during any calendar day.

5.3. 100 gallons of fuel in the Nanuq seldom used sources in aggregate during any rolling 7-day period. The Nanuq seldom used sources include engines on the Nanuq that are not otherwise identified in the permit as emission units or categories of emission units on the Nanuq.

5.4. 2856 gallons of fuel in the Kvichak Nos. 1-3 in aggregate during any rolling 7-day period.

6. **Operating Location.** Except for transport of crew and supplies to and from the Discoverer or when responding to an oil spill, the oil spill response fleet shall operate at a location that is downwind from the Discoverer.

7. **Attachment to Discoverer.** At no time shall the Nanuq or any of the Kvichak work boats be attached to the Discoverer.

8. **Stack Test Requirements.** Prior to each of the first two drilling seasons while the Discoverer is operating under this permit in the Chukchi Sea, the permittee shall stack test at least one of the Nanuq propulsion engines (Units N-1 – 2) and one of the Nanuq non-propulsion generator engines (Units N-3 – 4) as follows:

   8.1. At the end of two drilling seasons that the Discoverer operates under this permit in the Chukchi Sea, all of Units N-1 – 4 shall have been stack tested under the requirements of this section.

   8.2. Each stack test shall be conducted at four different loads - 25 percent, 50 percent, 75 percent and 100 percent for the propulsion engines and at two loads – 50 percent and 100 percent for the non-propulsion engines.

   8.3. Each stack test run shall test for emissions of NO_X and NO_2.

   8.4. During each test run, the permittee shall monitor and record the following information:

      8.4.1. Quantity of fuel used (in gallons);

      8.4.2. Density of the fuel used (in lbs/gallon);

      8.4.3. Heat content of the fuel used (in Btu/gallon); and

      8.4.4. Electrical power output (in kWe).

   8.5. For each engine, each load, and each pollutant, the permittee shall determine emission factors in the following units: lbs/kWe-hr and lbs/gallon.

9. **Monitoring, Recordkeeping and Reporting.** The permittee shall:

   9.1. Equip each of Units FD-N-1 - 4 with a diesel fuel flow meter, or install a single fuel meter for all of Units FD-N-1 - 4:

      9.1.1. Each fuel flow meter shall be located so that there is no potential for fuel inflows or outflows between it and the engine(s) or engine group being served by the meter;

      9.1.2. Each fuel flow meter shall be totalizing and non-resettable; and

      9.1.3. Each fuel flow meter shall measure the fuel flow rate with accuracy equal to or better than 2 percent of the meter's upper range value.

   9.2. No less than 60 days before initial deployment of the Discoverer to the Chukchi Sea for the first drilling season, collect information from the manufacturer of each fuel flow meter so as to determine its accuracy. Submit this information to the EPA no less than 30 days prior to operation within the Chukchi Sea.

   9.3. Maintain the accuracy of each fuel flow meter in accordance with manufacturer's recommendations.

   9.4. Monitor and record fuel usage for each propulsion and generator engine (Units N-1 – 4) on a hourly basis.

9.5. For each instance in which a Nanuq seldom used source is operated while the Discoverer is an OCS Source, the permittee shall:

9.5.1. Record the duration of the episode for each such seldom used source;

9.5.2. Record the fuel consumption on a daily basis for each such seldom used source as provided in Condition B.6.4.2; and

9.5.3. Calculate and record for the previous 6 calendar days the rolling 7-day fuel consumption of the Nanuq seldom used sources in aggregate by adding each day's fuel consumption to the total fuel consumed in the previous 6-calendar days.

9.6. Record any instance that the Nanuq or Kvichak work boats attach to the Discoverer.

9.7. Each day, calculate and record for the previous calendar day, the emissions of NO_X, in pounds per hour and pounds per day using the highest emission factor for each tested engine collected under Condition Q.8.5 and fuel usage data collected under Condition Q.9.4.

9.8. Monitor and record the exhaust temperature of each engine by use of the HiBACK monitor and alarm unit, while the engine is in operation.

9.9. Each day, calculate and record for the previous calendar day, the percent of operational time for each engine that the exhaust temperature was above 300^oC (572^oF).

R. POST-CONSTRUCTION AMBIENT AIR QUALITY MONITORING

1. **Ambient Air Quality Monitoring Station.** The permittee shall install, operate and maintain a Federal Reference Method or Federal Equivalent Method ambient air quality monitoring station to measure and record $PM_{2.5}$ concentration data in accordance with EPA, 1984a: Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-450/4-87-007, May 1987, U.S. Environmental Protection Agency, Research Triangle Park, NC.

1.1. An alternative $PM_{2.5}$ monitoring station may be used in lieu of the required monitoring station provided that approval of the monitoring station is obtained from the EPA;

1.2. The permittee shall use a continuous sampler and a manual sampler to measure $PM_{2.5}$. In addition, filters from the manual sampler shall be analyzed as provided for in the EPA-approved ambient air quality and meteorological monitoring plan required pursuant to Condition R.3 to allow for the chemical speciation of $PM_{2.5}$ constituents, including but not limited to sulfates, nitrates, organics, metals, sea salt and crustal matter.

1.3. The monitoring period shall commence within 120 days after the final permit is issued and shall continue for a minimum of 1 year after commencement of initial operation of the Discoverer in the Chukchi Sea as an OCS Source;

1.4. The data recovery shall be as provided for in the EPA-approved ambient air quality and meteorological monitoring plan required pursuant to Condition R.3; and

1.5. The monitoring station shall continue to operate and record data until such time that written approval is obtained from the EPA authorizing the termination of its operation.

2. **Meteorological Monitoring Station.** The permittee shall install, operate and maintain a meteorological monitoring station to monitor and record data in accordance with EPA, 1984a: Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-450/4-87-007, May 1987, U.S. Environmental Protection Agency, Research Triangle Park, NC.

2.1. An alternative meteorological monitoring station may be used in lieu of the required monitoring station provided that approval of the monitoring station is obtained from the EPA;

2.2. Data shall include horizontal wind direction and speed, temperature, solar radiation and temperature difference;

2.3. Each quarter's data recovery shall be as provided for in the EPA-approved ambient air quality and meteorological monitoring plan required pursuant to Condition R.3;

2.4. The monitoring period shall commence within 120 days after the final permit is issued and shall continue for a minimum of 1 year after commencement of operation of the OCS Source; and

2.5. The monitoring station shall continue to operate and record data until such time that written approval is obtained from the EPA authorizing the termination of its operation.

3. **Ambient Air Quality and Meteorological Monitoring Plan.** At least 60 days prior to the commencement of the data collection, the permittee shall submit to the EPA for approval an ambient air quality and meteorological monitoring plan for the post-construction monitoring requirements specified in Conditions R.1 and R.2 in accordance with the requirements of 40 CFR Part 58, Appendix A "Quality Assurance Requirements for SLAMS, SPMs and PSD Air Monitoring." The plan shall include a description of the proposed monitoring site.

4. **Monthly Reporting.** Within 45 days after the end of each calendar month, the permittee shall submit to the EPA a printed summary of the $PM_{2.5}$ and meteorological monitoring data collected during the prior calendar month.

5. **Audit Reports.** The permittee shall submit audit reports with 45 days after the following events:

5.1. Completion of the post-installation equipment audit;

5.2. Completion of independent performance and system audits;

5.3. Completion of quarterly audits required for ambient air quality data collection system; and

5.4. Completion of the semi-annual audits required for the meteorological data collection system.

Quarterly and semi-annual audit periods shall be based on a calendar year.

6. **Annual Report.** Within 60 days after the end of each calendar year and following completion of the collection of monitoring, the permittee shall submit to the EPA annual/final reports in text, tabular, and graphic forms, including data in digitized format. The digitized formats of the measured air quality and meteorological data shall be in ASCII format and AIRS format.

7. **System and Performance Audit Report**. Within 60 days after completion of data collection, the permittee shall also submit the final report for the system and performance audits required prior to monitoring termination.

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ATTACHMENT A: EPA NOTIFICATION FORM

Excess Emissions and Permit Deviation Reporting

OCS Source (Facility) Name **Air Quality Permit Number**

Company Name

When did you identify the Excess Emissions/Permit Deviation?
Date: / / Time: :

When did the event/deviation occur?
Begin: Date: / / Time: : (please use 24hr clock)
End: Date: / / Time: : (please use 24hr clock)

What was the duration of the event/deviation: : (hrs:min) or days
(total # of hrs, min, or days, if intermittent then include only the duration of the actual emissions/deviation)

Reason for notification: (please check only 1 box and go to the corresponding section)
☐Excess Emissions Complete Section 1 and Certify
☐Deviation from Permit Conditions Complete Section 2 and Certify
☐Deviation from Compliance Order by Consent, Compliance Order, or Settlement Agreement Complete Section 2 and Certify

Section 1. Excess Emissions

(a) Was the exceedance ☐Intermittent or ☐Continuous

(b) Cause of Event (Check one that applies):
☐Start Up/Shut Down ☐Natural Cause (weather/earthquake/flood)
☐Control Equipment Failure ☐Scheduled Maintenance/Equipment Adjustments
☐Bad fuel/coal/gas ☐Upset Condition ☐Other

(c) Description:
Describe briefly what happened and the cause. Include the parameters/operating conditions exceeded, limits, monitoring data and exceedance.

(d) Emission Units Involved:
Identify the emission units or source involved in the event, using the same identification number and name as in the permit. Identify each emission standard (including any throughput limit) potentially exceeded during the event and the exceedance.

Unit ID	Emission Unit Name	Permit Condition Exceeded/Limit/ Potential Exceedance

(e) Type of Incident (please check only one):

☐Opacity percent ☐Venting (gas/scf) ☐Control Equipment Down
☐Fugitive Emissions ☐Emission Limit Exceeded ☐Record Keeping Failure
☐Marine Vessel Opacity ☐Flaring ☐Other:

(f) Unavoidable Emissions:
Do you intend to assert that these excess emissions were unavoidable? ☐YES ☐NO

Certify Report (go to end of form)

Section 2. Permit Deviations

(a) Permit Deviation Type (check one only) (check boxes correspond with sections in permit):
☐ Source Specific
☐ Failure to monitor/report
☐ General Source Test/Monitoring Requirements
☐ Recordkeeping/Reporting/Compliance Certification
☐ Standard Conditions Not Included in Permit
☐ Generally Applicable Requirements
☐ Reporting/Monitoring for Diesel Engines
☐ Insignificant Source
☐ Facility Wide
☐ Other Section: (title of section and section # of your permit)

(b) Emission Units Involved:
Identify the source involved in the event, using the same identification number and name as in the permit. List the corresponding Permit condition and the deviation.

Unit ID	Emission Unit Name	Permit Condition /Potential Deviation

(c) Description of Potential Deviation:
Describe briefly what happened and the cause. Include the parameters/operating conditions and the potential deviation.

(d) Corrective Actions:
Describe actions taken to correct the deviation or potential deviation and to prevent future recurrence.

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

Printed Name **Title** **Date**

Signature **Phone number**

To Submit this Report:

1. Fax this form to: Facsimile no. 206-553-0110

   Or

2. E-mail to: R10OCSAirPermits_Reports@epa.gov

   Or

3. Mail to: OCS/PSD Air Quality Permits
   U.S. EPA - Region 10, AWT-107
   1200 Sixth Avenue, Suite 900
   Seattle, WA 98101

ATTACHMENT B: VISIBLE EMISSIONS FIELD DATA SHEET

Permit No. R10OCS/PSD-AK-09-01

Certified Observer: ____________________

Company & Stationary Source: ____________________

Location: ____________________

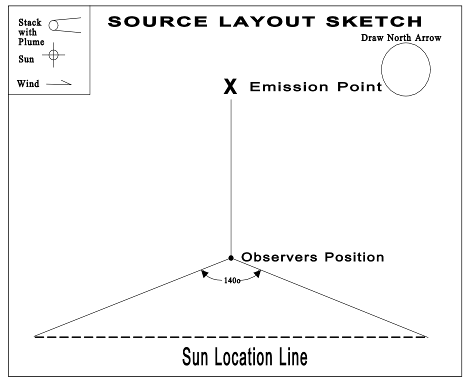
Test No.: __________ Date: __________

Emission Unit: ____________________

Operating Rate: ____________________

____

____



Clock Time	Initial				Final
Observer location Distance to discharge					
Direction from discharge					
Height of observer point					
Background description					
Weather conditions Wind Direction					
Wind speed					
Ambient temperature					
Relative humidity					
Sky conditions: (clear, overcast, % clouds, etc.)					
Plume description: Color					
Distance visible					
Water droplet plume? (Attached or detached?)					
Other information					

Page ___ of ___

Company & Stationary Source____________________________ Certified Observer___________________

Test Number _________________________ Clock time_________________

Date:		Visibility Reduction Every 15 Seconds (Opacity)				Steam Plume (check if applicable)		Comments
Hr	Min	0	15	30	45	Attached	Detached	

Additional information:

_____________________________________ _________________________________

Observer Signature and Date Certified By and Date

Data Reduction:

Duration of Observation Period (minutes) ________ Duration Required by Permit (minutes)_________

Number of Observations ______________________ Highest Six –Minute Average Opacity (%)______

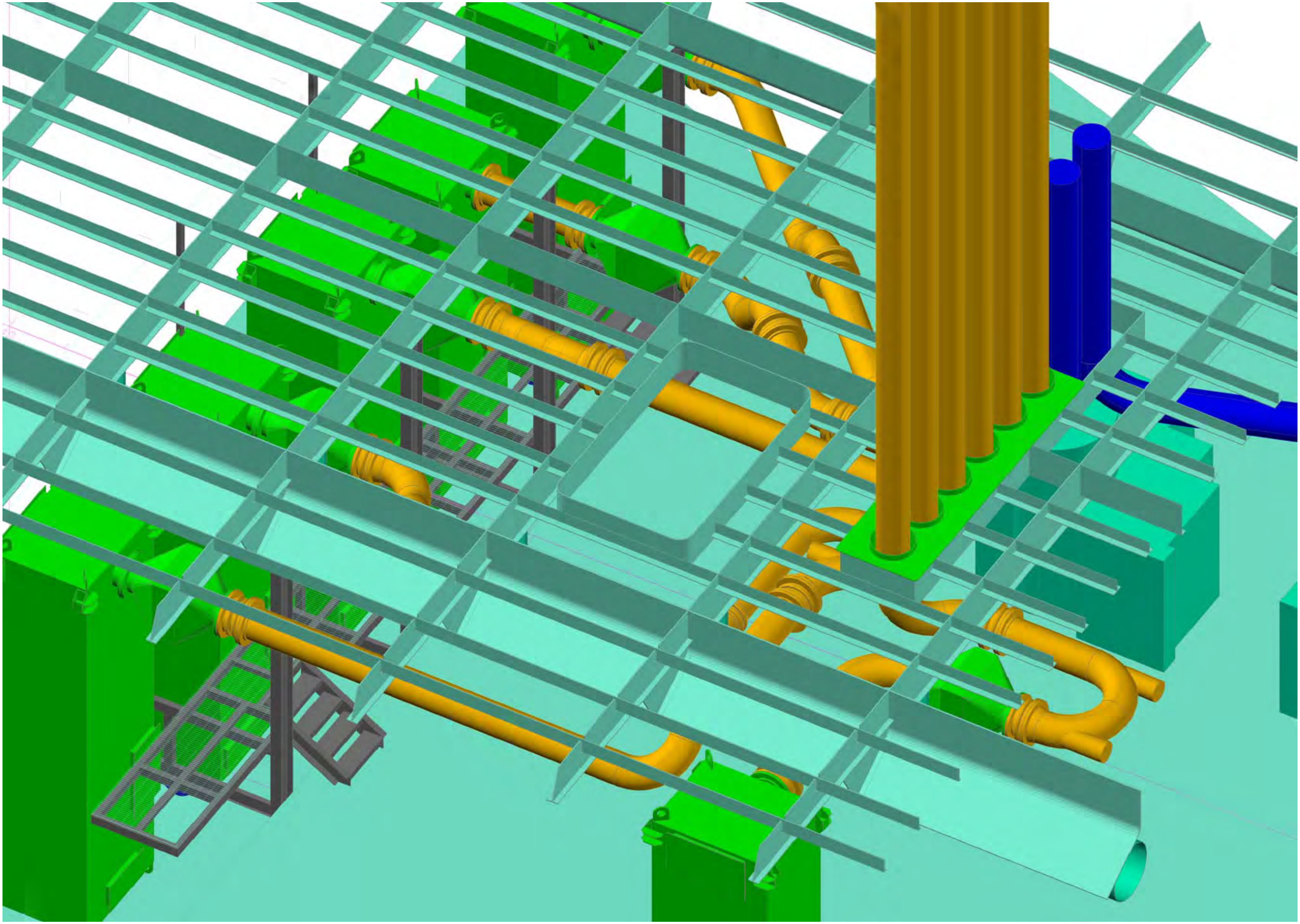
Number of Observations exceeding 20 % ________

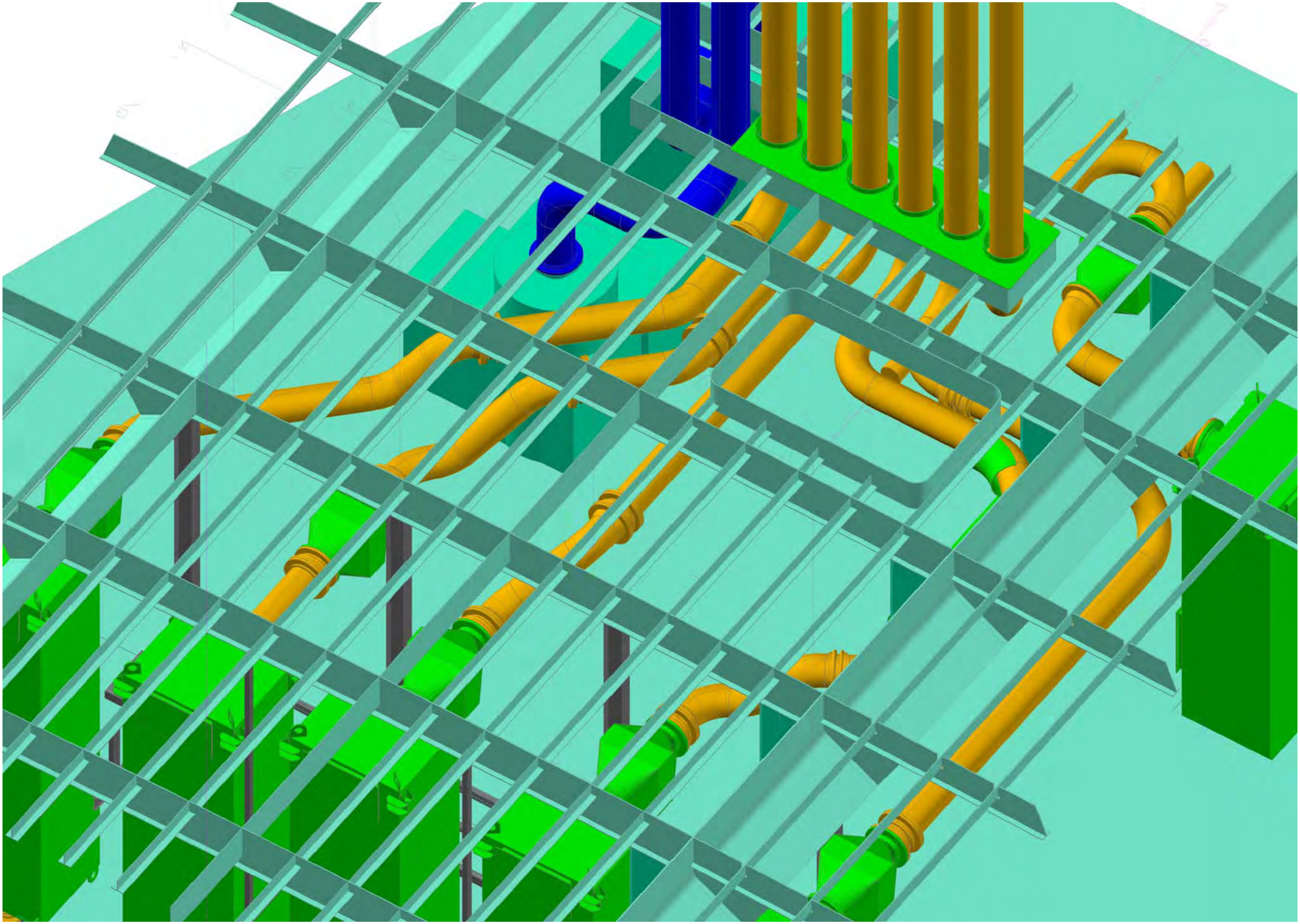
Average Opacity Summary

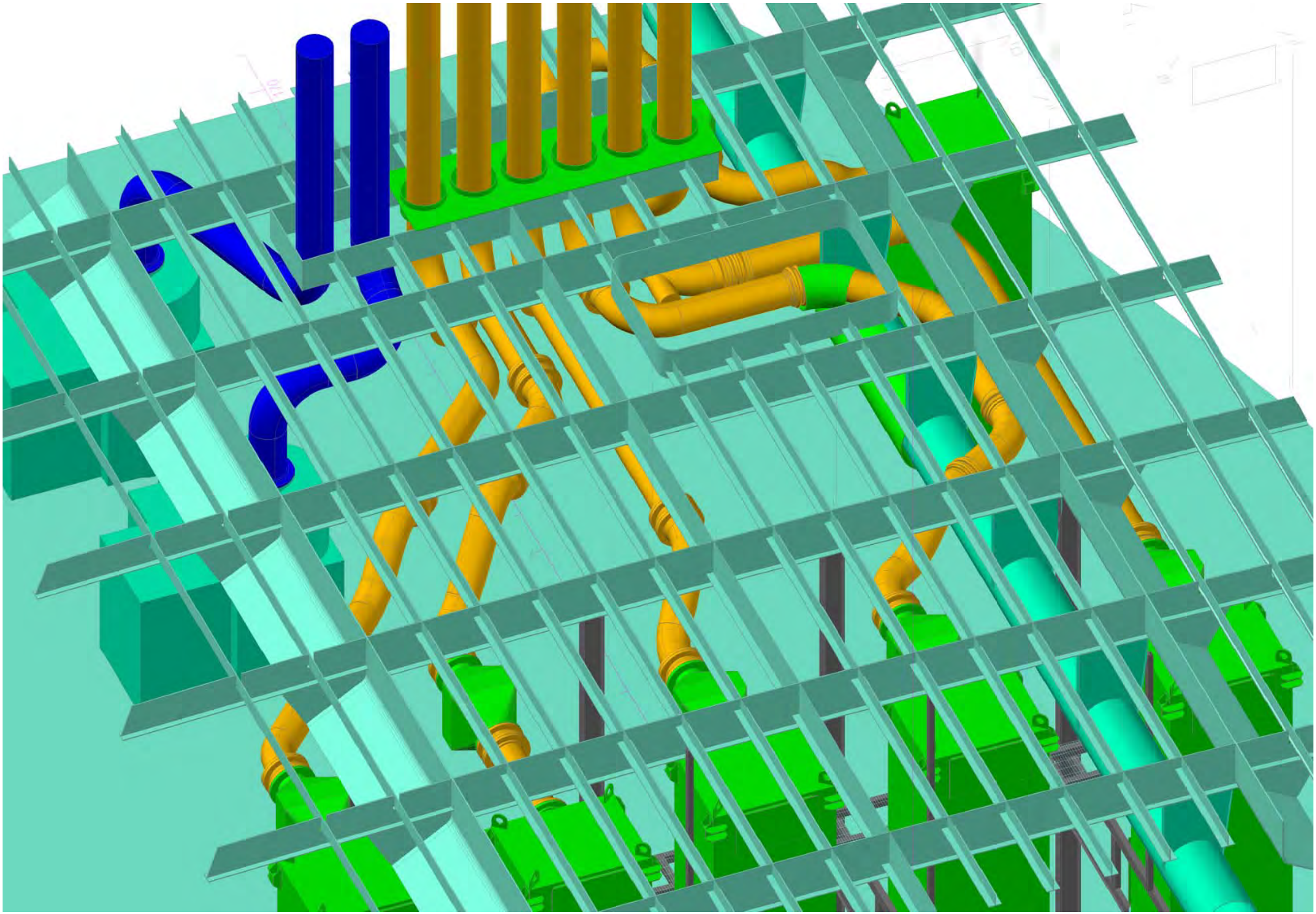
Set Number	Time Start—End	Opacity	
		Sum	Average

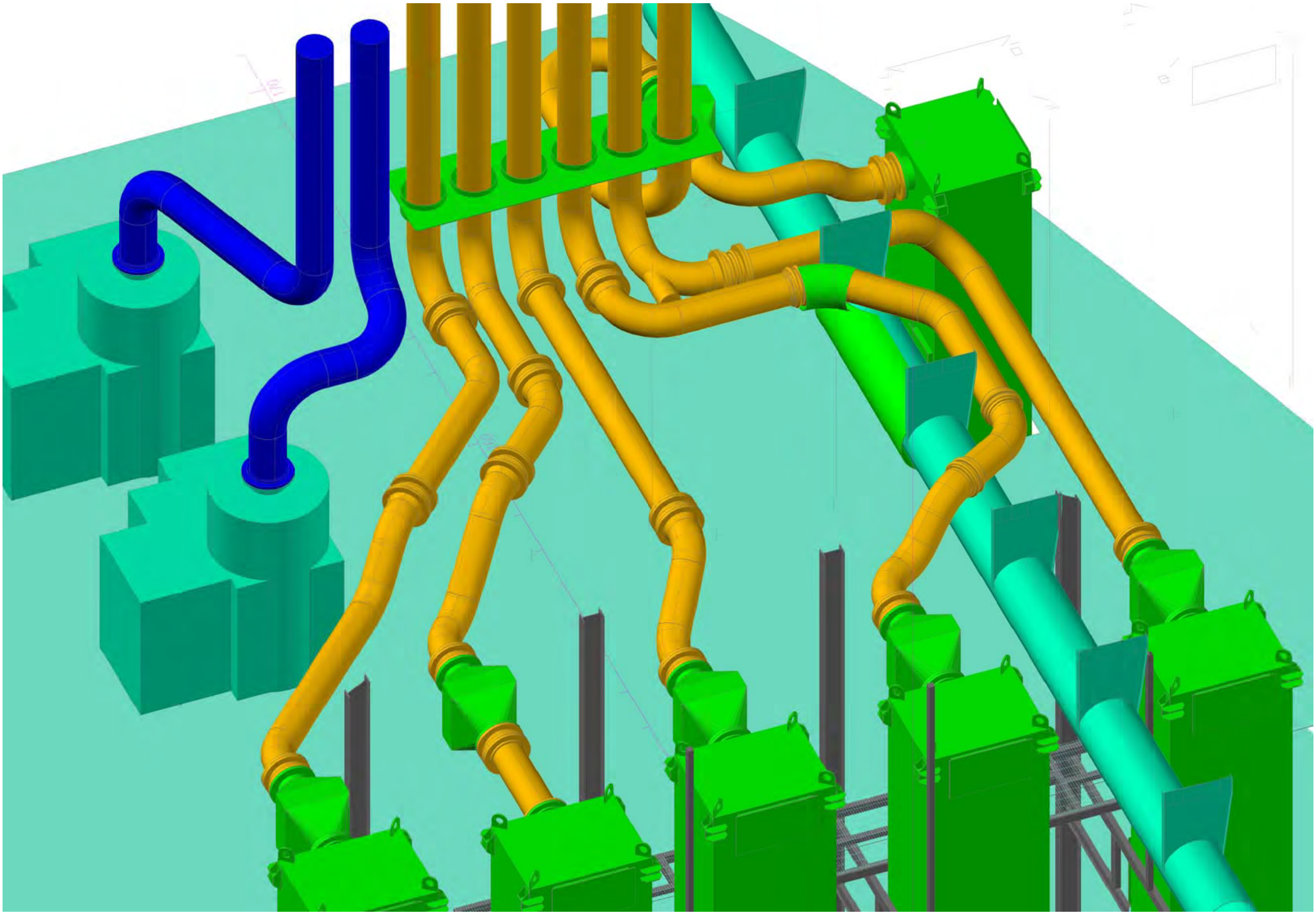
Appendix B

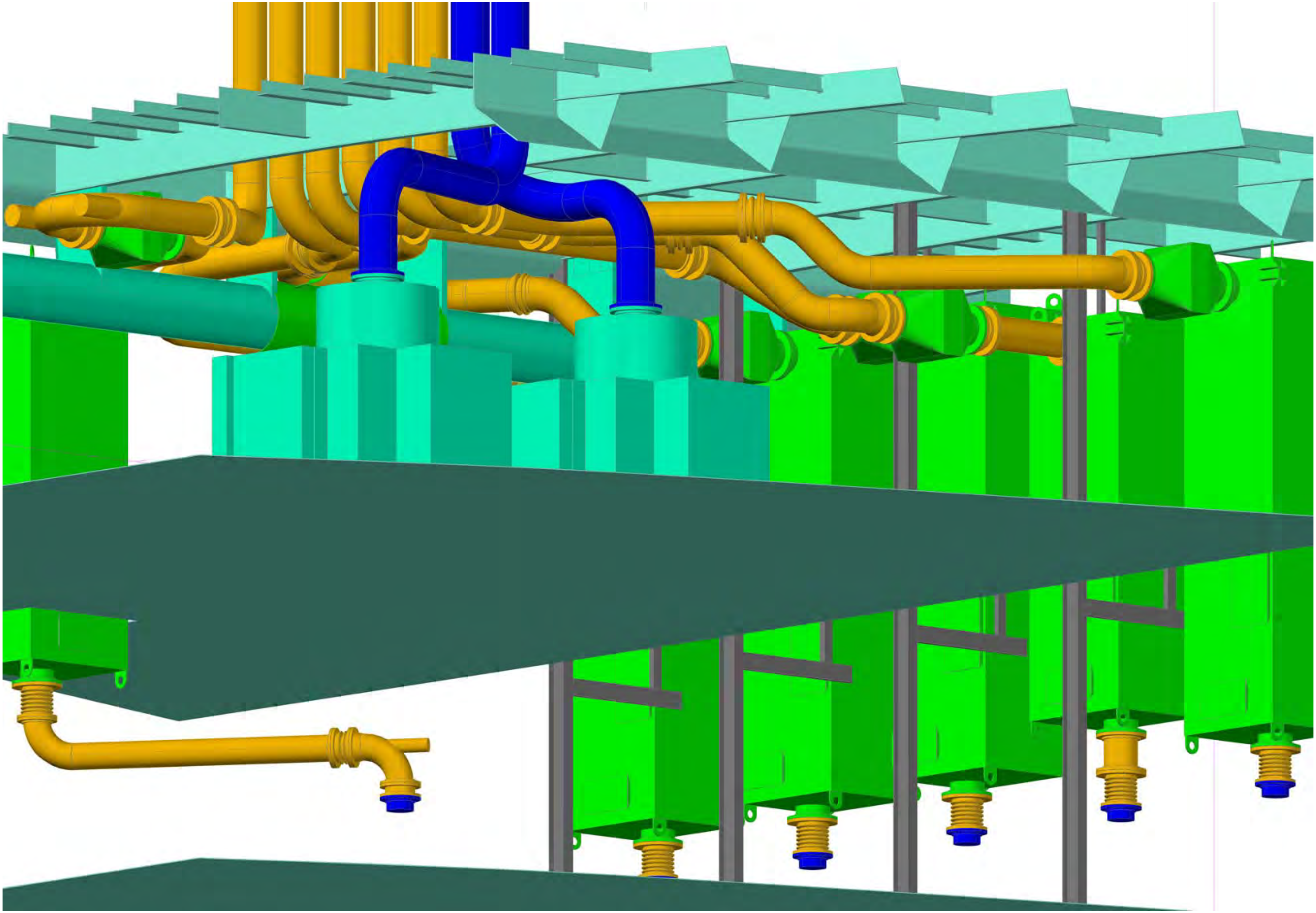
Computer models of the E-POD Installation inside the Discoverer

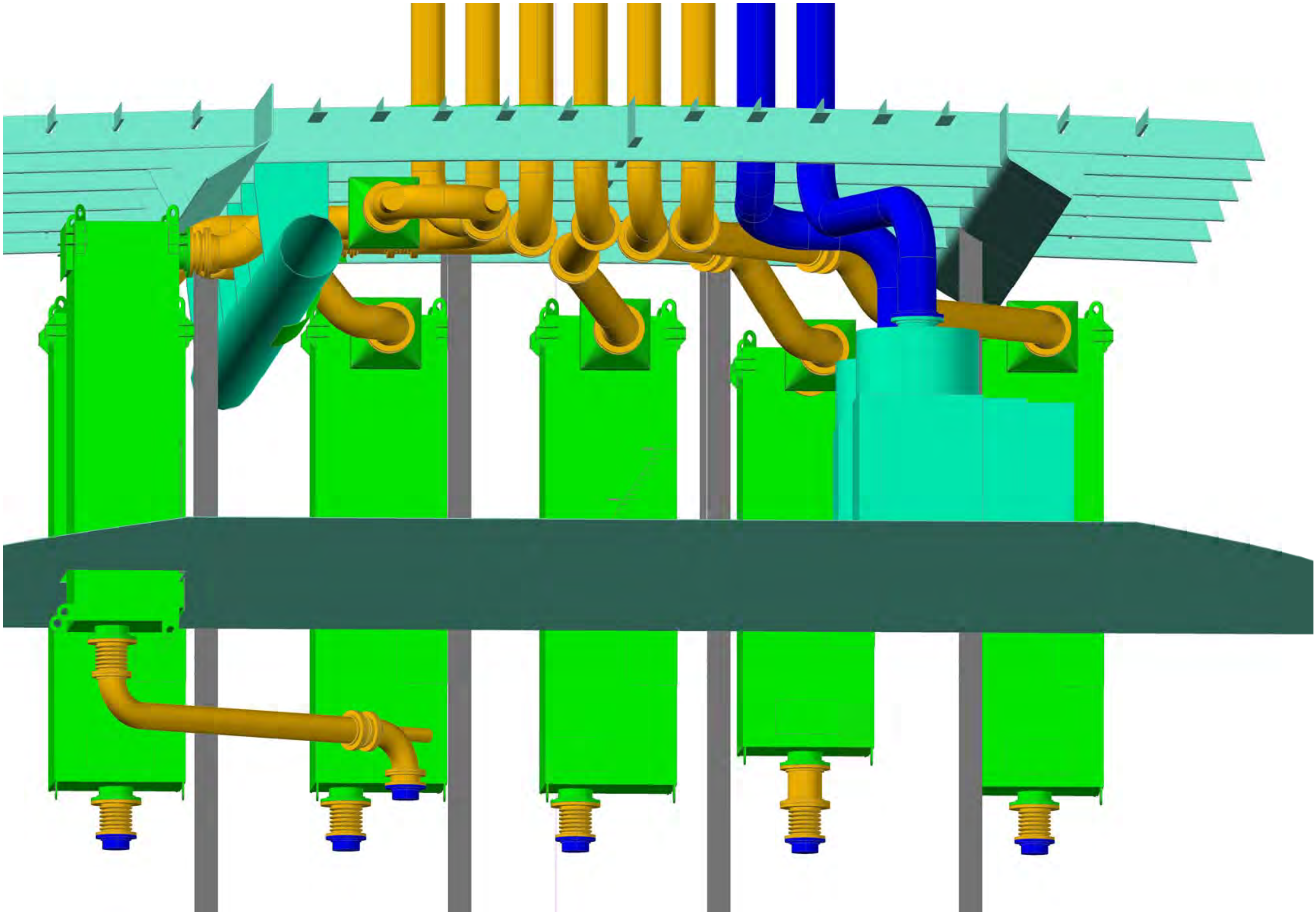


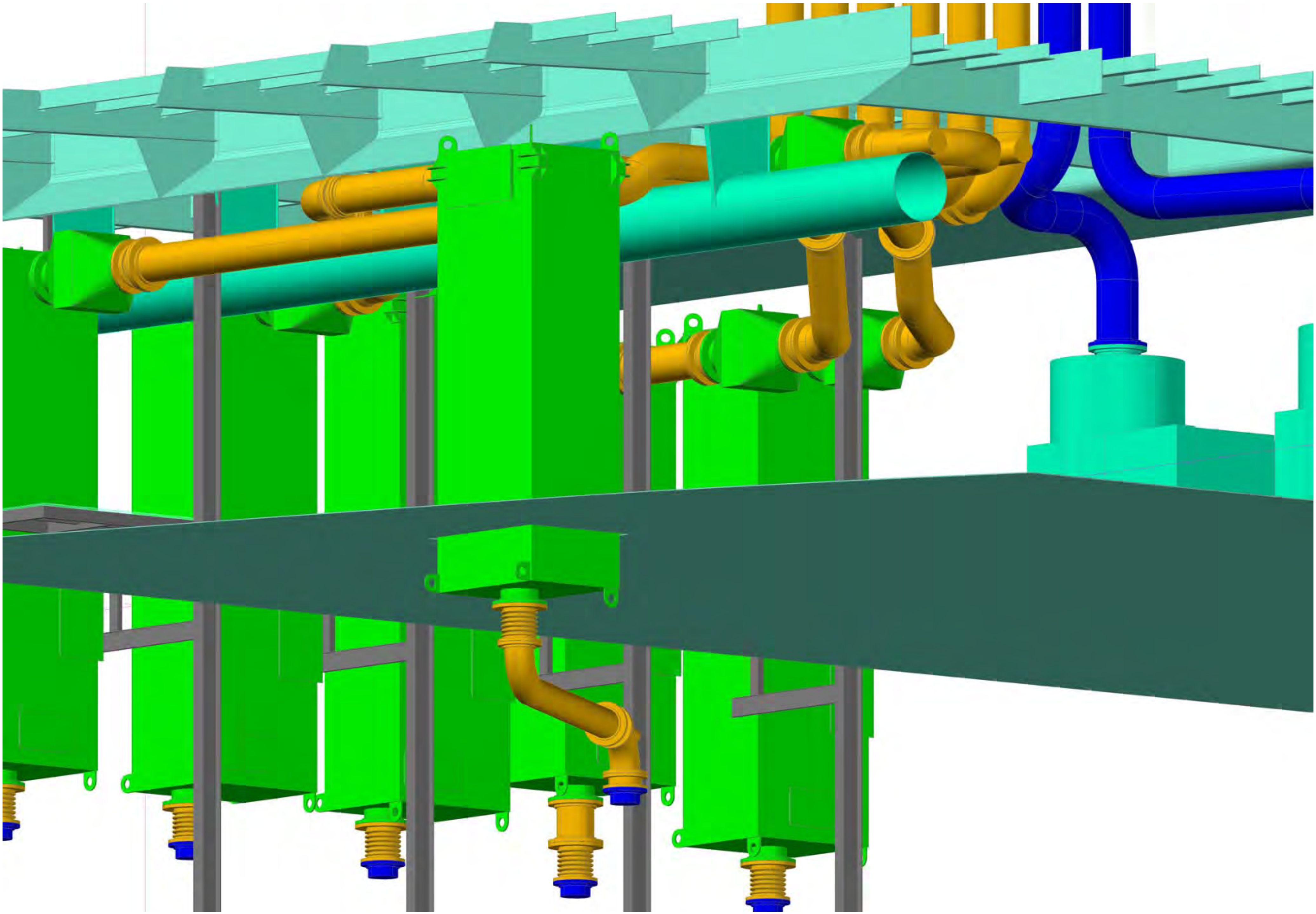


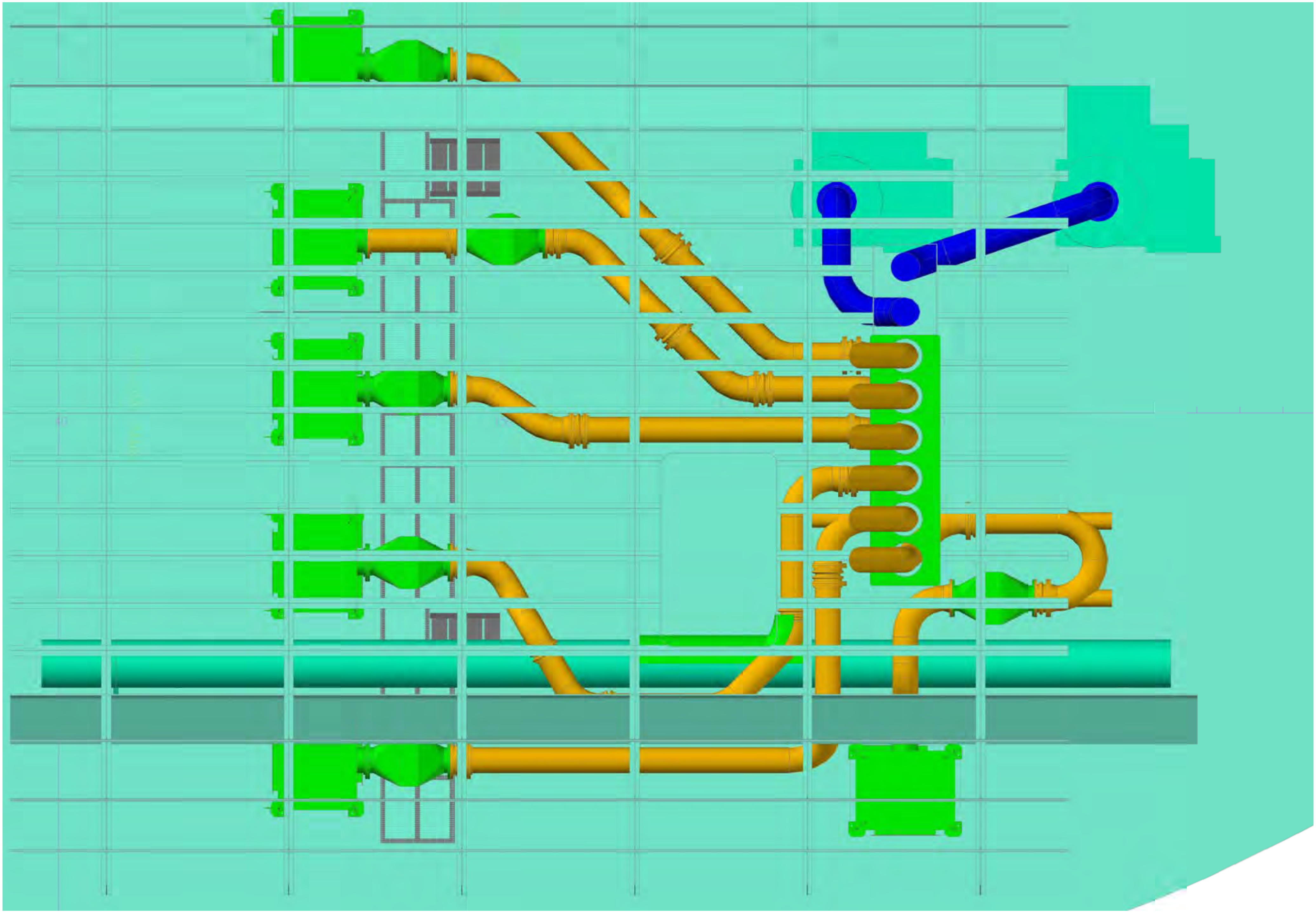


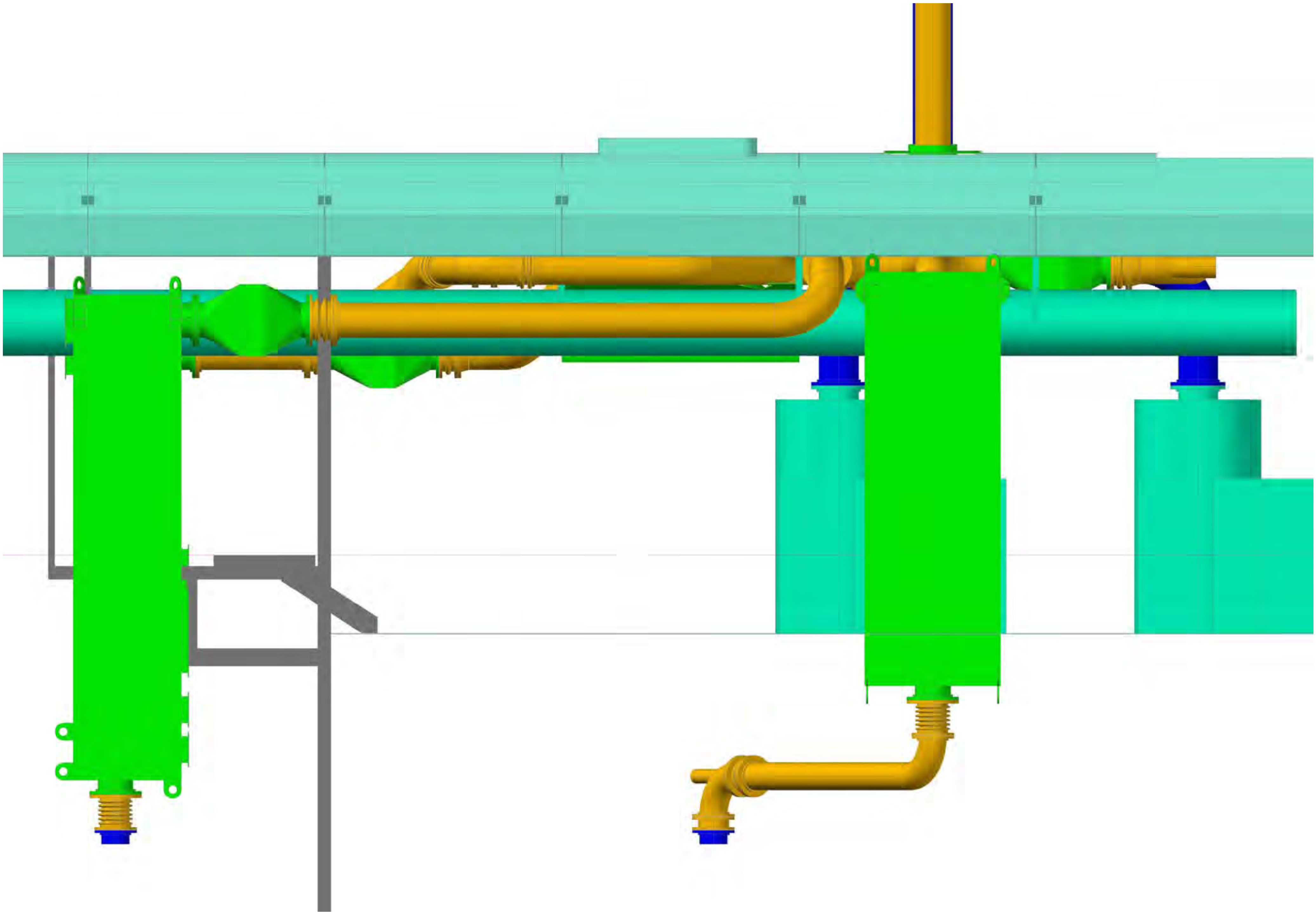


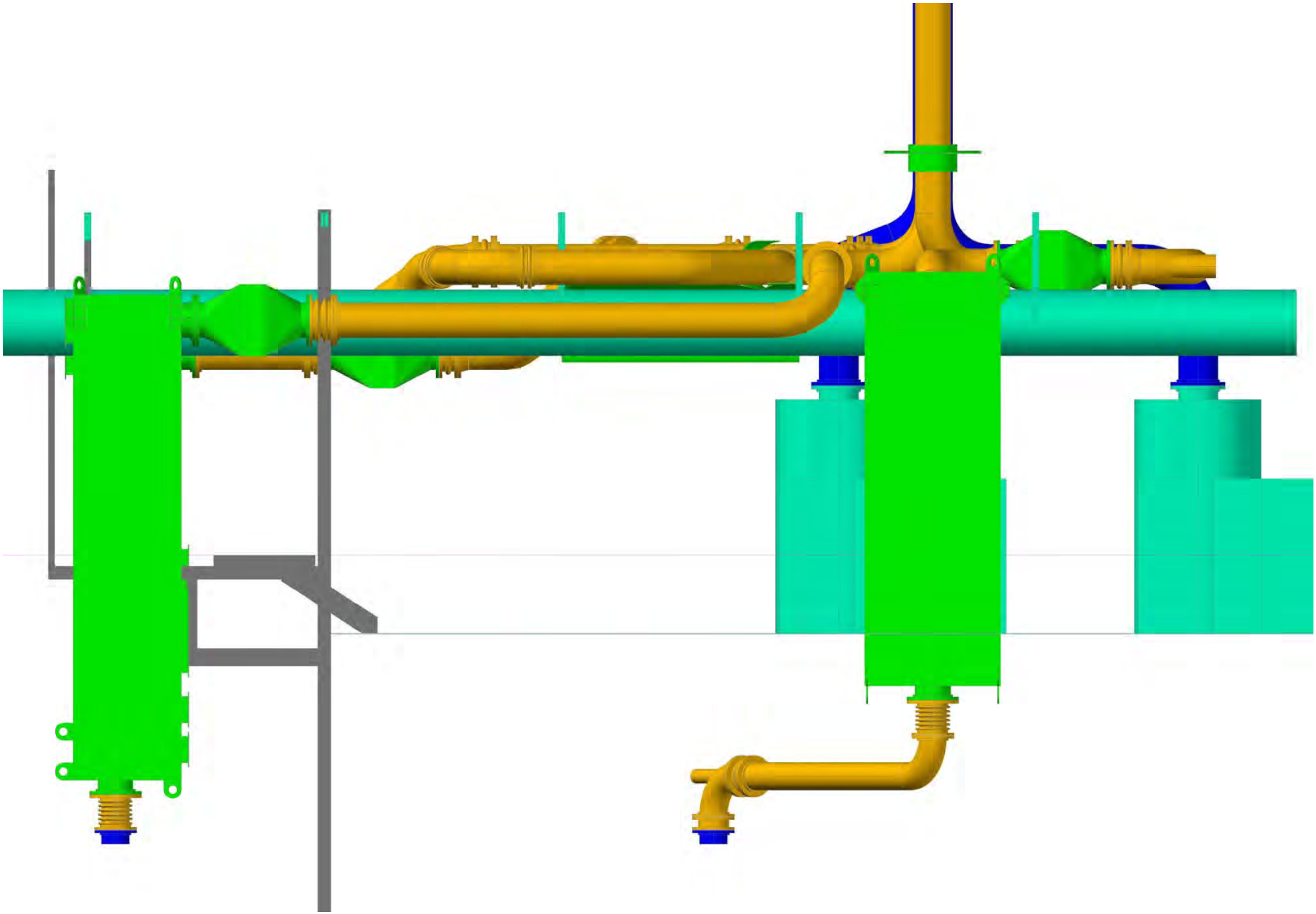


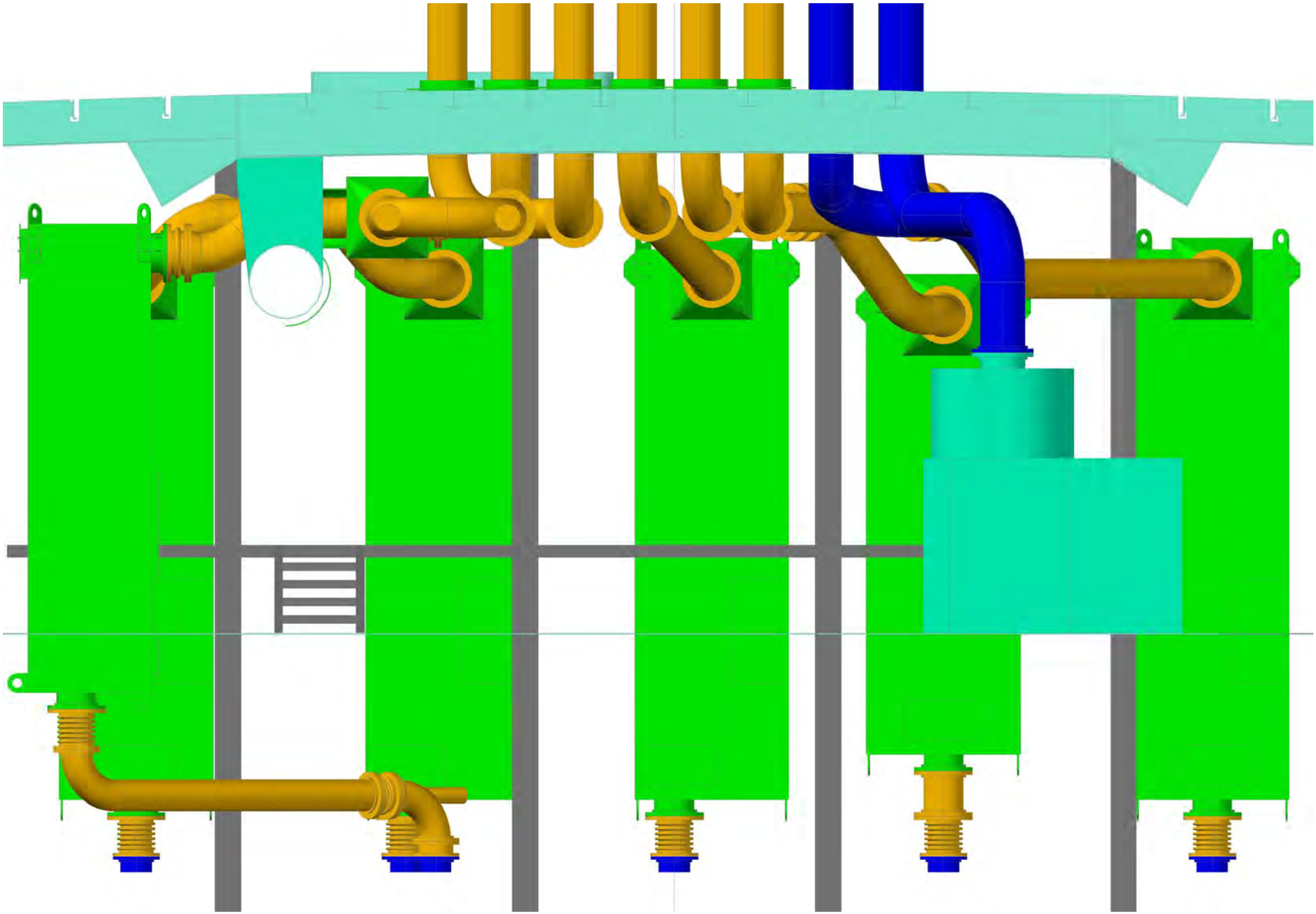










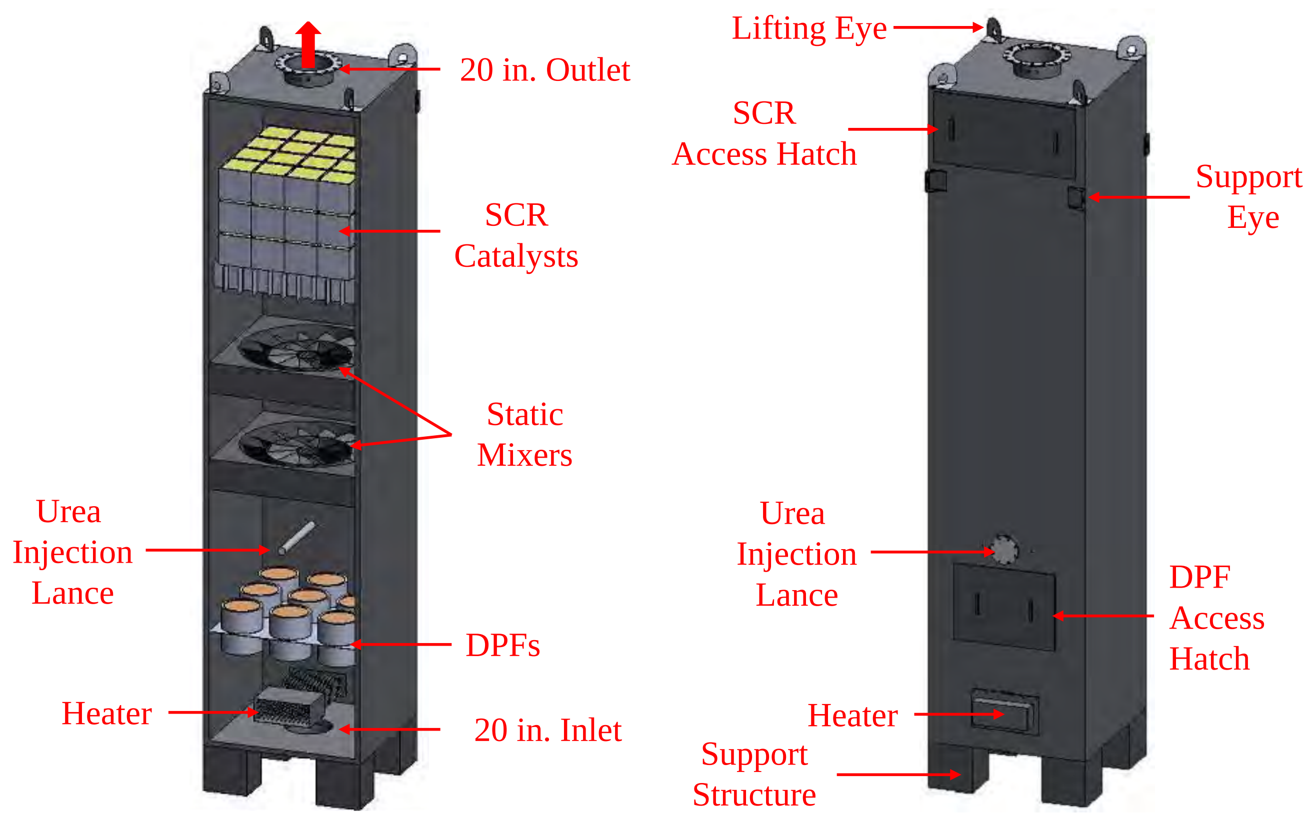


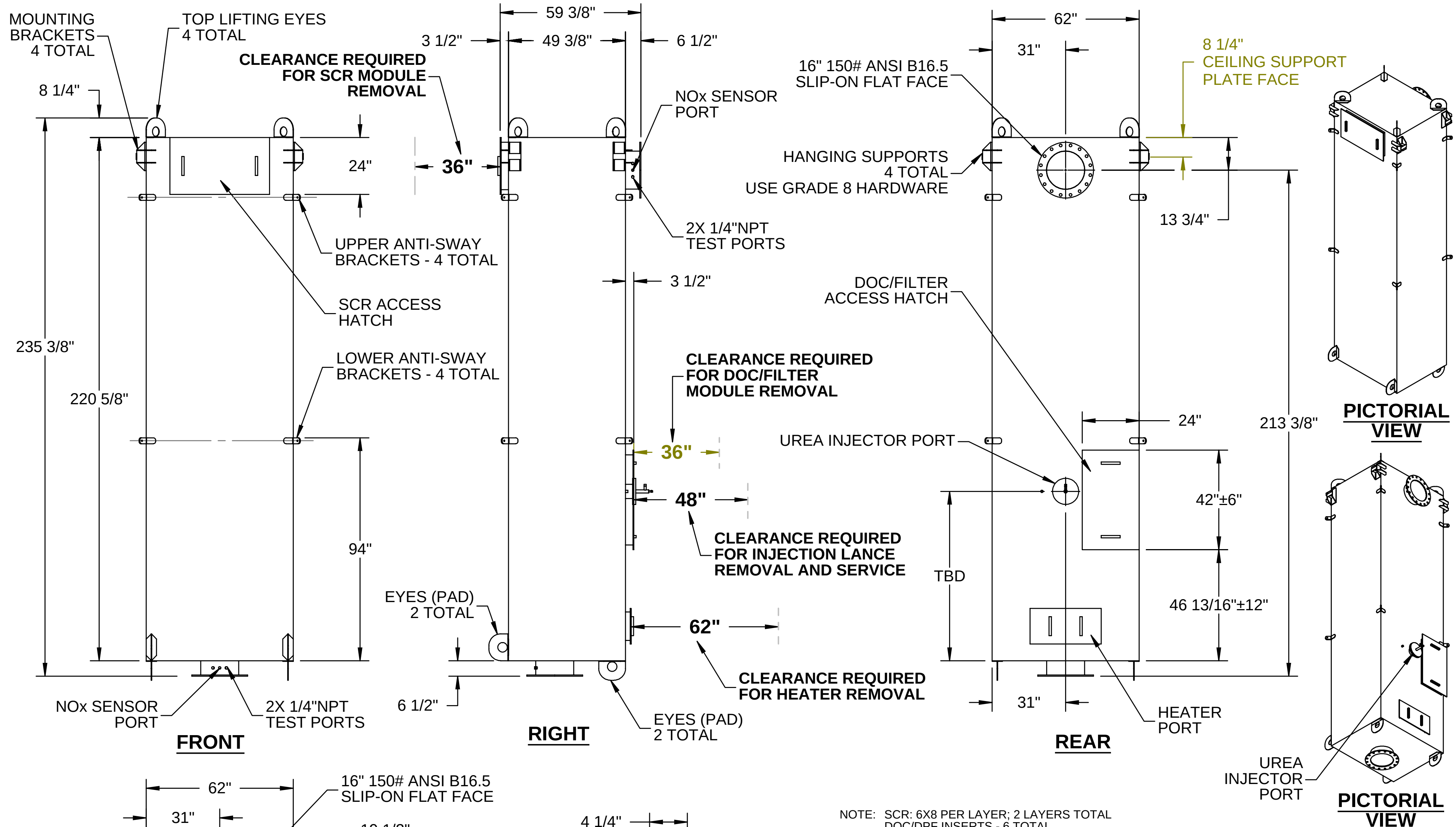
Appendix C

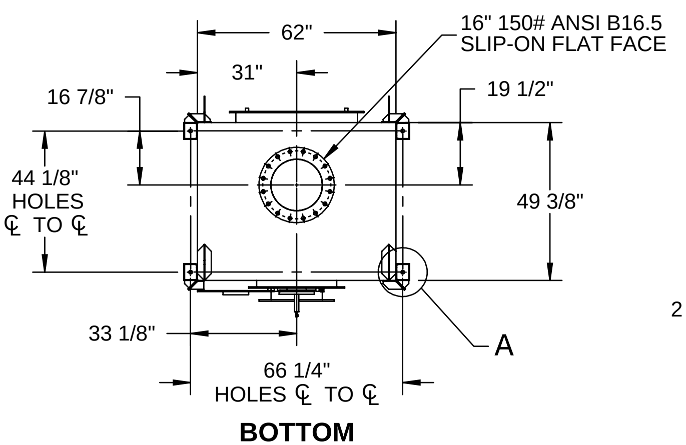
E-POD Specifications

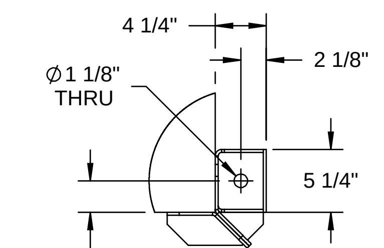
Vertical E-POD Layout

emissions solutions









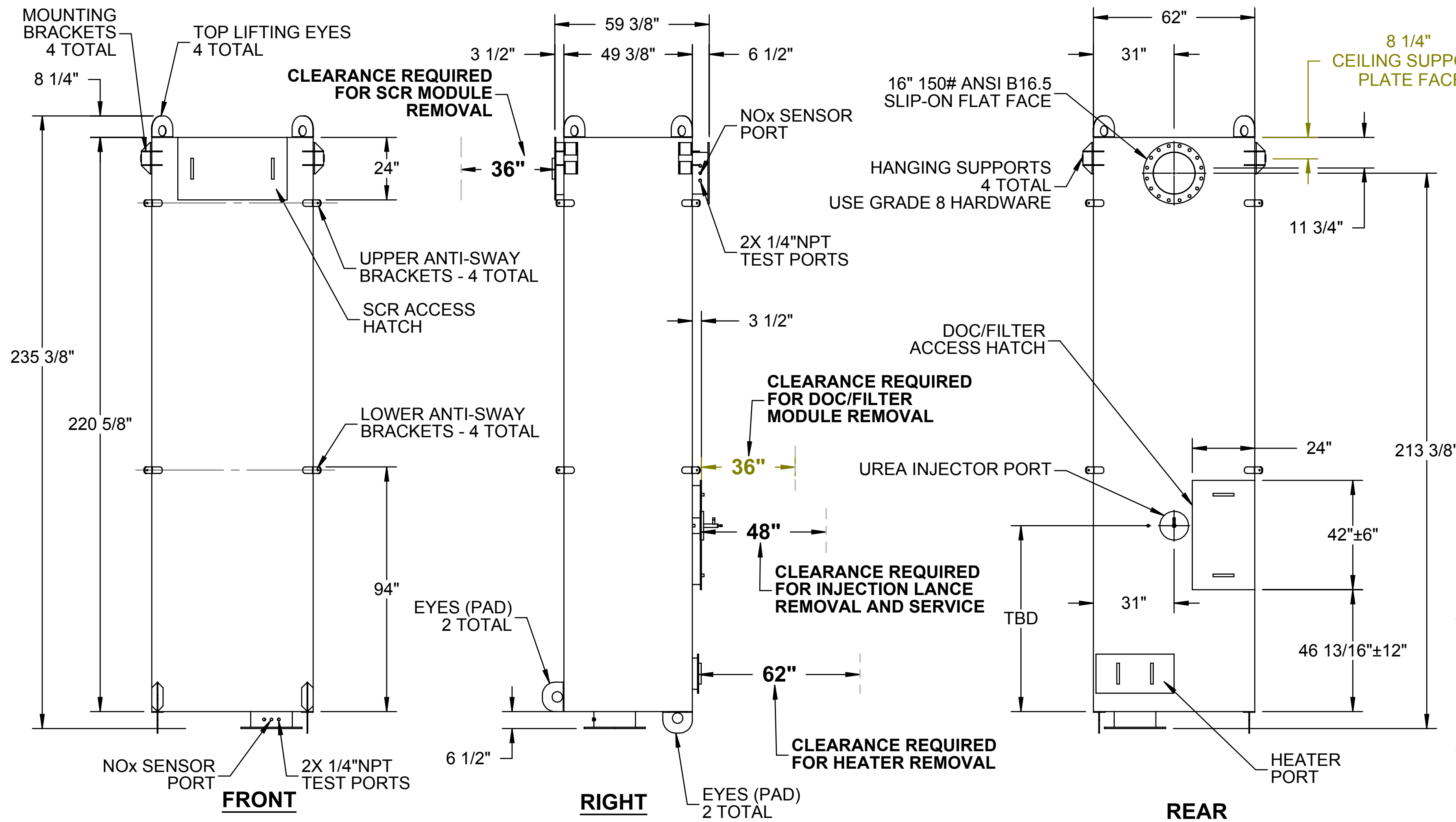
DETAIL A
HANGING SUPPORT
BOTTOM VIEW
SCALE 1 : 16

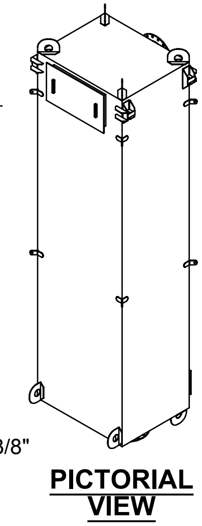
NOTE: SCR: 6X8 PER LAYER; 2 LAYERS TOTAL
DOC/DPF INSERTS - 6 TOTAL

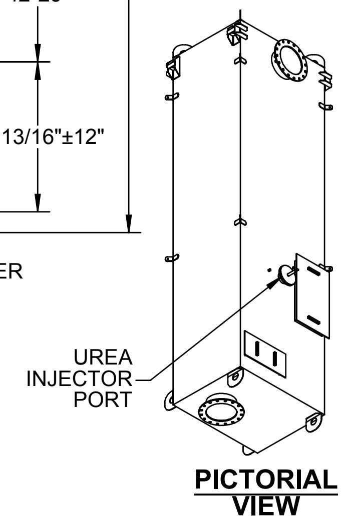
NOTE: INSTALLATION REQUIRES BELLOWS AT THE INLET AND OUTLET FLANGES. INLET AND OUTLET PIPING MUST BE ADEQUATELY SUPPORTED TO PREVENT DAMAGE TO THE CATALYST FLANGE AND HOUSING.

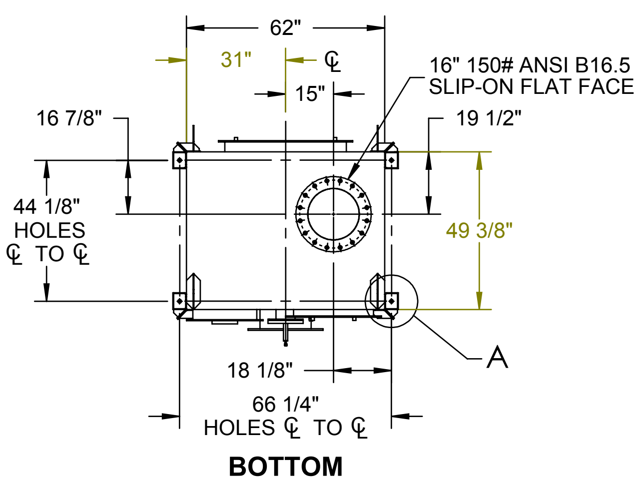
APPROXIMATE WT: 9,000 lbs.

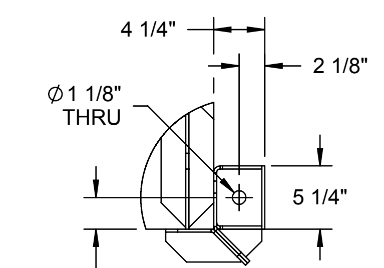
TITLE: 11110401AE rev 1		CleanAIR Systems, Inc. Santa Fe New Mexico U.S.A.		
SCALE: 1:60	MATERIAL: 316 SS	FIXTURE NUMBER:		GENERAL TOLERANCES: UNLESS OTHERWISE SPECIFIED ± 1/32 ANGLE ± 2° BREAK ALL EDGES 1/64" RAD.
DRAWN BY: CG	DRAWN: 2/23/2012 PRINTED: 2/23/2012	PAGE#: 1:1	DRAWN IN: SOLIDWORKS	REV. A
NUMBER:	DESCRIPTION: E-POD, ENGINES 1 & 3 NOBLE DISCOVERER	3RD ANGLE PROJECTION	SIZE: A	











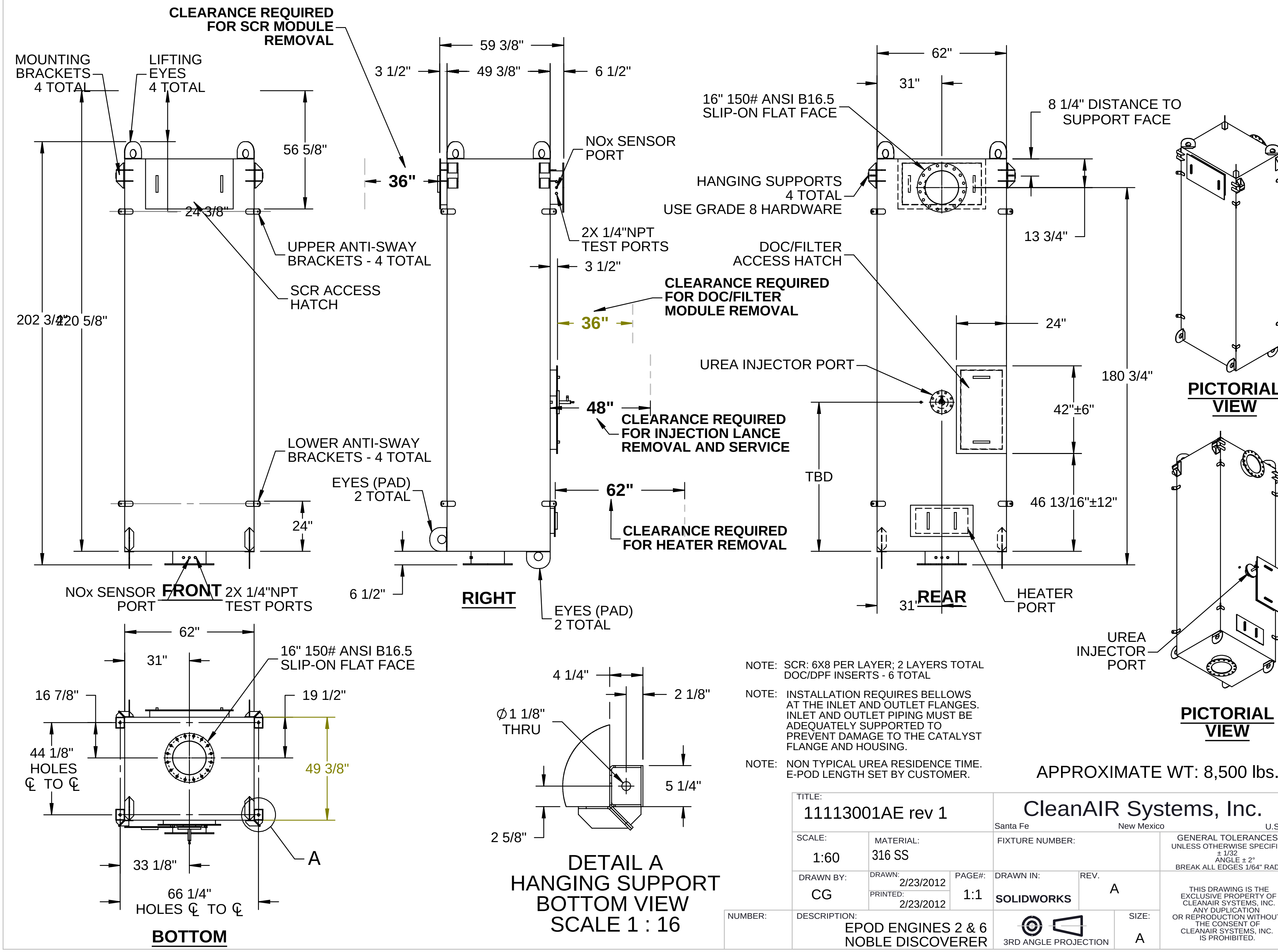
DETAIL A
HANGING SUPPORT
BOTTOM VIEW
SCALE 1 : 16

NOTE: SCR: 6X8 PER LAYER; 2 LAYERS TOTAL
DOC/DPF INSERTS - 6 TOTAL

NOTE: INSTALLATION REQUIRES BELLOWS AT THE INLET AND OUTLET FLANGES. INLET AND OUTLET PIPING MUST BE ADEQUATELY SUPPORTED TO PREVENT DAMAGE TO THE CATALYST FLANGE AND HOUSING.

APPROXIMATE WT: 9,000 lbs.

TITLE: 11112101AE rev 1		CleanAIR Systems, Inc. Santa Fe New Mexico U.S.A.	
SCALE: 1:60	MATERIAL: 316 SS	FIXTURE NUMBER:	GENERAL TOLERANCES: UNLESS OTHERWISE SPECIFIED ± 1/32 ANGLE ± 2° BREAK ALL EDGES 1/64" RAD.
DRAWN BY: CG	DRAWN: 2/23/2012 PRINTED: 2/23/2012 PAGE#: 1:1	DRAWN IN: SOLIDWORKS REV. A	THIS DRAWING IS THE EXCLUSIVE PROPERTY OF CLEANAIR SYSTEMS, INC. ANY DUPLICATION OR REPRODUCTION WITHOUT THE CONSENT OF CLEANAIR SYSTEMS, INC. IS PROHIBITED.
NUMBER:	DESCRIPTION: EPOD - ENGINE 4 & 5 N0BLE DISCOVERER	3RD ANGLE PROJECTION SIZE: A	



NOTE: SCR: 6X8 PER LAYER; 2 LAYERS TOTAL
DOC/DPF INSERTS - 6 TOTAL

NOTE: INSTALLATION REQUIRES BELLOWS AT THE INLET AND OUTLET FLANGES. INLET AND OUTLET PIPING MUST BE ADEQUATELY SUPPORTED TO PREVENT DAMAGE TO THE CATALYST FLANGE AND HOUSING.

NOTE: NON TYPICAL UREA RESIDENCE TIME. E-POD LENGTH SET BY CUSTOMER.

APPROXIMATE WT: 8,500 lbs.

TITLE: 11113001AE rev 1	CleanAIR Systems, Inc. Santa Fe New Mexico U.S.A.	
SCALE: 1:60	MATERIAL: 316 SS	FIXTURE NUMBER:	GENERAL TOLERANCES: UNLESS OTHERWISE SPECIFIED ± 1/32 ANGLE ± 2° BREAK ALL EDGES 1/64" RAD.
DRAWN BY: CG	DRAWN: 2/23/2012 PRINTED: 2/23/2012	PAGE#: 1:1	DRAWN IN: SOLIDWORKS	REV. A
NUMBER:	DESCRIPTION: EPOD ENGINES 2 & 6 NOBLE DISCOVERER	3RD ANGLE PROJECTION	SIZE: A

Appendix D

Discoverer D399 Emission Test Results

Summary of Discoverer D399 Emission Test Results

Species	Units	E-POD	Load	Max	Mean	Std. Dev.	Mean + 1 Std. Dev.	Mean + 2 Std. Dev.	Max + 1 Std. Dev.	Max + 2 Std. Dev.
NOx	g/kW-hr	1345	Low	0.99	0.61	0.22	0.84	1.06	1.21	1.44
			Medium	0.68	0.42	0.19	0.61	0.79	0.87	1.05
			High	0.78	0.43	0.25	0.67	0.92	1.03	1.28
			Composite	0.99	0.49	0.23	0.72	0.95	1.22	1.45
		26	Low	1.86	1.34	0.29	1.63	1.93	2.15	2.45
			Medium	1.40	1.21	0.17	1.39	1.56	1.58	1.75
			High	1.28	1.20	0.07	1.27	1.34	1.35	1.42
			Composite	1.86	1.25	0.20	1.45	1.65	2.06	2.26
NH3	ppm	1345	Low	66	17	17	35	52	83	101
			Medium	87	34	30	64	95	117	147
			High	106	39	35	73	108	141	175
			Composite	106	30	29	59	88	135	164
		26	Low	9	7	2	9	10	11	13
			Medium	14	9	4	14	18	18	23
			High	13	8	3	11	14	15	18
			Composite	14	8	3	11	14	17	20

Engine Test Data: NOx (g/kW-hr)

	FD1				FD3				Load averages FD1, FD3, FD4, FD5
	Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average	
high	0.19	0.16	0.15	**0.17**	0.39	0.49	0.15	**0.34**	**0.43**
medium	0.21	0.18	0.18	**0.19**	0.56	0.53	0.47	**0.52**	**0.42**
low	0.41	0.25	0.31	**0.32**	0.56	0.55	0.61	**0.57**	**0.61**

	FD4				FD5				Composite average FD1, FD3, FD4, FD5
	Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average	
high	0.30	0.48	0.51	**0.43**	0.78	0.78	0.74	**0.77**	
medium	0.40	0.24	0.33	**0.33**	0.68	0.63	0.62	**0.65**	**0.49**
low	0.62	0.63	0.99	**0.75**	0.69	0.88	0.84	**0.81**	

	FD2				FD6				Composite average FD2 & FD6
	Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average	
high	1.25	1.28	1.25	**1.26**	1.15	1.15	1.11	**1.14**	
medium	1.40	1.40	1.30	**1.37**	1.08	1.03	1.06	**1.06**	**1.25**
low	1.86	1.49	1.30	**1.55**	1.16	1.09	1.14	**1.13**	

Engine Test Data: NH3 (ppm)

	FD1				FD3				Load averages
	Run 1	**Run 2**	**Run 3**	**Average**	**Run 1**	**Run 2**	**Run 3**	**Average**	**FD1,FD3,FD3,FD4**
high	76	90	106	**91**	12	9	58	**26**	**39**
medium	73	87	85	**81**	7	8	9	**8**	**34**
low	13	66	37	**38**	7	6	7	**6**	**17**
	FD4				**FD5**				**Composite average**
	Run 1	**Run 2**	**Run 3**	**Average**	**Run 1**	**Run 2**	**Run 3**	**Average**	**FD1,FD3,FD3,FD4**
high	35	16	13	**21**	16	16	17	**16**	
medium	17	46	22	**28**	17	19	19	**19**	**30**
low	11	10	9	**10**	15	13	15	**14**	
	FD2				**FD6**				**Composite average**
	Run 1	**Run 2**	**Run 3**	**Average**	**Run 1**	**Run 2**	**Run 3**	**Average**	**FD2 & FD6**
high	7	7	6	**6**	13	9	10	**10**	
medium	5	6	5	**5**	14	13	13	**13**	**8**
low	5	6	6	**5**	7	8	9	**8**	

Appendix E

NOx Ambient Air Quality Analysis

AIR SCIENCES INC.
DENVER • PORTLAND

TECHNICAL MEMORANDUM

DISCOVERER & INCREASE IN D399 NO_X EMISSIONS - AIR QUALITY ANALYSIS OF 1-HOUR AND ANNUAL NO_2

PREPARED FOR: Chris Lindsey & Pauline Ruddy, Shell

PREPARED BY: Tim Martin, Air Sciences Inc.

PROJECT NO.: 180-21-3

DATE: June 21, 2012

Introduction and Summary

The current pre-construction permit for the *Discoverer* limits the NOx emissions from the main generator engines (FD1 through 6) to 0.5 g/kW-hr. Concentrations from this level of emissions were modeled as a part of the permitting process and the modeling results were reported to EPA in April 29, 2011, May 19, 2011 and June 9, 2011 sets of documents and data files. Those results are part of the Statement of Basis (SOB) for the *Discoverer* permit. Shell provides herein an identical modeling analysis but with the FD1 through 6 NOx emissions raised to 2.0 g/kW-hr (four times the permitted emission rate). This technical memorandum briefly reviews the modeling approach utilized in the permit application and provides a demonstration that with all generators operating at the aforementioned increased NO_x emissions, ambient concentration increases are insignificant and the *Discoverer* and associated fleet will still meet the 1-hour and annual NO_2 NAAQS and annual NO_2 PSD increment.

Emissions and Source Characterization

A plan view of the *Discoverer* source unit configuration is provided in Figure 1. Given the configuration of the stacks and structures on the *Discoverer*, plumes may be down-washed and pulled into the structures' wake region. For the analysis, the structure downwash parameters used in AERMOD were calculated using the Building Profile Input Program (BPIP) (Version 04274). The building height and location information used in the BPIP analysis are also indicated on Figure 1. A close-up overview of the *Discoverer* and associated fleet characterization used in the modeling analysis is provided in Figure 2.

Although each well is expected to take no more than 30 days to complete, at which time the *Discoverer* will move to another location, the modeling was performed under the assumption that the *Discoverer* remains at a single location for 120 days. Thus the modeling included four times as much emissions and days of impact than should actually occur at any one location. Furthermore, on these days, the sources are emitting at their maximum allowable rate (their PTE), which in practice never happens continuously. Thus the dispersion modeling for the *Discoverer* produced concentrations higher than those that would be expected from actual *Discoverer* drilling activities.

Figure 1: Layout of Emission Units on the Discoverer

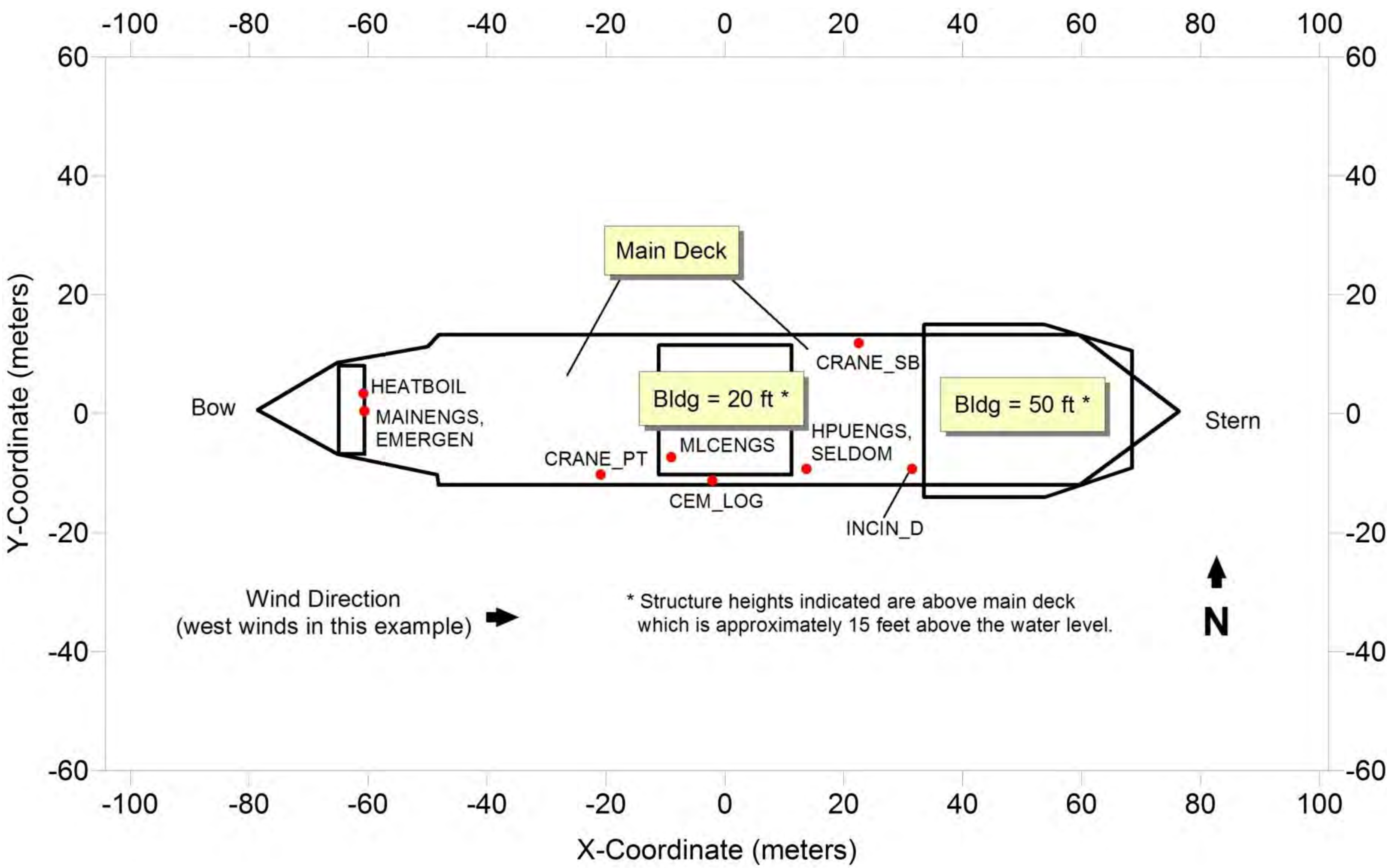
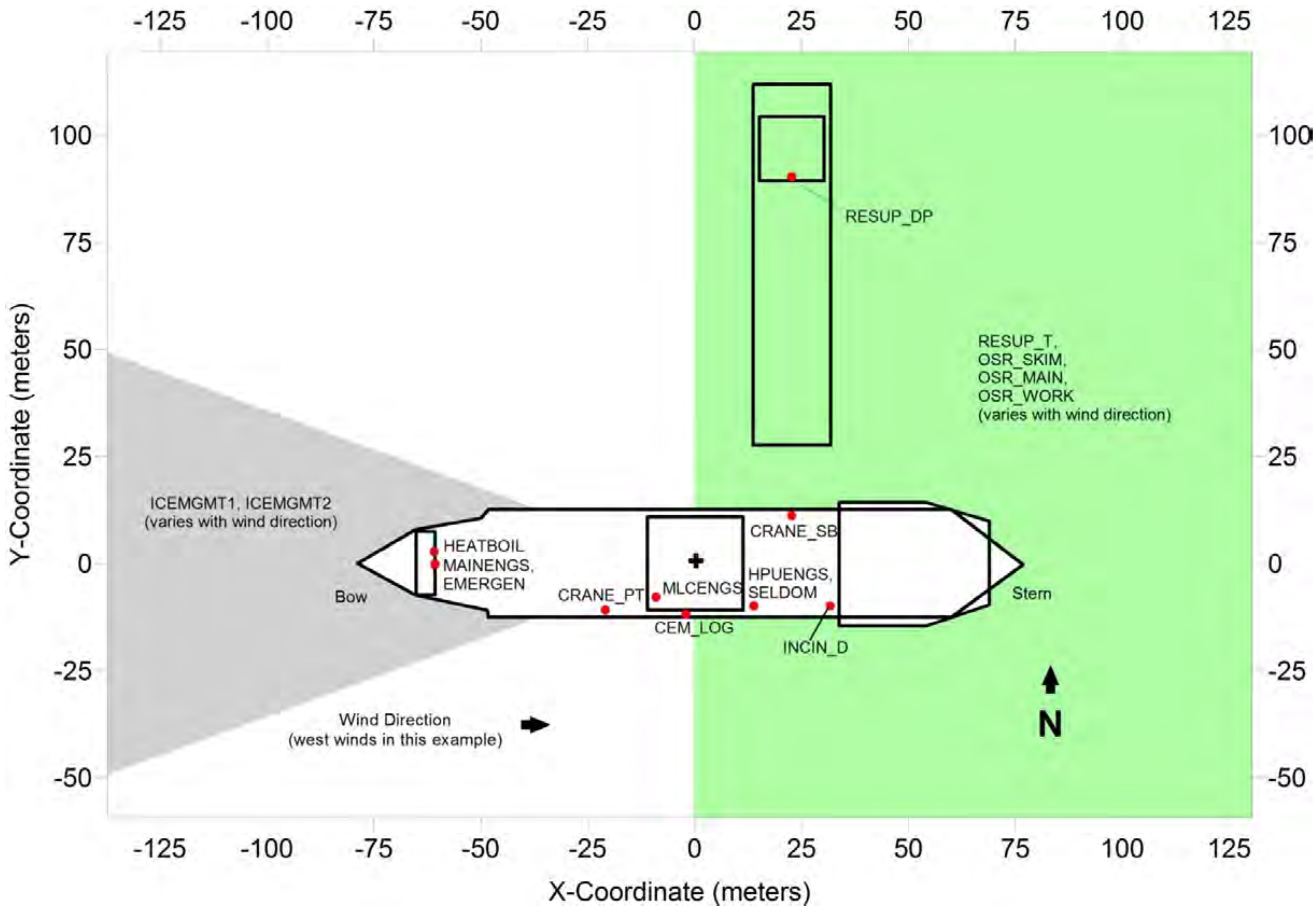


Figure 2: Close-up Overview of the Discoverer and Associated Fleet Configuration Used in the Modeling Analysis



Air Quality Model

For the modeling analysis, version (09292) of AERMOD was used to estimate air quality concentrations resulting from sources of emissions at the project. AERMOD is an advanced modeling system that incorporates boundary layer theory, turbulence, and effects of terrain features into air dispersion simulations. AERMOD is the current model recommended by EPA for most industrial applications for assessing concentrations within 50 kilometers. It reflects the latest science and is the appropriate model to use assuming acceptable meteorological data are available.

Meteorological Data for Use with AERMOD

The AERMOD modeling system involves the use of a meteorological pre-processor, called AERMET, that assumes the surface is solid ground that is subject to the normal diurnal pattern of heating and cooling that follows periods of daylight and periods of nighttime. This meteorological pre-processor is appropriate for conditions when the Arctic has a frozen solid ice surface, but for periods of open water, it is inappropriate. To allow the use of AERMOD for all periods in the Arctic, Shell developed an alternative to the AERMET pre-processor to be used for periods of open water (called AERMOD-COARE) to better simulate open-water conditions by using meteorological tower and buoy data sets to prepare a meteorological data set suitable for AERMOD; its details are documented in the March 18, 2011 permit application materials. AERMOD-COARE was approved by EPA for use in open water conditions in the Beaufort and Chukchi Seas. See Memorandum from George Bridgers, Office of Air Quality Planning and Standards (OAQPS), Re: "Model Clearinghouse Review of AERMOD-COARE as an Alternative Model Application in an Arctic Marine Ice Free Environment," dated May 6, 2011.

With the COARE adaptation for meteorological pre-processing, AERMOD was used for over-water conditions in the Arctic. This approach by-passed AERMET during periods when the sea ice has given way to open water. For periods of ice, Shell utilized the standard AERMET meteorological pre-processor to provide data to AERMOD. In this way, the latest EPA methodologies for addressing dispersion, downwash, NOx to NO_2 conversion and other topics were used in these applications, without sacrificing any accuracy with respect to the air-sea interface that would result from the use of AERMET during open water conditions.

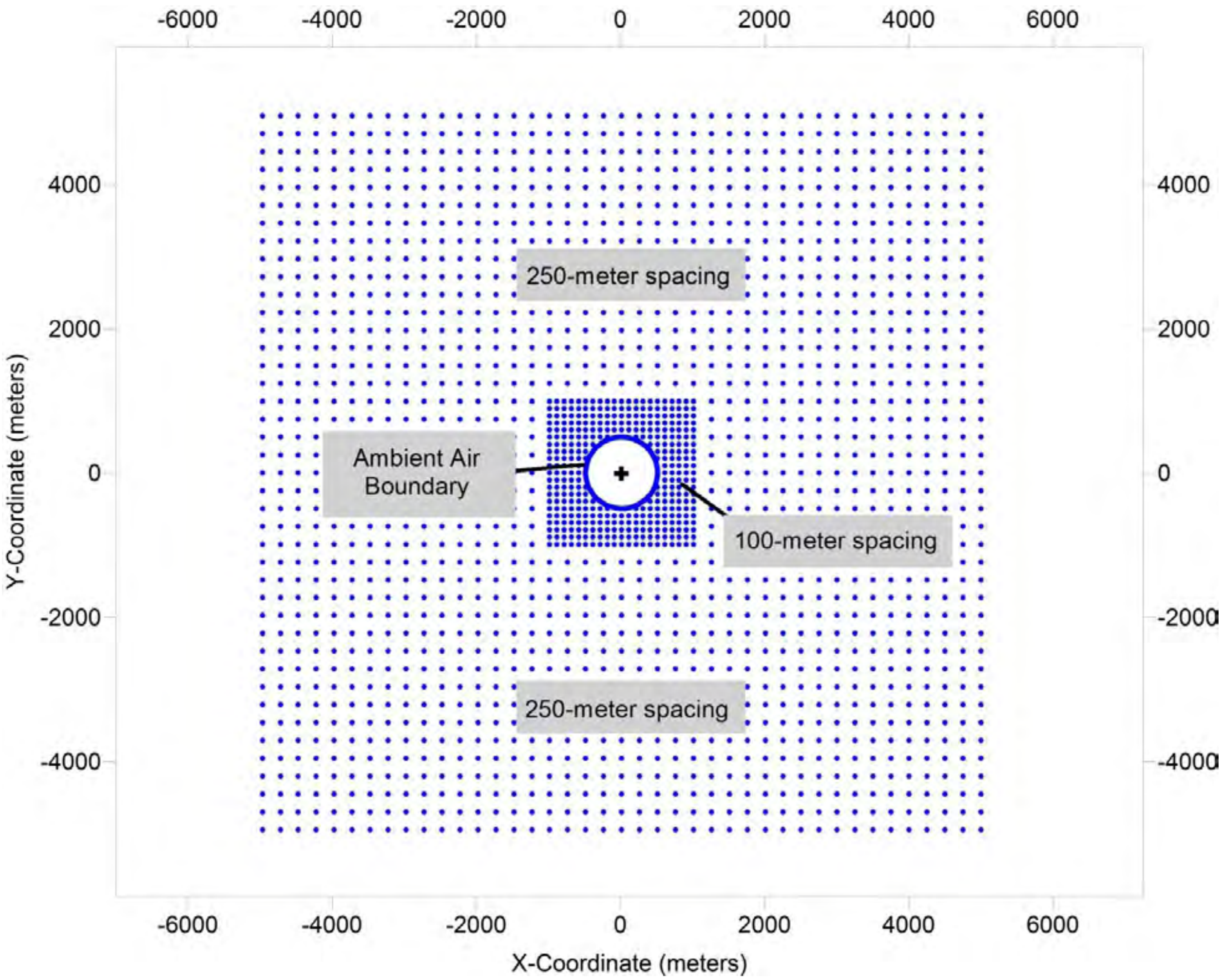
Ambient Air Boundary and Receptors

The ambient air standards are applicable at the ambient air boundary and beyond, which essentially is the nearest location to the *Discoverer* that the hypothetical public can approach. For the modeling analyses, that boundary was assumed to be 500 meters from the center of the *Discoverer*.

Modeled receptors were placed on the ambient air boundary and spaced at approximately 25 meters. To capture maximum concentrations from the *Discoverer* and its associated fleet, receptors were placed every 100 meters out to 1 kilometer from the center of the *Discoverer*. Receptors were spaced every 250-meters from 1 kilometer to 5 kilometers from the center of the *Discoverer* to cover all activity areas upwind and downwind of the *Discoverer*. An overview of the receptor grid used in the modeling analysis is provided in Figure 3.

Figure 3: Overview of Receptor Grid Used in the Modeling Analysis

(+ in the figure represents the *Discoverer*)



Increase in FD1 through 6 NOx Emissions and Associated Results

Shell provides herein an identical modeling analysis to the SOB, but with the FD1 through 6 NOx emissions raised to 2.0 g/kW-hr (four times the permitted emission rate).

Table 1 below provides a summary of the maximum daily NOx emissions for the *Discoverer* and associated fleet from the SOB (Table 1 of the SOB) compared to the revised emission rates for this analysis where the FD1 through 6 NOx emissions are increased by four times to 2.0 g/kW-hr (i.e., 445.6 lb NOx/day). Note that the SOB daily NOx emissions from FD1 through 6 are only 1.0% of the total emissions. Even when increased four-fold (4x), the daily NOx emissions from FD1 through 6 are still only 4.0% of the total daily NOx emissions.

The results for the analysis are provided in Table 2 below and demonstrate that with all generators operating at this increase of emissions, the 1-hour and annual NO_2 NAAQS and annual NO_2 PSD increment is met. The concentrations from this analysis are compared to the results summarized in the SOB, Table 9 and indicate no changes in maximum modeled 1-hour NO_2 concentrations when the main generator engine (D399) NOx emissions are increased. The maximum modeled 1-hour NO_2 concentration consistent with the form of the NAAQS (98^{th} percentile) is due entirely to other emission units either on the *Discoverer* or the associated fleet. The annual NO_2 concentrations from this analysis increase slightly compared to the SOB values.

Table 1: Summary of Discoverer Maximum Daily NOx Emissions

	Daily NOx Emissions			
	Statement of Basis		Main Gen. Emis. Increased by 4x to 2 g/kW-hr	
Source	lb/day	% Total	lb/day	% Total
Discoverer				
Generation	**111.4**	**1.0%**	**445.6**	**4.0%**
MLC Compressor	170.6	1.6%	170.6	1.5%
HPU Engines	79.0	0.7%	79.0	0.7%
Cranes	59.5	0.6%	59.5	0.5%
Cementing/Logging	157.3	1.5%	157.3	1.4%
Heaters & Boilers	76.5	0.7%	76.5	0.7%
Seldom-used units	12.6	0.1%	12.6	0.1%
Emergency Generator	39.5	0.4%	39.5	0.4%
Incinerator	3.3	0.0%	3.3	0.0%
Primary Ice Management				
Propulsion & Generation	1576.9	14.8%	1576.9	14.3%
Heaters & Boilers	36.1	0.3%	36.1	0.3%
Seldom-used units	8.4	0.1%	8.4	0.1%
Incinerator	9.2	0.1%	9.2	0.1%
Secondary Ice Management / Anchor Handler				
Propulsion & Generation	1625.4	15.2%	1625.4	14.8%
Heaters & Boilers	14.4	0.1%	14.4	0.1%
Seldom-used units	8.4	0.1%	8.4	0.1%
Incinerator	9.2	0.1%	9.2	0.1%
Resupply Ship - transit mode				
Propulsion & Generation	704.4	6.6%	704.4	6.4%
Resupply Ship - DP mode				
Propulsion & Generation	2817.4	26.4%	2817.4	25.6%
Offshore Management / Skimmer vessel				
Propulsion & Generation	1192.6	11.2%	1192.6	10.8%
Seldom-used units	8.4	0.1%	8.4	0.1%
Incinerator	7.5	0.1%	7.5	0.1%
OSR vessel				
Propulsion & Generation	1618.6	15.2%	1618.6	14.7%
Seldom-used units	8.4	0.1%	8.4	0.1%
Incinerator	7.5	0.1%	7.5	0.1%
OSR work boats				
Work Boats	317.7	3.0%	317.7	2.9%
TOTAL - (lb/day)	10680.2	100.0%	11014.4	100.0%

Table 2: Summary of Maximum 1-Hour and Annual NO_2 Modeled Concentrations – Chukchi Sea

Scenario	Averaging Period	Max. Modeled Shell Conc. Without Background Concentration [2] (μg/m³)	Background Concentration (μg/m³)	Max. Modeled Conc. With Background Concentration [1] (μg/m³)	NAAQS (μg/m³)	PSD Class II Increment (μg/m³)
Main Generator Emissions (D399s) Increased 4x	1-hour	160.8	13.2	174.0	188	NE
Values from Permit SOB	1-hour	160.8	13.2	174.0	188	NE
Main Generator Emissions (D399s) Increased 4x	Annual	3.8	2.0	5.8	100	25
Values from Permit SOB	Annual	3.3	2.0	5.3	100	25

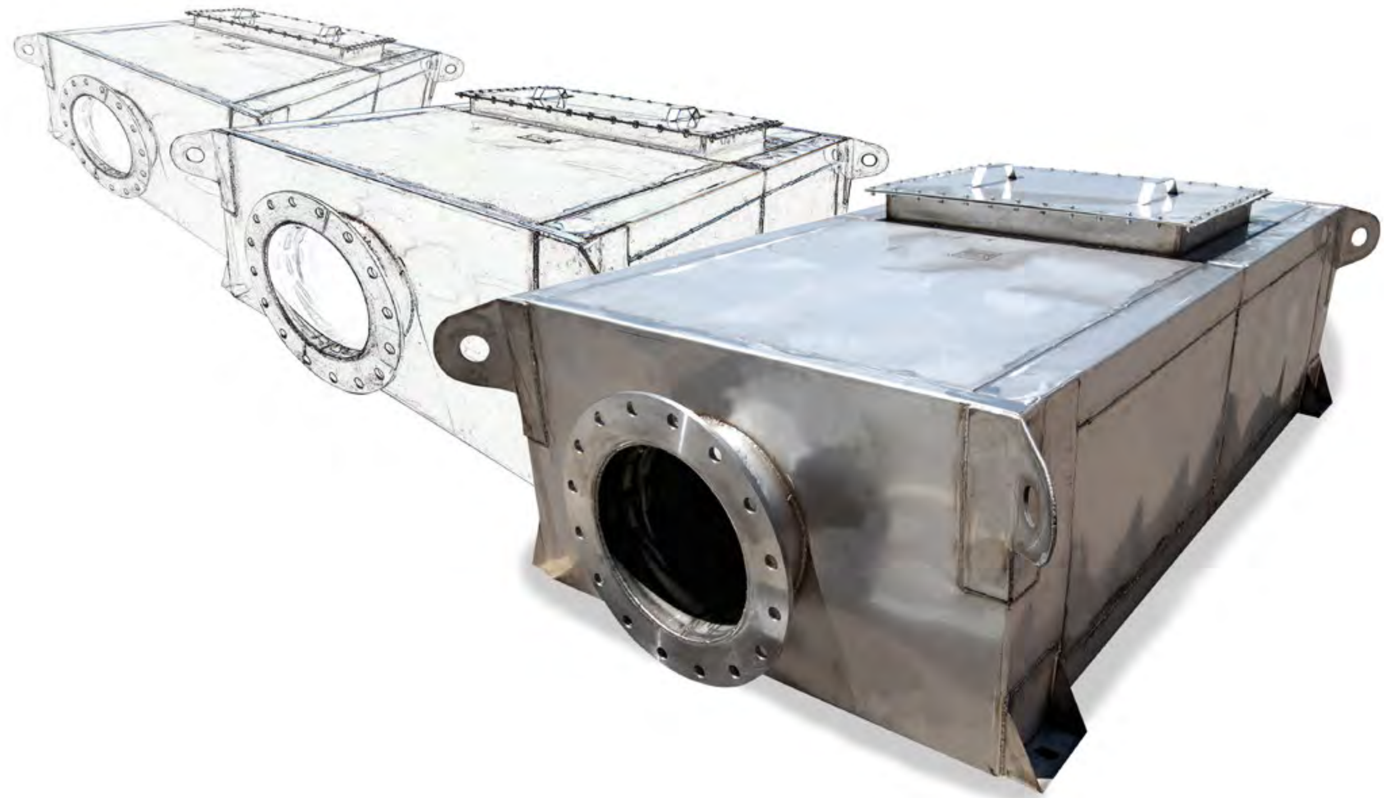
[1] Maximum modeled concentrations plus background concentrations are compared to the NAAQS.

[2] Maximum modeled concentrations (i.e., Shell-only concentrations without background concentrations) are compared to the PSD increment.

NE = Not established.

Appendix F

CleanAIR Manufacturer's Guarantee



The CleanAIR PERMIT™ Filter System

Reduces PM, CO and HC

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

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

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

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

CARB Verified Level 3+
for Prime and Emergency Generators

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

CleanAIR SYSTEMS

CARB Level 3+ Verified

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

Customized to Client's Specifications

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

Guaranteed Long-Life Construction

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

No Health Risk

- Uses non-toxic, non-vanadium particulate filters

How the PERMIT™ Filter Works

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

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

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

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

Meet CARB Level 3+ Standards

with the

CleanAIR PERMIT Filter

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

CleanAIR SYSTEMS

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

PERMIT™ Filter Emissions Reduction Summary

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

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

Guidelines for PERMIT™ Filter Passive Regeneration

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

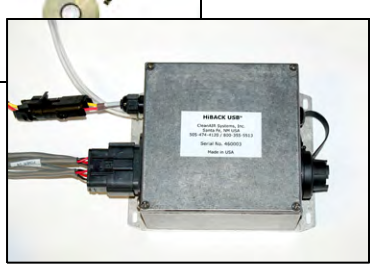
- At least 30% of the operating time the exhaust temperature is above 300°C and the engine load is above 40%
- Fuel sulfur content <15 ppm, ULSD
- Engine PM output of < 0.2 g/bhp-hr

How Sulfur in Fuel Affects the PERMIT™ Filter Performance

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

CleanAIR HiBACK USB™ Data Logging and Alarm System

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



2.

HiBACK™ USB Data logger and alarm system with software

System Components:

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

1a. *PERMIT Filters inside of silencer unit*

3. *Optional insulated blanket*

1.

CleanAIR SYSTEMS

PERMIT™ Filter Package Designs for Stationary Engines

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

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

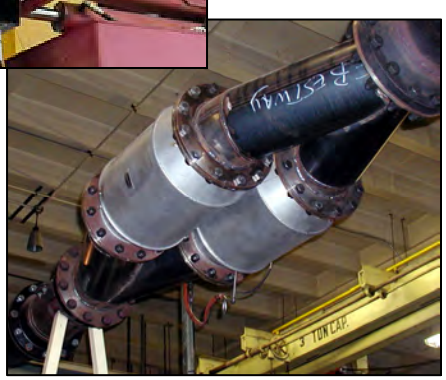
A filter/silencer replacement design is available for applications that require higher levels of sound attenuation or that require multiple PERMIT™ Filters. The corrosion-resistant stainless steel shell has a removable panel allowing complete access to the filters mounted inside. The fully-insulated,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

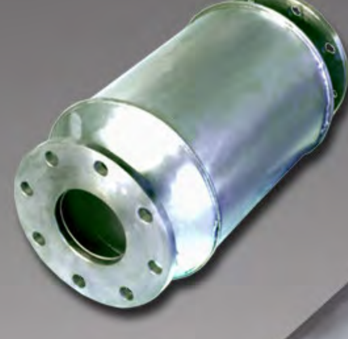
Silencer Type	Typical Attenuation
Industrial Grade	22 – 29 dBA
Critical Grade	27 – 35 dBA
Super Critical Grade	30 – 38 dBA

Optional Equipment for System:

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

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

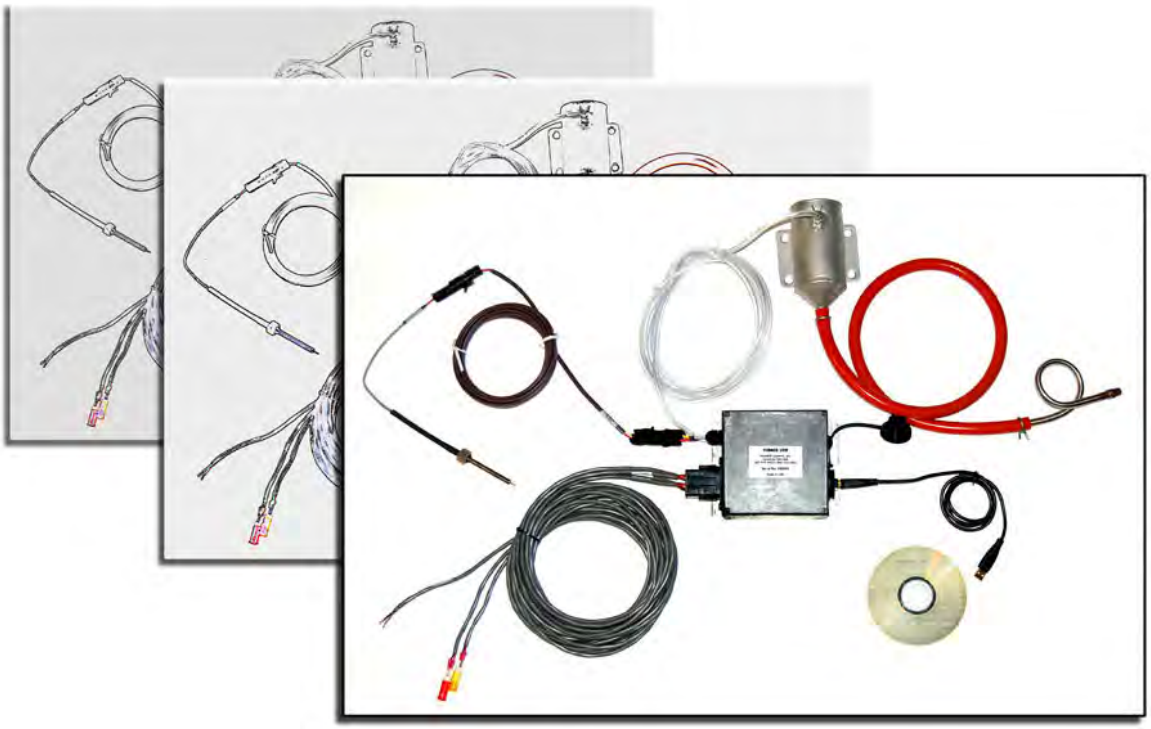




CleanAIR SYSTEMS

Appendix G

CleanAIR's Product Specification for HiBACK USB Units



The CleanAIR HiBACK USB™

Data logging and Alarm System for Diesel Engines

The HiBACK USB™ is a microprocessor-based data logger and alarm system designed to record and monitor exhaust backpressure and temperature. Monitoring these engine exhaust parameters provides useful information about engine performance as well as the performance of a CleanAIR Systems emissions control device.

The HiBACK USB™ unit can warn the operator of possible problems with the emissions control device such as plugging or excessive backpressure on the engine. It can also track the duty cycle of the engine and allow analysis for operation time, exhaust temperature and backpressure profiles. Data collected by the HiBACK USB™ can be downloaded to a computer for detailed analysis using optional software.

HiBACK USB™ Specifications

The unit is housed in an aluminum, water-resistant enclosure (5" x x5" x 21/2"), and operates on 10 to 28 VDC. At 12 V, the unit requires 200 milliamps. Power to the unit is only required when the engine is in operation. The operating temperature range is -12°C (10°F) to 55°C (130°F).

Measurement for temperature is made by a K-type thermocouple, and backpressure is measured with a transducer. There is enough memory to record 26,000 lines of data. A line of data is made up of individual readings for exhaust pressure (inches of water), exhaust temperature (°C), date, time (hours: minutes), and event code. Typically, 100 hours of operating time is stored before the memory is filled. When the memory is full the program overwrites the oldest data. Data can be downloaded directly to the user's desktop for analysis through the USB port using optional interactive Windows-based software that interfaces with the device. With a simple USB connection, optional software and 10VDC to 28 VDC power, the user can view a real-time display of exhaust temperature and backpressure, then download data directly to Microsoft Excel. *(Optional software sold separately.)*

Self-diagnostic features for troubleshooting are also included with the HiBACK USB™.

Monitors & Records

Exhaust Backpressure, Temperature and Event Codes

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

CleanAIR SYSTEMS

Monitors and Records

- Monitors and Records Exhaust Backpressure and Temperature, Time, Date and Event Codes
- Available with Optional Software for Real-Time Monitoring and Data Download – USB Interface
- Self-Diagnostics

Dependable Warning System

- Warns Vehicle Operator of Backpressure or Temperature Problems
- Wide operational window for exhaust temperature

Guaranteed Long-Life Construction

- All Products Constructed to Operate Under Extreme Conditions

Top: The HiBACK USB™ Control Box

Left: Control Box mounted on engine control panel

The HiBACK USB™ Features:

- Self-diagnostics
- USB interface
- Large data storage: 26,000 lines of data (100 hours)
- Wide operational window: -12°C (10°F) to 55°C (130°F)
- External reset button
- Reverse voltage safety
- Event codes
- Optional user-friendly Windows-based software (available in two levels) with real-time monitoring *(software sold separately)*
- Quick-release connections
- Water-resistant enclosure and connections
- Fast processor power: the ability to data log up to 1 sample per second

Monitors & Records

Exhaust Backpressure, Temperature and Event Codes

HiBACK USB™ mounted on diesel particulate filter showing condensing can and high temperature silicon hose

HiBACK USB™ control box mounted on engine control panel

CleanAIR SYSTEMS

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www.cleanairsys.com

HiBACK USB™ Software Features

HiBACK USB™ Software Options (available in two levels)	HiBACK USB™ Software Level 1	HiBACK USB™ Software Level 2
Download Data to Excel	**Yes**	**Yes**
Real-time Monitoring	**Yes**	**Yes**
Reset Alarms	**No**	**Yes**
Change Logging Intervals	**No**	**Yes**

Backpressure Alarm Outputs

The HiBACK™ unit has three outputs available for operator usage. All outputs are pre-set before the unit is delivered.

Output 1: Triggers a yellow LED. This output is set 10% below the maximum recommended backpressure. Allows the user time to analyze data and service the filter if needed.
Output 2: Set at the maximum recommended backpressure limit. When this level is reached a red LED is illuminated. User must shut down and service the filter.
Output 3: A voltage output for customer use. Can be used to interface with the engine ECM to initiate a power de-rating mode, turn on an audible alarm, or send a signal to a remote operator.

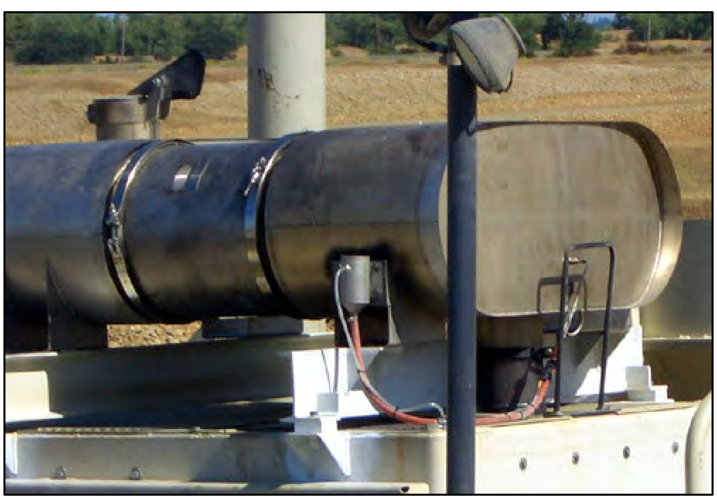
External Reset Button

This feature allows the user to reset the HiBACK USB™ 2 times without connecting to a computer.

Self Diagnostics and Event Codes

The HiBACK USB™ includes the capability to self-diagnose temperature and backpressure sensing problems that may occur with the HiBACK USB™. A series of event codes will illuminate yellow and red LED's in different sequences depending on the diagnostics being detected.

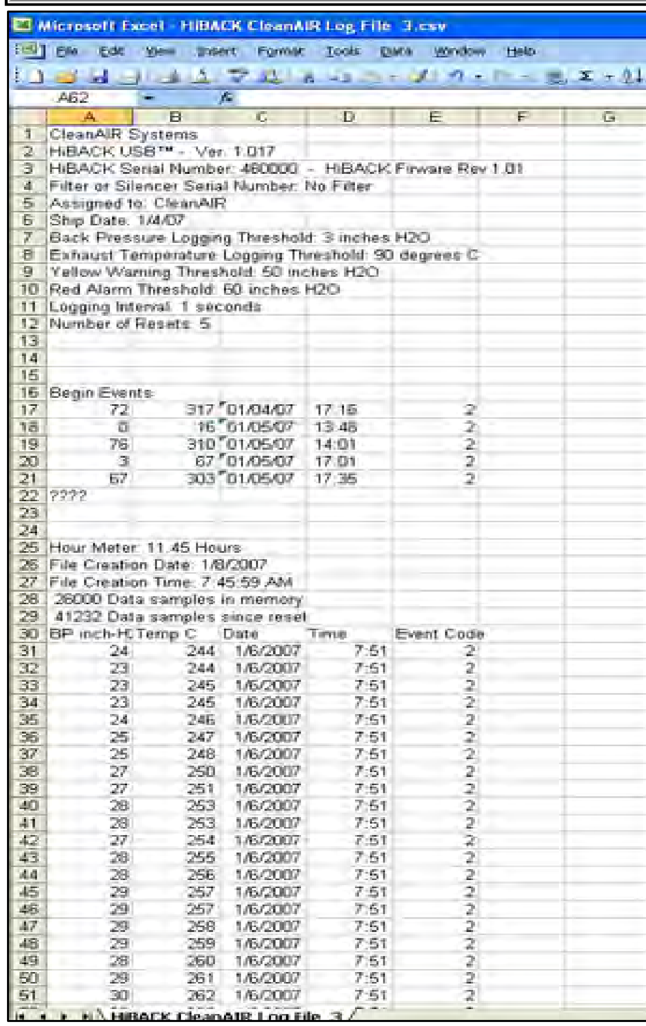
The HiBACK USB™ is sold only for use with products manufactured by CleanAIR.



HiBACK USB™ mounted on diesel particulate filter showing condensing can, high temperature silicon hose and port

HiBACK USB™ Installation Kit

- HiBACK USB™ control box
- K-type thermocouple and bushing
- 12' TC lead wire
- 12' Wiring Harness
- LED Kit
- Stainless steel water condensing unit
- 3/8" stainless steel cooling tube with fitting
- High temperature silicone hose
- Low temperature PVC tubing
- Optional software for real-time monitoring and data download.



Microsoft Excel - HiBACK CleanAIR Log File 3.csv

	A	B	C	D	E	F	G
1	CleanAIR Systems						
2	HiBACK USB™ - Ver. 1.017						
3	HiBACK Serial Number: 460000 - HiBACK Firware Rev 1.01						
4	Filter or Silencer Serial Number: No Filter						
5	Assigned to: CleanAIR						
6	Ship Date: 1/4/07						
7	Back Pressure Logging Threshold: 3 inches H2O						
8	Exhaust Temperature Logging Threshold: 90 degrees C						
9	Yellow Warning Threshold: 50 inches H2O						
10	Red Alarm Threshold: 60 inches H2O						
11	Logging Interval: 1 seconds						
12	Number of Resets: 5						
13							
14							
15							
16	Begin Events:						
17	72	317	01/04/07	17:15	2		
18	6	16	01/05/07	13:48	2		
19	76	310	01/05/07	14:01	2		
20	3	67	01/05/07	17:01	2		
21	67	303	01/05/07	17:35	2		
22	????						
23							
24							
25	Hour Meter: 11.45 Hours						
26	File Creation Date: 1/8/2007						
27	File Creation Time: 7:45:59 AM						
28	26000 Data samples in memory						
29	41232 Data samples since reset						
30	BP inch-H	Temp C	Date	Time	Event Code		
31	24	244	1/6/2007	7:51	2		
32	23	244	1/6/2007	7:51	2		
33	23	245	1/6/2007	7:51	2		
34	23	245	1/6/2007	7:51	2		
35	24	246	1/6/2007	7:51	2		
36	25	247	1/6/2007	7:51	2		
37	25	248	1/6/2007	7:51	2		
38	27	250	1/6/2007	7:51	2		
39	27	251	1/6/2007	7:51	2		
40	28	253	1/6/2007	7:51	2		
41	28	253	1/6/2007	7:51	2		
42	27	254	1/6/2007	7:51	2		
43	28	255	1/6/2007	7:51	2		
44	28	256	1/6/2007	7:51	2		
45	29	257	1/6/2007	7:51	2		
46	29	257	1/6/2007	7:51	2		
47	29	258	1/6/2007	7:51	2		
48	29	259	1/6/2007	7:51	2		
49	28	260	1/6/2007	7:51	2		
50	29	261	1/6/2007	7:51	2		
51	30	262	1/6/2007	7:51	2		

HiBACK CleanAIR Log File 3

Data download display in Microsoft Excel of exhaust temperature and backpressure data.

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

Appendix H

Caterpillar 3608 Data Sheet

3608

DIESEL ENGINE TECHNICAL DATA

CATERPILLAR®

Marine RATING: Industrial 10/11/2006

ENGINE SPEED (rpm):	1000	TURBOCHARGER PART #:	194-8722
COMPRESSION RATIO:	13:1	FUEL TYPE:	Distillate
AFTERCOOLER WATER (°C):	50		
JACKET WATER OUTLET (°C):	90		
IGNITION SYSTEM:	MUI		
EXHAUST MANIFOLD:	DRY		

RATING		NOTES	LOAD		100%	75%	50%
ENGINE POWER		(2)	bkW		2710	2033	1355
ENGINE DATA							
FUEL CONSUMPTION	**(ISO 3046/1)**	**(1)**	**g/bkw-hr**		**198.7**	**197.6**	**206.2**
FUEL CONSUMPTION	(NOMINAL)	(1)	g/bkw-hr		202.5	201.4	210.2
FUEL CONSUMPTION	(90% CONFIDENCE)	(1)	g/bkw-hr		204.7	203.9	213.0
AIR FLOW (@ 25°C, 101.3 kPaa)			Nm3/min		297.6	236.5	164.7
AIR MASS FLOW			kg/hr		19921	15826	11020
COMPRESSOR OUTLET PRESSURE			kPa (abs)		280.8	199.6	110.3
COMPRESSOR OUTLET TEMPERATURE			°C		196.9	157.9	110.0
INLET MANIFOLD PRESSURE			kPa (abs)		277.0	196.9	108.8
INLET MANIFOLD TEMPERATURE			°C		45.9	43.2	42.3
TIMING		(9)	°BTDC		12.5	12.5	12.5
EXHAUST STACK TEMPERATURE			°C		370.9	354.4	371.9
Catsmoke					0.0068	0.0100	0.0178
EXHAUST GAS MASS FLOW			kg/hr		20473	16237	11304
EMISSIONS							
NOx (as NO)		(3)	g/bkW-hr		8.88	9.65	10.55
CO		(3)	g/bkW-hr		0.73	0.65	0.88
THC (molecular weight of 13.018)		(3)	g/bkW-hr		0.99	1.26	1.51
Particulates		(3)	g/bkW-hr		0.17	0.20	0.25
ENERGY BALANCE DATA							
FUEL INPUT ENERGY (LHV)	(NOMINAL)	(1)	KW		6566	4883	3390
HEAT REJ. TO JACKET WATER	(NOMINAL)	(4)	KW		539	440	343
HEAT REJ. TO ATMOSPHERE	(NOMINAL)	(5)	KW		131	98	68
HEAT REJ. TO OIL COOLER	(NOMINAL)	(6)	KW		285	251	218
HEAT REJ. TO EXH. (LHV to 25°C)	(NOMINAL)	(4)	KW		2082	1575	1186
HEAT REJ. TO EXH. (LHV to 177°C)	(NOMINAL)	(4)	KW		1632	1349	925
HEAT REJ. TO AFTERCOOLER	(NOMINAL)	(7) (8)	KW		800	479	218

CONDITIONS AND DEFINITIONS

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

NOTES

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

DM5529 - 01

3608

DIESEL ENGINE TECHNICAL DATA

CATERPILLAR®

Marine

RATING: Marine/MCR

ENGINE SPEED (rpm):	1000
COMPRESSION RATIO:	13:1
AFTERCOOLER WATER (°C):	32
JACKET WATER OUTLET (°C):	90
IGNITION SYSTEM:	MUI
EXHAUST MANIFOLD:	DRY

TURBOCHARGER PART #:	194-8722
FUEL TYPE:	Distillate
RATED ALTITUDE @ 25°C (m):	150

RATING		NOTES	LOAD	25%	100%	75%	50%
ENGINE POWER		(2)	bkW	678	2710	2033	1355
ENGINE DATA							
FUEL CONSUMPTION	**(ISO 3046/1)**	**(1)**	**g/bkw-hr**	**238.8**	**198.7**	**197.6**	**206.2**
FUEL CONSUMPTION	(NOMINAL)	(1)	g/bkw-hr	243.4	202.5	201.4	210.2
FUEL CONSUMPTION	(90% CONFIDENCE)	(1)	g/bkw-hr	246.5	204.7	203.9	213.0
AIR FLOW (@ 25°C, 101.3 kPaa)			Nm3/min	98.5	297.6	236.5	164.7
AIR MASS FLOW			kg/hr	6595	19921	15826	11020
COMPRESSOR OUTLET PRESSURE			kPa (abs)	35.1	280.8	199.6	110.3
COMPRESSOR OUTLET TEMPERATURE			°C	60.2	196.9	157.9	110.0
INLET MANIFOLD PRESSURE			kPa (abs)	34.9	277.0	196.9	108.8
INLET MANIFOLD TEMPERATURE			°C	43.5	45.9	43.2	42.3
TIMING		(9)	°BTDC	12.5	12.5	12.5	12.5
EXHAUST STACK TEMPERATURE			°C	357.9	370.9	354.4	371.9
EXHAUST GAS MASS FLOW			kg/hr	6755	20473	16237	11304
EMISSIONS							
NOx (as NO)		(3)	g/bkW-hr	12.85	8.88	9.65	10.55
CO		(3)	g/bkW-hr	2.11	0.73	0.65	0.88
THC (molecular weight of 13.018)		(3)	g/bkW-hr	1.82	0.86	1.00	1.27
Particulates		(3)	g/bkW-hr	0.59	0.29	0.27	0.31
ENERGY BALANCE DATA							
FUEL INPUT ENERGY (LHV)	(NOMINAL)	(1)	KW	1959	6566	4883	3390
HEAT REJ. TO JACKET WATER	(NOMINAL)	(4)	KW	234	539	440	343
HEAT REJ. TO ATMOSPHERE	(NOMINAL)	(5)	KW	39	131	98	68
HEAT REJ. TO OIL COOLER	(NOMINAL)	(6)	KW	179	285	251	218
HEAT REJ. TO EXH. (LHV to 25°C)	(NOMINAL)	(4)	KW	737	2082	1575	1186
HEAT REJ. TO EXH. (LHV to 177°C)	(NOMINAL)	(4)	KW	619	1632	1349	925
HEAT REJ. TO AFTERCOOLER	(NOMINAL)	(7) (8)	KW	93	800	479	218

CONDITIONS AND DEFINITIONS

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

NOTES

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6) HEAT REJECTION TO LUBE OIL TOLERANCE IS ± 20% OF FULL LOAD DATA. (heat rate based on treated water)
7) HEAT REJECTION TO AFTERCOOLER TOLERANCE IS ± 5% OF FULL LOAD DATA. (heat rate based on treated water)
8) TOTAL AFTERCOOLER HEAT = AFTERCOOLER HEAT x ACHRF (heat rate based on treated water)
9) TIMING BASED ON AFM INJECTORS.

DM5529 - 04

Appendix I

PM Ambient Air Quality Analysis

AIR SCIENCES INC.
DENVER • PORTLAND

TECHNICAL MEMORANDUM

DISCOVERER & INCREASE IN OSR VESSEL $PM_{2.5}$ AND PM_{10} EMISSIONS - AIR QUALITY ANALYSIS OF 24-HOUR AND ANNUAL $PM_{2.5}$ AND PM_{10}

PREPARED FOR: Chris Lindsey & Pauline Ruddy, Shell

PREPARED BY: Tim Martin, Air Sciences Inc.

PROJECT NO.: 180-21-3

DATE: June 22, 2012

Introduction and Summary

The current pre-construction permit for the *Discoverer* limits the Oil Spill Response (OSR) vessel Propulsion and Generation (P&G) $PM_{2.5}$ to 3.03 lb $PM_{2.5}$/day and PM_{10} emissions to 3.03 lb PM_{10}/day. Concentrations from this level of emissions were modeled as a part of the permitting process and the modeling results were reported to EPA in a May 19, 2011 set of documents and data files. Those results are part of the Statement of Basis (SOB) for the *Discoverer* permit. Shell provides herein an identical modeling analysis but with the OSR vessel P&G $PM_{2.5}$ and PM_{10} emissions each raised to 36.4 lb/day (twelve times the permitted emission rates). This technical memorandum briefly reviews the modeling approach utilized in the permit application and provides a demonstration that with the OSR vessel P&G operating at the aforementioned increased $PM_{2.5}$ and PM_{10} emissions, ambient concentration increases are insignificant and the *Discoverer* and associated fleet will still meet the 24-hour and annual $PM_{2.5}$ NAAQS and 24-hour and annual PM_{10} NAAQS and PSD increments.

Emissions and Source Characterization

A plan view of the *Discoverer* source unit configuration is provided in Figure 1. Given the configuration of the stacks and structures on the *Discoverer*, plumes may be down-washed and pulled into the structures' wake region. For the analysis, the structure downwash parameters used in AERMOD were calculated using the Building Profile Input Program (BPIP) (Version 04274). The building height and location information used in the BPIP analysis are also indicated on Figure 1. A close-up overview of the *Discoverer* and associated fleet characterization used in the modeling analysis is provided in Figure 2.

Although each well is expected to take no more than 30 days to complete, at which time the *Discoverer* will move to another location, the modeling was performed under the assumption that the *Discoverer* remains at a single location for 120 days. Thus the modeling included four times as much emissions and days of impact than should actually occur at any one location. Furthermore, on these days, the sources are emitting at their maximum allowable rate (their PTE), which in practice never happens continuously. Thus the dispersion modeling for the *Discoverer* produced concentrations higher than those that would be expected from actual *Discoverer* drilling activities.

Figure 1: Layout of Emission Units on the Discoverer

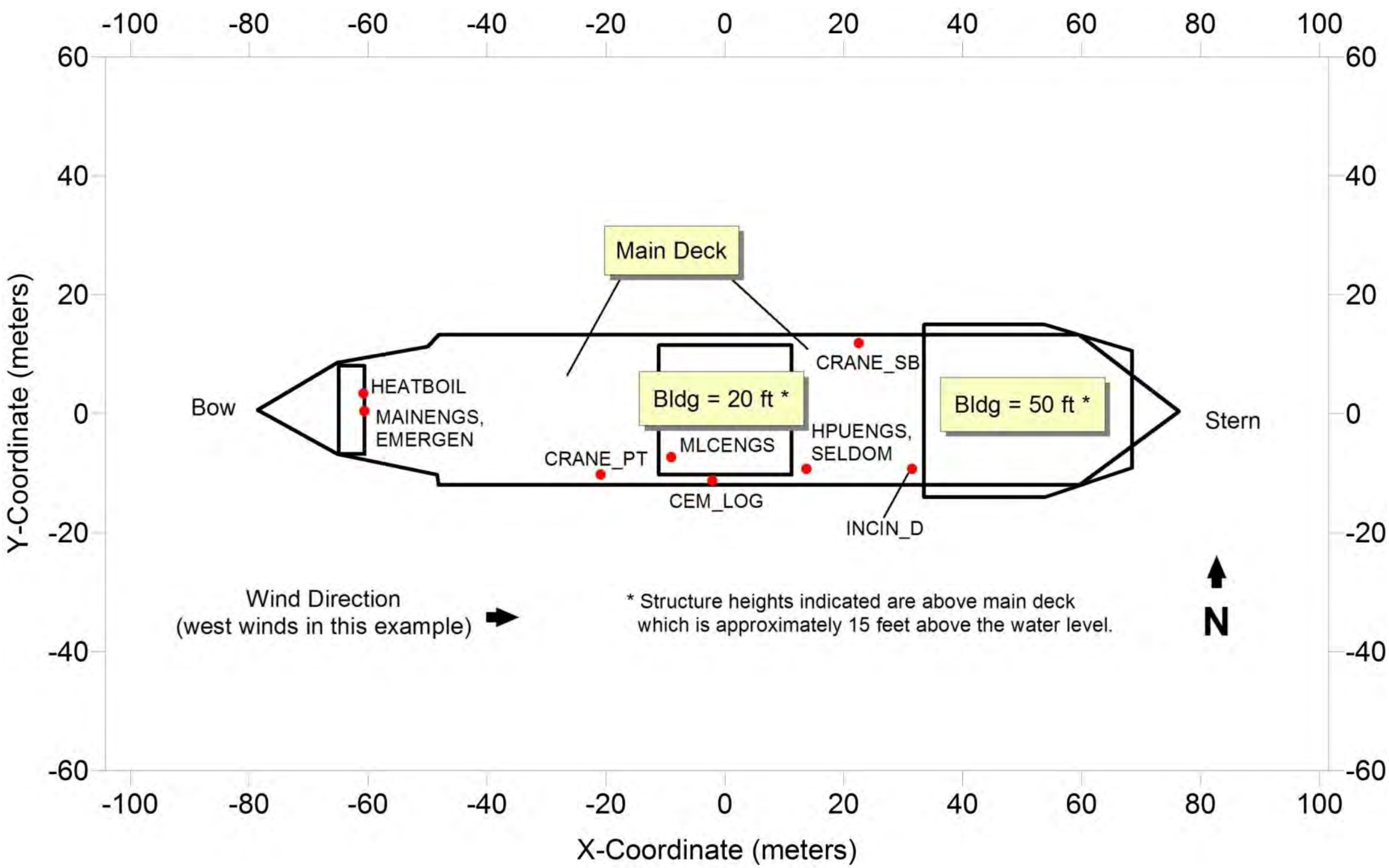
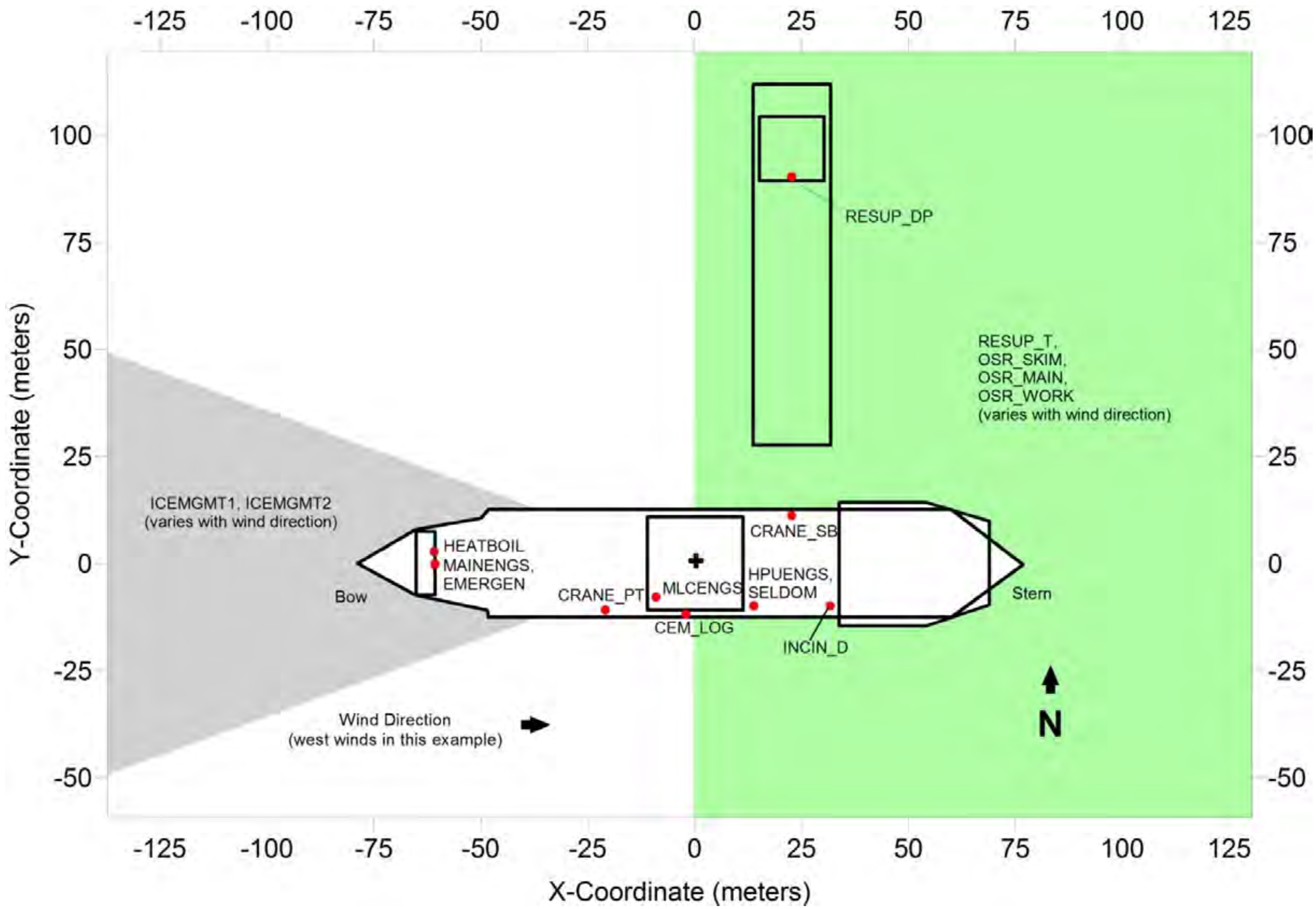


Figure 2: Close-up Overview of the Discoverer and Associated Fleet Configuration Used in the Modeling Analysis



Air Quality Model

For the modeling analysis, version (09292) of AERMOD was used to estimate air quality concentrations resulting from sources of emissions at the project. AERMOD is an advanced modeling system that incorporates boundary layer theory, turbulence, and effects of terrain features into air dispersion simulations. AERMOD is the current model recommended by EPA for most industrial applications for assessing concentrations within 50 kilometers. It reflects the latest science and is the appropriate model to use assuming acceptable meteorological data are available.

Meteorological Data for Use with AERMOD

The AERMOD modeling system involves the use of a meteorological pre-processor, called AERMET, that assumes the surface is solid ground that is subject to the normal diurnal pattern of heating and cooling that follows periods of daylight and periods of nighttime. This meteorological pre-processor is appropriate for conditions when the Arctic has a frozen solid ice surface, but for periods of open water, it is inappropriate. To allow the use of AERMOD for all periods in the Arctic, Shell developed an alternative to the AERMET pre-processor to be used for periods of open water (called AERMOD-COARE) to better simulate open-water conditions by using meteorological tower and buoy data sets to prepare a meteorological data set suitable for AERMOD; its details are documented in the March 18, 2011 permit application materials. AERMOD-COARE was approved by EPA for use in open water conditions in the Beaufort and Chukchi Seas. See Memorandum from George Bridgers, Office of Air Quality Planning and Standards (OAQPS), Re: "Model Clearinghouse Review of AERMOD-COARE as an Alternative Model Application in an Arctic Marine Ice Free Environment," dated May 6, 2011.

With the COARE adaptation for meteorological pre-processing, AERMOD was used for over-water conditions in the Arctic. This approach by-passed AERMET during periods when the sea ice has given way to open water. For periods of ice, Shell utilized the standard AERMET meteorological pre-processor to provide data to AERMOD. In this way, the latest EPA methodologies for addressing dispersion, downwash, NOx to NO_2 conversion and other topics were used in these applications, without sacrificing any accuracy with respect to the air-sea interface that would result from the use of AERMET during open water conditions.

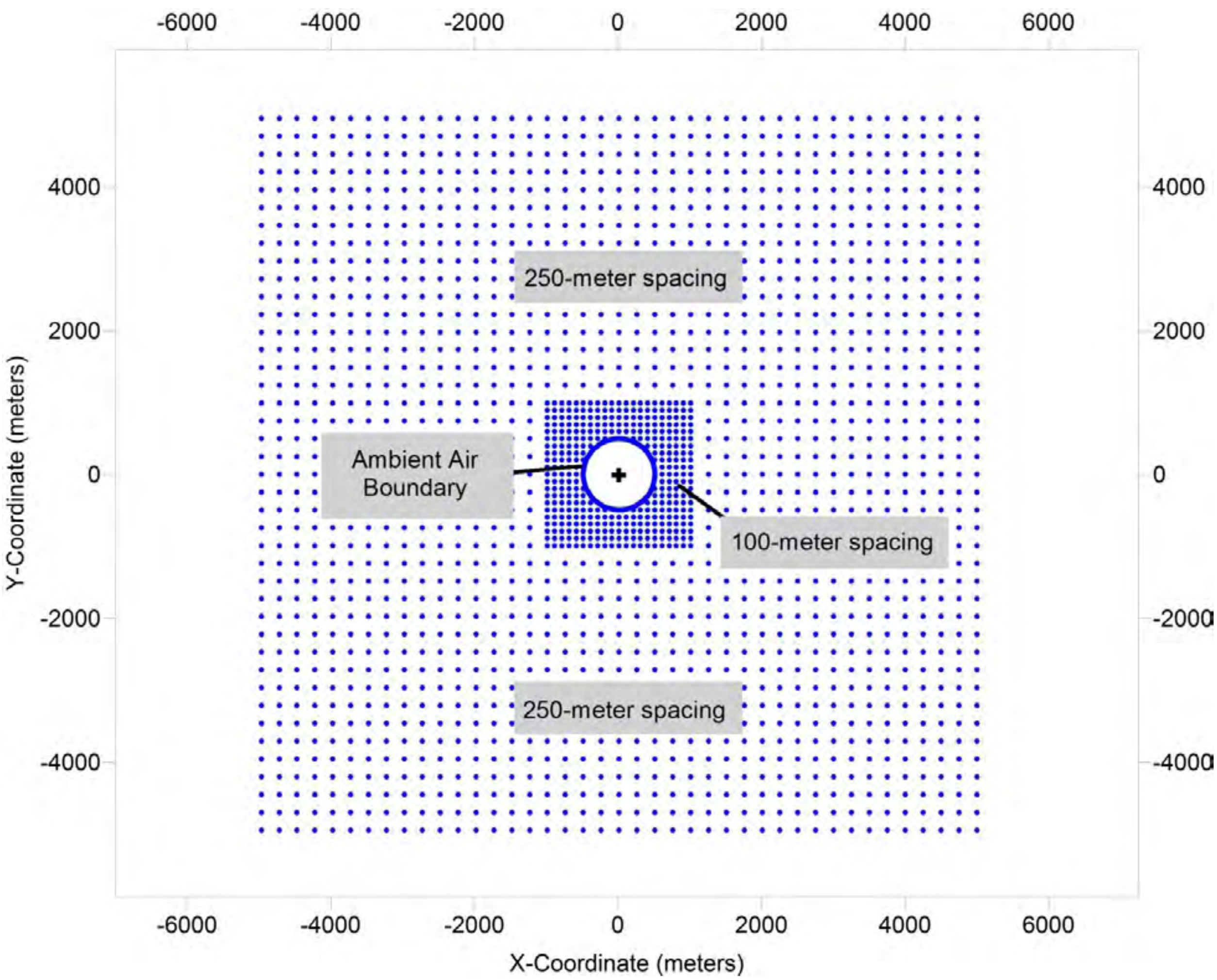
Ambient Air Boundary and Receptors

The ambient air standards are applicable at the ambient air boundary and beyond, which essentially is the nearest location to the *Discoverer* that the hypothetical public can approach. For the modeling analyses, that boundary was assumed to be 500 meters from the center of the *Discoverer*.

Modeled receptors were placed on the ambient air boundary and spaced at approximately 25 meters. To capture maximum concentrations from the *Discoverer* and its associated fleet, receptors were placed every 100 meters out to 1 kilometer from the center of the *Discoverer*. Receptors were spaced every 250-meters from 1 kilometer to 5 kilometers from the center of the *Discoverer* to cover all activity areas upwind and downwind of the *Discoverer*. An overview of the receptor grid used in the modeling analysis is provided in Figure 3.

Figure 3: Overview of Receptor Grid Used in the Modeling Analysis

(+ in the figure represents the *Discoverer*)



Increase in OSR Vessel P&G Emissions and Associated Results

Shell provides herein an identical modeling analysis to the SOB, but with the OSR vessel P&G $PM_{2.5}$ and PM_{10} emissions each raised to 36.4 lb/day (twelve times the permitted emission rates).

Table 1a below provides a summary of the daily $PM_{2.5}$ emissions for the *Discoverer* and associated fleet from the SOB (Table 1 of the SOB) compared to the revised emission rates for this analysis where the OSR P&G emissions are increased to 36.4 lb $PM_{2.5}$/day. Note that the SOB daily $PM_{2.5}$ emissions from OSR vessel P&G are only 0.4% of the total emissions. Even when increased, the daily $PM_{2.5}$ emissions from OSR vessel P&G are still only 4.5% of the total daily $PM_{2.5}$ emissions. Because the OSR incinerator already constitutes a large percentage of daily $PM_{2.5}$ emissions from the OSR vessel, the twelve-fold increase in OSR vessel P&G emissions only increases emissions from the entire OSR vessel by approximately 2.92 times the SOB/permitted values (i.e., OSR vessel with P&G 12x of 50.7 lb $PM_{2.5}$/day divided by 17.3 lb $PM_{2.5}$/day OSR vessel value from SOB).

Table 1b below provides a summary of the daily PM_{10} emissions for the *Discoverer* and associated fleet from the SOB (Table 1 of the SOB) compared to the revised emission rates for this analysis where the OSR P&G emissions are increased to 36.4 lb PM_{10}/day. Even when increased, the daily PM_{10} emissions from OSR vessel P&G are still only 4.4% of the total daily PM_{10} emissions. Because the OSR incinerator already constitutes a large percentage of daily PM_{10} emissions from the OSR vessel, the twelve-fold increase in OSR vessel P&G emissions only increases emissions from the entire OSR vessel by approximately 2.41 times the SOB/permitted values (i.e., OSR vessel with P&G 12x of 57.0 lb PM_{10}/day divided by 23.6 lb PM_{10}/day OSR vessel value from SOB).

The results for the analysis are provided in Tables 2a ($PM_{2.5}$ NAAQS) and Table 2b (PM_{10} NAAQS and PSD increment) below and demonstrate that with the OSR vessel operating at this increase of emissions, the 24-hour and annual $PM_{2.5}$ NAAQS and 24-hour and annual PM_{10} NAAQS and PSD increments are met. The concentrations from this analysis are compared to the results summarized in the SOB, Table 9 and indicate only small changes in maximum modeled $PM_{2.5}$ and PM_{10} concentrations when the OSR vessel P&G emissions are increased. These small changes in concentration indicate that these sources are small contributors to the total overall $PM_{2.5}$ and PM_{10} concentrations.

Table 1a: Summary of Discoverer Maximum Daily $PM_{2.5}$ Emissions

	Daily $PM_{2.5}$ Emissions			
	Statement of Basis		OSR Vessel (P&G) Emis. Increased by 12x	
Source	lb/day	% Total	lb/day	% Total
Discoverer				
Generation	28.3	3.7%	28.3	3.5%
MLC Compressor	4.3	0.6%	4.3	0.5%
HPU Engines	0.6	0.1%	0.6	0.1%
Cranes	0.4	0.1%	0.4	0.0%
Cementing/Logging	3.9	0.5%	3.9	0.5%
Heaters & Boilers	9.0	1.2%	9.0	1.1%
Seldom-used units	0.9	0.1%	0.9	0.1%
Emergency Generator	2.8	0.4%	2.8	0.3%
Incinerator	4.6	0.6%	4.6	0.6%
Primary Ice Management				
Propulsion & Generation	246.4	32.1%	246.4	30.8%
Heaters & Boilers	6.0	0.8%	6.0	0.7%
Seldom-used units	0.6	0.1%	0.6	0.1%
Incinerator	16.8	2.2%	16.8	2.1%
Secondary Ice Management / Anchor Handler				
Propulsion & Generation	254.0	33.1%	254.0	31.7%
Heaters & Boilers	2.4	0.3%	2.4	0.3%
Seldom-used units	0.6	0.1%	0.6	0.1%
Incinerator	16.8	2.2%	16.8	2.1%
Resupply Ship - transit mode				
Propulsion & Generation	18.8	2.4%	18.8	2.3%
Resupply Ship - DP mode				
Propulsion & Generation	75.1	9.8%	75.1	9.4%
Offshore Management / Skimmer vessel				
Propulsion & Generation	21.4	2.8%	21.4	2.7%
Seldom-used units	0.6	0.1%	0.6	0.1%
Incinerator	13.7	1.8%	13.7	1.7%
OSR vessel				
Propulsion & Generation	**3.0**	**0.4%**	**36.4**	**4.5%**
Seldom-used units	0.6	0.1%	0.6	0.1%
Incinerator	13.7	1.8%	13.7	1.7%
OSR work boats				
Work Boats	22.3	2.9%	22.3	2.8%
TOTAL - (lb/day)	767.6	100.0%	801.0	100.0%

Table 1b: Summary of Discoverer Maximum Daily PM_{10} Emissions

	Daily PM_{10} Emissions			
	Statement of Basis		OSR Vessel (P&G) Emis. Increased by 12x	
Source	lb/day	% Total	lb/day	% Total
Discoverer				
Generation	28.3	3.6%	28.3	3.4%
MLC Compressor	4.3	0.5%	4.3	0.5%
HPU Engines	0.6	0.1%	0.6	0.1%
Cranes	0.4	0.1%	0.4	0.0%
Cementing/Logging	3.9	0.5%	3.9	0.5%
Heaters & Boilers	9.0	1.1%	9.0	1.1%
Seldom-used units	0.9	0.1%	0.9	0.1%
Emergency Generator	2.8	0.4%	2.8	0.3%
Incinerator	5.3	0.7%	5.3	0.6%
Primary Ice Management				
Propulsion & Generation	246.4	30.9%	246.4	29.7%
Heaters & Boilers	6.0	0.8%	6.0	0.7%
Seldom-used units	0.6	0.1%	0.6	0.1%
Incinerator	24.6	3.1%	24.6	3.0%
Secondary Ice Management / Anchor Handler				
Propulsion & Generation	254.0	31.9%	254.0	30.6%
Heaters & Boilers	2.4	0.3%	2.4	0.3%
Seldom-used units	0.6	0.1%	0.6	0.1%
Incinerator	24.6	3.1%	24.6	3.0%
Resupply Ship - transit mode				
Propulsion & Generation	18.8	2.4%	18.8	2.3%
Resupply Ship - DP mode				
Propulsion & Generation	75.1	9.4%	75.1	9.0%
Offshore Management / Skimmer vessel				
Propulsion & Generation	21.4	2.7%	21.4	2.6%
Seldom-used units	0.6	0.1%	0.6	0.1%
Incinerator	20.0	2.5%	20.0	2.4%
OSR vessel				
Propulsion & Generation	**3.0**	**0.4%**	**36.4**	**4.4%**
Seldom-used units	0.6	0.1%	0.6	0.1%
Incinerator	20.0	2.5%	20.0	2.4%
OSR work boats				
Work Boats	22.3	2.8%	22.3	2.7%
TOTAL - (lb/day)	796.5	100.0%	829.9	100.0%

Table 2a: Summary of Maximum 24-Hour and Annual $PM_{2.5}$ Modeled Concentrations – Chukchi Sea

Scenario	Averaging Period	Max. Modeled Shell Conc. Without Background Concentration (μg/m³)	Background Concentration (μg/m³)	Max. Modeled Conc. With Background Concentration [1] (μg/m³)	NAAQS (μg/m³)
OSR Vessel (P&G) Emissions Increased 12x	24-hour	12.7	11.0	23.7	35
Values from Permit SOB	24-hour	12.4	11.0	23.4	35
OSR Vessel (P&G) Emissions Increased 12x	Annual	0.5	2.0	2.5	15
Values from Permit SOB	Annual	0.4	2.0	2.4	15

[1] Maximum modeled concentrations plus background concentrations are compared to the NAAQS.

Table 2b: Summary of Maximum 24-Hour and Annual PM_{10} Modeled Concentrations – Chukchi Sea

Scenario	Averaging Period	Max. Modeled Shell Conc. Without Background Concentration [2] (μg/m³)	Background Concentration (μg/m³)	Max. Modeled Conc. With Background Concentration [1] (μg/m³)	NAAQS (μg/m³)	PSD Class II Increment (μg/m³)
OSR Vessel (P&G) Emissions Increased 12x	24-hour	12.0	79.0	91.0	150	30
Values from Permit SOB	24-hour	11.5	79.0	90.5	150	30
OSR Vessel (P&G) Emissions Increased 12x	Annual	0.5	---	---	---	17
Values from Permit App.	Annual	0.5	---	---	---	17

[1] Maximum modeled concentrations plus background concentrations are compared to the NAAQS.

[2] Modeled concentrations (i.e., Shell-only concentrations without background concentrations) are compared to the PSD increment.

For the 24-hour average values, the highest-second-highest value is presented.