April 8, 2016

Washington State Department of Ecology
300 Desmond Drive SE
Lacey, WA 98503

Attn: Gary Huitsing

Re: April 2016 Updated Request for Revisions to Approval Order No. 14AQ-E537
Microsoft Oxford Data Center
Quincy, Washington

Dear Gary:

On behalf of Microsoft Corporation (Microsoft), this letter requests amendments to the August 2014 Approval Order No. 14AQ-E537 ("the Approval Order") for the Oxford Data Center in Quincy, Washington. This revised application addresses the Washington State Department of Ecology's (Ecology's) comments in your Incompleteness Letter dated March 10, 2016. As described in detail in this letter, Microsoft requests the following revisions:

- Allow shorter emergency generator stacks
- Allow eight new "reserve emergency generators," which will serve as backups to the currently permitted emergency generators
- Allow the currently permitted generators to operate at electrical loads from zero up to 100 percent during unplanned outages or scheduled electrical bypass maintenance
- Eliminate runtime limits for each individual activity and replace them with consolidated runtime limits
- Requests approval to use the 40 CFR Part 1065 dilution tunnel stack sampling apparatus
- Streamline stack testing requirements
- Streamline recordkeeping and reporting requirements
- Revise the annual potential-to-emit limits to be consistent with more aggressive assumptions for the "Theoretical Maximum Year."

Reasons for Requested Permit Revisions

Microsoft owns and operates the Oxford Data Center in Quincy, Washington. The Washington State Department of Ecology (Ecology) issued current Approval Order No. 14AQ-E537 on August 14, 2014. In February 2015, Microsoft submitted an application to amend the August 2014 Approval Order to accommodate operation over the entire range of generator loads from 0 to 100 percent, and to revise several other conditions of the Approval Order. Ecology published a Preliminary Determination in May 2015 and submitted it for public comment. Prior to final action on the Preliminary Determination, however, Microsoft asked Ecology to suspend the review process to accommodate additional changes in the operation of the data center. This application includes as new amendments all of the changes that Ecology published for comment in May 2015, and some additional changes that Microsoft engineers requested since that time. Ecology took comment on many of the edits in this application, but Ecology requested that the current application include all changes proposed since issuance of the 2014 approval order. They include:

- **Stack Parameters**. Condition 2.4 of the Approval Order specifies allowable stack heights and diameters. The final engineering drawings for the data center show slightly shorter and wider stacks than those authorized in Condition 2.4. Microsoft requests edits to the stack height and diameter limits in Condition 2.4 to track the final design specifications for the stacks. The revised ambient analysis provided in Appendix B demonstrates that, even with the reduced dispersion caused by the shorter and wider stacks, the ambient impacts will comply with all regulatory requirements.
- **New Reserve Generators**. The 37 currently permitted generators, which are designed to carry the on-demand server load during unplanned outages, have been re-designated as "primary emergency generators." For this permit revision, we have added eight new 2.5-megawatt (MW) "reserve generators," which will serve as secondary backup units to the primary emergency generators. The reserve generators are designed to temporarily activate at zero electrical load (idle speed) during an unplanned outage. The locations for the eight new reserve generators are shown in the revised version of the Site Plan (see attached Figure 1). The reserve generators will be designed to be identical to the currently permitted 2.5-MW primary generators (they will be in individual weather enclosures, they will be equipped with the same add-on emission controls, and they will have the same stack heights). As shown on Figure 1, the new reserve generators will be located inside the spatial footprint of the clusters of primary generators. A reserve generator would automatically replace one of the primary generators if the primary generator encountered problems during startup. Otherwise, all of the new reserve generators are designed to run at idle load then shut down within 30 minutes after the start of the unplanned outage. All reserve generators will be subject to the same scheduled runtime for testing and maintenance as the primary generators. The revised ambient analysis provided in Appendix B demonstrates that, even with the increased emissions caused by the new generators, the ambient impacts will comply with all regulatory requirements.
- **Increase Allowable Ranges of Generator Load**. The Approval Order authorizes operation of the generators at three specified load levels. In addition, it limits the number of generators that can operate at loads exceeding 85 percent. Microsoft engineers advised that these limits would prevent the generators from responding to the variable power demands imposed by the servers during an outage. Therefore, Microsoft requests that Ecology revise the Approval Order to allow each emergency generator to operate at loads from idle to 100 percent during all runtime including unplanned outages, electrical bypass, or scheduled testing and maintenance. The revised ambient analysis provided in Appendix B demonstrates that, even with the increased emissions caused by the expanded range of allowable loads, the ambient impacts will comply with all regulatory requirements.

Requested Revisions to August 2014 Approval Order

Appendix A provides a consolidated set of redline edits of the August 2014 Approval Order. It includes amendments that Ecology reviewed and proposed for comment in May 2015, and additional changes that Microsoft engineers requested after Microsoft submitted the February 2015 application to amend the Approval Order. This section provides an explanation for the edits proposed in Appendix A.

Table 1.1: "Primary Emergency Generators" vs. "Reserve Generators"

The 37 currently permitted emergency generators should be re-designated as "primary emergency generators" because they are designed to automatically activate during an unplanned outage and carry the as-needed variable electrical demand for the servers, cooling towers, and other equipment. Table 1.1 should be revised to include the eight new "reserve generators."

Project Summary: Item 1

Paragraph 1 should be revised to include a description of the eight new 2.5-MW reserve generators.

Tables 2.1 and 2.2: Revised Potential-to-Emit

Tables 2.1 and 2.2 should be revised to describe the increased emission rates caused by eight new reserve generators and less restrictive load limits during unplanned outages and electrical bypass maintenance. With the exception of diesel engine exhaust particulate matter (DEEP) and nitrogen oxides (NO_x), all annual potential-to-emit should be derived by dividing the "theoretical maximum year" emission rate by 3. Appendix B describes the updated emission rates. An Excel spreadsheet with the revised emission calculations has been provided under separate cover.

Determinations: Paragraph 4

The deletion of load restrictions from Condition 3.2.5 coupled with slightly shorter stacks will cause a modeled exceedance of the 1-hour nitrogen dioxide (NO_2) acceptable source impact level (ASIL) at the unpopulated industrial property line. As a result, the Second-Tier Health Risk Assessment has been revised to address NO_2 as well as diesel engine exhaust particulate matter (DEEP). This paragraph should be revised to reference the Second-Tier Health Risk Assessment for NO_2.

Approval Conditions

Condition 1.1: Replacement of Superseded Order

This condition picks up language Ecology proposed in the May 2015 Preliminary Determination, reciting that this order supersedes the 2014 Approval Order.

Condition 1.2: Restrictions on Use of Engines

This condition adds language Ecology proposed in the May 2015 Preliminary Determination to bar use of the engines for demand response and peak shaving purposes.

Condition 2.1: Equipment Restrictions

Condition 2.1 should be revised to include both the currently permitted primary emergency generators and the proposed new reserve generators.

Condition 2.4: Allowable Stack Heights and Stack Diameters

Stack parameter limits should be updated to reflect the final design of the stacks as described above.

Condition 3.1: Fuel Usage Limits

Condition 3.1 should be revised to increase the allowable fuel usage, consistent with Microsoft's request to add new reserve generators. Calculations of the new fuel usage values are provided in Appendix B.

Condition 3.2: Load-Based Operating Hour Limits

Condition 3.2 of the Approval Order limits operation of the data center engines to levels of "no load" (also described as "idle"), "approximately 80 percent," and 100 percent. Condition 3.2 does not authorize operation of an engine at other load levels. In reality, however, the Oxford generators will have to operate at other loads during both unplanned outages and planned maintenance and testing.

During a power outage or an electrical system bypass, the load on the generators will automatically vary during any hour of the day to match the system loads imposed on the servers. Server loads vary significantly throughout the day as population centers become more or less active. System loads also vary over longer periods as servers are added and older ones decommissioned, or as new services attract users or fade from popularity. Microsoft anticipates that the engines will run most of the time at intermediate loads between 25 and 88 percent, but Microsoft needs the flexibility to run at loads from 10 to 100 percent during unplanned outages, and during certain planned situations. For example:

- Engines may operate for "corrective testing," which is testing to diagnose mechanical problems. Depending on the problem, testing may occur at numerous intermediate loads to ascertain the source, ranging from idle to 100 percent load.
- Microsoft's routine monthly and semiannual load bank tests might be run at numerous intermediate loads.
- During electrical system bypass events, the generators must carry the load on the servers, which varies as described above.

Condition 3.2 currently authorizes each engine to operate 29 hours per year at no load, 40 hours per year at "approximately 80 percent load," and 17.5 hours per year at 100 percent load, for a total of 86.5 hours per year per engine. For the reasons noted above, Microsoft requests that the permit be simplified to delete the load-based operating hour limits. The modeling analysis described in Appendix B shows that the National Ambient Air Quality Standards (NAAQS) and Chapter 173-460 Washington Administrative Code (WAC) health impact thresholds are protected if the engines average no more than 86 hours per year per engine, no more than 160 generator-hours per day, and if the facility-wide emissions of nitrogen oxides (NO_x) during a power outage are limited to no more than 575 pounds per hour. Load-based operating hour limits are not necessary, and they could impair the data center's ability to meet load in the event of an outage.

Conditions 3.2.1 and 3.2.2: Annual Runtime Limits for Primary Emergency Generators and Reserve Generators

Conditions 3.2.1 and 3.2.2 should be revised to reflect the addition of the new reserve generators. The new reserve generators will require an average of 40 hours per year for scheduled testing and maintenance, identical to the currently permitted primary emergency generators.

If one of the primary generators fails during an unplanned outage, its reserve generator will automatically activate and take over that primary generator's load, after which the failed primary generator will quickly be shut down. Under Condition 3.2.1, if one of the primary generators fails during an outage and is temporarily replaced by a reserve generator, then the actual runtime for the reserve generator when it provides electrical power to the servers will be subtracted from the allowable annual runtime for the failed primary generator.

Under the proposed new Condition 3.2.2, the reserve generators should be allowed an average of 40 hours per year for scheduled testing and maintenance (averaged across all reserve generators, 36-month rolling average).

No runtime limit should be set for the reserve generators during unplanned outages when they temporarily operate at high load to replace a failed primary generator. Per proposed Condition 3.2.1, each reserve generator hour of operation during an outage reduces the operating hour allowance for the primary generator it replaces. As a result, use of the reserve generators to carry load will cause no net increase in permitted operating hours.

The updated NO_2 NAAQS modeling analysis in Appendix B shows that facility-wide emission limits protect the 1-hour NO_2 NAAQS. The revised DEEP/NO_2 second-tier risk analysis demonstrates that the health risks caused by the increased NO_2 ambient concentrations are negligible.

Condition 3.3.2: Operating Hour Allowance for Source Testing

Microsoft requests that Condition 3.3.2 be revised to allow up to 45 hours of runtime for each source testing event. Microsoft explained the need for this adjustment in its comments on the Preliminary Determination.[1]

Condition 4.1: General Testing and Maintenance

This condition should include the proposed new reserve generators.

---

[1] Letter of July 29, 2014 from John Radick to Beth Mort at 3-4 ("Microsoft Comments").

Condition 4.4 and Table 4: Single Load Emission Limits and Source Testing

Microsoft requests several amendments to Table 4. First, Microsoft asks Ecology to reduce the number of source tests (but not the frequency of testing) required by Table 4, to reduce the burden, cost, and extra emissions associated with running source tests. Microsoft included this request in its comments on the Preliminary Determination for the current Approval Order [Microsoft Comments at 5-6). Ecology found this request to be "reasonable" (see Ecology's Response to Comments (August 15, 2014) at 18]. The amendments proposed in Appendix A that address source test intensity come from a redline version that Kay Shirey sent to Matt Cohen on July 1, 2014. They would revise Condition 4.4 to require testing one engine every 3 years, but increase the minimum number of engines tested from eight to nine. Microsoft proposes an edit to Condition 4.4.4 to add one more source test as requested by Ecology.

Second, since filing the original Notice of Construction (NOC) application, Microsoft has obtained load-specific emissions data from Caterpillar for each of the three engine models in use at the data center. Caterpillar provided estimated emission rates at 10, 25, 50, 75, and 100 percent load, including condensable (i.e., "back-half") particulate matter (PM) emission rates (see Appendix B of this letter). This information was not available when Microsoft filed its NOC application in June 2014. It shows different emission rates for most pollutants than the rates that Microsoft originally modeled in its June 2014 permit application. It also shows that peak emissions occur at load levels other than 80 percent.

The Caterpillar data do not affect the US Environmental Protection Agency (EPA) five-load weighted average emission limits or source test methods. For the single load limits, however, the Caterpillar data support revisions to Table 4. Microsoft proposes to set the single load limit for each pollutant at 120 percent of the emission rate supplied by Caterpillar for that pollutant at the load at which Caterpillar estimates peak emissions will occur, unless the peak emission rate occurs at idle.[2] Microsoft then proposes to source-test for that pollutant at the load at which the limit applies. By requiring compliance testing for each pollutant at either 50, 75, or 100 percent load, Ecology will reduce the source testing burden and obtain data for Caterpillar's predicted peak emission rate for that pollutant. The 20 percent safety factor built into each limit accounts for estimating error and operational variability, in a situation where the vendor provided only estimated emission rates, not guarantees. Where Caterpillar applied its own safety factor to the estimated PM emission rates, Microsoft proposes to use the Caterpillar estimates as limits.

Microsoft requests that Table 4 be revised to allow the option of using the 40 CFR Part 89 dilution tunnel stack testing system as an option to using the 40 CFR Part 60 stack testing methods currently required by the Approval Order.

[2] Engines rarely if ever carry load at idle, and an emission limit set for an engine operating without load would not provide useful information about the performance of the engines under normal operating scenarios.

The "Single Load" emission limits in Table 4 should be revised to specify the maximum emission rate at each maximum load for each pollutant.

Condition 5.2: Facility-Wide Annual Emission Limits

As described in Appendix B, the flexibility to run engines at any load between 10 and 100 percent, combined with the use of Caterpillar's new emissions data, requires adjustments to the facility-wide annual emission limits in Condition 5.2. The revised facility-wide limits are now "ultra-worst-case" values that assume the maximum possible operating conditions for each pollutant. For example, the revised DEEP emission rate now assumes that each of the 45 generators operates at the allowable hours per year exclusively at 10 percent load, which is the load at which the PM emission rate is highest. For another example, the revised NO_x emission rate now assumes that each of the 37 primary generators operates for 86 hours per year and the eight new reserve generators operate for 40 hours per year exclusively at 100 percent load, which is the load at which the NO_x emission rate is highest.

Condition 5.2 should be revised to specify the annual emission limits as 3-year rolling averages, to reflect the 3-year rolling runtime limit specified by Condition 3.2.1. The revised ambient impact assessment provided in Appendix B evaluates the theoretical-maximum annual-average impacts assuming that all of the allowable emissions during any 3-year rolling period could occur during a single year (except for the 70-year average DEEP cancer risk, which continues to be modeled based on the 3-year rolling average DEEP emission rate).

The revised facility-wide annual emission limits presented in this resubmittal account for the revised assumption that all cold-start conditions last for 15 minutes, and account for inclusion of the "black-puff" factors for CO and volatile organic compounds (VOCs).

Appendix B shows the derivation of the revised annual limits. It then models the worst-case emission rates permitted by the proposed emission limits and operating hour restrictions to demonstrate that NAAQS and Chapter 173-460 WAC health impact thresholds are protected.

Proposed New Condition 5.5: Facility-Wide 1-Hour NO_x Emission Limit

This proposed new condition sets an allowable facility-wide NO_x emission limit of 575 lbs/hr. That is the facility-wide NO_x emission rate calculated for the first hour of an unplanned outage when all 37 primary generators activate with a cold start to 100 percent load for 1 hour, while all 8 reserve generators activate with a cold start to 10 percent load for 30 minutes. Detailed emission calculations for this scenario are provided in Appendix B. The revised second-tier risk assessment for NO_2 uses AERMOD[3] modeling based on that facility-wide NO_x emission rate of 575 lbs/hour. The second-tier risk analysis demonstrates that the NO_2 human health risks would be acceptable at the NO_x emission rate of 575 lbs/hour.

[3] American Meteorological Society (AMS)/US Environmental Protection Agency (EPA) regulatory model.

Proposed new recordkeeping and reporting conditions to reflect this new facility-wide emission limit are proposed in new Conditions 8.5.6 and 9.2.6.

Microsoft will calculate the actual facility-wide NO_x emission rate during a 1-hour power outage based on real-time monitoring of the actual generator load and runtime for each generator. Based on the recorded actual generator load, the actual NO_x emissions during the initial cold-start period and the subsequent warmed-up period will be calculated by using polynomial curve-fit equations for the load vs. emission curves, similar to those presented in Appendix B. Those polynomial curve-fit equations will be developed based on the forecast or measured emission rates at the five generator loads subject to stack emission testing (100, 75, 50, 25, and 10 percent). The proposed new condition allows Microsoft to choose which set of five-load emission data to use to develop the curve-fit equations for each size of generator. Until actual stack test data are available for any given generator size, Microsoft will be required to use Caterpillar's worst-case emission forecasts, which were also used for the ambient impact assessment in Appendix B. We anticipate that Caterpillar's worst-case emission forecasts are conservatively high. However, after stack test data for each size of generator become available from the stack emission testing required by the current Approval Order, Microsoft will use the more realistic stack test data to develop new curve-fit equations for subsequent use in the actual emission calculations.

Condition 6: Operation and Maintenance Manuals

Microsoft agrees to incorporate Caterpillar's recommendations for low-load operation into the required operation and maintenance manuals. Microsoft agrees that any supplemental high-load runtime required after extended low-load operation will be included in the overall runtime limit set by Condition 3.2.1.

Condition 8.5.3: Recordkeeping Requirements

This condition should be revised to include language Ecology requested, requiring the data center to log the reasons for operating the engines.

New Condition 8.5.6: Recordkeeping of Actual NO_x Emissions During Power Outages

This proposed new condition requires Microsoft to keep records of the actual aggregate 1-hour NO_x emissions during each power outage that triggers activation of 30 or more generators. The 30-generator recordkeeping threshold is the number of generators that, if activated simultaneously at 100 percent load, could potentially cause the maximum 1-hour NO_2 concentration at the facility boundary to approach ¾ of the ASIL.

New Condition 9.2.6: Reporting of Actual NO_x Emissions Exceeding the New Allowable Facility-Wide NO_x Emission Limit

Under this proposed new condition, Microsoft would be required to report each occurrence in which a power outage that caused the actual facility-wide NO_x emissions to exceed the new facility-wide emission limit of 575 lbs/hour.

Compliance with WAC-173-400-111(8)

WAC 173-400-111(8)(a) lists the criteria that govern review of a request to revise an approval order. It states that the permitting authority may approve the request if it finds that:

(i) The change in conditions will not cause the source to exceed an emission standard set by regulation or rule. The only emission standards prescribed by rule that apply to the Oxford generators are those in New Source Performance Standard (NSPS) Subpart IIII, and those imposed by Chapter 173-400 WAC. The proposed amendments will not affect compliance with any of those standards.

(ii) No ambient air quality standard will be exceeded as a result of the change. The ambient impact demonstration provided as Appendix B shows that the proposed amendments will not cause or contribute to an NAAQS exceedance or cause data center emissions to exceed any ambient thresholds applicable to toxic air pollutants.

(iii) The change will not adversely affect the ability of the permitting authority to determine compliance with an emissions standard. Microsoft's proposed edits to Table 4 will maintain the frequency of source testing currently required by the Approval Order. Allowing Microsoft to test one engine rather than two during each test will not adversely affect Ecology's ability to determine compliance with emission standards, where 37 of the engines are identical, and any non-compliance revealed by a source test requires three additional tests, including a second test on the same engine.

(iv) The revised order will continue to require BACT for each new source approved by the order except where the Federal Clean Air Act requires LAER. Microsoft's requested changes do not alter Ecology's previous best available control technology (BACT) determination. All generators must continue to use Tier 2-certified engines.

(v) The revised order meets the requirements of WAC 173-400-111, 173-400-113, 173-400-720, 173-400-830, and 173-460-040. The revised emission limits will not trigger any new permitting requirements or emission standards.

* * * * *

We thank you for your prompt attention to these requested permit revisions. Please call me at (425) 329-0320 if you have any additional questions about this matter.

LANDAU ASSOCIATES, INC.

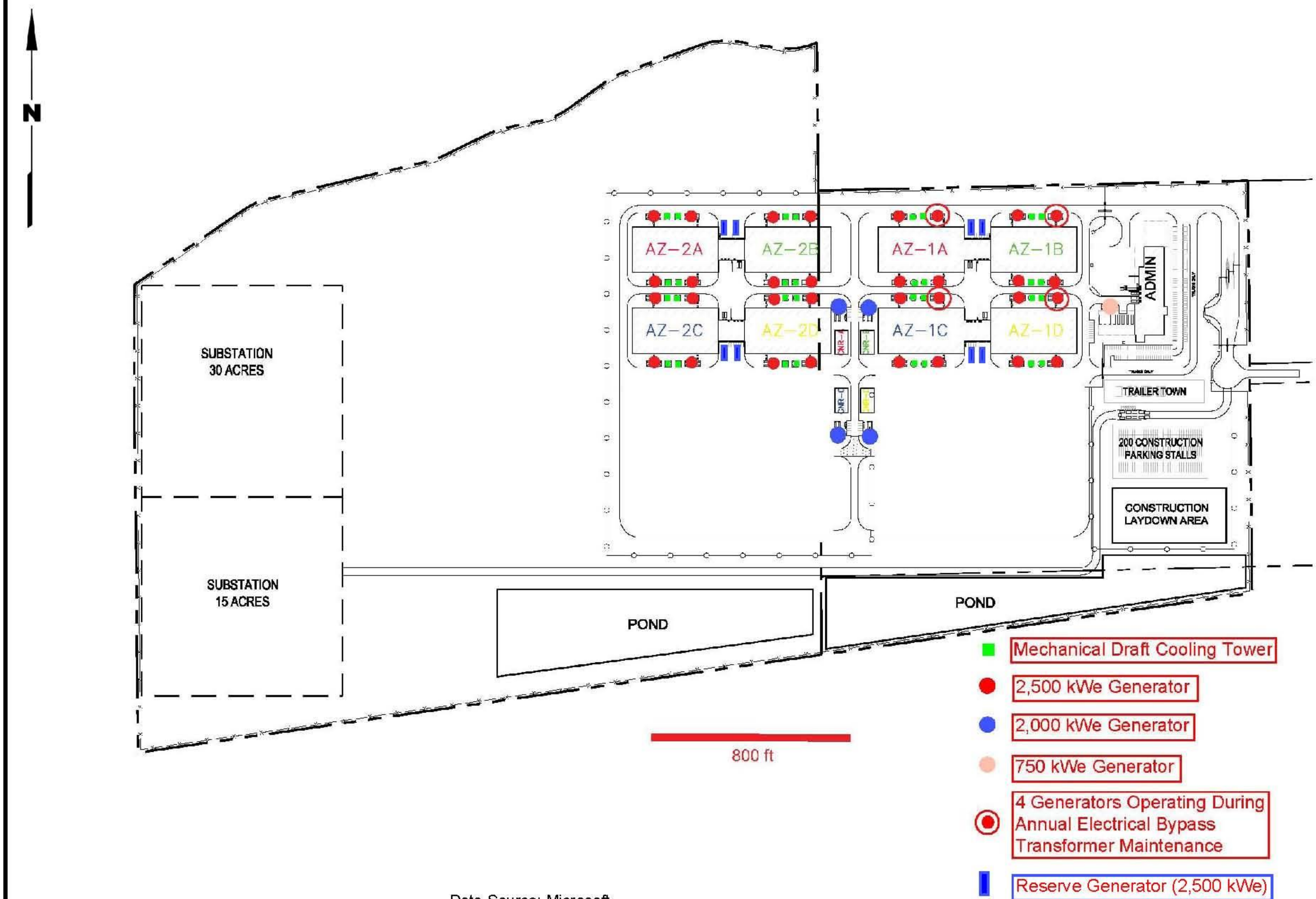
Jim Wilder, PE
Senior Associate

JMW/ccy
P:\1409\001\010\FileRm\R\April 2016 NOC Package to Respond to Incompleteness\April 2016 NOC Letter\April 2016 NOC_ltr.docx - 04-08-16.docx

cc: Gary Palcisko, Washington State Department of Ecology
Jolaine Johnson, Washington State Department of Ecology
John Radick, Microsoft Corporation
Sue Cheung, Microsoft Corporation

Attachments

Figure 1: Site Plan
Appendix A: Redline Showing Proposed Revisions to Approval Order 14AQ-E537
Appendix B: April 2016 Emission Calculations and Ambient Impact Assessment



Data Source: Microsoft

Project Oxford Data Center Quincy, Washington	**Site Plan**	Figure 1

LANDAU ASSOCIATES

APPENDIX A

Redline Showing Proposed Revisions to Approval Order 14AQ-E537

APRIL-2016 2016 VERSION
YELLOWHIGHLIGHTS INDICATE CHANGES TO RESPOND TO MARCH 2016 INCOMPLETENESS LETTER

APPENDIX A

Formatted: Not Highlight

MICROSOFT'S PROPOSED CHANGES TO AUGUST 2014 APPROVAL ORDER
STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

IN THE MATTER OF APPROVING A NEW)
AIR CONTAMINANT SOURCE FOR)
MICROSOFT CORPORATION)
THE OXFORD DATA CENTER)

Microsoft Requested Revisions, Apr-2016
APPROVAL ORDER No. 14AQ-E537

TO: John Radick, Senior Program Manager
US-Data Center Services
Microsoft Corporation
5600 148th Avenue NE
Redmond, WA 98052

On December 11, 2014____, 2016, Ecology received a Notice of Construction (NOC) application submittal from the Microsoft Corporation (MSN**)** requesting revisions to Approval Order 14AQ-E537 (dated August 15, 2014), for the Oxford Data Center located at Industrial Park #5, west of Road R NW at the end of Port Industrial Parkway in Quincy, WA. The NOC application was determined to be incomplete, and on January 7, 2015 Ecology issued an incompleteness letter to Microsoft. On February 2, 2015 Microsoft provided a revised NOC application to Ecology. On February 20, 2015____, 2016 Microsoft provided a revised Second-Tier Risk Analysis to Ecology. The application was considered complete on March 17, 2015______, 2016.

EQUIPMENT

A list of equipment for this project is provided in Tables 1.1–1.4 below. Engine sizes listed in Tables 1.1–1.3 are in megawatt (MWe) units with the "e" indicating "electrical" based on generator power ratings listed on the engine specifications provided with the application. MWe is the assumed engine power rating unit for all Approval Conditions related to this Order.

Table 1.1. 2.5 MWe Engine & Generator Serial Numbers for Phases 1 & 2				
Phase/Building	**Unit ID**	**Engine SN**	**Generator SN**	**Build Date**
Primary Emergency Generators				
Ph 1/AZ-4A				
"				
"				
"				

Table 1.1. 2.5 MWe Engine & Generator Serial Numbers for Phases 1 & 2				
Phase/Building	**Unit ID**	**Engine SN**	**Generator SN**	**Build Date**
Ph 1/AZ-4B				
"				
"				
"				
Ph 1/AZ-4C				
"				
"				
"				
Ph 1/AZ-4D				
"				
"				
"				
Ph 2/AZ-3A				
"				
"				
"				
Ph 2/AZ-3B				
"				
"				
"				
Ph 2/AZ-3C				
"				
"				
"				
Ph 2/AZ-3D				
"				
"				
"				
Reserve Emergency Generators				
	RES-1			
	RES-2			
	RES-3			
	RES-4			
	RES-5			
	RES-6			
	RES-7			
	RES-8			

Table 1.2. 2.0 MWe Engine & Generator Serial Numbers for Phases 1 & 2				
Building	**Unit ID**	**Engine SN**	**Generator SN**	**Build Date**
CNR-A	CNR-A			
CNR-B	CNR-B			
CNR-C	CNR-C			
CNR-D	CNR-D			

Table 1.3. 0.750 MWe Engine & Generator Serial Numbers for Phases 1 & 2				
Building	**Unit ID**	**Engine SN**	**Generator SN**	**Build Date**
Admin				

Table 1.4. Cooling Towers for Phases 1 & 2			
Phase/Building	**# Cooling Towers**	**# Cells per Tower**	**Total # Cooling Tower Cells**
Ph 1/AZ-4A	4	4	16
Ph 1/AZ-4B	4	4	16
Ph 1/AZ-4C	4	4	16
Ph 1/AZ-4D	4	4	16
Ph 2/AZ-3A	4	4	16
Ph 2/AZ-3B	4	4	16
Ph 2/AZ-3C	4	4	16
Ph 2/AZ-3D	4	4	16
Total	32	4	128

PROJECT SUMMARY

1. When completed, Tthe Oxford Data Center will contain four Phase 1 activity zone (AZ) buildings designated AZ-4A, AZ-4B, AZ-4C, AZ-4D; four core network room (CNR) buildings; an administrative building; and four phase 2 AZ buildings designated AZ-3A, AZ-3B, AZ-3C, AZ-3D. Building construction for the Phase 1 generators and cooling towers ~~is expected to begin~~ began before the end of ~~October~~ 2014~~ with commissioning of generators spread over an approximately 9-month period~~. Construction of Phase 2 is expected to begin within 18 months after the start of generator commissioning for Phase 1. Project Oxford Phases 1 and 2 will have thirty-two (32) Caterpillar Model 3516C-HD-TA diesel powered electric emergency generators in the activity zone buildings with a power rating of 2.5 MWe per generator, four (4) Caterpillar Model 3516C-TA diesel powered electric emergency generators in the CNR buildings with a power rating of 2.0 MWe per generator, and one (1) Caterpillar Model C27ATAAC diesel powered electric emergency generator in the

administrative building with a power rating of 0.75 MWe. The combined Phases 1 and 2 will also use eight (8) reserve emergency generators rated at 2.5 MWe.

2. Project Oxford will use SPX-Marley Model MD5008PAF2 cooling towers to dissipate heat from the AZ buildings. Each cooling tower has four cells and four fans. Each of the eight AZ buildings will have four cooling towers for a total of thirty-two (32) cooling towers. Each of the thirty-two individual cooling towers has a design recirculation rate of 950 gallons per minute (gpm) and 143,600 cubic feet per minute (cfm).

Combined Phase 1 and 2 emissions for Project Oxford are contained in Tables 2.1 and 2.2.

Table 2.1. Criteria Pollutants Potential to Emit for Phases 1 & 2 (TPY)

Pollutant	Main Generator Engines	Cooling Towers	Total Facility Emissions
Total particulate matter (PM)	All $PM_{2.5}$	23	23.8
PM smaller than 10 microns (PM10)	All $PM_{2.5}$	12.8	13.6
PM smaller than 2.5 microns PM2.5)	0.814	2.99	3.80
Carbon monoxide (CO)	7.3	0	7.3
Nitrogen oxides (NO_X)	33.0	0	33.0
Volatile organic compound (VOC)	1.033	Negligible	1.033
Sulfur dioxide (SO_2)	0.069	0	0.069
Lead	Negligible	0	Negligible

[a] All PM emissions from the generator engines are $PM_{2.5}$, and all $PM_{2.5}$ from the generator engines is considered Diesel Engine Exhaust Particulate (DEEP).

~~Table 2.1. Criteria Pollutants Potential to Emit for Phases 1 & 2 (TPY)~~

~~Pollutant~~	~~Main Generator Engines~~	~~Cooling Tower~~	~~Total Facility Emissions~~
~~Total particulate matter (PM)~~	~~All $PM_{2.5}$~~	~~23~~	~~23.5~~ 23.7
~~PM smaller than 10 microns in diameter (PM_{10})~~	~~All $PM_{2.5}$~~	~~12.8~~	~~13.3~~ 13.5
~~PM smaller than 2.5 microns in diameter ($PM_{2.5}$)[a]~~	~~0.536~~ 0.73	~~2.99~~	~~3.53~~ 3.7

Formatted: Highlight

Formatted: Highlight

Comment [jw1]: Set to the 70-yr average value used to calculate DEEP cancer risk in the Second Tier HIA Report

Formatted: Highlight

Formatted: Highlight

Comment [jw2]: Set equal to 1/3 * theoretical max year

Formatted: Highlight

Formatted: Highlight

Comment [jw3]: Set to 1/3* 99 tpy, to keep the maximum theoretical year < 100 tpy

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted Table

Table 2.1. Criteria Pollutants Potential to Emit for Phases 1 & 2 (TPY)			
Pollutant	**Main Generator Engines**	**Cooling Tower**	**Total Facility Emissions**
Carbon monoxide (CO)	15.6 4.7	0	15.6 4.7
Nitrogen oxides (NO_x)	8.6 27.0	0	8.6 27.0
Volatile organic compound (VOC)	8.0E-01 0.84	Negligible	0.84
Sulfur dioxide (SO_2)	4.7E-02 5.7E-02	0	4.7E-02 5.7E-02
Lead	Negligible	0	Negligible
[a] All PM emissions from the generator engines are $PM_{2.5}$, and all $PM_{2.5}$ from the generator engines is considered Diesel Engine Exhaust Particulate (DEEP).			

Table 2.2 Toxic Air Pollutants Potential To Emit for Phases 1&2 (TPY)			
Pollutant	**Main Generator Engines**	**Cooling Towers**	**Total Facility Emissions**
DEEP (a)	0.814	0	0.814
CO	7.3	0	7.3
SO2	0.069	0	0.069
Primary Nitrogen Dioxide (NO2) (b)	3.300	0	3.300
Benzene	3.47E-03	0	3.47E-03
Toluene	1.26E-03	0	1.26E-03
Xylenes	8.64E-04	0	8.64E-04
1,3-Butadiene	1.75E-04	0	1.75E-04
Formaldehyde	3.53E-04	0	3.53E-04
Acetaldehyde	1.13E-04	0	1.13E-04
Acrolein	3.53E-05	0	3.53E-05
Benzo(a)Pyrene	1.15E-06	0	1.15E-06
Benzo(a)anthracene	2.78E-06	0	2.78E-06
Chrysene	6.85E-06	0	6.85E-06
Benzo(b)fluoranthene	4.97E-06	0	4.97E-06
Benzo(k)fluoranthene	9.76E-07	0	9.76E-07
Dibenz(a,h)anthracene	1.55E-06	0	1.55E-06
Ideno(1,2,3-cd)pyrene	1.85E-06	0	1.85E-06
Napthalene	5.82E-04	0	5.82E-04
Propylene	1.25E-02	0	1.25E-02
Ammonia	1.14	0	1.14
Fluoride	0	4.80E-03	4.80E-03
Manganese	0	4.60E-04	4.60E-04

Formatted Table

Formatted: Highlight

Formatted Table

Formatted: Highlight

Comment [jw4]: Set to the 70-yr average value used in the DEEP HIA cancer risk analysis.

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Comment [jw5]: AP-42 TAPs calculated based on 1/3 * theoretical maximum year fuel usage

Formatted: Highlight (×20)

Copper	0	1.60E-04	1.60E-04
Chloroform	0	2.60E-04	2.60E-04
Bromodichloromethane	0	2.60E-04	2.60E-04
Bromoform	0	6.90E-03	6.90E-03

[a] DEEP is measured by EPA Method 5 (or 201a), which measures filterable (front-half) particulate emissions.

[b] NO_2 is assumed to be equal to 10 percent of the total NO_X emitted.

~~Table 2.2. Toxic Air Pollutants Potential To Emit for Phases 1 & 2 (TPY)~~			
~~Pollutant~~	~~Main Generator Engines~~	~~Cooling Tower~~	~~Total Facility Emissions~~
~~CO~~	~~15.6~~ 4.7	~~0~~	~~15.6~~ 4.7
~~Ammonia~~	~~0.71~~ 1.03	~~0~~	~~0.71~~ 1.03
~~DEEP[a]~~	~~5.36E-01~~ 0.73	~~0~~	~~5.36E-01~~ 0.73
~~SO_2~~	~~4.7E-02~~ 5.7E-02	~~0~~	~~4.7E-02~~ 5.7E-02
~~Primary nitrogen dioxide (NO_2)[b]~~	~~8.6E-01~~ 2.7	~~0~~	~~8.7E-01~~ 2.7
~~Benzene~~	~~2.4E-03~~ 2.9E-03	~~0~~	~~2.4E-03~~ 2.9E-03
~~Toluene~~	~~8.6E-04~~ 1.0E-03	~~0~~	~~8.6E-04~~ 1.0E-03
~~Xylenes~~	~~5.9E-04~~ 7.2E-04	~~0~~	~~5.9E-04~~ 7.2E-04
~~1,3 Butadiene~~	~~1.2E-04~~ 1.5E-04	~~0~~	~~1.2E-04~~ 1.5E-04
~~Formaldehyde~~	~~2.4E-04~~ 2.9E-04	~~0~~	~~2.4E-04~~ 2.9E-04
~~Acetaldehyde~~	~~7.7E-05~~ 9.4E-05	~~0~~	~~7.7E-05~~ 9.4E-05
~~Acrolein~~	~~2.4E-05~~ 2.9E-05	~~0~~	~~2.4E-05~~ 2.9E-05
~~Benzo(a)pyrene~~	~~7.9E-07~~ 9.5E-07	~~0~~	~~7.9E-07~~ 9.5E-07
~~Benzo(a)anthracene~~	~~1.9E-06~~ 2.3E-06	~~0~~	~~1.9E-06~~ 2.3E-06
~~Chrysene~~	~~4.7E-06~~ 5.7E-06	~~0~~	~~4.7E-06~~ 5.7E-06
~~Benzo(b)fluoranthene~~	~~3.4E-06~~ 4.1E-06	~~0~~	~~3.4E-06~~ 4.1E-06
~~Benzo(k)fluoranthene~~	~~6.7E-07~~ 8.1E-07	~~0~~	~~6.7E-07~~ 8.1E-07
~~Dibenz(a,h)anthracene~~	~~1.1E-06~~ 1.3E-06	~~0~~	~~1.1E-06~~ 1.3E-06
~~Ideno(1,2,3-cd)pyrene~~	~~1.3E-06~~ 1.5E-06	~~0~~	~~1.3E-06~~ 1.5E-06
~~Napthalene~~	~~4.0E-04~~ 4.8E-04	~~0~~	~~4.0E-04~~ 4.8E-04
~~Propylene~~	~~8.5E-03~~ 1.0E-02	~~0~~	~~8.5E-03~~ 1.0E-02

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Table 2.2. Toxic Air Pollutants Potential To Emit for Phases 1 & 2 (TPY)			
Pollutant	Main Generator Engines	Cooling Tower	Total Facility Emissions
Fluoride	0	4.8E-03	4.8E-03
Manganese	0	4.6E-04	4.6E-04
Copper	0	1.6E-04	1.6E-04
Chloroform	0	2.6E-04	2.6E-04
Bromodichloromethane	0	2.6E-04	2.6E-04
Bromoform	0	6.9E-03	6.9E-03
[(a)] DEEP is measured by EPA Method 5 (or 201a), which measures filterable (front-half) particulate emissions. [(b)] NO_2 is assumed to be equal to 10 percent of the total NO_x emitted.			

DETERMINATIONS

In relation to this project, the Washington State Department of Ecology (Ecology), pursuant to Revised Code of Washington (RCW) 70.94.152, Washington Administrative Code (WAC) 173-460-040, and WAC 173-400-110, makes the following determinations:

1. The project, if constructed and operated as herein required, will be in accordance with applicable rules and regulations, as set forth in Chapter 173-400 WAC, and Chapter 173-460 WAC, and the operation thereof, at the location proposed, will not emit pollutants in concentrations that will endanger public health.

2. The proposed project, if constructed and operated as herein required, will meet applicable air quality requirements as defined below:

Table 2a.1 BACT Determinations	
Pollutant(s)	BACT Determination
PM, CO, and VOCs	a. Use of EPA Tier 2 certified engines installed and operated as emergency engines, as defined in 40 CFR Section 60.4219. b. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII. c. Use of high-efficiency drift eliminators which achieve a liquid droplet drift rate of no more than 0.0005 percent of the recirculation flow rate within each cooling tower.
NO_X	a. Use of EPA Tier 2 certified engines installed and operated as emergency engines, as defined in 40 CFR Section 60.4219, and satisfy the written verification requirements of Approval Condition 2.5. b. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
SO_2	Use of ultra-low sulfur diesel fuel containing no more

Table 2a.1 BACT Determinations	
Pollutant(s)	**BACT Determination**
	than 15 parts per million by weight of sulfur.

3. The proposed project, if constructed and operated as herein required, will utilize Best Available Control Technology for toxic air pollutants (TAPs) (tBACT) as defined below:

Table 3.1 tBACT Determinations	
TAPs	**tBACT Determination**
Acetaldehyde, CO, acrolein, benzene, benzo(a)pyrene, 1,3-butadiene, DEEP, formaldehyde, toluene, total PAHs, xylenes, chrysene, benzo(a)anthracene, napthalene, benzo(b)fluoranthene, propylene, dibenz(a,h)anthracene, Ideno(1,2,3-cd)pyrene, fluoride, manganese, copper, chloroform, bromodichloromethane, bromoform,	Compliance with the VOC and PM BACT requirement.
Ammonia	No more than 15 parts per million volume-dry (ppmvd) at 15 percent oxygen per engine.
NO_2	Compliance with the NO_X BACT requirement.
SO_2	Compliance with the SO_2 BACT requirement.

4. In accordance with WAC 173-460-090, a second tier health risk analysis has been submitted by the applicant for DEEP and NO2 ambient impacts. emissions. Ecology has concluded that this project has satisfied all requirements of a second tier analysis [pending].

THEREFORE, IT IS ORDERED that the project as described in the NOC application and more specifically detailed in plans, specifications, and other information submitted to Ecology is approved for construction and operation, provided the following conditions are met:

APPROVAL CONDITIONS

1. ADMINISTRATIVE CONDITION

1.1. Notice of Construction Approval Order No. 14AQ-E537 is rescinded and replaced entirely with this Approval Order .

1.1.1.2. The emergency engine generators approved for operation by this Order are to be used solely for those purposes authorized for emergency generators under 40 CFR 60, Subpart IIII. This includes the hourly operation requirements described in 40 CFR 60.4211(f), except that there shall be no operation of this equipment to produce power for demand-response arrangements, peak shaving arrangements, nor to provide power as part of a financial arrangement with another entity, nor to supply power to the grid.

1.2.1.3. The Oxford Data Center shall coordinate engine maintenance and testing schedules with Dell and the Microsoft Columbia Data Center in Quincy to minimize overlap between data center scheduled testing. Microsoft shall maintain records of the coordination communications with the other data centers, and those communications shall be available for review by Ecology.

2. EQUIPMENT RESTRICTIONS

2.1. The thirty-two primary emergency generator 2.5 MWe engines, eight 2.5 MWe reserve generator engines, four 2.0 MWe engines, and the single 0.750 MWe engine shall be operated in accordance with applicable 40 CFR 60, Subpart IIII requirements including but not limited to: certification by the manufacturer to meet the 40 CFR 89 EPA Tier 2 emissions levels as required by 40 CFR 60.4202; and installed and operated as emergency engines, as defined in 40 CFR 60.4219. At the time of the effective date of this permit, Tier 4 interim and Tier 4 final certified engines (as specified in 40 CFR 1039.102 Table 7 and 40 CFR 1039.101 Table 1, respectively), are not required for 0.750 MWe, 2.0 MWe, and 2.5 MWe electrical generators used for emergency purposes as defined in 40 CFR 60.4219 in attainment areas in Washington State. However, any engines installed at the Oxford Data Center after Tier 4 or other limits are implemented by EPA for emergency generators, shall meet the applicable specifications as required by EPA at the time the emergency engines are installed.

2.2. Each engine must be equipped with selective catalytic reduction (SCR) and catalyzed diesel particulate filter (DPF) controls to meet the emission requirements of EPA Tier 4 engines. The only 0.750 MWe, 2.0 MWe, and 2.5 MWe engines and electrical generating units approved for operation at the Oxford Data Center are those listed in Tables 1.1–1.3 above.

2.3. Replacement of failed engines with identical engines (same manufacturer and model) requires notification prior to installation, but will not require NOC unless there is an emission rate increase from the replacement engines.

2.4. The thirty-two 2.5 MWe engine-generator and eight 2.5 MWe reserve generator exhaust stack dimensions shall be greater than or equal to 40~~46~~ feet above ground level, no more than 22~~18~~ inches in diameter, and approximately 12~~16~~ feet above roof height. The four 2.0 MWe engine-generator exhaust stack heights shall be greater than or equal to 40~~46~~ feet above ground level, no more than 22~~16~~ inches in diameter, and approximately 19~~16~~ feet above roof height. The one 0.750 MWe engine-generator exhaust stack height shall be greater than or equal to 35~~46~~ feet above ground level, no more than 14 inches in diameter, and approximately 12~~16~~ feet above roof height.

2.5. In addition to meeting EPA Tier 2 certification requirements, the source must have written verification from the engine manufacturer that each engine of the same make, model, and rated capacity installed at the facility uses the same electronic Programmable System Parameters, i.e., configuration parameters, in the electronic engine control unit.

3. OPERATING LIMITATIONS

3.1. Fuel consumption at the Oxford Data Center facility shall be limited to a total of 615,000 431,000 gallons per year and 148,000 119,300 gallons per day of diesel fuel equivalent to on-road specification No. 2 distillate fuel oil (less than 0.00150 weight percent sulfur). Total facility annual fuel consumption may be averaged over a three (3) year period using monthly rolling totals.

Comment [jw6]: Set to 1/3 * Theoretical Max Year

3.2. Except as provided in Approval Condition 3.3, the The thirty-seven (37) Project Oxford Data Center primary emergency engines and eight reserve engines shall not operate more than the following load specific limits:

3.2.1. Operational rpm with no load (referred to as idle): for weekly testing, corrective engine maintenance, and generator cool down, each Each generator shall not exceed 29 86 hours per year of operation averaged across all generators in service over a 36-month rolling monthly 3-year average. If a reserve generator is used to temporarily replace a primary generator during a power outage, then the actual runtime for the reserve generator at an electrical load exceeding zero load (idle) shall be deducted from the primary generator's allowable runtime.

3.2.2. Each reserve generator shall not exceed 40 hours per year for purposes other than power outages, averaged across all reserve generators in service over a 36-month rolling period.

3.2.3. For commissioning events, each engine shall not exceed a one-time total of 50 hours of operation over a full range of loads, averaged over all facility engines commissioned in that year.

3.2.4. For stack testing, no more than one engine shall be tested per year, every three years, with each engine operating no more than 45 hours per testing event. Each testing event shall be conducted according to the testing requirements in Approval Condition 4. If more than 45 hours are needed for re-testing to satisfy Approval Condition 4.4, those hours should be deducted from other preapproved hours in Approval Condition 3.2. Additional operation of the engines for the purpose of emissions testing beyond the operating time and fuel consumption limits authorized by this Order will be considered by Ecology upon request in writing.

Comment [jw7]: Microsoft requests no changes to Condition 3.2.4.

3.2.5. Daily generator usage shall not exceed a maximum limit of 160 generator hours per calendar day, except during up to four days per year of emergency power outage.

No more than three 2.5 MWe generators shall operate simultaneously during any given hour at a load exceeding 85 percent.

3.2.1. Approximately eighty percent load: for emergency power outages, load bank testing, corrective engine testing, electrical bypass for switchgear, transformer, or substation operations, and non-emergency situations authorized by 40 CFR 60.4211(f), the following conditions apply:

3.2.2.1 Each generator shall not exceed 40 hours per year of operation averaged across all generators in service over a rolling monthly 3-year average.

3.2.2.2 Daily generator usage shall not exceed a maximum limit of 192 MWe hours per calendar day, except during up to four days per year of emergency power outage.

3.2.2.3 Maximum hourly generator usage shall be limited to no more than four 2.5 MWe generators operating simultaneously during any given hour except during emergency power outages.

3.2.2. One hundred percent load: for monthly load bank testing, semiannual load bank testing, and as needed generator corrective maintenance, each generator shall not exceed 17.5 hours per year of operation averaged across all generators in service over a rolling monthly 3-year average, with no more than three 2.5 MWe generators operating simultaneously during any given hour.

3.3. The Oxford Data Center engines shall not exceed the following operating limits during commissioning and stack testing:

3.3.1. For commissioning events, each generator shall not exceed a one-time total of 50 hours of operation over a full range of loads, averaged over all facility generators commissioned in that year.

3.3.2. For stack testing, no more than two generators shall be tested per year, every three years, with each generator operating no more than 30 hours per testing event averaged over all generators tested in that year, and each testing event shall be conducted according to the testing requirements in Approval Condition 4. If more than 30 hours per year of stack testing are needed for re-testing to satisfy Approval Condition 4.4, those hours should be combined with any of the pre-approved hours in Approval Condition 3.2. Additional operation of the engines for the purpose of emissions testing beyond the operating hour and fuel consumptions limits authorized by this Order will be considered by Ecology upon request in writing.

3.4.3.3. All of the 32 Phase 1 and 2 cooling towers shall comply with the following conditions:

3.4.1.3.3.1. Each individual cooling tower unit shall use a mist eliminator that meets the BACT determination for PM of Section 2(c) of this Order.

3.4.2.3.3.2. Chemicals containing hexavalent chromium cannot be used to pre-treat the cooling tower makeup water.

4. GENERAL TESTING AND MAINTENANCE REQUIREMENTS

4.1. The Oxford Data Center will follow engine-manufacturer's recommended diagnostic testing and maintenance procedures to ensure that each of the thirty-two (32) 2.5 MWe primary emergency generator engines, eight (8) reserve emergency generator engines, four (4) 2.0 MWe engines, and one (1) 0.750 MWe engines will conform to applicable engine specifications in Approval Condition 2.1 and applicable emission specifications in Approval Condition 5 throughout the life of each engine.

4.2. Any emission testing performed to verify conditions of this Approval Order or for submittal to Ecology in support of this facility's operations, requires that Microsoft comply with all requirements in 40 CFR 60.8 except subsection (g). 40 CFR 60.8(g) may be required by Ecology at their discretion. A test plan will be submitted to Ecology at least 30 days prior to testing that will include a testing protocol for Ecology approval that includes the following information:

4.2.1. The location and Unit ID of the equipment proposed to be tested.
4.2.2. The operating parameters to be monitored during the test.
4.2.3. A description of the source including manufacturer, model number, design capacity of the equipment and the location of the sample ports or test locations.
4.2.4. Time and date of the test and identification and qualifications of the personnel involved.
4.2.5. A description of the test methods or procedures to be used.

4.3. The Oxford Data Center shall source test engines as described in Approval Order 4.4 to show compliance with emission limits in Table 4.

4.4. The following testing requirements are for ammonia, PM, NO_X, CO, and non-methane hydro-carbons (NMHC). The test methods in Table 4 shall be used for each test event unless an alternate method is proposed by Microsoft and approved in writing by Ecology prior to the test. Except for ammonia testing, which requires only a single-load test, each pollutant in Table 4 shall be tested at two load testing approaches (five-load weighted and single load). A single testing event is defined as completion of all tests in Table 4 per engine, and each test shall be performed on different engines from those tested previously, until each engine at the data center has been tested except as provided in subsection 4.4.4. In the event that any source test shows non-compliance with any applicable Table 4 emission standards for the engines specified in Approval Condition 2.1, Microsoft shall repair or replace the engine and repeat the test on the same engine plus two additional engines from the same phase of the Oxford Data Center. Test reports shall be submitted to Ecology as provided in Condition 9.5 of this Order.

Table 4. Testing Requirements

Pollutant	Load Test	Test Method	Emission Limits	Compliance Test Frequency
PM	Five-load weighted avg.	EPA Method 5 or 201a; or alternative method from 40 CFR Part 1065.	0.03 g/kW-hr	Test two differentone engines at both load tests within 12 months of engine startup. Test two differentone untested engines every 3 years.
	Single Load Single50% load (± 2%78%-82%)	EPA Method 5 or 201a, and EPA Method 202, or alternative	0.115 lb/hr at 25% load (0.75 MWe)	
			0.21 32 lb/hr at 50% load (2.0 MWe)	
			0.288 34 lb/hr at 50%	

Comment [jw8]: I recommend we insert text into this table to explicitly allow us to use the Method 1065 dilution probe instead of Part 60 methods.
Formatted: Highlight
Formatted: Highlight
Comment [jw9]: In Table 4, the single load tests all cite the emission rate and maximum load for each pollutant.
Formatted: Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Font: 10 pt, Highlight

		method from 40 CFR Part 1065.	load (2.5 MWe)	
NO_X	Five-load weighted avg.	EPA Method 7E, or alternative method from 40 CFR Part 1065.	0.67 g/kW-hr	Test one engine at both load tests within 12 months of engine startup. Test one untested engine every 3 years.Test two different engines at both load tests within 12 months of engine startup. Test two different untested engines every 3 years.
	Single100%-load (78%-82%within 2%)	EPA Method 7E, or alternative method from 40 CFR Part 1065.	1.8 33 lb/hr (0.75 MWe) 2.64.04 lb/hr (2.0 MWe) 3.379.11 lb/hr (2.5 MWe)	
CO	Five-load weighted avg.	EPA Method 10, or alternative method from EPA Part 1065.	3.5 g/kW-hr	Test one engine at both load tests within 12 months of engine startup. Test one untested engine every 3 years.Test two different engines at both load tests within 12 months of engine startup. Test two different untested engines every 3 years.
	Single Load 100% load (within 2%)Single-load (78%-82%)	EPA Method 10, or alternative method from 40 CFR Part 1065.	0.75 28 0.36 lb/hr at 75% load (0.75 MWe) 10.1 0.83 0.94 lb/hr at 25% load (2.0 MWe) 15.041.44 lb/hr at 100% load (2.5 MWe)	
NMHC/ VOC	Five-load weighted avg.	EPA Method 25A and EPA Method 18, or alternative method from 40 CFR Part 1065.	0.19 g/kW-hr	Test one engine at both load tests within 12 months of engine startup. Test one untested engine every 3 years.Test two different engines at both load tests within 12 months of engine startup. Test two different untested engines every 3 years.
	Single Load Single50%-load (± 2%78%-82%)	EPA Method 25A and Method 18, or alternative method from 40 CFR Part 1065.	0.1 05 0.07 lb/hr at 25% load (0.75 MWe) 0.8 27 lb/hr at 50% load (2.0 MW e) 0.8 29 lb/hr at 50% load (2.5 MWe)	
Ammonia	Single75%-load (± 2%78%-82%)	BAAQMD Method ST-1B or EPA Method 320 or EPA CTM-027; or alternative method suitable for use with dilution probe method from 40 CFR Part	0.19 lb/hr (0.75 MWe) 0.51 48 lb/hr (2.0 MWe) 0.64 61 lb/hr (2.0 5 MWe)	Test one engine within 12 months of engine startup. Test one untested engine every 3 years.Test two different engines within 12 months of engine startup. Test two different untested engines every 3 years.

Formatted: Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Highlight
Formatted: Font: 10 pt, Highlight
Formatted: Highlight
Formatted: Font: 10 pt, Highlight

		1065.		

4.4.1. For the five load tests, testing shall be performed at each of the five engine torque load levels described in Table 2 of Appendix B to Subpart E of 40 CFR Part 89, and data shall be reduced to a single-weighted average value using the weighting factors specified in Table 2. Each test run shall be done within 2 percent of the target load value (e.g., the test runs for the nominal 10 percent load condition shall be done at loads from 8 to 12 percent). Microsoft may replace the dynamometer requirement in Subpart E of 40 CFR Part 89 with corresponding measurement of gen-set electrical output to derive horsepower output.

4.4.2. For all tests, Tthe F-factor described in Method 19 shall be used to calculate exhaust flow rate through the exhaust stack, except that EPA Method 2 shall be used to calculate the flow rate for purposes of particulate testing. The fuel meter data, as measured according to Approval Condition 4.5, shall be included in the test report, along with the emissions calculations.

4.4.3. Three test runs shall be conducted for each engine, except as allowed by the alternative 40 CFR Part 1065 sampling protocol. Each run must last at least 60 minutes, except as allowed by the alternative 40 CFR Part 1065 sampling protocol.. Analyzer data shall be recorded at least once every minute during the test. Engine run time and horsepower output and fuel usage shall be recorded during each test run for each load and shall be included in the test report. In lieu of these requirements, Microsoft may propose an alternative test protocol to Ecology in writing for approval.

4.4.4. The one (1) 0.750 MWe engine shall be stack tested according to Table 4. If the first two (2) 2.0 MWe engines tested are found to have consistent test results and are in compliance with all applicable Table 4 emission load tests, Microsoft may request approval from Ecology to discontinue compliance testing for the other two (2) 2.0 MWe engines. If the first five six (56) 2.5 MWe engines tested are found to have consistent test results and are in compliance with all applicable Table 4 emission load tests, Microsoft may request approval from Ecology to discontinue compliance testing for the other twenty-seven six (2726) 2.5 MWe engines.

4.5. Each engine shall be equipped with a properly installed and maintained non-resettable meter that records total operating hours.

4.6. Each engine shall be connected to a properly installed and maintained fuel flow monitoring system (either physical or generator manufacturer provided software) that records the amount of fuel consumed by the engine during each operation.

5. EMISSION LIMITS

Formatted: Highlight

Comment [jw10]: If we use the Part 1065 dilution probe we don't have to do three test runs at each load.

Formatted: Highlight

Comment [jw11]: If we use the Part 1065 dilution probe we don't have to do three 60-minute test runs at each load.

Formatted: Not Highlight

The thirty-two (32) primary 2.5 MWe engine-generators, the eight (8) reserve generator engines, the four (4) 2.0 MWe engine-generators, and the one (1) 0.750 MWe engine-generator shall meet the follow emission rate limitations:

5.1. Each emergency engine shall not exceed the applicable emission limits in Table 4.

5.2. Total annual facility-wide emissions shall not exceed the ~~following~~36-month rolling average emission estimates for~~:~~ ~~13.3 tons per year (tpy) of~~ PM10, ~~; 3.53 tpy of~~ PM2.5,~~; 15.6 tpy of~~ CO, ~~; 8.6 tpy of~~ NOx, ~~; 0.8 tpy of~~ VOC,~~; 0.047 tpy of~~ SO2,~~; 0.536 tpy of~~ DEEP,~~; 0.86 tpy of~~ NO2,~~;~~ and ~~0.71 tpy of~~ ammonia as listed in Tables 2.1 and 2.2.

5.3. Visual emissions from each diesel ~~electric generator~~ engine exhaust stack shall be no more than five percent, with the exception of a ten (10) minute period after unit start-up. Visual emissions shall be measured by using the procedures contained in 40 CFR 60, Appendix A, Method 9.

5.4. Ammonia ~~concentrations~~ emission rates shall comply with the emission limits in Table 4.

~~5.4.~~5.5. The actual 1-hour aggregate NOx emissions from all engines operating in any hour shall not exceed 575 lbs. Actual NOx emissions shall be based on algebraic equations of load-specific NOx emission factors derived from either the manufacturer's published data, or from the results of on-site stack emission testing as actual stack test data become available.

Comment [jw12]: The NO2-HIA was done for a facility-wide NOx emission rate of 575 lbs/hr during a power outage, with all primary gens running at 100% and all 8 reserve gens running at 10% for 30 minutes.

6. OPERATION AND MAINTENANCE MANUALS

A site-specific O&M manual for the Oxford Data Center facility equipment shall be developed and followed. Manufacturer's operating instructions and design specifications for the engines, generators, cooling towers, and associated equipment shall be included in the manual. The manual shall include the manufacturer's recommended procedures for low-load generator operation. The O&M manual shall be updated to reflect any modifications of the equipment or its operating procedures. Emissions that result from failure to follow the operating procedures contained in the O&M manual or manufacturer's operating instructions may be considered proof that the equipment was not properly installed, operated, and/or maintained. The O&M manual for the diesel engines, cooling towers, and associated equipment shall at a minimum include:

6.1. Manufacturer's testing and maintenance procedures that will ensure that each individual engine will conform to the EPA ~~Tiered~~ Emission Standards appropriate for that engine throughout the life of the engine.

6.2. Normal engine operating parameters and design specifications.

6.3. Operating maintenance schedule for engines and cooling towers.

6.4. Specification sheet for cooling towers verifying 0.0005 percent drift rating, water flow, air flow, makeup water rate, and a list of chemicals used to pre-treat cooling tower makeup water.

7. SUBMITTALS

All notifications, reports, and other submittals shall be sent to:

Washington State Department of Ecology
Air Quality Program
4601 N. Monroe Street
Spokane, WA 99205-1295

8. RECORDKEEPING

All records, O&M manual, and procedures developed under this Order shall be organized in a readily accessible manner and cover a minimum of the most recent 60-month period. The following records are required to be collected and maintained.

8.1. Fuel receipts with amount of diesel and sulfur content for each delivery to the facility.

8.2. Annual hours of operation for each diesel engine.

8.3. Annual number of start-ups for each diesel engine.

8.4. Annual gross power generated by facility-wide operation of the emergency backup electrical generators.

8.5. Record of each operational period for each engine with the following information:

8.5.1 Date of engine operation,
8.5.2 engine unit ID,
8.5.3 reason for operating: an operational period for an engine will be identified as one of the following reasons for operating: EMERGENCY SITUATIONS, STACK TESTING, COMMISSIONING, MAINTENANCE CHECKS, READINESS TESTING, DEVIATION OF VOLTAGE OR FREQUENCY, or UNSPECIFIED NON-EMERGENCY SITUATIONS.
8.5.4 duration of operation, and
8.5.5 the percent of generator electrical load.
8.5.58.5.6 For each unplanned power outage that activates 30 or more generators in an hour, record the actual 1-hour NOx emission rate from all operating engines.

8.6 Upset condition log for each facility permitted emission unit (the 45 37 engines and 32 cooling towers) and their respective control units that include unit ID, date, time, duration of upset, cause, and corrective action.

Comment [jw13]: This recordkeeping threshold is designed to ease the burden of calculating and recording the emissions from power outages that do not activate enough generators to threaten the NO2-ASIL.

During a full power outage, the 45 combined generators cause a maximum NO2 concentration of 605 ug/m3,compared to the ASIL of 470 ug/m3. Therefore, it is unlikely that fewer than 30 generators would ever cause an ASIL exceedance:

45 gens x (470/605) = 35 gen threshold.

Round it down to a recordkeeping threshold of 30 generators.

8.7 Applicable recordkeeping for emergency engines required by 40 CFR Part 60, Subpart IIII Section 60.4214 (b), (c), and (d).

8.8 Air quality complaints received from the public or other entity, and the affected emissions units.

9 REPORTING

9.1 The serial number of the engine and the generator, and the engine build date will be submitted prior to installation of each engine.

9.2 The following information will be submitted to the AQP at the address in Condition 7 above by January 31 of each calendar year.

- 9.2.1 Monthly rolling annual total summary of air contaminant emissions,
- 9.2.2 Monthly rolling facility-wide generator hours of operation with annual total.
- 9.2.3 Monthly rolling gross power generation with annual total.
- 9.2.4 Monthly rolling annual total summary of fuel usage (in gallons).
- 9.2.5 Calendar year annual total runtime hours ~~for each range of generator electrical load~~.
- ~~9.2.5~~9.2.6 For each power outage operating scenario described in Condition 8.5.6, the aggregate NOx emission rate for all operating engines during each hour in which the NOx emission rate exceeds 575 lbs/hour.

9.3 Written notification that the O&M manual described in Approval Condition 6 has been developed and updated within 60 days after the issuance of this Order. A copy of the most current O&M manual will be provided to Ecology if requested.

9.4 Any air quality complaints resulting from operation of the emissions units or activities shall be promptly assessed and addressed. A record shall be maintained of Microsoft Corporation's action to investigate the validity of the complaint and what, if any, corrective action was taken in response to the complaint. Ecology shall be notified within three (3) days of receipt of any such complaint.

9.5 ~~Results of any stack testing performed~~Stack test reports of any engine shall be submitted to Ecology within 45 days of completion of the test and shall include, at a minimum, the following information:

- 9.5.1 The information from Conditions 4.2.3, 4.2.4, and 4.2.5 including field and analytical laboratory data, quality assurance/quality control procedures and documentation.
- 9.5.2 A summary of results, reported in units and averaging periods consistent with the applicable emission standard or limit.
- 9.5.3 A summary of control system or equipment operating conditions.

9.5.4 A summary of operating parameters for the diesel engines being tested.
9.5.5 Copies of field data and example calculations.
9.5.6 Chain of custody information.
9.5.7 Calibration documentation
9.5.8 Discussion of any abnormalities associated with the results.
9.5.9 A statement signed by the senior management official of the testing firm certifying the validity of the source test report.

9.6 ~~If Microsoft operates or contracts to operate any emergency diesel engine at the data center in non-emergency situations authorized by 40 CFR 60.4211(f),~~ Microsoft shall ~~submit the~~ follow the annual report requirementsd of ~~by~~ 40 CFR 60.4214(d).

10 GENERAL CONDITIONS

10.1 **Commencing/Discontinuing Construction and/or Operations:** This Approval Order shall become void if construction of Phase 1 is not commenced within eighteen (18) months following the date of this Approval Order, or if Phase 2 is not commenced within eighteen (18) months following completion of commissioning of the final engine in Phase 1. No additional engines shall be installed, if construction of both phases is discontinued for a period of eighteen (18) months, or if operation of backup emergency diesel electric generators are ~~is~~ discontinued at the facility for a period of eighteen (18) months, unless prior written notification is received by Ecology at the address in Condition 7 above.

10.2 **Compliance Assurance Access:** Access to the source by representatives of Ecology or the EPA shall be permitted upon request. Failure to allow such access is grounds for enforcement action under the federal Clean Air Act or the Washington State Clean Air Act, and may result in revocation of this Approval Order.

10.3 **Availability of Order and O&M Manual:** Legible copies of this Order and the O&M manual shall be available to employees in direct operation of the emergency diesel electric generators, and cooling towers, and be available for review upon request by Ecology.

10.4 **Equipment Operation:** Operation of the generator units, cooling towers, and related equipment shall be conducted in compliance with all data and specifications submitted as part of the NOC application and in accordance with the O&M manual, unless otherwise approved in writing by Ecology.

10.5 **Modifications:** Any modification to the generators, engines, or cooling towers and their related equipment's operating or maintenance procedures, contrary to information in the NOC application, shall be reported to Ecology at least 60 days before such modification. Such modification may require a new or amended NOC Approval Order.

10.6 **Activities Inconsistent with the NOC Application and this Approval Order:** Any activity undertaken by the permittee or others, in a manner that is inconsistent with the NOC application and this Order, shall be subject to Ecology enforcement under applicable regulations.

10.7 **Obligations under Other Laws or Regulations:** Nothing in this Approval Order shall be construed to relieve the permittee of its obligations under any local, state, or federal laws or regulations.

All plans, specifications, and other information submitted to Ecology relative to this project and further documents and any authorizations or approvals or denials in relation thereto shall be kept at the Eastern Regional Office of the Department of Ecology in the "Air Quality Controlled Sources" files, and by such action shall be incorporated herein and made a part thereof.

Authorization may be modified, suspended, or revoked in whole or part for cause including, but not limited to the following:

1. Violation of any terms or conditions of this authorization;
2. Obtaining this authorization by misrepresentation or failure to disclose fully all relevant fact.

The provisions of this authorization are severable and, if any provision of this authorization, or application of any provisions of their circumstances, and the remainder of this authorization, shall not be affected thereby.

YOUR RIGHT TO APPEAL

You have a right to appeal this Approval Order to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of this Approval Order. The appeal process is governed by Chapter 43.21B RCW and Chapter 371-08 WAC. “Date of receipt” is defined in RCW 43.21B.001(2).

To appeal you must do the following within 30 days of the date of receipt of this Approval Order:

- File your appeal and a copy of this Approval Order with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.
- Serve a copy of your appeal and this Approval Order on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in Chapter 43.21B RCW and Chapter 371-08 WAC.

ADDRESS AND LOCATION INFORMATION

Street Addresses	Mailing Addresses

Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive SE Lacey, WA 98503 **Pollution Control Hearings Board** 1111 Israel Road SW, Suite 301 Tumwater, WA 98501	**Department of Ecology** Attn: Appeals Processing Desk P.O. Box 47608 Olympia, WA 98504-7608 **Pollution Control Hearings Board** P.O. Box 40903 Olympia, WA 98504-0903

For additional information visit the Environmental Hearings Office Website: http://www.eho.wa.gov

To find laws and agency rules visit the Washington State Legislature Website: http://www1.leg.wa.gov/CodeReviser

DATED this ~~15th~~ xxth day of ~~August~~ xxx ~~2014~~ 2016 , at Spokane, Washington.

Formatted: Highlight

Formatted: Highlight

Reviewed By:

Gary J. Huitsing, P.E.
Science and Engineering Section
Air Quality Program
Department of Ecology
State of Washington

Approved By:

Karen K. Wood, Section Manager
Regional Air Quality Section
Eastern Regional Office
Department of Ecology
State of Washington

APPENDIX B

April 2016 Emission Calculations and Ambient Impact Assessment

Appendix B (April 2016)
Revised Emission Calculations and Ambient Impact Assessment
Revision to August 2014 Approval Order
Microsoft Oxford Data Center
Quincy, Washington

This appendix presents the revised generator runtime scenarios, revised emission calculations, and revised AERMOD[1] ambient air quality dispersion modeling to support Microsoft's requested revisions to the August 2014 Approval Order for the Microsoft Oxford Data Center in Quincy, Washington. This revised air quality assessment addresses the following changes:

- **As-Built Stack Parameters**. Revise the allowable stack heights and diameters listed in Condition 2.4 of the Approval Order to match the actual as-built values. This revised modeling assessment also uses "as-built" stack temperatures and flow rates specified by Caterpillar equipment specifications.
- **New Reserve Generators**. The 37 currently permitted generators, which will carry server load during unplanned outages, have been redesignated as "primary emergency generators." For this permit revision, we have added eight new 2.5 megawatt (MW) "reserve generators," which will serve as secondary backup units to the primary emergency generators. The reserve generators are designed to temporarily activate at zero electrical load (idle speed) during an unplanned outage. The locations for the eight new reserve generators are shown in the revised version of the Site Plan (see attached Figure 1). The reserve generators will be designed to be identical to the 2.5-MW primary generators (they will be in individual weather enclosures, they will be equipped with the same add-on emission controls, and they will have the same stack heights). As shown on Figure 1, the new reserve generators will be located inside the spatial footprint of the clusters of primary generators. A reserve generator would automatically replace one of the primary generators if the primary generator encountered problems during startup. Otherwise, all reserve generators are designed to continue running at idle load then shut down within 30 minutes after the start of the unplanned outage. All reserve generators will be subject to the same scheduled runtime for testing and maintenance as the primary generators. The emissions from the reserve generators were calculated by assuming that they will always operate at the worst-case electrical load for each pollutant.
- **Expand Range of Allowable Generator Loads**. Revise the Approval Order to allow all of the primary emergency generators to operate at loads from zero load (idle) up to 100 percent during all runtime including unplanned outages, electrical bypass, or scheduled testing and maintenance.

Load-Specific Emission Factors from Caterpillar

This revised ambient modeling analysis uses "as-built" load-specific emission data for Caterpillar generators, which are provided instead of the previous emission rates from the June-2014 permit application, which were based on the maximum of the data received from any of Microsoft's generator bidders (Caterpillar, Cummins, or MTU). The "as-built" Caterpillar data provide estimates of load-specific emission rates for total particulate matter (PM; combined front-half plus back-half).

[1] American Meteorological Society (AMS)/US Environmental Protection Agency (EPA) regulatory model.

Although Caterpillar has provided a vendor guarantee for the warmed-up controlled five-load weighted average emission rates, Caterpillar does not guarantee its individual-load controlled estimated emission rates. Therefore, because the individual-load emission rates are subject to stack emission testing, a safety factor of 1.20 has been applied to all of Caterpillar's estimates of the individual-load controlled emission rates. The allowable emission rates specified by the Approval Order, and the emission rates input to the air quality dispersion models, use this 1.20 safety factor. Note, the 1.2 safety factor was not applied to Caterpillar's estimates for the Potential Site Variation uncontrolled (Tier 2-certified) emission rates, and the 1.2 safety factor was not added to the five-load weighted average emissions.

The adjusted per-generator hourly emission estimates, specified at discrete generator loads of 10, 25, 50, 75, and 100 percent, and including adjustments for cold-start factors and Caterpillar's suggested 1.20 safety factor, are provided in Tables C-1, C-2, and C-3 of Attachment B-2. For these revised emission calculations, Caterpillar's 1.20 safety factor was applied to each pollutant for the controlled, warmed-up emission rates. Caterpillar's recommended 1.20 safety factor was not applied to the cold-start emission rates because the cold-start rates are derived from US Environmental Protection Agency (EPA) Tier 2 engine emission data that have been confirmed by historical emission testing data at other data centers. However, the listed cold-start emission factors include the "black-puff" adjustment factors that were used in Microsoft's original permit application (1.26 for PM and volatile organic compounds [VOCs], and 1.56 for carbon monoxide [CO]).

Table 1 provides a summary of the revised load-specific emission rate forecasts, for both the "cold-start" engine conditions and the fully warmed-up conditions. The highlighted cells in Table 1 indicate the worst-case assumed load values that were used for the revised emission calculations and ambient impact modeling.

Revised Generator Runtime Limits and Operating Scenarios

Microsoft requests that each of the 37 primary emergency generators be allowed to operate for up to 86 hours per year, at any load from idle (represented by 10 percent electrical load) up to 100 percent, and for any purpose, with no annual runtime restrictions at any intermediate loads. The eight new reserve generators should be allowed to run for 40 hours per year for scheduled testing and maintenance. The proposed new reserve generators would not increase the facility-wide runtime during power outages. Instead, according to Microsoft's proposed revision to Condition 3.2.1, the actual runtime for each reserve generator during a power outage must be deducted from the permitted runtime for the primary emergency generators.

However, for this permit revision application Microsoft requests a flexible new plant-wide emission limit: *"Facility-wide nitrogen oxide (NO_x) emissions from all engines combined shall not exceed 575 lbs/hr."* The plant-wide emission limit of 575 lbs/hour was calculated for a facility-wide power outage by assuming all 37 primary generators operate for 1 hour after a cold start at 100 percent load, while the eight reserve generators run at 10 percent load following a cold start.

The operating scenarios used to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) and the acceptable source impact levels (ASILs) are as follows:

- To calculate the facility-wide annual emissions of PM, diesel engine exhaust particulate matter (DEEP) and VOCs, every generator is assumed to operate for 86 hours per year at an exclusive electrical load of 10 percent, which is the load at which the load-specific emission rates are highest (see Attachment B-2, Table B-2-1A). That same short-term emission rate was assumed for unplanned outages and electrical bypass. Cold-start emissions were calculated by assuming every cold-start period at low load (with a low stack temperature and long warm-up period) lasts for 15 minutes. Each of the 37 primary generators is assumed to operate for 86 hours per year at an exclusive electrical load of 10 percent, which is the load at which the load-specific DEEP emission rates are highest. Each of the eight new reserve generators is assumed to operate for a shorter duration (40 hours per year), because the reserve generators are not designed to operate more than 30 minutes during an outage, and they will not operate during electrical bypass activities.
- To model compliance with the 24-hour PM_{10}[2] NAAQS, it was assumed the 37 primary generators operate for 24 hours at 10 percent load following a cold-start power outage, while the 8 reserve generators operate for 30 minutes at 10 percent load. The emission calculations include adjustments for cold-start conditions.
- To model compliance with the 24-hour $PM_{2.5}$[3] NAAQS, the four generators closest to the northeast facility boundary are assumed to operate for 24 hours during electrical bypass maintenance, each at an exclusive electrical load of 10 percent (see Attachment B-2, Table B-2-2B). No reserve generators will be used during electrical bypass activity. The emission calculations include adjustments for cold-start conditions.
- To calculate the facility-wide annual emissions of nitrogen oxides (NO_x) and carbon monoxide (CO), every generator is assumed to operate for 86 hours per year at an exclusive electrical load of 100 percent, which is the load at which the load-specific emission rates are highest (see Attachment B-2, Table B-2-1). That same short-term emission rate was assumed for unplanned outages and electrical bypass. Cold-start emissions were calculated by assuming that every cold-start period for 100 percent load (with a high stack temperature and short warm-up period) lasts for 10 minutes.
- To model compliance with the 1-hour nitrogen dioxide (NO_2) NAAQS, a stochastic analysis was used to consider 1-hour emissions during up to 4 days per year of 1-hour power outages, plus up to 16 days per year of electrical bypass maintenance. The emission calculations include adjustments for cold-start conditions. During each power outage the 37 primary generators will operate at 100 percent load for 1 hour following a cold start, while the 8 new reserve generators would operate for 30 minutes at 10 percent load. It was assumed that four generators (one generator in each of four AZ buildings) will operate simultaneously during electrical bypass maintenance, which is the same scenario evaluated in the original June 2014 application (see Attachment B-2, Table B-2-2E). All four generators are assumed to operate at 100 percent load. No reserve generators will be used during electrical bypass activity. The Washington State Department of Ecology's (Ecology's) stochastic Monte Carlo statistical package was used to evaluate the 8th-highest daily 1-hour NO_2 impacts.

[2] Particulate matter with an aerodynamic diameter less than or equal to 10 microns.
[3] Particulate matter with an aerodynamic diameter less than or equal to 2.5 microns.

- To model compliance with the NO_2 ASIL, all 37 primary generators are assumed to operate simultaneously for 1 hour at 100 percent load during a power outage, while the eight reserve generators operate at 10 percent load for 30 minutes (see Attachment B-2, Table B-2-2D). The facility-wide NO_x emission rate for that scenario is 575 lbs/hour, which is the basis for the requested new emission limit in Condition5.5 of the Approval Order.

Revised Emission Calculations

Screenshots of the revised emission calculation spreadsheets used to calculate the revised emission rates are provided in Attachment B-2. Detailed calculations for the annual-average emission rates are provided in Attachment B-2, Table B-2-1. Detailed emission rates for the operational scenarios corresponding to each NAAQS ambient standard are calculated in Attachment B-2, Table B-2-2.

Table 2 lists the revised facility-wide annual-average potential-to-emit emission rates including both the diesel generators and cooling towers (note that Microsoft has requested no changes to the current permit limits for the cooling towers). In some cases, Microsoft's request for operating flexibility results in an increase in the facility-wide emission rate. However, as described in the next section, in no cases do the increases in calculated emission rates cause the modeled ambient impacts to exceed any NAAQS standard. Microsoft's requested revisions cause the modeled ambient NO_2 concentration to exceed the ASIL, which requires Microsoft to submit a second-tier health impact assessment for NO_2.

Table 3 lists the revised emission calculations for each toxic air pollutant (TAP), and compares the TAP emission rates to the respective small-quantity emission rate (SQER) emission thresholds that require ambient air quality analysis.

Revised Theoretical Maximum Annual Emission Rates

As requested by Ecology, the calculated theoretical-maximum annual fuel usage and emission rates were revised upward compared to the estimates in the January 2016 submittal. The revised emission calculations are provided in Tables B2-1A, B2-1B,and B2-1C in Attachment B-2. The theoretical maximum annual generator usage includes the following activity:

- All primary emergency generators operating for 256 hours in the single worst-case year (three times the permitted 3-year rolling value of 86 hours per year).
- All reserve emergency generators operating for 120 hours for scheduled testing in the single worst-case year (three times the permitted 3-year rolling value of 40 hours per year).
- Commissioning of 18 generators in the single worst-case year.
- Conducting four stack emission test in the single worst-case year.

Updated Best Available Control Technology (BACT) Assessment

Ecology requested the BACT and toxics BACT (tBACT) cost-effectivenes analysis presented in the 2014 application be revised to reflect the increased number of generators and the increased emission rates caused by the requested permit revisions. Revised cost-effectiveness calculations are presented in

Attachment B-3. As with the 2014 analysis, the BACT evaluation considered the cost effectiveness for these emission control devices:

- "Tier 4F-capable" package proposed by Microsoft and required by the current Approval Order, including a catalyzed diesel particulate filter (DPF) and selective catalytic reduction (SCR) for NO_x removal
- Catalyzed DPF by itself
- SCR by itself
- Diesel oxidation catalyst (DOC) by itself

For this revised analysis, the following factors were changed:

- The increased facility-wide capital cost resulting from adding emission controls to the eight new reserve generators was calculated.
- The facility-wide uncontrolled emission rates were increased to match the new 70-year average annual values.
- The annual-average removal efficiencies for DPF by itself, SCR by itself, and DOC by itself were revised downward to match the corresponding efficiencies for the components of the Tier 4F-capable system, to account for the large amount of cold-start generator runtime at this data center. For example, Caterpillar estimates the warmed-up NO_x removal efficiency for its SCR is 90 percent, but after accounting for the annual cold-start runtime when the SCR is not activated, the annual-average NO_x removal efficiency drops to only 64 percent.

The following aspects were not changed for this revised BACT assessment:

- The per-generator capital cost was not changed. Caterpillar's original cost estimates reflected the "quantity discount" for Microsoft's purchase of multiple generators.
- As with the 2014 assessment, the annual costs for control equipment operation and maintenance were set to zero, which results in a conservatively low estimate of cost effectiveness.

Table 4 shows the revised BACT cost effectiveness for critria pollutants for each control strategy, and Table 5 shows the revised tBACT cost effectiveness for TAPs for each control device. As with the 2014 analysis, the conservatively low-cost-effectiveness values for every control strategy exceed Ecology's presumptive thresholds. Therefore, Microsoft believes Ecology should retain the BACT determinations specified by the current Approval Order.

Revised Stack Parameters to Match As-Built Stack Conditions

Condition 2.4 of the current Approval Order specifies that all generator stacks must be 46 feet tall, and 16 feet taller than the roof height of the adjacent building. However, the as-built stack heights differ from those permitted values. The correct as-built stack parameters and building heights are listed below.

Generator Size	Stack Height (feet)	Stack Inside Diameter (inches)	Height of Permanent Building Structure Including Parapet Walls	Stack Height Above Rooftop (feet)
2.5 MW	40	22	Height of AZ Buildings = 28.5 feet	11.5
2.0 MW	40	22	Height of CNR buildings = 20.8 feet	19
0.75 MW	35.6	12	Height of administration building = 23.8 feet	11.8

The stack flow rates and exhaust temperatures used for AERMOD modeling in February 2014 were based on speculation that the generators to be installed might be manufactured by either Cummins or MTU. However, the engines actually installed at the facility will be manufactured by Caterpillar. Therefore, the previously assumed stack flow rates and temperatures have been replaced by as-built specifications for the actual Caterpillar engines. Caterpillar specifications for exhaust gas properties at the exhaust manifold (upstream of the emission control devices) are provided in Attachment B-1. The as-built flow rate and temperature data for the top of the exhaust stacks (downstream of the control devices) are shown below.

Generator Size	Exhaust Stack Flow Rate (actual cubic feet per minute)		Exhaust Stack Temperature (degrees F)	
	100% load	10% load	100% load	10% load
2.5 MW	18,094	4,435	768	500
2.0 MW	14,131	4,138	605	406
0.75 MW	5,184	1,534	802	385

The actual stack flow rate and temperature at the top of the stacks downstream of the add-on emission control devices will be lower than the Caterpillar-specified values at the engine exhaust manifold. Caterpillar did not provide flow rate and temperature data for conditions at the top of the stack, but it did provide data for flow rate and temperature data at the engine exhaust manifold upstream of the emission control devices. Based on actual stack test data for the controlled generators at the Vantage Data Center, the stack exhaust temperature was reduced by 147°F compared to the manifold exhaust temperature, and the actual stack exhaust flow rate was adjusted to 92 percent of the specified value at the exhaust manifold.

Summary of Revised Ambient Impact Assessment

The modeled ambient impacts for each pollutant and averaging period were revised to reflect the changes in facility-wide emission rates and changes in stack parameters. A DVD of the AERMOD files was provided to Ecology with the January 2016 application package.

The Approval Order specifies annual-average limits on generator runtimes and generator emissions on a 3-year rolling average. As requested by Ecology, the ambient impact assessment was revised to evaluate the theoretical maximum-year annual-average impacts by assuming that all of the runtimes and emissions within the 3-year rolling period could theoretically occur in one single year, and by assuming a large number of generators are commissioned during that same year, and four of the required stack tests are conducted in that same year. That theoretical maximum-year analysis was applied to the annual-average NAAQS and ASILs.

Table 6 summarizes the modeled ambient air quality impacts associated with the requested Approval Order revision, after revising the stack parameters and adding the new reserve generators, and accounting for the flexible operating range of 10 to 100 percent.

The overall finding is that the modeled ambient impacts for some pollutants and averaging periods changed compared to the values presented in our June 2014 and January 2016 applications (some modeled impacts increased while other modeled impacts decreased), but in all cases the modeled ambient impacts continue to be comfortably below all ambient limits. The calculated ambient impacts for each criteria air pollutant (including local and regional background) are still below the NAAQS.

The modeled ambient impacts for all TAPs other than DEEP and NO_2 are well below their respective ASILs. Microsoft's requested permit revisions resulted in an increase in the annual-average DEEP emissions, and the modeled ambient impact for DEEP continues to exceed its ASIL. Microsoft's requested permit revisions, including adding the eight new reserve generators, caused the modeled 1-hour NO_2 impact to exceed its ASIL. The following sections describe how the requested increase in allowable DEEP and NO_2 emissions affects the second-tier cancer risk analysis for DEEP and the non-cancer risk analysis for NO_2. A complete revised second-tier risk analysis report for DEEP and NO_2 has been submitted to Ecology under separate cover.

Revised Second-Tier DEEP Cancer Risk Results

A second-tier health impact assessment for DEEP has been provided under separate cover. The summary of the analysis is provided in Lines 11-12 of Table B-2-4. Detailed runtime and 70-year annual-average DEEP emission estimates for this scenario are provided in Table B-2-1A of Attachment B-2. The analysis from the February 2015 permit application was repeated for this reanalysis, adding the new reserve generators, and using the as-built stack parameters.

The "theoretical maximum annual" emission rate for DEEP is 2.64 tons per year, whereby all of the allowable emissions over a 3-year rolling period are assumed to occur in one single calendar year, with every generator operating at 10 percent load (the load at which Caterpillar forecasts the particulate emission rate is highest). The modeled "theoretical maximum year" DEEP impact at the property line, assuming the as-built stack parameters, is 0.46 micrograms per cubic meter ($\mu g/m^3$), compared to the previous value of 0.325 $\mu g/m^3$ that was presented in the February 2015 application.

The emission rate used for the DEEP cancer risk analysis uses the 70-year average emission rate (0.814 tons per year), which assumes every generator operates for its permitted 86 hours per year and also accounts for periodic stack emission testing during the 70-year operating period, with every generator operating at 10 percent load (the load at which Caterpillar forecasts the particulate emission rate is highest). The modeled 70-year average DEEP cancer risk at the maximally impacted residential receptor (MIRR), assuming the as-built stack parameters, is 5.9-per-million, compared to the previous 5.73-per-million value that was presented in the February 2015 DEEP risk assessment report.

Second-Tier NO_2 Health Impact Assessment Results

A second-tier health impact assessment for NO_2 has been provided under separate cover. The modeled 1st-highest ambient concentrations for NO_2 exceed the ASIL at unpopulated areas adjacent to the facility boundary, with a maximum 1st-highest concentration of 605 μg/m^3, which exceeds the ASIL of 470 μg/m^3.

However, the spatial zone where the modeled ambient concentration exceeds the ASIL does not extend as far as any offsite buildings or routinely-populated areas at nearby businesses. Furthermore, the modeled occurrences of ASIL exceedances at the unpopulated facility boundary are extremely rare. Based on those findings, the health impact assessment concludes that the modeled NO_2 impacts do not pose an unacceptable human health risk.

Detailed Descriptions of AERMOD Analysis for Each Pollutant and Averaging Period

24-Hour PM_{10} NAAQS During Facility-Wide Power Outage

This analysis is unchanged from the January 2016 submittal. The summary of the analysis is provided in Line 1 of Table B-2-4 in Attachment B-2. Detailed runtime and emission estimates for this scenario are provided in Table B-2-2A of Attachment B-2. The methodology from the February 2015 permit application was repeated for this reanalysis after adding the new reserve generators, using the as-built stack parameters, but retaining the same worst-case generator loads during power outages. The emission rate assumes two 24-hour power outages each year, with every generator operating at 10 percent load (the load at which Caterpillar forecasts the particulate emission rate is highest). As shown in Table B-2-2A, the new reserve generators contribute only 2.1 lbs/hour out of the facility-wide total of 357 lbs/hour, or approximately 0.6 percent of the facility-wide total emissions. The minor emissions from the new reserve generators will be distributed within the spatial footprint of the previously modeled primary generators. Based on these considerations, the ambient impact at the increased emission rate caused by addition of the new reserve generators was calculated using an AERMOD dispersion factor from a previous model run that used reduced as-built stack heights, but did not include the new reserve generator stacks. The stack flow rate and temperature were set to the new as-built conditions at 10 percent load. Using local and regional background values modeled in the original June 2014 permit application, the modeled 2nd-highest 24-hour impact, including local and regional background, is only 116 μg/m^3 compared to the allowable NAAQS of 150 μg/m^3.

24-Hour $PM_{2.5}$ NAAQS During Four-Generator Electrical Bypass Switchgear and Transformer Maintenance

This analysis is unchanged from the January 2016 submittal. The summary of the analysis is provided in Line 2 of Table B-2-4 in Attachment B-2. Detailed runtime and emission estimates for this scenario are provided in Table B-2-2B of Attachment B-2. The assumed scenario from the February 2015 permit application was repeated for this reanalysis using the as-built stack parameters. The emission rate assumes four generators operating simultaneously at the four AZ buildings closes to the northeast property corner, with every generator operating at 10 percent load (the load at which Caterpillar forecasts the particulate emission rate is highest). No reserve generators will be used for scheduled electrical bypass activity. The stack flow rate and temperature were set to the new as-built conditions at 10 percent load.

The 24-hour $PM_{2.5}$ NAAQS is based on the 3-year average of the 98th-percentile impact (equivalent to the 8th-highest day), but to provide a conservative analysis the compliance demonstration used the ***1st-highest*** modeled value. The ambient impact was calculated from an AERMOD dispersion factor from a previous model run using reduced as-built stack heights. Using local and regional background values modeled in the original June 2014 permit application, the modeled 3-year average of the ***1st-highest*** 24-hour impact, including local and regional background, is only 30 $\mu g/m^3$ compared to the allowable NAAQS of 35 $\mu g/m^3$.

Annual $PM_{2.5}$ NAAQS (Theoretical Maximum Year)

The annual $PM_{2.5}$ NAAQS is based on the annual mean concentration, averaged over 3 years. Therefore, this analysis was revised from the January 2016 submittal to account for the increased annual-average emission rate calculated based on a 3-year theoretical maximum emission rate. Even with the increased emission rate, the Oxford-only impact is a very small fraction of the NAAQS, and after adding local and regional background the cumulative impact is comfortably below the NAAQS.

Carbon Monoxide NAAQS During Facility-Wide Power Outage

This analysis is unchanged from the January 2016 submittal. The summary of the analysis is provided in Lines 4-5 of Table B-2-4 in Attachment B-2. Detailed runtime and emission estimates for this scenario are provided in Table B-2-2C of Attachment B-2. The analysis from the February 2015 permit application was repeated for this reanalysis using the as-built stack parameters. The emission rate assumes two 24-hour power outages each year, with all generators operating at 100 percent load (the load at which Caterpillar forecasts the CO emission rate is highest). The stack flow rate and temperature were set to the new as-built conditions at 100 percent load.

The new reserve generators will contribute only a small fraction of the facility-wide emissions, and the new reserve generators will be distributed inside the spatial footprint of the previously modeled primary generators. Based on these considerations, the ambient impacts at the increased emission rates were calculated from an AERMOD dispersion factor from a previous model run that assumed reduced as-built stack heights but did not include the new reserve generator stacks. Using local and regional background values modeled in the original June 2014 permit application, the modeled 2nd-highest 1-hour and 8-hour impacts are only a small fraction of the NAAQS limits.

Miscellaneous Gaseous TAPs During Facility-Wide Power Outage

The analysis of 24-hour average ammonia and acrolein impacts is unchanged. However, the analysis of the theoretical-maximum annual benzene impact was revised to use the increased annual benzene emission rate. To analyze the ambient impacts for ammonia, acrolein, and benzene (the miscellaneous gaseous TAPs whose emission rates exceed the SQER thresholds), the emission rates were revised to assume all generators operate at 100 percent load. The maximum emission rates were calculated to occur with fuel usage corresponding to 100 percent load based on the EPA's AP-42 emission factors (EPA 1995[4]). The ambient concentrations were calculated from AERMOD dispersion factors from a previous model run using reduced as-built stack parameters.

The new reserve generators will contribute only a small fraction of the facility-wide emissions, and the new reserve generators will be distributed inside the spatial footprint of the previously modeled primary generators. Based on these considerations, the ambient impacts with the increased emission rates caused by addition of the new reserve generators were calculated using AERMOD dispersion factors from previous model runs that included reduced as-built stack heights but did not include the new reserve generator stacks. As listed in Lines 11-13 of Table B-2-4, the modeled ambient impacts for ammonia, acrolein, and benzene are all well below their respective ASILs.

Annual NO_2 NAAQS (Theoretical Maximum Year)

This analysis was revised from the January 2016 submittal to account for the increased theoretical maximum annual emission rate. The modeled annual-average emission rate was set to 99 tons per year to match the proposed new potential-to-emit value in the revised Approval Order. Even with the increased emission rate, the Oxford-only impact is a very small fraction of the NAAQS, and after adding local and regional background the cumulative impact is comfortably below the NAAQS.

NO_2 ASIL During Facility-Wide Power Outage

This analysis is unchanged from the January 2016 submittal. The summary of the analysis is provided in Line 7 of Table B-2-4 in Attachment B-2. Detailed runtime and emission estimates for this scenario are provided in Table B-2-2D of Attachment B-2. The methodology from the February 2015 permit application was repeated for this reanalysis using the as-built stack parameters, and addition of the new reserve generators. The 1-hour emission rate assumes a facility-wide power outage with all the primary generators operating at 100 percent load for 1 hour, while the eight new reserve generators run at 10 percent load for 30 minutes before they shut down. For this screening-level analysis, the power outage emissions were assumed to occur continuously (8,760 hours per year for 5 modeling years), and the plume volume molar ratio method (PVMRM) module of the AERMOD model was used to select the 1st-highest 1-hour NO_2 impact during the 5 modeling years. The modeled 1st-highest

[4] EPA. 1995. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. Fifth Edition. AP-42. Office of Air Quality Planning and Standards, Office of Air and Radiation, U.S. Environmental Protection Agency. January.

1-hour NO_2 impact is 605 µg/m^3 at the unpopulated northern property line, which exceeds the ASIL of 470 µg/m^3. A second-tier health impact assessment for NO_2 has been provided under separate cover to demonstrate that the minor ASIL exceedance at the unpopulated property line does not cause unacceptable public health risks.

Stochastic 'Monte Carlo' Analysis of 98th-Percentile 1-Hour NO_2 NAAQS Accounting for Power Outages and Four-Generator 'Electrical Bypass' Maintenance

This analysis is unchanged from the January 2016 submittal. The summary of the analysis is provided in Line 6 of Table B-2-4 in Attachment B-2. Detailed runtime and emission estimates for this scenario are provided in Table B-2-2E and Table B-2-5 of Attachment B-2. Ecology's stochastic Monte Carlo statistical analysis was used to evaluate the 98th-percentile 1-hour NO_2 impact caused by randomly occurring emissions distributed throughout the data center. The stochastic Monte Carlo analysis considered conservatively high occurrences of two runtime events:

- A conservatively high 4 calendar days per year of facility-wide power outages (with the 37 primary generators operating at 100 percent load while the eight new reserve generators operate at 10 percent load). In reality, power outages at the Quincy data centers occur infrequently, so a facility-wide power outage is unlikely to actually occur more than 1 day per year. The emission rates assume every generator is subject to a cold start.
- 16 days per year of electrical bypass maintenance randomly distributed at various locations within the data center (with each day of electrical bypass consisting of four generators at 100 percent load). This frequency is equivalent to 2 days per year of electrical bypass at each of the eight AZ buildings. That frequency is conservatively high, because Microsoft plans its transformer and switchgear maintenance in a manner so no AZ building is likely to require more than 1 day per year of electrical bypass. Furthermore, Microsoft plans to conduct transformer and switchgear maintenance at each building on a 3-year cycle, rather than annually as modeled for this analysis. The emission rates assume every generator is subject to a cold start.

The 1-hour NO_2 NAAQS limit of 188 µg/m^3 is based on the 3-year rolling average of the 98th-percentile of the daily maximum 1-hour NO_2 impact (which means the 8th-highest daily 1-hour NO_2 impact cannot exceed 188 µg/m^3). As quantified in the June 2014 air quality permit application, the modeled background NO_2 value at the Oxford Data Center is 16 µg/m^3, so the acceptable Oxford-only NO_2 impact is 172 ug/m^3 (188 – 16 = 172). Therefore, any NO_x emission event that contributes an Oxford-only NO_2 impact exceeding 172 µg/m^3 can theoretically contribute to the facility exceeding the 98th-percentile NO_2 NAAQS.

In order for the Oxford Data Center to cause the 1-hour ambient NO_2 concentration to exceed 172 µg/m^3 on any given day at any given receptor location, the following events must occur simultaneously:

- The generators must be operating with a high NO_x emission rate during a facility-wide power outage affecting all 45 generators simultaneously.
- The wind must be blowing directly toward the given receptor location.

- The atmospheric dispersion conditions must be unusually poor.

Ecology's stochastic Monte Carlo statistical package was developed specifically to evaluate compliance with the 1-hour NO_2 NAAQS for intermittent emission sources such as data centers. It is designed to evaluate, for each receptor location, the probability that each of the three required conditions described above will occur more than eight times per year. Ecology's Monte Carlo modeling technique uses post-processing files from AERMOD/PVMRM model runs that have been completed for each representative generator runtime regime at the facility. The Monte Carlo script then randomizes results from 1,000 iterative runs that included random selection from all the possible generator runtime regimes, wind directions, and wind speeds to estimate the probability that the 1-hour NO_2 NAAQS will be violated at any given receptor location. Monte Carlo modeling assumptions were developed based on discussions with Ecology and are summarized in Table B-2-5 in Attachment B-2.

The AERMOD/PVMRM modeling runs listed in Table B-2-5 (only for the activities with a predicted 1st-highest 1-hour NO_2 impact exceeding the 172 μg/m^3 trigger value) were included in the stochastic Monte Carlo analysis. These modeling runs accounted for a conservatively high total of 20 days per year of facility-wide power outages and/or four-generator electrical bypass maintenance. Modeling runs for the low-emission, single-generator runtime events (including monthly testing, corrective maintenance, and stack emission testing) were not included in the Monte Carlo modeling because their maximum modeled 1-hour ambient NO_2 impacts are less than the 172 μg/m^3 trigger value that could theoretically cause a 98th-percentile NAAQS exceedance.

A DVD of air dispersion modeling files, post-processing files, and Monte Carlo output files has been provided to Ecology under separate cover.

Even with the combination of conservative runtime assumptions (4 days of power outage, and 2 days of electrical bypass at each AZ building), the stochastic Monte-Carlo analysis indicates that the Oxford-only 98th-percentile 1-hour NO_2 impact is only 100 μg/m^3, and the location of the maximum receptor location is at the unpopulated northern facility boundary next to the two AZ buildings closest to the northeast facility boundary. The regional and local background concentration at that location (16 μg/m^3) was derived from the deterministic worst-case AERMOD modeling provided in the June 2014 permit application, accounting for local emission sources including the Dell Data Center, Microsoft Columbia Data Center, and the ConAgra food processing plant. After adding those regional and local background values, the Monte Carlo model predicts that the conservatively high 20 days of multi-generator operation at the data center will comply with the 98th-percentile NO_2 NAAQS with a considerable margin of safety:

Oxford-only 98th-percentile impact	100 μg/m^3
Regional plus local background	16 μg/m^3
Cumulative impact	116 μg/m^3
Allowable NAAQS limit	188 μg/m^3

If more realistic generator runtime assumptions are used (only two power outages per year, and only 1 day per year of electrical bypass at each AZ building), the Monte Carlo package predicts even lower 98th-percentile NO_2 impacts:

Oxford-only 98th-percentile impact	27 µg/m^3
Regional plus local background	16 µg/m^3
Cumulative impact	43 µg/m^3
Allowable NAAQS limit	188 µg/m^3

Screenshots of Calculation Spreadsheets

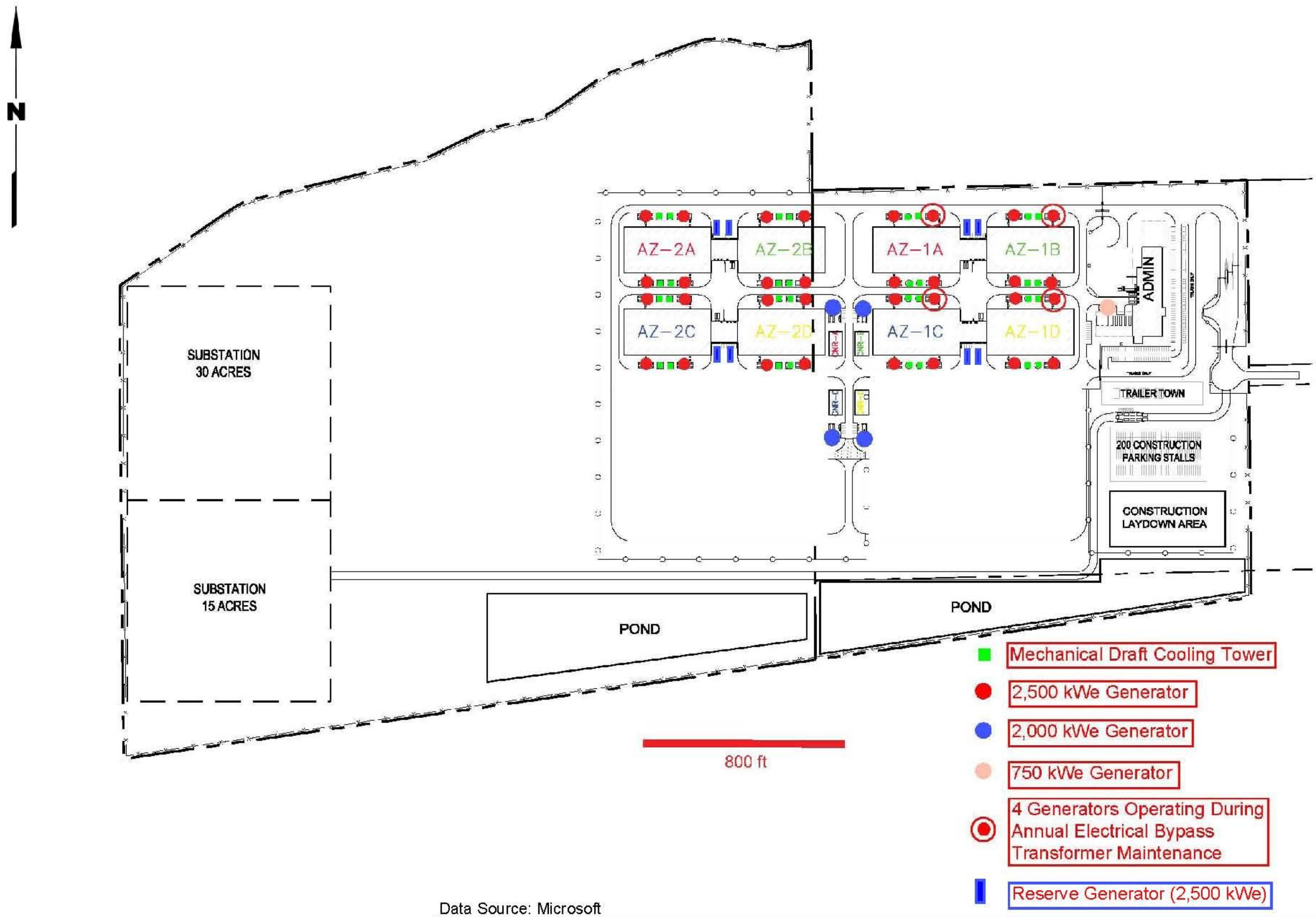
Attachment B-2 shows screenshots of the revised emission calculation spreadsheets that are being provided to Ecology for review. The emission calculations were done using the same general methods used in the February 2015 application, except for the following:

- Corrected the "as-built" heights and diameters
- Used "as-built" Caterpillar data for stack temperature and flow rate
- Added eight new reserve generators
- Assumed all primary generators can operate with no restrictions at loads between 10 percent and 100 percent. For each pollutant, selected the generator load that produces the highest emission rate.

Attachments

Figure 1:	Site Plan
Table 1:	Caterpillar Load-Specific Emission Rates for Diesel Generators
Table 2	Revised Potential-to-Emit
Table 3:	Revised Toxic Air Pollutant Emission Rates
Table 4:	March 2016 Revised BACT Cost Effectiveness for Criteria Air Pollutants
Table 5:	March 2016 Revised tBACT Cost Effectiveness for Toxic Air Pollutants
Table 6:	Revised Cumulative Ambient Impacts
Attachment B-1:	Caterpillar Specifications
Attachment B-2:	Screenshots of April 2016 Revised Emission Calculation Spreadsheets
Attachment B-3:	March 2016 BACT Cost-Effectiveness Calculations

P:\1409\001\010\FileRm\R\April 2016 NOC Package to Respond to Incompleteness\April 2016 NOC Letter\Appendix B\April 2016_Revised Emission Calcs_apb.docx



Data Source: Microsoft

Project Oxford Data Center Quincy, Washington	**Site Plan**	Figure 1

LANDAU ASSOCIATES

TABLE 1
CATERPILLAR LOAD-SPECIFIC EMISSION RATES FOR DIESEL GENERATORS
MICROSOFT OXFORD DATA CENTER
QUINCY, WASHINGTON

Pollutant	Condition	lbs/hour at 100% Load	lbs/hour; Maximum Between 10%-75% Loads	lbs/hour at 10% Load
2.5-MW Generators				
NO_x	Cold	50.6	31.1	7.02
	Warm	9.11	3.73	1.26
CO Including Black Puff Cold-Start Factor	Cold incl. 1.56 black puff factor	9.38	4.62	4.62
	Warm	1.4	1.11	1.109
NMHC Including Black Puff Cold-Start Factor	Cold inc. 1.26 black puff factor	1.1	1.2	1.21
	Warm	0.198	0.346	0.346
PM Including Black Puff Cold-Start Factor, Front Half Plus Back Half	Cold incl. 1.26 black puff factor on front half	0.407	0.635	0.635
	Warm	0.272	0.401	0.401
2.0-MW Generators				
NO_x	Cold	42.1	22.5	6.46
	Warm	4.04	7.75	7.75
CO Including Black Puff Cold-Start Factor	Cold incl. 1.56 black puff factor	3.45	3.95	6.16
	Warm	0.8	0.95	0.948
NMHC Including Black Puff Cold-Start Factor	Cold inc. 1.26 black puff factor	0.93	1.13	1.23
	Warm	0.167	0.353	0.353
PM Including Black Puff Cold-Start Factor, Front Half Plus Back Half	Cold incl. 1.26 black puff factor on front half	0.373	0.661	0.661
	Warm	0.209	0.434	0.434
750-kW Generator				
NO_x	Cold	15.8	9.2	2.89
	Warm	1.33	3.47	3.47
CO Including Black Puff Cold-Start Factor	Cold incl. 1.56 black puff factor	1.15	1.51	1.9
	Warm	0.3	0.44	0.439
NMHC Including Black Puff Cold-Start Factor	Cold inc. 1.26 black puff factor	0.12	0.22	0.28
	Warm	0.022	0.106	0.106
PM Including Black Puff Cold-Start Factor, Front Half Plus Back Half	Cold incl. 1.26 black puff factor on front half	0.349	0.608	0.608
	Warm	0.04	0.136	0.136
Color-highlighted cells indicate worst-case load-specific values used for emission calculations and ambient air quality impact modeling.				

TABLE 2
REVISED POTENTIAL-TO-EMIT
MICROSOFT OXFORD DATA CENTER
QUINCY, WASHINGTON

Pollutant	**Tons Per Year Emissions**
Diesel Generators	
Fuel Usage	615,000 gallons/yr
NO_x (set to value that results in theoretical maximum year emission less than 100 tpy	33
DEEP, PM_{10}, $PM_{2.5}$ from diesel exhaust (includes total PM as front-half plus back-half)	0.814 (70-yr average)
CO	7.3
VOCs	1.03
Ammonia	1.14
SO_2	0.069
Cooling Tower Drift	
Cooling Tower Drift Total Suspended Particulates	23
Cooling Tower Drift PM_{10}	12.8
Cooling Tower $PM_{2.5}$	
Combined Generators and Cooling Towers	
Facility-Wide Total Suspended Particulates	23.8
Facility-Wide PM_{10}	13.7
Note: All values other than DEEP and NO_x were derived by dividing the “theoretical maximum year” value by 3.	

TABLE 3
REVISED TOXIC AIR POLLUTANT EMISSION RATES
MICROSOFT OXFORD DATA CENTER
QUINCY, WASHINGTON

Pollutant	CAS Number	SQER		Facility Emissions		SQER Exceeded?
Diesel Generator TAPs						
DEEP (Theoretical Max Annual)	None	0.639	lbs/yr	5,286	lbs/yr	**Yes**
CO	630-08-0	50.2	lbs/hour	126.0	lbs/hour	**Yes**
Ammonia	7664-41-7	9.3	lbs/day	518	lbs/day	**Yes**
SO_2		1.45	lbs/hour	1.3	lbs/hour	No
NO_2	10102-44-0	1.03	lbs/hour	57.5	lbs/hour	**Yes**
Benzene (Theoretical Max Annual)	71-43-2	6.62	lbs/yr	20.84	lbs/yr	**Yes**
Toluene	108-88-3	657	lbs/day	0.572	lbs/day	No
Xylenes	95-47-6	58	lbs/day	0.393	lbs/day	No
1,3-Butadiene (Theoretical Max Annual)	106-99-0	1.13	lbs/yr	1.06	lbs/yr	No
Formaldehyde (Theoretical Max Annual)	50-00-0	32	lbs/yr	2.14	lbs/yr	No
Acetaldehyde (Theoretical Max Annual)	75-07-0	71	lbs/yr	0.69	lbs/yr	No
Acrolein	107-02-8	0.0079	lbs/day	0.016	lbs/day	**Yes**
Benzo(a)pyrene (Theoretical Max Annual)	50-32-8	0.174	lbs/yr	7.0E-03	lbs/yr	No
Benzo(a)anthracene (Theoretical Max Annual)	56-55-3	1.74	lbs/yr	1.5E-02	lbs/yr	No
Chrysene (Theoretical Max Annual)	218-01-9	17.4	lbs/yr	3.8E-02	lbs/yr	No
Benzo(b)fluoranthene (Theoretical Max Annual)	205-99-2	1.74	lbs/yr	2.8E-02	lbs/yr	No
Benzo(k)fluoranthene (Theoretical Max Annual)	207-08-9	1.74	lbs/yr	5.4E-03	lbs/yr	No
Dibenz(a,h)anthracene (Theoretical Max Annual)	53-70-3	0.16	lbs/yr	8.6E-03	lbs/yr	No
Ideno(1,2,3-cd)pyrene (Theoretical Max Annual)	193-39-5	1.74	lbs/yr	1.0E-02	lbs/yr	No
Naphthalene (Theoretical Max Annual)	91-20-3	5.64	lbs/yr	3.53	lbs/yr	No
Propylene	115-07-1	394	lbs/yr	5.68	lbs/yr	No
Cooling Tower TAPs						
Fluoride	---	1.71	lbs/day	0.0260	lbs/day	No
Manganese	---	0.0053	lbs/day	0.00252	lbs/day	No
Copper	---	0.219	lbs/hour	3.5E-05	lbs/hour	No
Chloroform	67-66-3	8.35	lbs/year	0.526	lbs/year	No
Bromodichloromethane	75-27-4	5.18	lbs/year	0.526	lbs/year	No
Bromoform	75-25-2	174	lbs/year	13.8	lbs/year	No

Shaded rows indicate the emission rate exceeds the SQER

TABLE 4
MARCH 2016 REVISED BACT COST EFFECTIVENESS FOR CRITERIA AIR POLLUTANTS
MICROSOFT OXFORD DATA CENTER
QUINCY, WASHINGTON

Control Device	Cost Effectiveness ($/ton)				
	PM (Front half plus Method 202 back half)	CO	VOCs	NO_x	Combined Pollutants
Tier 4F-Capable Integrated Control System (Catalyzed DPF + SCR)	$839,678	$313,628	$1,463,920	$33,707	$28,793
Urea-SCR Alone	Ineffective	Ineffective	Ineffective	$16,209	$16,209
Catalyzed DPF Alone	$352,233	$131,562	$614,094	Ineffective	$82,861
Diesel Oxidation Catalyst Alone	$523,842	$53,251	$248,562	Ineffective	$40,468

TABLE 5
MARCH 2016 REVISED TBACT COST EFFECTIVENESS FOR TOXIC AIR POLLUTANTS
MICROSOFT OXFORD DATA CENTER
QUINCY, WASHINGTON

Control Device	Cost Effectiveness ($/ton)					
	DEEP (Front half plus Method 202 back half)	CO	Carcinogen VOCs	NO_2	Acrolein	Combined Pollutants
Tier 4F-Capable Integrated Control System (Catalyzed DPF + SCR)	$839,678	$313,628	$77,677,470	$337,066	$10,138,457,408	$134,707
Urea-SCR Alone	Ineffective	Ineffective	Ineffective	$162,089	Ineffective	$162,089
Catalyzed DPF Alone	$352,233	$131,562	$32,584,592	Ineffective	$443,476,385	$94,620
Diesel Oxidation Catalyst Alone	$523,842	$53,251	$13,188,995	Ineffective	$1,721,426,645	$47,607

TABLE 6
REVISED CUMULATIVE AMBIENT IMPACTS
MICROSOFT OXFORD DATA CENTER
QUINCY, WASHINGTON

Pollutant and Averaging Time	Ambient Impacts (µg/m³)			
	Oxford Increment (Annual values are theoretical maximum)	Regional and Local Background (Inc. cooling towers)	Total Ambient Impact	NAAQS or ASIL
PM_{10}				
24-hr during facility-wide outage	26.6	89	116	150
$PM_{2.5}$				
1st-highest 24-hr during electrical bypass	8.4	21.71	30	35
Annual (Theoretical maximum year)[a]	0.15	6.75	6.9	12
Carbon Monoxide				
1-hr during facility-wide outage	421	842	1,263	40,000
8-hr during facility-wide outage	205	482	687	10,000
Nitrogen Dioxide				
1-hr NO_2-NAAQS, 8th-highest stochastic model	100	16	116	188
Annual average NO_2 (Theoretical maximum year)	19.4	2.8	22.2	100
NO_2 ASIL, 1st-highest 1-hr during facility-wide outage	605	1-hr NO_2 ASIL = 470		
Toxic Air Pollutants				
Theoretical maximum annual DEEP[a]	0.46	Annual DEEP ASIL = 0.0033		
Ammonia 24-hr at MIBR (ultra-worst case)	26	Ammonia 24-hr ASIL = 70.8		
Acrolein 24-hr at MIBR (ultra-worst case)	0.00079	Acrolein 24-hr ASIL = 0.06		
Benzene (Theoretical maximum annual)[a]	0.0105	Annual DEEP ASIL = 0.0033		

[a] Theoretical maximum annual assumes the allowable emissions over the 3-year rolling period occur in 1 year, along with commissioning of 18 generators plus 4 stack emission tests.

ATTACHMENT B-1

Caterpillar Specifications

DIESEL GENERATOR SET

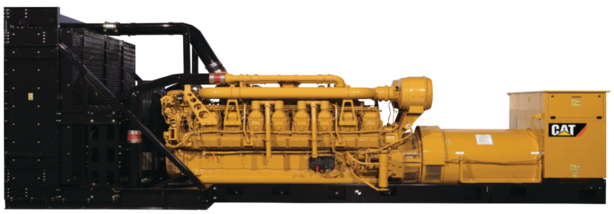


Image shown may not reflect actual package.

Mission Critical Standby

2500 ekW 3125 kVA
60 Hz 1800 rpm 480 Volts

Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.

FEATURES

FUEL/EMISSIONS STRATEGY
- EPA Certified for Stationary Emergency Application (EPA Tier 2 emissions levels)

DESIGN CRITERIA
- The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

UL 2200 / CSA - Optional
- UL 2200 listed packages
- CSA Certified
  Certain restrictions may apply.
  Consult with your Cat® Dealer.

FULL RANGE OF ATTACHMENTS
- Wide range of bolt-on system expansion attachments, factory designed and tested
- Flexible packaging options for easy and cost effective installation

SINGLE-SOURCE SUPPLIER
- Fully prototype tested with certified torsional vibration analysis available

WORLDWIDE PRODUCT SUPPORT
- Cat dealers provide extensive post sale support including maintenance and repair agreements
- Cat dealers have over 1,800 dealer branch stores operating in 200 countries
- The Cat® S•O•S℠ program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

CAT® 3516C-HD TA DIESEL ENGINE
- Reliable, rugged, durable design
- Field-proven in thousands of applications worldwide
- Four-stroke-cycle diesel engine combines consistent performance and excellent fuel economy with minimum weight

CAT GENERATOR
- Matched to the performance and output characteristics of Cat engines
- Industry leading mechanical and electrical design
- Industry leading motor starting capabilities
- High Efficiency

CAT EMCP 4 CONTROL PANELS
- Simple user friendly interface and navigation
- Scalable system to meet a wide range of customer needs
- Integrated Control System and Communications Gateway

SEISMIC CERTIFICATION
- Seismic Certification available
- Anchoring details are site specific, and are dependent on many factors such as generator set size, weight, and concrete strength.
  IBC Certification requires that the anchoring system used is reviewed and approved by a Professional Engineer
- Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007
- Pre-approved by OSHPD and carries an OSP-0084-10 for use in healthcare projects in California

FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

System	Standard	Optional
Air Inlet	• Single element canister type air cleaner • Service indicator	[ ] Dual element & heavy duty air cleaners [ ] Air inlet adapters & shut-off
Cooling	• Radiator with guard • Coolant drain line with valve • Fan and belt guards • Cat® Extended Life Coolant	[ ] Radiator duct flange
Exhaust	• Dry exhaust manifold • Flanged faced outlets	[ ] Mufflers and Silencers [ ] Stainless steel exhaust flex fittings [ ] Elbows, flanges, expanders & Y adapters
Fuel	• Secondary fuel filters • Fuel priming pump • Flexible fuel lines • Fuel cooler*	[ ] Water separator [ ] Duplex fuel filter
Generator	• Cat digital voltage regulator (CDVR) with kVAR/PF control, 3-phase sensing • Winding temperature detectors • Anti-condensation heaters	[ ] Oversize & premium generators [ ] Bearing temperature detectors
Power Termination	• Bus bar (NEMA or IEC mechanical lug holes)- right side standard • Top and bottom cable entry	[ ] Circuit breakers, UL listed, 3 pole with shunt trip,100% rated, manual or electrically operated [ ] Circuit breakers, IEC compliant, 3 or 4 pole with shunt trip, manual or electrically operated [ ] Bottom cable entry [ ] Power terminations can be located on the right, left and/or rear as an option.
Governor	• ADEM™ 3	[ ] Load share module
Control Panels	• EMCP 4.2 Genset controller	[ ] Digital I/O Module [ ] Generator temperature monitoring & protection
Lube	• Lubricating oil and filter • Oil drain line with valves • Fumes disposal • Gear type lube oil pump	[ ] Oil level regulator [ ] Deep sump oil pan [ ] Electric & air prelube pumps [ ] Manual prelube with sump pump [ ] Duplex oil filter
Mounting	• Rails - engine / generator / radiator mounting • Rubber anti-vibration mounts (shipped loose)	[ ] Spring-type vibration isolator [ ] IBC Isolators
Starting/Charging	• 24 volt starting motor(s) • Batteries with rack and cables • Battery disconnect switch	[ ] Battery chargers [ ] Charging alternator [ ] Oversize batteries [ ] Ether starting aid [ ] Heavy duty starting motors [ ] Barring device (manual) [ ] Air starting motor with control & silencer [ ] Jacket water heater
General	• Right-hand service • Paint - Caterpillar Yellow except rails and radiators are gloss black • SAE standard rotation • Flywheel and flywheel housing - SAE No. 00	[ ] UL 2200 [ ] CSA certification [ ] CE Certificate of Conformance [ ] Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007
Note	Standard and optional equipment may vary for UL 2200 Listed Packages. UL 2200 Listed packages may have oversized generators with a different temperature rise and motor starting characteristics.	

SPECIFICATIONS

CAT GENERATOR

Cat Generator
Frame size.. 1842
Excitation.. Permanent Magnet
Pitch.. 0.6667
Number of poles.. 4
Number of bearings.. 2
Number of Leads... 006
Insulation....................... UL 1446 Recognized Class H with tropicalization and antiabrasion
- Consult your Caterpillar dealer for available voltages
IP Rating.. IP23
Alignment.. Closed Coupled
Overspeed capability.. 125
Wave form Deviation (Line to Line)......................... 003.00
Voltage regulator............. 3 Phase sensing with selectible volts/Hz
Voltage regulation............ Less than +/- 1/2% (steady state)
Less than +/- 1/2% (w/3% speed change)

CAT DIESEL ENGINE

3516C-HD ATAAC, V-16, 4-Stroke Water-cooled Diesel
Bore.. 170.00 mm (6.69 in)
Stroke... 215.00 mm (8.46 in)
Displacement.. 78.08 L (4764.73 in^3)
Compression Ratio... 14.7:1
Aspiration.. TA
Fuel System.................................... Electronic unit injection
Governor Type.. ADEM3

CAT EMCP 4 SERIES CONTROLS

EMCP 4 controls including:
- Run / Auto / Stop Control
- Speed and Voltage Adjust
- Engine Cycle Crank
- 24-volt DC operation
- Environmental sealed front face
- Text alarm/event descriptions

Digital indication for:
- RPM
- DC volts
- Operating hours
- Oil pressure (psi, kPa or bar)
- Coolant temperature
- Volts (L-L & L-N), frequency (Hz)
- Amps (per phase & average)
- ekW, kVA, kVAR, kW-hr, %kW, PF

Warning/shutdown with common LED indication of:
- Low oil pressure
- High coolant temperature
- Overspeed
- Emergency stop
- Failure to start (overcrank)
- Low coolant temperature
- Low coolant level

Programmable protective relaying functions:
- Generator phase sequence
- Over/Under voltage (27/59)
- Over/Under Frequency (81 o/u)
- Reverse Power (kW) (32)
- Reverse reactive power (kVAr) (32RV)
- Overcurrent (50/51)

Communications:
- Six digital inputs (4.2 only)
- Four relay outputs (Form A)
- Two relay outputs (Form C)
- Two digital outputs
- Customer data link (Modbus RTU)
- Accessory module data link
- Serial annunciator module data link
- Emergency stop pushbutton

Compatible with the following:
- Digital I/O module
- Local Annunciator
- Remote CAN annunciator
- Remote serial annunciator

Mission Critical Standby 2500 ekW 3125 kVA

60 Hz 1800 rpm 480 Volts

TECHNICAL DATA

Open Generator Set - - 1800 rpm/60 Hz/480 Volts	DM9228	
EPA Certified for Stationary Emergency Application (EPA Tier 2 emissions levels)		
Generator Set Package Performance		
Genset Power rating @ 0.8 pf	3125 kVA	
Genset Power rating with fan	2500 ekW	
Fuel Consumption		
100% load with fan	656.8 L/hr	173.5 Gal/hr
75% load with fan	510.8 L/hr	134.9 Gal/hr
50% load with fan	372.4 L/hr	98.4 Gal/hr
Cooling System[1]		
Air flow restriction (system)	0.12 kPa	0.48 in. water
Engine Coolant capacity with radiator/exp. tank	504.0 L	133.1 gal
Engine coolant capacity	233.0 L	61.6 gal
Radiator coolant capacity	271.0 L	71.6 gal
Inlet Air		
Combustion air inlet flow rate	204.2 m^3/min	7211.3 cfm
Exhaust System		
Exhaust stack gas temperature	490.7 ° C	915.3 ° F
Exhaust gas flow rate	554.5 m^3/min	19582.0 cfm
Exhaust flange size (internal diameter)	203.2 mm	8.0 in
Exhaust system backpressure (maximum allowable)	6.7 kPa	26.9 in. water
Heat Rejection		
Heat rejection to coolant (total)	826 kW	46975 Btu/min
Heat rejection to exhaust (total)	2502 kW	142288 Btu/min
Heat rejection to aftercooler	786 kW	44700 Btu/min
Heat rejection to atmosphere from engine	161 kW	9156 Btu/min
Heat rejection to atmosphere from generator	101.5 kW	5772.3 Btu/min
Alternator[2]		
Motor starting capability @ 30% voltage dip	6559 skVA	
Frame	1842	
Temperature Rise	150 ° C	270 ° F
Lube System		
Sump refill with filter	466.0 L	123.1 gal
Emissions (Nominal)[3]		
NOx g/hp-hr	5.32 g/hp-hr	
CO g/hp-hr	.42 g/hp-hr	
HC g/hp-hr	.1 g/hp-hr	
PM g/hp-hr	.037 g/hp-hr	

[1] For ambient and altitude capabilities consult your Cat dealer. Air flow restriction (system) is added to existing restriction from factory.

[2] Generator temperature rise is based on a 40 degree C ambient per NEMA MG1-32. UL 2200 Listed packages may have oversized generators with a different temperature rise and motor starting characteristics.

[3] Emissions data measurement procedures are consistent with those described in EPA CFR 40 Part 89, Subpart D & E and ISO8178-1 for measuring HC, CO, PM, NOx. Data shown is based on steady state operating conditions of 77ºF, 28.42 in HG and number 2 diesel fuel with 35º API and LHV of 18,390 btu/lb. The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations. Emissions data is based on 100% load and thus cannot be used to compare to EPA regulations which use values based on a weighted cycle.

RATING DEFINITIONS AND CONDITIONS

Meets or Exceeds International Specifications: AS1359, CSA, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, UL508A, 72/23/EEC, 98/37/EC, 2004/108/EC

Mission Critical Standby - Output available with varying load for the duration of the interruption of the normal source power. Average power output is 85% of the standby power rating. Typical peak demand up to 100% of standby rated ekW for 5% of the operating time. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year. Fuel stop power in accordance with ISO3046. Standby ambients shown indicate ambient temperature at 100% load which results in a coolant top tank temperature just below the shutdown temperature.

Ratings are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

Fuel rates are based on fuel oil of 35° API [16° C (60° F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.). Additional ratings may be available for specific customer requirements, contact your Cat representative for details. For information regarding Low Sulfur fuel and Biodiesel capability, please consult your Cat dealer.

DIMENSIONS

Package Dimensions		
Length	**6982.5 mm**	**274.9 in**
Width	**2569.2 mm**	**101.15 in**
Height	**3009.3 mm**	**118.48 in**

NOTE: For reference only - do not use for installation design. Please contact your local dealer for exact weight and dimensions. (General Dimension Drawing #3292332).

CAT® SCR PROPOSAL

Friday, April 18, 2014 Quotation Number: **13102801RW-E** Revision: **4**

SCR & DPF units in a 409L Stainless Steel Double Wall Critical Grade Silencer Housing

Project Description:	**Microsoft Quincy MWH01 - Cat 3516C HD 2500 ekW Generators**

NC Power Systems
Brant Briody
Sales Representative
17900 W. Valley Highway
Tukwila, WA 98188

Email: bbriody@ncpowersystems.com
Telephone: **(425) 656-4587**
Mobile: **(206) 510-3491**

Application Specifications:

Site Location (Address):	**Quincy Washingtion**		
Environment (Alt,Temp,RH):	**1300 ft, 10 deg to 90 deg F**		
Mounting Location:	**Over Generator**		
Regulation Requirement:	**BACT targeting non-certified Tier 4 Final Levels**		
Average Running Load (%):	**?**	Runtime (hr/yr):	**100**
Minimal Operating Load (%):	**30%**	Minimal Exhaust Temp:	**300 deg C**

Engine Specifications: *Quantity 16 CAT, reference # DM8266*

Engine Model Number:	**3516C HD, Tier 2**			Engine S/N:	**SBK00251**
Generator Power Rating (ekW):	**2,500**	**Standby**		EPA Family #:	**CCPXL78.1NZS**
Engine Displacement (liters):	**78**			Model Name:	**Generator**
Max Fuel Sulfur Content (ppm):	**< 50**				
Engine Power Output (bhp):	**3,633**	or	***2710***	***bkW @ 1800 RPM***	
Exhaust Flow Rate (ACFM):	**19,579**	or	***554.4***	***m^3/min***	
Exhaust Stack Temp (deg F):	**915**	or	***490.6***	***deg C***	
Max Exhaust Pressure(" H_2O):	**27**	or	***6.7***	***kPa***	

Estimated Engine Emissions Data:

Requirement	**Emissions Source:**	***Potential Site Variation***	
BACT		***Pre Catalyst***	***Post Catalyst Estimates*****
g/bkW-hr		**g/bkW-hr**	**g/bkW-hr**
0.67	**NOx***	**5.93**	**0.67**
3.50	**CO**	**1.61**	**3.50**
0.19	**HC**	**0.47**	**0.19**
0.03	**PM**	**0.14**	**0.03**

**NOx Reductions will be validated by a calibrated gas analyzer during Dealer Site Commissioning of the CAT SCR System at defined load points and steady-state conditions.*

***Post Catalyst Emissions Reduction based on 100% Load, ISO conditions and exhaust temperatures above 300 deg C through the SCR Catalyst*

DPF Specifications:

Material:	**Platinum Group Catalyzed Cordierite Ceramic wall-flow filter substrates**	
Number of Filters:	**12**	**FDA221**
Typical Regeneration using ULSD:	Above 350 deg C (662 deg F) for 30% of engine operating time & greater than 40% engine load	
Max Number of Cold Starts:	**12 consecutive 10 minute idle sessions followed by 2 hrs regeneration**	

CATERPILLAR

SCR Specifications:

Material:	**Extruded Vanadia Substrates**		# T6 Modules:	**30**
Total Amount of Catalyst (cubic ft):	**54 (15.3 cubic meters)**		# T2 Modules:	**60**
Number of Catalyst Layers:	**3 layers @ 80 blocks/layer**	***8 wide by 10 high***	# T4 Modules:	
Injection Lance:	**36 inches (914 mm)**			
Approximate DEF Consumption:	**7 gal/hr or 26.6 liters/hr of 32.5% Technical Grade Urea**			
Recommended Reductant:	***32.5% DEF (Diesel Exhaust Fluid), Please reference Cat document PELJ1160***			
Maximum Ammonia Slip:	***Not Specified***			

Dosing Control Cabinet: *Nema 12 Enclosure (36" high x 32" wide x 12" deep)*

*Touch Screen Display & Dual NOx Sensors for a True Closed-Loop System
*Controller, Pressure Sensor, Temperature Sensor, Dosing Pump, Pressure Regulator, Secondary Urea Filter
*Power requirement: 240/120 volts AC, 10/20 amps, 50 or 60 Hertz
*Records NOx levels pre and post, Temperature and Pressure, Time and Date
*ModBus Communications Enabled
*Auto Start, Stop and Purge Cycle

Tube Bundle: *Dosing Control Cabinet to Injection Lance*

*1/4" Heat Traced Stainless Steel tubing for DEF Flow
*1/2" Stainless Steel or Poly tubing for Compressed Air

Injection and Mixing Section: *Integrated within the E-POD housing*

*Air & Urea Injection with Static Mixers internal to the SCR Silencer Housing
*Compressed Air requirement to be Oil Free, 10 SCFM @ 100 PSIG with a refrigerated dryer

Silencer Housing Specifications:

Material:	**409L Stainless Steel, Double Wall, Welded Surface Finish**				
Approximate Dimensions L x W x H (inches):	**197**	**x**	**94**	**x**	**71**
Approximate Dimensions L x W x H (mm):	**5,004**	**x**	**2,388**	**x**	**1,803**
Estimated Weight (pounds / kilograms):	**10,000**	**/ 4550**			
Silencer Sound Reduction (dBa):	**27-35**	**Critical Grade Silencing**			
Est. Pressure Drop Silencer+SCR+DPF ("H_2O):	**21.8**	*as configured at rated load or (kPa):*			***5.4***
Inlet Size inches (mm):	**24 (610)**		**Flange**	# of Inlets:	**1**
Outlet Size inches (mm):	**24 (610)**		**Flange**		

This System Includes:

SILENCER - Stainless Steel:	**Yes**	INTERNAL Mixing and DEF Injection:	**Yes**
SCR Catalyst:	**Yes**	Dosing Control Cabinet:	**Yes**
DPF Units:	**Yes**	Operation & Maintenance Manual:	**Yes**
		Start-up Commissioning:	**No**

Notes:

Recommended minimum engine load of 20% and 360 degrees C through the particulate filters to ensure filter regeneration and prevent wet stacking the catalyst. If this is not possible then following 4 hours of cumulative runtime at low loads the engines should be run with at least 50% load for 2 hours to regenerate the filter media.

Terms & Conditions:	***Incoterms:***	**FCA**	**Santa Fe**
Warranty:	**24 months or 8,000 hours of operation, whichever comes first, from date of commissioning**		

Pricing:

	Ref/Cat #	*Closed-Loop System* Description	Quantity	Unit Price	Dealer Net Total (USD)
1	**12041601AE**	CAT® SCR w/ SCR & DPF in a 409L Stainless Steel Double Wall Critical Grade Silencer			
2	**12041601AE-IB**	Custom Insulating Blanket			
				Estimated Freight:	
				Total:	

	Ref/Cat #	*Recommended Equipment:* Description	Quantity	Unit Price	Dealer Net Total (USD)
1	**376-8483**	Atlas Copco SF-4 Air Compressor (typically 460 Volt/ 3 phase, call for options)	**16**		

M310P28768A88160E8459

CATERPILLAR®

Cat 3516C HD 2500 ekW Tier 2 Generator, DM8266

SCR Operation Status*	TMI Potential Site Variation Data						Estimated Reduction at % Load							
	Engine Load	Exhaust Temp	NOx	CO	HC	PM	NOx		CO		HC		PM	
	%	deg C	g/bkW-hr	g/bkW-hr	g/bkW-hr	g/bkW-hr	Reduction %	g/bkW-hr	Reduction %	g/bkW-hr	Reduction %	g/bkW-hr	Reduction %	g/bkW-hr
On	**100%**	491	8.55	1.02	0.19	0.07	85%	1.28	80%	0.20	85%	0.03	85%	0.01
On	**75%**	459	6.90	0.64	0.24	0.07	90%	0.69	80%	0.13	80%	0.05	85%	0.01
On	**50%**	455	5.01	0.78	0.39	0.09	90%	0.50	80%	0.16	80%	0.08	85%	0.01
On	**25%**	444	4.69	1.97	0.54	0.19	90%	0.47	80%	0.39	80%	0.11	85%	0.03
On	**10%**	342	8.67	5.71	1.19	0.39	85%	1.30	80%	1.14	70%	0.36	85%	0.06

**SCR in operation above 330 deg C*

Estimated EPA D2 Cycle 5 Mode Weighted Average									
Engine Load	D2 Cycle Weight	NOx		CO		HC		PM	
%	%	Pre g/bkW-hr	Post g/bkW-hr	Pre g/bkW-hr	Post g/bkW-hr	Pre g/bkW-hr	Post g/bkW-hr	Pre g/bkW-hr	Post g/bkW-hr
100%	**5%**	0.428	0.064	0.051	0.010	0.009	0.001	0.003	0.001
75%	**25%**	1.726	0.173	0.161	0.032	0.060	0.012	0.017	0.003
50%	**30%**	1.504	0.150	0.233	0.047	0.117	0.023	0.028	0.004
25%	**30%**	1.408	0.141	0.591	0.118	0.161	0.032	0.056	0.008
10%	**10%**	0.867	0.130	0.571	0.114	0.119	0.036	0.039	0.006
D2 Average:		**5.932**	**0.658**	**1.607**	**0.321**	**0.466**	**0.105**	**0.143**	**0.022**
EPA Tier 4 Final:			**0.670**		**3.500**		**0.190**		**0.030**

PERFORMANCE DATA[DM9228]

November 27, 2013

Performance Number: DM9228 **Change Level: 01**

SALES MODEL:	3516C	**COMBUSTION:**	DI
ENGINE POWER (BHP):	3,634	**ENGINE SPEED (RPM):**	1,800
GEN POWER WITH FAN (EKW):	2,500.0	**HERTZ:**	60
COMPRESSION RATIO:	14.7	**FAN POWER (HP):**	130.1
APPLICATION:	PACKAGED GENSET	**ASPIRATION:**	TA
RATING LEVEL:	MISSION CRITICAL STANDBY	**AFTERCOOLER TYPE:**	ATAAC
SUB APPLICATION:	STANDARD	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
PUMP QUANTITY:	2	**INLET MANIFOLD AIR TEMP (F):**	122
FUEL TYPE:	DIESEL	**JACKET WATER TEMP (F):**	210.2
MANIFOLD TYPE:	DRY	**TURBO CONFIGURATION:**	PARALLEL
GOVERNOR TYPE:	ADEM3	**TURBO QUANTITY:**	4
ELECTRONICS TYPE:	ADEM3	**TURBOCHARGER MODEL:**	GT6041BN-48T-1.10
CAMSHAFT TYPE:	STANDARD	**CERTIFICATION YEAR:**	2010
IGNITION TYPE:	CI	**CRANKCASE BLOWBY RATE (FT3/HR):**	3,619.4
INJECTOR TYPE:	EUI	**FUEL RATE (RATED RPM) NO LOAD (GAL/HR):**	16.2
FUEL INJECTOR:	2501368	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,539.4
REF EXH STACK DIAMETER (IN):	12		
MAX OPERATING ALTITUDE (FT):	2,953		

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
2,500.0	100	3,633	336	0.334	173.5	78.1	121.9	1,235.6	67.6	915.2
2,250.0	90	3,283	303	0.335	157.1	71.3	119.4	1,190.0	61.3	881.2
2,000.0	80	2,935	271	0.339	142.3	64.3	116.9	1,158.9	55.3	864.0
1,875.0	75	2,760	255	0.342	134.9	60.7	115.8	1,145.6	52.3	858.5
1,750.0	70	2,586	239	0.346	127.6	57.0	114.7	1,133.3	49.3	854.6
1,500.0	60	2,237	207	0.354	113.0	49.5	112.7	1,112.4	43.2	851.2
1,250.0	50	1,889	174	0.365	98.4	41.3	111.0	1,091.8	36.8	850.7
1,000.0	40	1,547	143	0.373	82.5	31.4	109.4	1,061.5	29.3	856.6
750.0	30	1,203	111	0.385	66.2	21.7	107.9	1,010.3	22.1	848.2
625.0	25	1,029	95	0.394	57.9	17.2	107.2	968.3	18.7	831.1
500.0	20	854	79	0.403	49.2	12.7	106.4	902.0	15.5	796.1
250.0	10	497	46	0.441	31.3	4.8	104.1	700.7	9.8	647.3

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
2,500.0	100	3,633	85	466.7	7,212.2	19,578.8	32,046.3	33,260.4	7,001.7	6,362.4
2,250.0	90	3,283	78	443.0	6,831.8	17,980.7	30,219.3	31,318.8	6,593.0	6,013.7
2,000.0	80	2,935	70	417.8	6,404.5	16,560.6	28,284.6	29,277.2	6,151.5	5,625.4
1,875.0	75	2,760	66	404.7	6,173.3	15,893.2	27,261.3	28,202.4	5,928.1	5,427.1
1,750.0	70	2,586	63	391.2	5,929.9	15,232.6	26,196.0	27,086.8	5,698.4	5,222.0
1,500.0	60	2,237	55	363.5	5,411.9	13,879.0	23,947.5	24,739.5	5,205.5	4,779.1
1,250.0	50	1,889	46	334.6	4,843.3	12,413.0	21,444.3	22,133.2	4,657.5	4,283.2
1,000.0	40	1,547	36	297.5	4,121.4	10,609.5	18,262.0	18,840.0	3,963.0	3,647.2
750.0	30	1,203	25	249.8	3,423.0	8,763.8	15,175.3	15,640.3	3,294.6	3,037.8
625.0	25	1,029	21	223.4	3,104.6	7,844.6	13,765.1	14,171.8	2,988.1	2,760.8
500.0	20	854	16	197.2	2,791.2	6,823.5	12,376.2	12,722.2	2,671.7	2,476.1
250.0	10	497	7	152.3	2,237.9	4,800.2	9,917.6	10,136.8	2,132.0	1,999.8

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHUAST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
2,500.0	100	3,633	46,992	9,146	142,265	79,907	19,835	44,723	154,077	372,403	396,702
2,250.0	90	3,283	44,242	8,557	127,929	70,449	17,960	39,380	139,243	337,204	359,207
2,000.0	80	2,935	41,477	8,162	116,879	63,561	16,262	34,167	124,444	305,311	325,233
1,875.0	75	2,760	40,076	8,007	111,588	60,518	15,425	31,612	117,053	289,608	308,505
1,750.0	70	2,586	38,657	7,874	106,293	57,637	14,588	29,085	109,651	273,881	291,752
1,500.0	60	2,237	35,755	7,684	95,729	52,220	12,915	24,201	94,874	242,485	258,307
1,250.0	50	1,889	32,626	7,527	85,184	46,626	11,245	19,401	80,109	211,118	224,893
1,000.0	40	1,547	29,235	7,262	72,693	40,153	9,427	13,873	65,583	176,995	188,544
750.0	30	1,203	25,476	6,784	59,425	32,726	7,565	8,706	51,005	142,037	151,305
625.0	25	1,029	23,394	6,435	52,542	28,568	6,621	6,496	43,653	124,317	132,429
500.0	20	854	21,006	5,995	44,739	23,683	5,624	4,534	36,223	105,594	112,484
250.0	10	497	15,737	5,026	27,795	12,371	3,578	1,916	21,071	67,181	71,564

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	2,500.0	1,875.0	1,250.0	625.0	250.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	3,633	2,760	1,889	1,029	497
TOTAL NOX (AS NO2)		G/HR	22,948	14,101	7,004	3,568	3,185
TOTAL CO		G/HR	2,726	1,304	1,092	1,496	2,098
TOTAL HC		G/HR	500	499	543	408	437
PART MATTER		G/HR	185.5	123.7	132.1	139.5	141.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,818.9	2,229.5	1,544.3	1,352.7	2,230.2
TOTAL CO	(CORR 5% O2)	MG/NM3	351.8	213.9	252.3	594.6	1,552.7
TOTAL HC	(CORR 5% O2)	MG/NM3	55.9	72.8	108.8	140.7	282.4
PART MATTER	(CORR 5% O2)	MG/NM3	19.7	16.5	25.8	48.5	88.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,373	1,086	752	659	1,086
TOTAL CO	(CORR 5% O2)	PPM	281	171	202	476	1,242
TOTAL HC	(CORR 5% O2)	PPM	104	136	203	263	527
TOTAL NOX (AS NO2)		G/HP-HR	6.38	5.15	3.74	3.50	6.47
TOTAL CO		G/HP-HR	0.76	0.48	0.58	1.47	4.26
TOTAL HC		G/HP-HR	0.14	0.18	0.29	0.40	0.89
PART MATTER		G/HP-HR	0.05	0.05	0.07	0.14	0.29
TOTAL NOX (AS NO2)		LB/HR	50.59	31.09	15.44	7.87	7.02
TOTAL CO		LB/HR	6.01	2.88	2.41	3.30	4.62
TOTAL HC		LB/HR	1.10	1.10	1.20	0.90	0.96
PART MATTER		LB/HR	0.41	0.27	0.29	0.31	0.31

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	2,500.0	1,875.0	1,250.0	625.0	250.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	3,633	2,760	1,889	1,029	497
TOTAL NOX (AS NO2)		G/HR	19,123	11,751	5,837	2,974	2,654
TOTAL CO		G/HR	1,515	725	607	831	1,165
TOTAL HC		G/HR	376	375	408	307	329
TOTAL CO2		KG/HR	1,740	1,340	966	559	296
PART MATTER		G/HR	132.5	88.4	94.3	99.6	100.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,349.1	1,857.9	1,286.9	1,127.3	1,858.5
TOTAL CO	(CORR 5% O2)	MG/NM3	195.4	118.8	140.1	330.3	862.6
TOTAL HC	(CORR 5% O2)	MG/NM3	42.1	54.8	81.8	105.8	212.3
PART MATTER	(CORR 5% O2)	MG/NM3	14.1	11.8	18.4	34.7	63.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,144	905	627	549	905
TOTAL CO	(CORR 5% O2)	PPM	156	95	112	264	690
TOTAL HC	(CORR 5% O2)	PPM	79	102	153	197	396
TOTAL NOX (AS NO2)		G/HP-HR	5.32	4.30	3.12	2.92	5.39
TOTAL CO		G/HP-HR	0.42	0.26	0.32	0.82	2.37
TOTAL HC		G/HP-HR	0.10	0.14	0.22	0.30	0.67
PART MATTER		G/HP-HR	0.04	0.03	0.05	0.10	0.20
TOTAL NOX (AS NO2)		LB/HR	42.16	25.91	12.87	6.56	5.85
TOTAL CO		LB/HR	3.34	1.60	1.34	1.83	2.57
TOTAL HC		LB/HR	0.83	0.83	0.90	0.68	0.72
TOTAL CO2		LB/HR	3,836	2,955	2,130	1,233	654
PART MATTER		LB/HR	0.29	0.19	0.21	0.22	0.22
OXYGEN IN EXH		%	9.4	10.4	11.3	12.2	14.4
DRY SMOKE OPACITY		%	1.7	1.4	1.9	2.5	3.8
BOSCH SMOKE NUMBER			0.58	0.49	0.62	0.92	1.27

DIESEL GENERATOR SET

Image shown may not reflect actual package.

Mission Critical Standby
2000 ekW 2500 kVA
60 Hz 1800 rpm 480 Volts

Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.

FEATURES

FUEL/EMISSIONS STRATEGY
- EPA Certified for Stationary Emergency Application (EPA Tier 2 emissions levels)

DESIGN CRITERIA
- The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

UL 2200 / CSA - Optional
- UL 2200 listed packages
- CSA Certified

Certain restrictions may apply.
Consult with your Cat® Dealer.

FULL RANGE OF ATTACHMENTS
- Wide range of bolt-on system expansion attachments, factory designed and tested
- Flexible packaging options for easy and cost effective installation

SINGLE-SOURCE SUPPLIER
- Fully prototype tested with certified torsional vibration analysis available

WORLDWIDE PRODUCT SUPPORT
- Cat dealers provide extensive post sale support including maintenance and repair agreements
- Cat dealers have over 1,800 dealer branch stores operating in 200 countries
- The Cat® S•O•S℠ program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

CAT® 3516C TA DIESEL ENGINE
- Reliable, rugged, durable design
- Field-proven in thousands of applications worldwide
- Four-stroke-cycle diesel engine combines consistent performance and excellent fuel economy with minimum weight

CAT GENERATOR
- Matched to the performance and output characteristics of Cat engines
- Industry leading mechanical and electrical design
- Industry leading motor starting capabilities
- High Efficiency

CAT EMCP 4 CONTROL PANELS
- Simple user friendly interface and navigation
- Scalable system to meet a wide range of customer needs
- Integrated Control System and Communications Gateway

SEISMIC CERTIFICATION
- Seismic Certification available
- Anchoring details are site specific, and are dependent on many factors such as generator set size, weight, and concrete strength.
  IBC Certification requires that the anchoring system used is reviewed and approved by a Professional Engineer
- Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007
- Pre-approved by OSHPD and carries an OSP-0084-10 for use in healthcare projects in California

FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

System	Standard	Optional
Air Inlet	• Air cleaner	
Cooling	• Package mounted radiator	
Exhaust	• Exhaust flange outlet	[ ] Exhaust mufflers (except Tier 4)
Fuel	• Primary fuel filter with integral water separator • Secondary fuel filters • Fuel priming pump	
Generator	• Matched to the performance and output characteristics of Cat engines • Load adjustment module provides engine relief upon load impact and improves laod acceptance and recovery time • IP23 protection	[ ] Oversize and premium generators [ ] Permanent magnet excitation (PMG) [ ] Internal excited (IE) [ ] Anti-condensation space heaters
Power Termination	• Bus bar	[ ] Circuit breakers, UL listed [ ] Circuit breakers, IEC compliant
Control Panel	• EMCP 4 Genset Controller	[ ] EMCP 4.2 [ ] EMCP 4.3 [ ] EMCP 4.4 [ ] Generator temperature monitoring and protection [ ] Load share module [ ] Digital I/O module [ ] Remote monitoring software
Mounting		[ ] Rubber vibration isolators
Starting/Charging		[ ] Battery chargers [ ] Oversize batteries [ ] Jacket water heater [ ] Heavy duty starting system [ ] Charging alternator [ ] Air starting motor with control and silencer (3500 & C175 models only)
General	• Paint - Caterpillar Yellow except rails and radiators gloss black	The following options are based on regional and product configuration: [ ] Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007 [ ] EU Certificate of Conformance (CE) [ ] UL 2200 package [ ] CSA Certification [ ] EEC Declaration of Conformity [ ] Enclosures- sound attenuated, weather protective [ ] Automatic transfer switches (ATS) [ ] Integral & sub-base fuel tanks [ ] Integral & sub-base UL listed dual wall fuel tanks

SPECIFICATIONS

CAT GENERATOR

Cat Generator
Frame size.. 825
Excitation... Permanent Magnet
Pitch... 0.6667
Number of poles.. 4
Number of bearings..................................... Single bearing
Number of Leads... 006
Insulation....................... UL 1446 Recognized Class H with tropicalization and antiabrasion
- Consult your Caterpillar dealer for available voltages
IP Rating.. IP23
Alignment... Pilot Shaft
Overspeed capability... 150
Wave form Deviation (Line to Line)........................... 003.00
Voltage regulator............. 3 Phase sensing with selectible volts/Hz
Voltage regulation............Less than +/- 1/2% (steady state)
Less than +/- 1/2% (w/3% speed change)

CAT DIESEL ENGINE

3516C ATAAC, V-16, 4-Stroke Water-cooled Diesel
Bore... 170.00 mm (6.69 in)
Stroke.. 190.00 mm (7.48 in)
Displacement.. 69.00 L (4210.64 in³)
Compression Ratio... 14.7:1
Aspiration.. TA
Fuel System................................... Electronic unit injection
Governor Type.. ADEM3

CAT EMCP 4 SERIES CONTROLS

EMCP 4 controls including:
- Run / Auto / Stop Control
- Speed and Voltage Adjust
- Engine Cycle Crank
- 24-volt DC operation
- Environmental sealed front face
- Text alarm/event descriptions

Digital indication for:
- RPM
- DC volts
- Operating hours
- Oil pressure (psi, kPa or bar)
- Coolant temperature
- Volts (L-L & L-N), frequency (Hz)
- Amps (per phase & average)
- ekW, kVA, kVAR, kW-hr, %kW, PF

Warning/shutdown with common LED indication of:
- Low oil pressure
- High coolant temperature
- Overspeed
- Emergency stop
- Failure to start (overcrank)
- Low coolant temperature
- Low coolant level

Programmable protective relaying functions:
- Generator phase sequence
- Over/Under voltage (27/59)
- Over/Under Frequency (81 o/u)
- Reverse Power (kW) (32)
- Reverse reactive power (kVAr) (32RV)
- Overcurrent (50/51)

Communications:
- Six digital inputs (4.2 only)
- Four relay outputs (Form A)
- Two relay outputs (Form C)
- Two digital outputs
- Customer data link (Modbus RTU)
- Accessory module data link
- Serial annunciator module data link
- Emergency stop pushbutton

Compatible with the following:
- Digital I/O module
- Local Annunciator
- Remote CAN annunciator
- Remote serial annunciator

Mission Critical Standby 2000 ekW 2500 kVA

60 Hz 1800 rpm 480 Volts

TECHNICAL DATA

Open Generator Set - - 1800 rpm/60 Hz/480 Volts	DM9168	
EPA Certified for Stationary Emergency Application (EPA Tier 2 emissions levels)		
Generator Set Package Performance		
Genset Power rating @ 0.8 pf	2500 kVA	
Genset Power rating with fan	2000 ekW	
Fuel Consumption		
100% load with fan	522.5 L/hr	138.0 Gal/hr
75% load with fan	406.8 L/hr	107.5 Gal/hr
50% load with fan	293.6 L/hr	77.6 Gal/hr
Cooling System[1]		
Air flow restriction (system)	0.12 kPa	0.48 in. water
Engine Coolant capacity with radiator/exp. tank	475.0 L	125.5 gal
Engine coolant capacity	233.0 L	61.6 gal
Radiator coolant capacity	242.0 L	63.9 gal
Inlet Air		
Combustion air inlet flow rate	185.5 m³/min	6550.9 cfm
Exhaust System		
Exhaust stack gas temperature	400.1 ° C	752.2 ° F
Exhaust gas flow rate	433.1 m³/min	15294.8 cfm
Exhaust flange size (internal diameter)	203.2 mm	8.0 in
Exhaust system backpressure (maximum allowable)	6.7 kPa	26.9 in. water
Heat Rejection		
Heat rejection to coolant (total)	759 kW	43164 Btu/min
Heat rejection to exhaust (total)	1788 kW	101683 Btu/min
Heat rejection to aftercooler	672 kW	38217 Btu/min
Heat rejection to atmosphere from engine	133 kW	7564 Btu/min
Heat rejection to atmosphere from generator	107.5 kW	6113.5 Btu/min
Alternator[2]		
Motor starting capability @ 30% voltage dip	4647 skVA	
Frame	825	
Temperature Rise	130 ° C	234 ° F
Lube System		
Sump refill with filter	466.0 L	123.1 gal
Emissions (Nominal)[3]		
NOx g/hp-hr	5.45 g/hp-hr	
CO g/hp-hr	.3 g/hp-hr	
HC g/hp-hr	.11 g/hp-hr	
PM g/hp-hr	.025 g/hp-hr	

[1] For ambient and altitude capabilities consult your Cat dealer. Air flow restriction (system) is added to existing restriction from factory.

[2] Generator temperature rise is based on a 40 degree C ambient per NEMA MG1-32. UL 2200 Listed packages may have oversized generators with a different temperature rise and motor starting characteristics.

[3] Emissions data measurement procedures are consistent with those described in EPA CFR 40 Part 89, Subpart D & E and ISO8178-1 for measuring HC, CO, PM, NOx. Data shown is based on steady state operating conditions of 77ºF, 28.42 in HG and number 2 diesel fuel with 35º API and LHV of 18,390 btu/lb. The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations. Emissions data is based on 100% load and thus cannot be used to compare to EPA regulations which use values based on a weighted cycle.

RATING DEFINITIONS AND CONDITIONS

Applicable Codes and Standards: AS1359, CSA C22.2 No 100-04, UL142, UL489, UL601, UL869, UL2200, NFPA 37, NFPA 70, NFPA 99, NFPA 110, IBC, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, 72/23/EEC, 98/37/EC, 2004/108/EC

Mission Critical Standby - Output available with varying load for the duration of the interruption of the normal source power. Average power output is 85% of the standby power rating. Typical peak demand up to 100% of standby rated ekW for 5% of the operating time. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year.

Ratings are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

Fuel Rates are based on fuel oil of 35° API (16° C or 60° F) gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.).

Additional Ratings may be available for specific customer requirements. Consult your Cat representative for details.

DIMENSIONS

Package Dimensions		
Length	6434.6 mm	253.33 in
Width	2378.7 mm	93.65 in
Height	2958.4 mm	116.47 in

NOTE: For reference only - do not use for installation design. Please contact your local dealer for exact weight and dimensions. (General Dimension Drawing #2846051).

CATERPILLAR

Cat 3516C 2000 ekW Tier 2 Generator, DM8263

SCR Operation Status*	TMI Potential Site Variation Data						Estimated Reduction at % Load							
	Engine Load	Exhaust Temp	NOx	CO	HC	PM	NOx		CO		HC		PM	
	%	*deg C*	*g/bkW-hr*	*g/bkW-hr*	*g/bkW-hr*	*g/bkW-hr*	Reduction %	*g/bkW-hr*	Reduction %	*g/bkW-hr*	Reduction %	*g/bkW-hr*	Reduction %	*g/bkW-hr*
On	**100%**	400	8.77	0.72	0.20	0.05	92%	0.70	80%	0.14	85%	0.03	85%	0.01
On	**75%**	363	6.22	0.51	0.31	0.07	93%	0.44	80%	0.10	80%	0.06	85%	0.01
On	**50%**	346	5.12	0.80	0.46	0.11	93%	0.36	80%	0.16	80%	0.09	85%	0.02
On	**25%**	339	6.76	2.84	0.66	0.42	90%	0.68	80%	0.57	80%	0.13	85%	0.06
OFF	**10%**	289	9.56	5.84	1.45	0.66	80%	1.91	80%	1.17	70%	0.43	85%	0.10

**SCR in operation above 330 deg C*

Using 80% NOx Reduction @ 10% load for D2 Calculations

Estimated EPA D2 Cycle 5 Mode Weighted Average									
Engine Load	D2 Cycle Weight	NOx		CO		HC		PM	
%	*%*	*Pre g/bkW-hr*	*Post g/bkW-hr*	*Pre g/bkW-hr*	*Post g/bkW-hr*	*Pre g/bkW-hr*	*Post g/bkW-hr*	*Pre g/bkW-hr*	*Post g/bkW-hr*
100%	**5%**	0.438	0.035	0.036	0.007	0.010	0.002	0.003	0.000
75%	**25%**	1.555	0.109	0.127	0.025	0.077	0.015	0.017	0.003
50%	**30%**	1.536	0.108	0.241	0.048	0.137	0.027	0.032	0.005
25%	**30%**	2.027	0.203	0.853	0.171	0.197	0.039	0.125	0.019
10%	**10%**	0.956	0.191	0.584	0.117	0.145	0.043	0.066	0.010
D2 Average:		**6.512**	**0.645**	**1.842**	**0.368**	**0.566**	**0.127**	**0.242**	**0.036**
EPA Tier 4 Final:			**0.670**		**3.500**		**0.190**		**0.030**

CATERPILLAR®

CAT® SCR PROPOSAL

Friday, April 18, 2014 Quotation Number: **14022801RW-E** Revision:

SCR & DPF units in a 409L Stainless Steel Double Wall Critical Grade Silencer Housing

Project Description:	**Microsoft Quincy MWH01 - Cat 3516C 2000 ekW Generators**

NC Power Systems
Brant Briody *Email:* bbriody@ncpowersystems.com
Sales Representative *Telephone:* **(425) 656-4587**
17900 W. Valley Highway *Mobile:* **(206) 510-3491**
Tukwila, WA 98188

Application Specifications:

Site Location (Address):	**Quincy Washingtion**		
Environment (Alt,Temp,RH):	**1300 ft, 10 deg to 90 deg F**		
Mounting Location:	**Over Generator**		
Regulation Requirement:	**BACT targeting non-certified Tier 4 Final Levels**		
Average Running Load (%):		Runtime (hr/yr):	**100**
Minimal Operating Load (%):	**30%**	Minimal Exhaust Temp:	**350 deg C**

Engine Specifications: *Quantity 4 CAT, reference # DM8263*

Engine Model Number:	**3516C , Tier 2**			Engine S/N:	**516DE5B**
Generator Power Rating (ekW):	**2,000**	**Standby**		EPA Family #:	
Engine Displacement (liters):	**69**			Model Name:	**Generator**
Max Fuel Sulfur Content (ppm):	**< 50**				
Engine Power Output (bhp):	**2,937**	or	***2191***	***bkW @ 1800 RPM***	
Exhaust Flow Rate (ACFM):	**15,293**	or	***433.0***	***m^3/min***	
Exhaust Stack Temp (deg F):	**752**	or	***400.0***	***deg C***	
Max Exhaust Pressure(" H_2O):	**27**	or	***6.7***	***kPa***	

Estimated Engine Emissions Data:

Requirement	**Emissions Source:**	***Potential Site Variation***	
BACT		***Pre Catalyst***	***Post Catalyst Estimates*****
g/bkW-hr		**g/bkW-hr**	**g/bkW-hr**
0.67	**NOx***	**8.77**	**0.67**
3.50	**CO**	**0.72**	**3.50**
0.19	**HC**	**0.20**	**0.19**
0.03	**PM**	**0.05**	**0.03**

**NOx Reductions will be validated by a calibrated gas analyzer during Dealer Site Commissioning of the CAT SCR System at defined load points and steady-state conditions.*

***Post Catalyst Emissions Reduction based on 100% Load & Engine Rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JAN90 Standard Reference Conditions*

DPF Specifications:

Material:	**Platinum Group Catalyzed Cordierite Ceramic wall-flow filter substrates**	
Number of Filters:	**9**	**FDA221**
Typical Regeneration using ULSD:	Above 350 deg C (662 deg F) for 30% of engine operating time & greater than 40% engine load	
Max Number of Cold Starts:	**12 consecutive 10 minute idle sessions followed by 2 hrs regeneration**	

CATERPILLAR®

SCR Specifications:				
Material:	Extruded Vanadia Substrates		# T6 Modules:	24
Total Amount of Catalyst (cubic ft):	43 (12.2 cubic meters)		# T2 Modules:	48
Number of Catalyst Layers:	3 layers @ 64 blocks/layer	8 wide by 8 high	# T4 Modules:	
Injection Lance:	36 inches (914 mm)			
Approximate DEF Consumption:	8.4 gal/hr or 31.8 liters/hr of 32.5% Technical Grade Urea			
Recommended Reductant:	32.5% DEF (Diesel Exhaust Fluid), Please reference Cat document PELJ1160			
Maximum Ammonia Slip:	Not Specified			

Dosing Control Cabinet: *Nema 12 Enclosure (36" high x 32" wide x 12" deep)*

*Touch Screen Display & Dual NOx Sensors for a True Closed-Loop System
*Controller, Pressure Sensor, Temperature Sensor, Dosing Pump, Pressure Regulator, Secondary Urea Filter
*Power requirement: 240/120 volts AC, 10/20 amps, 50 or 60 Hertz
*Records NOx levels pre and post, Temperature and Pressure, Time and Date
*ModBus Communications Enabled
*Auto Start, Stop and Purge Cycle

Tube Bundle: *Dosing Control Cabinet to Injection Lance*

*1/4" Heat Traced Stainless Steel tubing for DEF Flow
*1/2" Stainless Steel or Poly tubing for Compressed Air

Injection and Mixing Section: *Integrated within the E-POD housing*

*Air & Urea Injection with Static Mixers internal to the SCR Silencer Housing
*Compressed Air requirement to be Oil Free, 10 SCFM @ 100 PSIG with a refrigerated dryer

Silencer Housing Specifications:					
Material:	409L Stainless Steel, Double Wall, Welded Surface Finish				
Approximate Dimensions L x W x H (inches):	182	x	94	x	58
Approximate Dimensions L x W x H (mm):	4,623	x	2,388	x	1,473
Estimated Weight (pounds / kilograms):	10,000	/ 4550			
Silencer Sound Reduction (dBa):	27-35	Critical Grade Silencing			
Est. Pressure Drop Silencer+SCR+DPF ("H_2O):	20.6	as configured at rated load or (kPa):			5.1
Inlet Size inches (mm):	20 (508)		Flange	# of Inlets:	1
Outlet Size inches (mm):	24 (610)		Flange		

This System Includes:			
SILENCER - Stainless Steel:	Yes	INTERNAL Mixing and DEF Injection:	Yes
SCR Catalyst:	Yes	Dosing Control Cabinet:	Yes
DPF Units:	Yes	Operation & Maintenance Manual:	Yes
		Start-up Commissioning:	No

Notes:

Engine should be run with a Load Bank during normal operation to provide minimum of 40% load in order to regenerate the DPF units.

Recommended minimum engine load of 40% and 360 degrees C through the particulate filters to ensure filter regeneration and prevent wet stacking the catalyst. If this is not possible then following 4 hours of cumulative runtime at low loads the engines should be run with at least 60% load for 2 hours to regenerate the filter media.

Terms & Conditions:	***Incoterms:***	**FCA**	**Santa Fe**
Warranty:	**24 months or 8,000 hours of operation, whichever comes first, from date of commissioning**		

Pricing:

	Ref/Cat #	***Closed-Loop System*** **Description**	**Quantity**	**Unit Price**	**Dealer Net Total (USD)**
1	**12080201AE**	CAT® SCR w/ SCR & DPF in a 409L Stainless Steel Double Wall Critical Grade Silencer			
2	**12080201AE-IB**	Custom Insulating Blanket			
				Estimated Freight:	
				Total:	

	Ref/Cat #	***Recommended Equipment:*** **Description**	**Quantity**	**Unit Price**	**Dealer Net Total (USD)**
1	**376-8483**	Atlas Copco SF-4 Air Compressor (typically 460 Volt/ 3 phase, call for options)			

M312P33992A93752E9370

PERFORMANCE DATA[DM8263]

Performance Number: DM8263 **Change Level: 03**

SALES MODEL:	3516C	**COMBUSTION:**	DI
ENGINE POWER (BHP):	2,937	**ENGINE SPEED (RPM):**	1,800
GEN POWER WITH FAN (EKW):	2,000.0	**HERTZ:**	60
COMPRESSION RATIO:	14.7	**FAN POWER (HP):**	114.0
APPLICATION:	PACKAGED GENSET	**ASPIRATION:**	TA
RATING LEVEL:	STANDBY	**AFTERCOOLER TYPE:**	ATAAC
SUB APPLICATION:	STANDARD	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
PUMP QUANTITY:	2	**INLET MANIFOLD AIR TEMP (F):**	122
FUEL TYPE:	DIESEL	**JACKET WATER TEMP (F):**	210.2
MANIFOLD TYPE:	DRY	**TURBO CONFIGURATION:**	PARALLEL
GOVERNOR TYPE:	ADEM3	**TURBO QUANTITY:**	4
ELECTRONICS TYPE:	ADEM3	**TURBOCHARGER MODEL:**	GTA5518BN-56T-1.12
CAMSHAFT TYPE:	STANDARD	**CERTIFICATION YEAR:**	2006
IGNITION TYPE:	CI	**CRANKCASE BLOWBY RATE (FT3/HR):**	2,937.9
INJECTOR TYPE:	EUI	**FUEL RATE (RATED RPM) NO LOAD (GAL/HR):**	13.7
FUEL INJECTOR:	2664387	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,244.1
REF EXH STACK DIAMETER (IN):	12		
MAX OPERATING ALTITUDE (FT):	3,117		

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
2,000.0	100	2,937	307	0.329	138.0	78.3	121.2	1,118.5	71.5	752.1
1,800.0	90	2,641	276	0.331	124.9	73.1	119.6	1,067.5	65.7	716.0
1,600.0	80	2,353	246	0.337	113.1	68.0	118.2	1,027.0	60.0	693.3
1,500.0	75	2,212	231	0.340	107.5	65.2	117.5	1,008.1	57.2	684.6
1,400.0	70	2,071	216	0.344	101.8	62.3	116.8	989.4	54.4	676.9
1,200.0	60	1,795	188	0.352	90.1	55.5	115.4	952.0	48.0	662.8
1,000.0	50	1,521	159	0.357	77.5	46.5	113.7	913.4	40.1	654.0
800.0	40	1,250	131	0.357	63.8	34.8	111.8	863.8	30.3	655.0
600.0	30	977	102	0.365	50.9	24.2	110.6	803.8	22.0	650.0
500.0	25	839	88	0.374	44.8	19.7	110.2	767.0	18.7	641.7
400.0	20	699	73	0.388	38.8	15.7	109.8	724.6	15.7	629.0
200.0	10	411	43	0.450	26.4	9.0	109.1	596.9	10.9	552.8

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
2,000.0	100	2,937	83	454.3	6,548.9	15,292.8	28,512.8	29,478.4	6,205.0	5,738.7
1,800.0	90	2,641	77	428.8	6,318.7	14,243.0	27,390.5	28,264.7	5,956.5	5,533.7
1,600.0	80	2,353	72	404.5	6,073.3	13,331.0	26,220.6	27,012.9	5,685.0	5,301.6
1,500.0	75	2,212	69	392.7	5,932.2	12,897.9	25,568.0	26,319.7	5,542.0	5,176.6
1,400.0	70	2,071	66	380.9	5,777.2	12,448.0	24,862.1	25,573.8	5,384.8	5,037.5
1,200.0	60	1,795	59	353.9	5,397.2	11,422.5	23,141.0	23,771.1	5,003.4	4,694.0
1,000.0	50	1,521	50	318.8	4,857.3	10,138.7	20,731.5	21,274.5	4,476.2	4,208.4
800.0	40	1,250	38	271.1	4,090.0	8,488.8	17,357.1	17,803.6	3,744.5	3,524.2
600.0	30	977	27	225.0	3,394.1	6,989.6	14,328.5	14,684.4	3,097.0	2,920.6
500.0	25	839	22	204.1	3,103.5	6,328.1	13,075.2	13,388.4	2,825.1	2,668.8
400.0	20	699	18	184.1	2,840.4	5,696.0	11,947.2	12,218.4	2,572.5	2,435.7
200.0	10	411	11	148.5	2,409.4	4,478.2	10,105.7	10,290.7	2,174.6	2,076.8

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHUAST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
2,000.0	100	2,937	43,150	7,564	101,696	49,615	15,778	38,240	124,558	296,234	315,563
1,800.0	90	2,641	40,179	7,175	92,069	43,106	14,280	34,105	111,977	268,102	285,596
1,600.0	80	2,353	37,427	6,907	84,225	38,510	12,931	30,201	99,774	242,774	258,615
1,500.0	75	2,212	36,092	6,791	80,632	36,523	12,286	28,303	93,784	230,664	245,715
1,400.0	70	2,071	34,737	6,671	77,064	34,629	11,640	26,432	87,835	218,548	232,809
1,200.0	60	1,795	31,877	6,341	69,432	30,722	10,302	22,179	76,103	193,426	206,048
1,000.0	50	1,521	28,631	6,026	60,835	26,675	8,865	17,129	64,508	166,434	177,294
800.0	40	1,250	24,910	5,810	50,784	22,387	7,288	11,280	53,005	136,837	145,766
600.0	30	977	21,252	5,496	41,420	18,139	5,820	6,677	41,431	109,268	116,397
500.0	25	839	19,405	5,303	37,082	16,055	5,124	4,986	35,574	96,210	102,488
400.0	20	699	17,492	5,098	32,738	13,986	4,431	3,593	29,634	83,193	88,622
200.0	10	411	13,286	4,670	23,481	8,473	3,022	1,516	17,448	56,745	60,447

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**2,000.0**	**1,500.0**	**1,000.0**	**500.0**	**200.0**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**2,937**	**2,212**	**1,521**	**839**	**411**
TOTAL NOX (AS NO2)		G/HR	19,098	10,213	5,798	4,218	2,932
TOTAL CO		G/HR	1,564	847	905	1,772	1,794
TOTAL HC		G/HR	423	513	512	409	443
PART MATTER		G/HR	103.2	99.5	123.9	256.7	203.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,299.4	2,320.1	1,852.8	2,379.4	2,855.8
TOTAL CO	(CORR 5% O2)	MG/NM3	257.0	181.1	277.5	896.4	1,715.8
TOTAL HC	(CORR 5% O2)	MG/NM3	60.1	93.7	132.1	194.2	379.5
PART MATTER	(CORR 5% O2)	MG/NM3	14.4	18.5	35.1	120.0	161.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,607	1,130	902	1,159	1,391
TOTAL CO	(CORR 5% O2)	PPM	206	145	222	717	1,373
TOTAL HC	(CORR 5% O2)	PPM	112	175	247	363	708
TOTAL NOX (AS NO2)		G/HP-HR	6.54	4.64	3.82	5.04	7.13
TOTAL CO		G/HP-HR	0.54	0.38	0.60	2.12	4.36
TOTAL HC		G/HP-HR	0.15	0.23	0.34	0.49	1.08
PART MATTER		G/HP-HR	0.04	0.05	0.08	0.31	0.49
TOTAL NOX (AS NO2)		LB/HR	42.10	22.52	12.78	9.30	6.46
TOTAL CO		LB/HR	3.45	1.87	2.00	3.91	3.95
TOTAL HC		LB/HR	0.93	1.13	1.13	0.90	0.98
PART MATTER		LB/HR	0.23	0.22	0.27	0.57	0.45

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**2,000.0**	**1,500.0**	**1,000.0**	**500.0**	**200.0**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**2,937**	**2,212**	**1,521**	**839**	**411**
TOTAL NOX (AS NO2)		G/HR	15,915	8,511	4,832	3,515	2,443
TOTAL CO		G/HR	869	471	503	984	997
TOTAL HC		G/HR	318	385	385	308	333
TOTAL CO2		KG/HR	1,383	1,068	762	430	250
PART MATTER		G/HR	73.7	71.1	88.5	183.4	145.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,749.5	1,933.4	1,544.0	1,982.8	2,379.8
TOTAL CO	(CORR 5% O2)	MG/NM3	142.8	100.6	154.2	498.0	953.2
TOTAL HC	(CORR 5% O2)	MG/NM3	45.2	70.4	99.3	146.0	285.3
PART MATTER	(CORR 5% O2)	MG/NM3	10.3	13.2	25.1	85.7	115.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,339	942	752	966	1,159
TOTAL CO	(CORR 5% O2)	PPM	114	80	123	398	763
TOTAL HC	(CORR 5% O2)	PPM	84	131	185	273	533
TOTAL NOX (AS NO2)		G/HP-HR	5.45	3.87	3.19	4.20	5.94
TOTAL CO		G/HP-HR	0.30	0.21	0.33	1.18	2.42
TOTAL HC		G/HP-HR	0.11	0.18	0.25	0.37	0.81
PART MATTER		G/HP-HR	0.03	0.03	0.06	0.22	0.35
TOTAL NOX (AS NO2)		LB/HR	35.09	18.76	10.65	7.75	5.39
TOTAL CO		LB/HR	1.92	1.04	1.11	2.17	2.20
TOTAL HC		LB/HR	0.70	0.85	0.85	0.68	0.73
TOTAL CO2		LB/HR	3,049	2,356	1,681	947	551
PART MATTER		LB/HR	0.16	0.16	0.20	0.40	0.32
OXYGEN IN EXH		%	10.8	12.3	13.3	14.2	15.8
DRY SMOKE OPACITY		%	0.3	0.5	1.2	3.7	3.0
BOSCH SMOKE NUMBER			0.15	0.21	0.43	1.25	1.12

Regulatory Information

EPA TIER 2		2006 - 2010		
GASEOUS EMISSIONS DATA MEASUREMENTS ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 89 SUBPART D AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. GASEOUS EMISSIONS VALUES ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE NON-ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	NON-ROAD	TIER 2	CO: 3.5 NOx + HC: 6.4 PM: 0.20

EPA EMERGENCY STATIONARY		2011 - ----		
GASEOUS EMISSIONS DATA MEASUREMENTS ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. GASEOUS EMISSIONS LIMIT VALUES ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE NON-ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 6.4 PM: 0.20

DIESEL GENERATOR SET

Image shown may not reflect actual package.

MISSION CRITICAL

750 ekW 938 kVA
60 Hz 1800rpm 480 Volts

Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.

FEATURES

FUEL/EMISSIONS STRATEGY
- EPA Certified for Stationary Emergency Application (EPA Tier 2 emissions levels)

DESIGN CRITERIA
- The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

UL 2200/ CSA - Optional
- UL 2200 listed packages
- CSA Certified

Certain restrictions may apply. Consult with your Cat® Dealer.

FULL RANGE OF ATTACHMENTS
- Wide range of bolt-on system expansion attachments, factory designed and tested
- Flexible packaging options for easy and cost effective installation

SINGLE-SOURCE SUPPLIER
- Fully prototype tested with certified torsional vibration analysis available

WORLDWIDE PRODUCT SUPPORT
- Cat dealers provide extensive post sale support including maintenance and repair agreements
- Cat dealers have over 1,800 dealer branch stores operating in 200 countries
- The Cat® S•O•S℠ program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

CAT® C27 ATAAC DIESEL ENGINE
- Utilizes ACERT™ Technology
- Reliable, rugged, durable design
- Four-cycle diesel engine combines consistent performance and excellent fuel economy with minimum weight
- Electronic engine control

CAT GENERATOR
- Designed to match the performance and output characteristics of Cat diesel engines
- Single point access to accessory connections
- UL 1446 recognized Class H insulation

CAT EMCP 4 CONTROL PANELS
- Simple user friendly interface and navigation
- Scalable system to meet a wide range of customer needs
- Integrated Control System and Communications Gateway

SEISMIC CERTIFICATION
- Seismic Certification available
- Anchoring details are site specific, and are dependent on many factors such as generator set size, weight, and concrete strength. IBC Certification requires that the anchoring system used is reviewed and approved by a Professional Engineer
- Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007
- Pre-approved by OSHPD and carries an OSP-0084-10 for use in healthcare projects in California

FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

System	Standard	Optional
Air Inlet	• Air cleaner	
Cooling	• Package mounted radiator	
Exhaust	• Exhaust flange outlet	[ ] Exhaust mufflers
Fuel	• Primary fuel filter with integral water separator • Secondary fuel filters • Fuel priming pump	
Generator	• Matched to the performance and output characteristics of Cat engines	[ ] Oversize and premium generators [ ] Permanent magnet excitation (PMG) [ ] Internal excited (IE) [ ] Anti-condensation space heaters
Power Termination	• Bus bar	[ ] Circuit breakers, UL listed [ ] Circuit breakers, IEC compliant
Control Panel	• EMCP 4 Genset Controller	[ ] EMCP 4.2 [ ] EMCP 4.3 [ ] EMCP 4.4 [ ] Generator temperature monitoring and protection [ ] Load share module [ ] Digital I/O module [ ] Remote monitoring software
Mounting		[ ] Rubber vibration isolators
Starting/Charging		[ ] Battery chargers [ ] Oversize batteries [ ] Jacket water heater [ ] Heavy duty starting system [ ] Charging alternator
General	• Paint - Caterpillar Yellow except rails and radiators gloss black	The following options are based on regional and product configuration: [ ] Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007 [ ] EU Certificate of Conformance (CE) [ ] UL 2200 package [ ] CSA Certification [ ] EEC Declaration of Conformity [ ] Enclosures- sound attenuated, weather protective [ ] Automatic transfer switches (ATS) [ ] Integral & sub-base fuel tanks [ ] Integral & sub-base UL listed dual wall fuel tanks

SPECIFICATIONS

CAT GENERATOR

Frame size 1296
Excitation .... Permanent Magnet
Pitch 0.6667
Number of poles 4
Number of bearings .... Single bearing
Number of Leads 012
Insulation .... UL 1446 Recognized Class H with tropicalization and antiabrasion
- Consult your Caterpillar dealer for available voltages
IP Rating ....Drip Proof IP23
Alignment .... Pilot Shaft
Overspeed capability 150
Wave form Deviation (Line to Line) ....Less than 5% deviation
Voltage regulator.................. 3 Phase sensing with selectible volts/Hz
Voltage regulation ....Less than +/- 1/2% (steady state)
Less than +/- 1% (no load to full load)

CAT DIESEL ENGINE

C27 TA, V-12, 4-Stroke Water-cooled Diesel
Bore .... 137.20 mm (5.4 in)
Stroke .... 152.40 mm (6.0 in)
Displacement ....27.03 L (1649.47 in^3)
Compression Ratio 16.5:1
Aspiration .... TA
Fuel System .... MEUI
Governor Type .... ADEM™ A4

CAT EMCP 4 SERIES CONTROLS

EMCP 4 controls including:
- Run / Auto / Stop Control
- Speed and Voltage Adjust
- Engine Cycle Crank
- 24-volt DC operation
- Environmental sealed front face
- Text alarm/event descriptions

Digital indication for:
- RPM
- DC volts
- Operating hours
- Oil pressure (psi, kPa or bar)
- Coolant temperature
- Volts (L-L & L-N), frequency (Hz)
- Amps (per phase & average)
- ekW, kVA, kVAR, kW-hr, %kW, PF

Warning/shutdown with common LED indication of:
- Low oil pressure
- High coolant temperature
- Overspeed
- Emergency stop
- Failure to start (overcrank)
- Low coolant temperature
- Low coolant level

Programmable protective relaying functions:
- Generator phase sequence
- Over/Under voltage (27/59)
- Over/Under Frequency (81 o/u)
- Reverse Power (kW) (32)
- Reverse reactive power (kVAr) (32RV)
- Overcurrent (50/51)

Communications:
- Six digital inputs (4.2 only)
- Four relay outputs (Form A)
- Two relay outputs (Form C)
- Two digital outputs
- Customer data link (Modbus RTU)
- Accessory module data link
- Serial annunciator module data link
- Emergency stop pushbutton

Compatible with the following:
- Digital I/O module
- Local Annunciator
- Remote CAN annunciator
- Remote serial annunciator

MISSION CRITICAL 750ekW 938kVA

60Hz 1800rpm 480Volts

TECHNICAL DATA

Open Generator Set - - 1800rpm/60 Hz/480 Volts	DM9071	
EPA Certified for Stationary Emergency Application		
(EPA Tier 2 emissions levels)		
Generator Set Package Performance		
Genset Power rating @ 0.8 pf	937.5 kVA	
Genset Power rating with fan	750 ekW	
Fuel Consumption		
100% load with fan	202.9 L/hr	53.6 Gal/hr
75% load with fan	162.4 L/hr	42.9 Gal/hr
50% load with fan	116.2 L/hr	30.7 Gal/hr
Cooling System [1]		
Air flow restriction (system)	0.12 kPa	0.48 in. water
Engine coolant capacity	55.0 L	14.5 gal
Inlet Air		
Combustion air inlet flow rate	58.7 m^3/min	2073.0 cfm
Exhaust System		
Exhaust stack gas temperature	509.3 °C	948.7 °F
Exhaust gas flow rate	158.9 m^3/min	5611.5 cfm
Exhaust flange size (internal diameter)	203 mm	8 in
Exhaust system backpressure (maximum allowable)	10.0 kPa	40.2 in. water
Heat Rejection		
Heat rejection to coolant (total)	324 kW	18426 Btu/min
Heat rejection to exhaust (total)	742 kW	42197 Btu/min
Heat rejection to aftercooler	138 kW	7848 Btu/min
Heat rejection to atmosphere from engine	100 kW	5687 Btu/min
Heat rejection to atmosphere from generator	56.5 kW	3216.0 Btu/min
Alternator [2]		
Motor starting capability @ 30% voltage dip	2117 skVA	
Frame	1296	
Temperature Rise	150 °C	270 °F
Lube System		
Sump refill with filter	68.0 L	18.0 gal
Emissions (Nominal) [3]		
NOx g/hp-hr	5.25 g/hp-hr	
CO g/hp-hr	.25 g/hp-hr	
HC g/hp-hr	.03 g/hp-hr	
PM g/hp-hr	.021 g/hp-hr	

[1] For ambient and altitude capabilities consult your Cat dealer. Air flow restriction (system) is added to existing restriction from factory.

[2] Generator temperature rise is based on a 40°C ambient per NEMA MG1-32. UL 2200 Listed packages may have oversized generators with a different temperature rise and motor starting characteristics.

[3] Emissions data measurement procedures are consistent with those described in EPA CFR 40 Part 89, Subpart D & E and ISO8178-1 for measuring HC, CO, PM, NOx. Data shown is based on steady state operating conditions of 77°F, 28.42 in HG and number 2 diesel fuel with 35° API and LHV of 18,390 btu/lb. The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations. Emissions data is based on 100% load and thus cannot be used to compare to EPA regulations which use values based on a weighted cycle.

CATERPILLAR®

Cat C27 750 ekW Tier 2 Generator, DM9071

SCR Operation Status*	TMI Potential Site Variation Data						Estimated Reduction at % Load							
	Engine Load	Exhaust Temp	NOx	CO	HC	PM	NOx		CO		HC		PM	
	%	deg C	g/bkW-hr	g/bkW-hr	g/bkW-hr	g/bkW-hr	Reduction %	g/bkW-hr	Reduction %	g/bkW-hr	Reduction %	g/bkW-hr	Reduction %	g/bkW-hr
On	**100%**	509	8.51	0.62	0.07	0.05	93%	0.60	80%	0.12	80%	0.01	85%	0.01
On	**75%**	489	6.38	1.05	0.12	0.09	92%	0.51	80%	0.21	80%	0.02	85%	0.01
On	**50%**	452	5.75	1.43	0.21	0.32	92%	0.46	80%	0.29	80%	0.04	85%	0.05
On	**25%**	366	6.78	2.01	0.32	0.43	90%	0.68	80%	0.40	70%	0.10	85%	0.06
OFF	**10%**	278	8.74	3.70	0.67	0.52	80%	1.75	70%	1.11	60%	0.27	85%	0.08

**SCR in operation above 330 deg C*

***80% NOx Reduction used for 10% load D2 Calculation as per bid spec*

Estimated EPA D2 Cycle 5 Mode Weighted Average									
Engine Load	D2 Cycle Weight	NOx		CO		HC		PM	
%	%	Pre g/bkW-hr	Post g/bkW-hr	Pre g/bkW-hr	Post g/bkW-hr	Pre g/bkW-hr	Post g/bkW-hr	Pre g/bkW-hr	Post g/bkW-hr
100%	**5%**	0.43	0.03	0.03	0.01	0.00	0.00	0.00	0.00
75%	**25%**	1.60	0.13	0.26	0.05	0.03	0.01	0.02	0.00
50%	**30%**	1.73	0.14	0.43	0.09	0.06	0.01	0.10	0.01
25%	**30%**	2.03	0.20	0.60	0.12	0.10	0.03	0.13	0.02
10%	**10%**	0.87	0.17	0.37	0.11	0.07	0.03	0.05	0.01
D2 Average:		**6.65**	**0.67**	**1.70**	**0.38**	**0.26**	**0.08**	**0.30**	**0.05**
EPA Tier 4 Final:			**0.67**		**3.50**		**0.19**		**0.03**

CATERPILLAR®

CAT® SCR PROPOSAL

Friday, April 18, 2014 Quotation Number: **13112201RW-E** Revision: **1**

SCR & DPF units in a 409L Stainless Steel Double Wall Critical Grade Silencer Housing

Project Description: **Microsoft Quincy MWH01- C27 750 ekW Generator**

NC Power Systems
Brant Briody
Sales Representative
17900 W. Valley Highway
Tukwila, WA 98188

Email: bbriody@ncpowersystems.com
Telephone: **(425) 656-4587**
Mobile: **(206) 510-3491**

Application Specifications:

Site Location (Address):	**Quincy Washingtion**		
Environment (Alt,Temp,RH):	**1300 ft, 10 deg to 90 deg F**		
Mounting Location:	**Over Generator**		
Regulation Requirement:	**BACT targeting non-certified Tier 4 Final Levels**		
Average Running Load (%):	**?**	Runtime (hr/yr):	**100**
Minimal Operating Load (%):	**30%**	Minimal Exhaust Temp:	**375 deg C**

Engine Specifications: *Quantity 1* *CAT, reference # DM9071*

Engine Model Number:	**C27, Tier 2**			Engine S/N:	**MJE02012**
Generator Power Rating (ekW):	**750**	**Standby**		EPA Family #:	**ACPXL27.0ESW**
Engine Displacement (liters):	**27**			Model Name:	**Generator**
Max Fuel Sulfur Content (ppm):	**< 50**				
Engine Power Output (bhp):	**1,141**	or	***851***	***bkW @ 1800 RPM***	
Exhaust Flow Rate (ACFM):	**5,610**	or	***158.9***	***m^3/min***	
Exhaust Stack Temp (deg F):	**949**	or	***509.4***	***deg C***	
Max Exhaust Pressure(" H_2O):	**40**	or	***10.0***	***kPa***	

Estimated Engine Emissions Data:

Requirement	Emissions Source:	*Potential Site Variation*	
BACT		***Pre Catalyst***	***Post Catalyst Estimates****
g/bkW-hr		**g/bkW-hr**	**g/bkW-hr**
0.67	**NOx***	**6.65**	**0.67**
3.50	**CO**	**1.70**	**3.50**
0.19	**HC**	**0.26**	**0.19**
0.03	**PM**	**0.30**	**0.03**

**NOx Reductions will be validated by a calibrated gas analyzer during Dealer Site Commissioning of the CAT SCR System at defined load points and steady-state conditions.*

***Post Catalyst Emissions Reduction based on 100% Load, ISO conditions*

DPF Specifications:

Material:	**Platinum Group Catalyzed Cordierite Ceramic wall-flow filter substrates**	
Number of Filters:	**3**	**FDA221**
Typical Regeneration using ULSD:	Above 375 deg C (707 deg F) for 30% of engine operating time & greater than 40% engine load	
Max Number of Cold Starts:	**12 consecutive 10 minute idle sessions followed by 2 hrs regeneration**	

CATERPILLAR

SCR Specifications:

Material:	**Iron Zeolite Catalyzed Cordierite Ceramic Substrates**		# T6 Modules:	**36**
Total Amount of Catalyst (cubic ft):	**17 (4.8 cubic meters)**		# T2 Modules:	
Number of Catalyst Layers:	**3 layers @ 24 blocks/layer**	***4 wide by 6 high***	# T4 Modules:	
Injection Lance:	**36 inches (914 mm)**			
Approximate DEF Consumption:	**2.5 gal/hr or 9.4 liters/hr of 32.5% Technical Grade Urea**			
Recommended Reductant:	***32.5% DEF (Diesel Exhaust Fluid), Please reference Cat document PELJ1160***			
Maximum Ammonia Slip:	***Not Specified***			

Dosing Control Cabinet: ***Nema 12 Enclosure (36" high x 32" wide x 12" deep)***

*Touch Screen Display & Dual NOx Sensors for a True Closed-Loop System
*Controller, Pressure Sensor, Temperature Sensor, Dosing Pump, Pressure Regulator, Secondary Urea Filter
*Power requirement: 240/120 volts AC, 10/20 amps, 50 or 60 Hertz
*Records NOx levels pre and post, Temperature and Pressure, Time and Date
*ModBus Communications Enabled
*Auto Start, Stop and Purge Cycle

Tube Bundle: ***Dosing Control Cabinet to Injection Lance***

*1/4" Heat Traced Stainless Steel tubing for DEF Flow
*1/2" Stainless Steel or Poly tubing for Compressed Air

Injection and Mixing Section: ***Integrated within the E-POD housing***

*Air & Urea Injection with Static Mixers internal to the SCR Silencer Housing
*Compressed Air requirement to be Oil Free, 10 SCFM @ 100 PSIG with a refrigerated dryer

Silencer Housing Specifications:

Material:	**409L Stainless Steel, Double Wall, Welded Surface Finish**				
Approximate Dimensions L x W x H (inches):	**120**	**x**	**80**	**x**	**45**
Approximate Dimensions L x W x H (mm):	**3,048**	**x**	**2,032**	**x**	**1,143**
Estimated Weight (pounds / kilograms):	**4,400**	**/ 2000**			
Silencer Sound Reduction (dBa):	**27-35**	**Critical Grade Silencing**			
Est. Pressure Drop Silencer+SCR+DPF ("H_2O):	**20.9**	*as configured at rated load or (kPa):*			***5.2***
Inlet Size inches (mm):	**12 (305)**		**Flange**	# of Inlets:	**1**
Outlet Size inches (mm):	**12 (305)**		**Flange**		

This System Includes:

SILENCER - Stainless Steel:	**Yes**	INTERNAL Mixing and DEF Injection:	**Yes**
SCR Catalyst:	**Yes**	Dosing Control Cabinet:	**Yes**
DPF Units:	**Yes**	Operation & Maintenance Manual:	**Yes**
		Start-up Commissioning:	**No**

This System Excludes:

Delivery/Freight Expenses, Consumables and Utilities
Installation and supply of interconnecting power, control cables, conduit, reductant tanks, plumbing, supply pumps, etc.
Installation, Commissioning of the Proposed System and any required permitting
Exhaust piping insulation *(Recommend insulating the exhaust from the engine to the inlet of the emissions control system)*

CATERPILLAR®

Notes:

Recommended minimum engine load of 30% and 375 degrees C through the particulate filters to ensure filter regeneration and prevent wet stacking the catalyst. If this is not possible then following 4 hours of cumulative runtime at low loads the engines should be run with at least 50% load for 2 hours to regenerate the filter media.

Terms & Conditions:	***Incoterms:***	**FCA**	**Santa Fe**
Warranty:	**24 months or 8,000 hours of operation, whichever comes first, from date of commissioning**		

Pricing:

	Closed-Loop System				**Dealer Net**
	Ref/Cat #	**Description**	**Quantity**	**Unit Price**	**Total (USD)**
1	**12031201AE**	**CAT® SCR w/ SCR & DPF in a 409L Stainless Steel Double Wall Critical Grade Silencer**			
2	**12031201AE-IB**	**Custom Insulating Blanket**			
			Estimated Freight:		
				Total:	

	Recommended Equipment:				**Dealer Net**
	Ref/Cat #	**Description**	**Quantity**	**Unit Price**	**Total (USD)**
1	**376-8483**	Atlas Copco SF-4 Air Compressor (typically 460 Volt/ 3 phase, call for options)			

M315P32175A73952E7759

PERFORMANCE DATA[DM9071]

November 26, 2013

Performance Number: DM9071 **Change Level: 02**

SALES MODEL:	C27
ENGINE POWER (BHP):	1,141
GEN POWER WITH FAN (EKW):	750.0
COMPRESSION RATIO:	16.5
APPLICATION:	PACKAGED GENSET
RATING LEVEL:	STANDBY
SUB APPLICATION:	STANDARD
PUMP QUANTITY:	1
FUEL TYPE:	DIESEL
MANIFOLD TYPE:	DRY
GOVERNOR TYPE:	ADEM4
ELECTRONICS TYPE:	ADEM4
IGNITION TYPE:	CI
INJECTOR TYPE:	EUI
REF EXH STACK DIAMETER (IN):	10
MAX OPERATING ALTITUDE (FT):	10,000
COMBUSTION:	DI
ENGINE SPEED (RPM):	1,800
HERTZ:	60
FAN POWER (HP):	37.5
ADDITIONAL PARASITICS (HP):	52.7
ASPIRATION:	TA
AFTERCOOLER TYPE:	ATAAC
AFTERCOOLER CIRCUIT TYPE:	JW+OC, ATAAC
INLET MANIFOLD AIR TEMP (F):	120
JACKET WATER TEMP (F):	210.2
TURBO CONFIGURATION:	PARALLEL
TURBO QUANTITY:	2
TURBOCHARGER MODEL:	GTA5008BS-56T-1.60
CERTIFICATION YEAR:	2006
PISTON SPD @ RATED ENG SPD (FT/MIN):	1,800.0

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
750.0	100	1,141	305	0.329	53.6	52.6	120.7	1,210.7	36.7	948.7
675.0	90	1,036	276	0.333	49.3	48.2	117.3	1,184.5	33.3	935.9
600.0	80	931	248	0.339	45.0	43.6	114.3	1,157.5	30.1	920.5
562.5	75	878	234	0.342	42.9	41.2	112.8	1,143.4	28.5	911.5
525.0	70	826	220	0.344	40.6	38.3	110.7	1,127.0	26.5	902.0
450.0	60	722	193	0.346	35.7	31.9	105.8	1,084.0	22.3	877.6
375.0	50	618	165	0.348	30.7	25.3	100.8	1,028.5	18.0	845.1
300.0	40	516	138	0.350	25.8	19.1	97.6	957.6	14.1	798.9
225.0	30	413	110	0.356	21.0	13.6	95.6	866.3	10.9	731.9
187.5	25	361	96	0.361	18.7	11.0	94.8	813.1	9.5	691.2
150.0	20	309	82	0.368	16.3	8.6	94.0	754.4	8.2	645.3
75.0	10	201	54	0.403	11.6	4.9	92.4	617.0	6.1	532.3

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
750.0	100	1,141	55	340.2	2,073.6	5,610.2	8,929.7	9,304.9	1,958.6	1,773.7
675.0	90	1,036	51	321.4	1,972.9	5,269.2	8,478.1	8,823.2	1,856.4	1,685.5
600.0	80	931	46	304.2	1,874.4	4,932.9	8,053.0	8,368.4	1,757.3	1,600.2
562.5	75	878	43	295.1	1,825.8	4,766.3	7,827.5	8,127.9	1,709.1	1,558.8
525.0	70	826	40	282.3	1,763.3	4,540.6	7,544.0	7,828.2	1,639.5	1,497.3
450.0	60	722	34	253.9	1,610.3	4,039.0	6,871.8	7,121.9	1,485.0	1,359.5
375.0	50	618	27	225.6	1,444.6	3,541.1	6,147.8	6,362.8	1,334.4	1,225.1
300.0	40	516	21	197.9	1,288.0	3,054.4	5,467.1	5,647.9	1,193.2	1,099.5
225.0	30	413	15	170.0	1,143.5	2,567.6	4,844.7	4,992.1	1,059.4	981.2
187.5	25	361	12	155.9	1,073.8	2,322.4	4,546.8	4,677.5	992.1	921.8
150.0	20	309	10	141.7	1,005.3	2,074.6	4,256.4	4,370.3	923.1	860.8
75.0	10	201	6	120.2	905.7	1,659.5	3,831.9	3,913.1	822.6	775.2

PERFORMANCE DATA[DM9071]

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHUAST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
750.0	100	1,141	18,420	5,664	42,192	23,831	6,126	7,849	48,396	115,016	122,520
675.0	90	1,036	17,400	5,193	39,249	22,066	5,635	6,930	43,919	105,788	112,691
600.0	80	931	16,092	4,896	36,354	20,327	5,147	6,123	39,470	96,630	102,935
562.5	75	878	15,154	5,120	34,836	19,404	4,904	5,715	37,253	92,070	98,078
525.0	70	826	14,494	5,043	33,095	18,346	4,642	5,184	35,034	87,162	92,850
450.0	60	722	13,468	4,399	29,123	15,903	4,084	4,077	30,613	76,677	81,680
375.0	50	618	11,700	4,303	24,895	13,283	3,509	3,072	26,205	65,876	70,174
300.0	40	516	10,463	3,778	20,710	10,638	2,951	2,194	21,876	55,406	59,021
225.0	30	413	9,817	2,772	16,546	7,940	2,405	1,443	17,528	45,159	48,105
187.5	25	361	9,420	2,280	14,506	6,617	2,133	1,114	15,330	40,038	42,651
150.0	20	309	8,879	1,864	12,505	5,323	1,858	813	13,103	34,888	37,164
75.0	10	201	6,965	1,736	8,856	2,900	1,326	427	8,541	24,901	26,525

PERFORMANCE DATA[DM9071]

November 26, 2013

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	750.0	562.5	375.0	187.5	75.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	1,141	878	618	361	201
TOTAL NOX (AS NO2)		G/HR	7,181	4,159	2,639	1,824	1,310
TOTAL CO		G/HR	520	683	655	540	554
TOTAL HC		G/HR	55	82	96	88	101
PART MATTER		G/HR	47.2	59.4	150.5	116.9	78.8
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,190.9	2,326.7	2,078.5	2,424.5	2,904.0
TOTAL CO	(CORR 5% O2)	MG/NM3	231.7	383.5	519.6	772.5	1,347.1
TOTAL HC	(CORR 5% O2)	MG/NM3	21.1	40.7	65.9	111.3	214.7
PART MATTER	(CORR 5% O2)	MG/NM3	17.2	27.7	103.8	128.4	160.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,554	1,133	1,012	1,181	1,414
TOTAL CO	(CORR 5% O2)	PPM	185	307	416	618	1,078
TOTAL HC	(CORR 5% O2)	PPM	39	76	123	208	401
TOTAL NOX (AS NO2)		G/HP-HR	6.35	4.76	4.29	5.06	6.52
TOTAL CO		G/HP-HR	0.46	0.78	1.07	1.50	2.76
TOTAL HC		G/HP-HR	0.05	0.09	0.16	0.24	0.50
PART MATTER		G/HP-HR	0.04	0.07	0.24	0.32	0.39
TOTAL NOX (AS NO2)		LB/HR	15.83	9.17	5.82	4.02	2.89
TOTAL CO		LB/HR	1.15	1.51	1.45	1.19	1.22
TOTAL HC		LB/HR	0.12	0.18	0.21	0.19	0.22
PART MATTER		LB/HR	0.10	0.13	0.33	0.26	0.17

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	750.0	562.5	375.0	187.5	75.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	1,141	878	618	361	201
TOTAL NOX (AS NO2)		G/HR	5,935	3,437	2,181	1,507	1,082
TOTAL CO		G/HR	278	365	351	289	296
TOTAL HC		G/HR	29	43	51	47	53
TOTAL CO2		KG/HR	525	419	298	180	112
PART MATTER		G/HR	24.2	30.5	77.2	59.9	40.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,637.1	1,922.9	1,717.8	2,003.7	2,400.0
TOTAL CO	(CORR 5% O2)	MG/NM3	123.9	205.1	277.9	413.1	720.4
TOTAL HC	(CORR 5% O2)	MG/NM3	11.2	21.5	34.9	58.9	113.6
PART MATTER	(CORR 5% O2)	MG/NM3	8.8	14.2	53.2	65.9	82.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,285	937	837	976	1,169
TOTAL CO	(CORR 5% O2)	PPM	99	164	222	330	576
TOTAL HC	(CORR 5% O2)	PPM	21	40	65	110	212
TOTAL NOX (AS NO2)		G/HP-HR	5.25	3.94	3.54	4.18	5.39
TOTAL CO		G/HP-HR	0.25	0.42	0.57	0.80	1.48
TOTAL HC		G/HP-HR	0.03	0.05	0.08	0.13	0.27
PART MATTER		G/HP-HR	0.02	0.03	0.13	0.17	0.20
TOTAL NOX (AS NO2)		LB/HR	13.08	7.58	4.81	3.32	2.39
TOTAL CO		LB/HR	0.61	0.81	0.77	0.64	0.65
TOTAL HC		LB/HR	0.06	0.10	0.11	0.10	0.12
TOTAL CO2		LB/HR	1,157	924	658	397	246
PART MATTER		LB/HR	0.05	0.07	0.17	0.13	0.09
OXYGEN IN EXH		%	8.9	10.1	11.2	13.2	15.4
DRY SMOKE OPACITY		%	0.4	1.4	2.9	4.4	3.8
BOSCH SMOKE NUMBER			0.18	0.48	1.07	1.51	1.40

Regulatory Information

EPA TIER 2		2006 - 2010		
GASEOUS EMISSIONS DATA MEASUREMENTS ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 89 SUBPART D AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. GASEOUS EMISSIONS VALUES ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE NON-ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	NON-ROAD	TIER 2	CO: 3.5 NOx + HC: 6.4 PM: 0.20

EPA EMERGENCY STATIONARY		2011 - ----		
GASEOUS EMISSIONS DATA MEASUREMENTS ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. GASEOUS EMISSIONS LIMIT VALUES ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE NON-ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 6.4 PM: 0.20

ATTACHMENT B-2

Screenshots of April 2016 Revised Emission Calculation Spreadsheets

Table B-2-1A. Mar-2016 70-year Average Emisions (Added 5-9s Reserve Generators Dec-2015)

Conditions Used for Feb-2015 DEEP Second Tier Risk Report: Ultra-Worst-Case Theoretical Maximum-Year Facility-Wide Emissions (DEEP + HC = all runtime at 10%; NOx + CO = all runtime at 100%; Fuel and AP-42 TAPs = 100% load)

Cherry-Picked Max 10%-100%; Each Stack Test = 45 hours

Gen #	Load Condition	Elec Load	Total No. Gens	No. of events per year: W	M	S	Correct Tests	Outage	Cool	Elec Bypass	Initial Comm	Stack Test	Duration of each event (hrs): W	M	S	Correct Tests	Outage	Cool	Elec Bypass	Initial Comm	Stack Test
2500 kWe; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	32		10	2	4				1	1		**0.250**	**0.250**	**0.250**				0.25	0.0121
	Warmed up		32		10	2	4				1	1		**0.111**	**0.195**	**0.528**				0.464	0.109
	Cold start		32					3		1							**0.250**		**0.250**		
	Warmed up		32		10	2	4	3		1				0.194	0.278	0.61	**7.75**		**15.75**		
	Cold start		32	52									0.25								
	Warmed up		32	52	10	2	4		18				0.25	0.194	0.278	0.61		0.167			
5-9s Reserve Gens, 2500 kWe	Cold start	All runtime at maximum possible emission rate for any load	8	52	10	2	4	3	0	0	1	1	0.25	0.250	0.250	0.25	0.25	0	0	0.25	0.0080
	Warmed up		8	52	10	2	4	3	0	0	1	1	0.25	0.500	0.751	1.750	0.25	0	0	0.464	0.0723
2000 kWe CNR Gens; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	4		10	2	4				1	1		**0.250**	**0.250**	**0.250**				0.25	0.032
	Warmed up		4		10	2	4				1	1		**0.111**	**0.195**	**0.528**				0.464	0.289
	Cold start		4					3		1							**0.250**		**0.250**		
	Warmed up		4		10	2	4	3		1				0.194	0.278	0.61	**7.75**		**15.75**		
	Cold start		4	52									0.25								
	Warmed up		4	52	10	2	4		18				0.25	0.194	0.278	0.61		0.167			
750 kWe Admin Gen; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	1		10	2	4				1	1		**0.250**	**0.250**	**0.250**				0.25	0.0643
	Warmed up		1		10	2	4				1	1		**0.111**	**0.195**	**0.528**				0.464	0.579
	Cold start		1					3		1							**0.250**		**0.250**		
	Warmed up		1		10	2	4	3		1				0.194	0.278	0.61	**7.75**		**15.75**		
	Cold start		1	52									0.25								
	Warmed up		1	52	10	2	4		18				0.25	0.194	0.278	0.61		0.167			

Gen #	Load Condition	Hours at Each Runtime Mode: W	M	S	Correct Tests	Outage	Cool	Elec Bypass	48 hrs Initial Comm	Stack Test	Total hrs/yr	Fuel Usage: Each Genset Fuel Gal/Hr	Facility-Wide Fuel Gal/Year
2500 kWe	Cold start	0	2.50	0.50	1.00	0	0		0.25	0.012	4.26	174	23,731
	Warmed up	0	1.11	0.39	2.11	0	0		0.464	0.109	4.19	174	23,319
	Cold start	0	0	0	0	0.75	0	0.25	0.00	0	1.00	174	5,568
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94	174	244,675
	Cold start	13.00	0	0	0	0	0		0.00	0	13.00	174	72,384
	Warmed up	13.00	1.94	0.56	2.44	0	3.01		0.000	0	20.95	174	116,644
5-9s Reserve Gens, 2500 kWe	Cold start	13.00	2.5	0.5	1.0	0.75	0	0	0	0.008	18.01	**174**	25,067
	Warmed up	13.00	5.00	1.50	7.00	0.75	0	0	0	0.0723	27.79	**174**	38,680
2000 kWe CNR Gens	Cold start	0	2.50	0.50	1.00	0	0		0.25	0.032	4.28	138	2,364
	Warmed up	0	1.11	0.39	2.11	0	0		0.464	0.289	4.37	138	2,411
	Cold start	0	0	0	0	0.75	0	0.25	0.00	0	1.00	138	552
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94	138	24,257
	Cold start	13.00	0	0	0	0	0		0.00	0	13.00	138	7,176
	Warmed up	13.00	1.94	0.56	2.44	0	3.01		0.000	0	20.95	138	11,564
750 kWe Admin Gen	Cold start	0	2.50	0.50	1.00	0	0		0.25	0.0643	4.31	53.6	231
	Warmed up	0	1.11	0.39	2.11	0	0		0.464	0.6	4.66	53.6	250
	Cold start	0	0	0	0	0.75	0	0.25	0.00	0	1.00	53.6	54
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94	53.6	2,355
	Cold start	13.00	0	0	0	0	0		0.00	0	13.00	53.6	697
	Warmed up	13.00	1.94	0.56	2.44	0	3.00		0.000	0	20.94	53.6	1,123
													603,100

Gen #	Load Condition	Pollutant Emissions: Each Genset PM lbs/hr	Facility Wide PM Tons/yr	Each Genset NOX lbs/hr	Each Genset NOx lbs/yr	Each Genset NOx Tons/yr	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Each Genset CO lbs/yr	Each Genset CO Tons/yr	Facility Wide CO Tons/yr	Each Genset HC lbs/hr	Each Genset HC lbs/yr	Each Genset HC Tons/yr	Facility-Wide HC Tons/yr
2500 kWe	Cold start	0.64	0.043	50.60	215.66	0.108	3.45	9.38	39.98	0.020	0.64	1.21	5.16	0.003	0.08
	Warmed up	0.401	0.027	9.11	38.15	0.019	0.61	1.44	6.03	0.003	0.10	0.350	1.47	0.001	0.02
	Cold start	0.64	0.0102	50.60	50.60	0.025	0.81	9.38	9.38	0.005	0.15	1.21	1.21	0.001	0.019
	Warmed up	0.401	0.28	9.11	400.32	0.200	6.41	1.44	63.28	0.032	1.01	0.350	15.38	0.008	0.25
	Cold start	0.64	0.132	50.60	657.80	0.329	10.52	9.38	121.94	0.061	1.95	1.21	15.73	0.008	0.252
	Warmed up	0.401	0.134	9.11	190.85	0.095	3.05	1.44	30.17	0.015	0.48	0.350	7.33	0.004	0.117
5-9s Reserve Gens, 2500 kWe	Cold start	0.64	0.046	**50.60**	911	0.456	3.64	**9.38**	168.92	0.084	0.68	**1.21**	21.79	0.011	0.087
	Warmed up	0.401	0.045	**9.11**	253	0.127	1.01	**1.44**	40.01	0.020	0.16	0.350	9.73	0.005	0.039
2000 kWe CNR Gens	Cold start	0.660	0.006	42.1	180.27	0.090	0.36	6.16	26.38	0.013	0.05	1.23	5.27	0.003	0.011
	Warmed up	0.434	0.004	4.04	17.65	0.009	0.04	0.95	4.15	0.002	0.01	0.35	1.53	0.001	0.00
	Cold start	0.660	0.00132	42.1	42.10	0.021	0.08	6.16	6.16	0.003	0.01	1.23	1.23	0.001	0.0025
	Warmed up	0.434	0.038	4.04	177.53	0.089	0.36	0.95	41.75	0.021	0.08	0.35	15.38	0.008	0.03
	Cold start	0.660	0.017	42.1	547.30	0.274	1.09	6.16	80.08	0.040	0.16	1.23	15.99	0.008	0.0320
	Warmed up	0.434	0.018	4.04	84.63	0.042	0.17	0.95	19.90	0.010	0.04	0.35	7.33	0.004	0.0147
750 kWe Admin Gen	Cold start	0.608	0.00131	15.80	68.17	0.034	0.03	1.90	8.20	0.004	0.00	0.28	1.21	0.001	0.0006
	Warmed up	0.136	0.00032	1.33	6.20	0.003	0.00	0.44	2.05	0.001	0.00	0.11	0.51	0.000	0.0003
	Cold start	0.608	0.00030	15.80	15.80	0.008	0.01	1.90	1.90	0.001	0.00	0.28	0.28	0.000	0.0001
	Warmed up	0.136	0.0030	1.33	58.44	0.029	0.03	0.44	19.33	0.010	0.01	0.11	4.83	0.002	0.0024
	Cold start	0.608	0.0040	15.80	205.40	0.103	0.10	1.90	24.70	0.012	0.01	0.28	3.64	0.002	0.0018
	Warmed up	0.136	0.0014	1.33	27.85	0.014	0.01	0.44	9.21	0.005	0.00	0.11	2.30	0.001	0.0012

For PM, 0.167-hr cold start period revised to 0.25 hours

70-yr average stack testing. Assume each test = 45 hrs (10% cold, 90% warm). Test 6 of the 32 AZ gens, test 2 of the 4 CNR gens; test the single Admin gen; test 1 of the 8 Reserve gens. Distribute stack testing over 70-years.

70-yr average Commissioning: 50 hours/generator, distributed over 70 years = 50/70 = 0.714 hrs/yr/gen. Assume 0.25 hrs/yr/gen cold-start

	PM	NOx	CO	VOC
Total Facility-Wide TPY	**0.814**	**31.8**	**5.56**	**0.966**
Existing Permit	0.536	8.60	15.60	0.80
Net Increase	52%	270%	-64%	21%

52 18

40 15

87.34

Hrs/yr/gen routine annual excluding commissioning and stack testing 86.77

Cold-Start Hours	15.86
Total Runtime	87.34
Percentage Cold-Start	18%

DEEP Emissions for AERMOD Input (Excluding Reserve gens)

2.5 Mwe	0.629	tpy	32	0.000566	g/sec each gen
2.0 Mwe	0.0842	tpy	4	0.000606	g/sec each gen
0.75 Mwe	0.0103	tpy	1	0.000296	g/sec each gen
TOTAL	0.723	tpy			

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

Table B-2-1B. Mar-2016 Typical Routine Year (No Stacktest, No Commissioning) Emisions (Added 5-9s Reserve Generators 9-29-2015)

No. of events per year

Gen #	Load Condition	Elec Load	Total No. Gens	W	M	S	Correct Tests	Outage	Cool	Elec Bypass	Initial Comm	Stack Test
2500 kWe AZ Gens; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	32		10	2	4					0
	Warmed up		32		10	2	4				0	0
	Cold start		32					3		1		
	Warmed up		32		10	2	4	3		1	0	
	Cold start		32	52								
	Warmed up		32	52	10	2	4		18		0	
5-9s Reserve Gens, 2500 kWe	Cold start	All runtime at maximum possible emission rate for any load	8	52	10	2	4	3	0	0	0	0
	Warmed up		8	52	10	2	4	3	0	0	0	0
2000 kWe CNR Gens; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	4		10	2	4					
	Warmed up		4		10	2	4				0	0
	Cold start		4					3		1		
	Warmed up		4		10	2	4	3		1	0	0
	Cold start		4	52								
	Warmed up		4	52	10	2	4		18		0	0
750 kWe Admin Gen; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	1		10	2	4					
	Warmed up		1		10	2	4				0	0
	Cold start		1					3		1		
	Warmed up		1		10	2	4	3		1	0	0
	Cold start		1	52								
	Warmed up		1	52	10	2	4		18		0	0

Duration of each event (hrs)

Gen #	Load Condition	W	M	S	Correct Tests	Outage	Cool	Elec Bypass	Initial Comm	Stack Test
2500 kWe AZ Gens	Cold start		0.250	0.250	0.250					0.141
	Warmed up		0.111	0.195	0.528				0.00	1.27
	Cold start					0.250		0.250		
	Warmed up		0.194	0.278	0.61	7.75		15.75	0.00	
	Cold start	0.25								
	Warmed up	0.25	0.194	0.278	0.61		0.167		0.00	
5-9s Reserve Gens, 2500 kWe	Cold start	0.25	0.250	0.250	0.25	0.25	0	0	0	0
	Warmed up	0.25	0.500	0.751	1.750	0.25	0	0	0	0
2000 kWe CNR Gens	Cold start		0.250	0.250	0.250					
	Warmed up		0.111	0.195	0.528				0.00	
	Cold start					0.250		0.250		
	Warmed up		0.194	0.278	0.61	7.75		15.75	0.00	
	Cold start	0.25								
	Warmed up	0.25	0.194	0.278	0.61		0.167		0.00	
750 kWe Admin Gen	Cold start		0.250	0.250	0.250					
	Warmed up		0.111	0.195	0.528				0.00	
	Cold start					0.250		0.250		
	Warmed up		0.194	0.278	0.61	7.75		15.75	0.00	
	Cold start	0.25								
	Warmed up	0.25	0.194	0.278	0.61		0.167		0.00	

Hours at Each Runtime Mode

Gen #	Load Condition	W	M	S	Correct Tests	Outage	Cool	Elec Bypass	48 hrs Initial Comm	Stack Test	Total hrs/yr
2500 kWe AZ Gens	Cold start	0	2.50	0.50	1.00	0	0		0	0.000	4.00
	Warmed up	0	1.11	0.39	2.11	0	0		0	0.00	3.62
	Cold start	0	0	0	0	0.75	0	0.25	0	0	1.00
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0	0	43.94
	Cold start	13.00	0	0	0	0	0		0	0	13.00
	Warmed up	13.00	1.94	0.56	2.44	0	3.01		0	0	20.95
5-9s Reserve Gens, 2500 kWe	Cold start	13.00	2.5	0.5	1.0	0.75	0	0	0	0	17.75
	Warmed up	13.00	5.00	1.50	7.00	0.75	0	0	0	0	27.25
2000 kWe CNR Gens	Cold start	0	2.50	0.50	1.00	0	0		0	0	4.00
	Warmed up	0	1.11	0.39	2.11	0	0		0	0	3.62
	Cold start	0	0	0	0	0.75	0	0.25	0	0	1.00
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0	0	43.94
	Cold start	13.00	0	0	0	0	0		0	0	13.00
	Warmed up	13.00	1.94	0.56	2.44	0	3.01		0	0	20.95
750 kWe Admin Gen	Cold start	0	2.50	0.50	1.00	0	0		0	0	4.00
	Warmed up	0	1.11	0.39	2.11	0	0		0	0	3.62
	Cold start	0	0	0	0	0.75	0	0.25	0	0	1.00
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0	0	43.94
	Cold start	13.00	0	0	0	0	0		0	0	13.00
	Warmed up	13.00	1.94	0.56	2.44	0	3.00		0	0	20.94
										86.51	
	Hrs/yr/gen routine annual excluding commissioning and stack testing										86.51

Max Year StackStack testing: None in typical year

Commissioning: none assumed for typical Year

Fuel Usage / Pollutant Emissions

Gen #	Load Condition	Each Genset Fuel Gal/Hr	Facility-Wide Fuel Gal/Year	Each Genset PM lbs/hr	Facility Wide PM Tons/yr	Each Genset NOX lbs/hr	Each Genset NOx lbs/yr	Each Genset NOx Tons/yr	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Each Genset CO lbs/yr	Each Genset CO Tons/yr	Facility Wide CO Tons/yr	Each Genset HC lbs/hr	Each Genset HC lbs/yr	Each Genset HC Tons/yr	Facility-Wide HC Tons/yr
2500 kWe AZ Gens	Cold start	174	22,272	0.64	0.041	50.60	202.40	0.101	3.24	9.38	37.52	0.019	0.60	1.21	4.84	0.002	0.08
	Warmed up	174	20,128	0.401	0.023	9.11	32.93	0.016	0.53	1.44	5.21	0.003	0.08	0.350	1.27	0.001	0.02
	Cold start	174	5,568	0.64	0.0102	50.60	50.60	0.025	0.81	9.38	9.38	0.005	0.15	1.21	1.21	0.001	0.019
	Warmed up	174	244,675	0.401	0.28	9.11	400.32	0.200	6.41	1.44	63.28	0.032	1.01	0.350	15.38	0.008	0.25
	Cold start	174	72,384	0.64	0.132	50.60	657.80	0.329	10.52	9.38	121.94	0.061	1.95	1.21	15.73	0.008	0.252
	Warmed up	174	116,644	0.401	0.134	9.11	190.85	0.095	3.05	1.44	30.17	0.015	0.48	0.350	7.33	0.004	0.117
5-9s Reserve Gens, 2500 kWe	Cold start	174	24,708	0.635	0.045	50.60	898	0.449	3.59	9.38	166.50	0.083	0.67	1.21	21.48	0.011	0.086
	Warmed up	174	37,933	0.401	0.044	9.11	248	0.124	0.99	1.44	39.24	0.020	0.16	0.350	9.54	0.005	0.038
2000 kWe CNR Gens	Cold start	138	2,208	0.660	0.005	42.1	168.40	0.084	0.34	6.16	24.64	0.012	0.05	1.23	4.92	0.002	0.010
	Warmed up	138	1,995	0.434	0.003	4.04	14.60	0.007	0.03	0.95	3.43	0.002	0.01	0.35	1.27	0.001	0.00
	Cold start	138	552	0.660	0.00132	42.1	42.10	0.021	0.08	6.16	6.16	0.003	0.01	1.23	1.23	0.001	0.0025
	Warmed up	138	24,257	0.434	0.038	4.04	177.53	0.089	0.36	0.95	41.75	0.021	0.08	0.35	15.38	0.008	0.03
	Cold start	138	7,176	0.660	0.017	42.1	547.30	0.274	1.09	6.16	80.08	0.040	0.16	1.23	15.99	0.008	0.0320
	Warmed up	138	11,564	0.434	0.018	4.04	84.63	0.042	0.17	0.95	19.90	0.010	0.04	0.35	7.33	0.004	0.0147
750 kWe Admin Gen	Cold start	53.6	214	0.608	0.00122	15.80	63.20	0.032	0.03	1.90	7.60	0.004	0.00	0.28	1.12	0.001	0.0006
	Warmed up	53.6	194	0.136	0.00025	1.33	4.81	0.002	0.00	0.44	1.59	0.001	0.00	0.11	0.40	0.000	0.0002
	Cold start	53.6	54	0.608	0.00030	15.80	15.80	0.008	0.01	1.90	1.90	0.001	0.00	0.28	0.28	0.000	0.0001
	Warmed up	53.6	2,355	0.136	0.0030	1.33	58.44	0.029	0.03	0.44	19.33	0.010	0.01	0.11	4.83	0.002	0.0024
	Cold start	53.6	697	0.608	0.0040	15.80	205.40	0.103	0.10	1.90	24.70	0.012	0.01	0.28	3.64	0.002	0.0018
	Warmed up	53.6	1,123	0.136	0.0014	1.33	27.85	0.014	0.01	0.44	9.21	0.005	0.00	0.11	2.30	0.001	0.0012
			596,701		PM				NOx				CO				VOC
	Total Facility-Wide TPY				0.805				31.4				5.49				0.955
	Existing Permit				0.536				8.60				15.60				0.80
	Net Increase				50%				265%				-65%				19%

For PM, 0.167-hr cold start period revised to 0.25 hours

52 18

40 15

DEEP Emissions for AERMOD Input				DEEP	
2.5 Mwe	0.622	tpy	32	0.000560	g/sec each gen
2.0 Mwe	0.0832	tpy	4	0.000599	g/sec each gen
0.75 Mwe	0.0101	tpy	1	0.000292	g/sec each gen
TOTAL	0.716	tpy			

Cold-Start Hours	15.00
Total Runtime	86.51
Percentage Cold-Start	17%

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

Table B-2-1C. Mar-2016 Theoretical Maximum Year Emissions

Single Generator Stacktest

	Hrs	45 hrs single 2.5 MW gen stacktest, tons/yr			
		PM	NOx	CO	HC
Cold	5	0.00143	0.1142	0.0876	0.0027
Warm	41	0.00815	0.1851	0.1429	0.0071
Total	45	0.00958	0.299	0.231	0.0098

Single Generator Commissioning

	Hrs	50 hrs single 2.5 MW gen Commission, tons/yr			
		PM	NOx	CO	HC
Cold	5	0.001588	0.1265	0.097106	0.003025
Warm	45	0.009023	0.204975	0.158274	0.007875
Total	50	0.01061	0.331	0.255	0.0109

Typical Year Facility-Wide No Stacktest and No Commissioning

Hrs	Typical Year Facility-Wide All Gens No Stacktest No Commissioning, tons/yr			
	PM	NOx	CO	HC
86	0.805	31.4	5.49	0.955

Fuel Calculation Factor Based on Fuel/DEEP Ratio

Fuel, gal/yr	596,701	gal/yr
DEEP TPY	0.805	TPY
Fuel/DEEP Ratio	741,639	gal per TPY

Combined Events to Develop theoretical 3-Year Aggregate Theoretical Max Year

Activity	Annual Events	Theoretical Maximum Year Emissions, TPY			
		PM	NOx	CO	HC
Typical Year Combined 45 Gens	3	2.41	94.2	16.5	2.86
Stack Testing of 2.5 MW Gen	4	0.0383	1.20	0.922	0.0394
Commissoining of 2.5 MW Gens	18	0.191	5.97	4.60	0.196
Mar-2016 Total Theoretical Emissions	--	2.64	101	22.0	3.10
Fuel Ration Typ. Yr					

Alternate Fuel Analysis for Theoretical Mx Yr

Gen Type	No.	Hrs	Fuel gph	Gallons
2.5 MW Primary Gens	32	259.5	174	1,444,896
2.0 MW gens	4	259.5	138	143,244
0.75 MW gens	1	259.5	54	14,013
Commission 2.5 MW gens	18	50	173	155,700
Stacktest 2.5 MW gens	4	45	173	31,140
Reserve 2.5 MW gens	8	43	173	59,512
				1,848,505
Annual PTE (1/3 * Theoretical Maximum Annual)				616,168

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\Apr16 AppB ready for PC\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]Theo Max Yr

100% Generator Loads and Emissions for AERMOD Modeling (100% Incl. Reserve Gens, Dec-2015)
Microsoft Oxford Data Center

Table B-2-2A. PM10 Emissions During Outage

Ultra-Worst Case PM10-NAAQS During Facility-Wide Power Outage at 10%

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 24-hr weighted average lbs/day			
2.5 Mwe	Cold Start	32	0.635	0.25	5.1	lbs/day				
	Warmed Up	32	0.401	23.75	304.8	lbs/day	9.7	lbs/day	0.0509	g/sec
2.0 Mwe	Cold Start	4	0.661	0.25	0.66	lbs/day				
	Warmed Up	4	0.434	23.75	41.2	lbs/day	10.5	lbs/day	0.0550	g/sec
750 kWe	Cold Start	1	0.608	0.25	0.2	lbs/day				
	Warmed Up	1	0.136	23.75	3.2	lbs/day	3.4	lbs/day	0.0178	g/sec
2.5 Mwe Reserve Gens	Cold Start	8	0.635	0.25	1.3	lbs/day				
	Warmed Up	8	0.401	0.25	0.80	lbs/day	0.259	lbs/day	0.00136	g/sec
Facility-Wide Emissions					357.2	lbs/day				

Table B-2-2B. PM2.5 Emissions During Electrical Bypass

Application scenario - Aug-2015 Cherry-Picked PM2.5 NAAQS During 4-Gen Electrical Bypass at 10% Load

Gen Size	Engine Temp	**No. of Gens**	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 24-hr weighted average lbs/day			
2.5 Mwe	Cold Start	**4**	0.635	0.25	0.6	lbs/day				
	Warmed Up	**4**	0.401	23.75	38.1	lbs/day	9.7	lbs/day	0.0509	g/sec
2.0 Mwe	Cold Start	0	0	0	0.0					
	Warmed Up	0	0	0	0.0					
750 kWe	Cold Start	0	0	0	0.0					
	Warmed Up	0	0	0	0.0					
Facility-Wide Emissions					38.7	lbs/day				

Table B-2-2C. CO Emissions During Outage

CO-NAAQS During Facility-Wide Power Outage; Ultra-Worst Case at 100% Load

Corrected 1-13-15 for CO black puff factor

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 1-hr weighted average lbs/hr			
2.5 Mwe at 100%	Cold Start	32	9.38	0.167	50.1	lbs/hr				
	Warmed Up	32	1.44	0.833	38.4	lbs/hr	2.77	lbs/hr	0.349	g/sec
2.0 Mwe @ 100%	Cold Start	4	5.38	0.167	3.6	lbs/hr				
	Warmed Up	4	0.83	0.833	2.8	lbs/hr	1.590	lbs/hr	0.200	g/sec
750 kWe @ 100%	Cold Start	1	1.794	0.167	0.3	lbs/hr				
	Warmed Up	1	0.437	0.833	0.4	lbs/hr	0.663	lbs/hr	0.084	g/sec
2.5 Mwe Reserve Gens at Zero Load (10%)	Cold Start	8	7.21	0.25	14.4	lbs/hr				
	Warmed Up	8	1.11	0.25	2.2	lbs/hr	2.080	lbs/hr	0.262	g/sec
Facility-Wide Emissions					112.2	lbs/hr				

79.2

Table B-2-2D. 100%-Idle Reserve NOx Emissions During Outage

REVISED NO2-ASIL EMISSION RATES - Polynomial Cherry-Picked NOx-NO2 ASIL During Facility-Wide Power Outage at 100% Loads

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 1-hr weighted average lbs/hr			
2.5 Mwe @ 100%	Cold Start	32	50.6	0.167	270.4	lbs/hr				
	Warmed Up	32	9.1	0.833	242.6	lbs/hr	16.0	lbs/hr	2.022	g/sec
2.0 Mwe @ 100% polynomial fit	Cold Start	4	42.1	0.167	28.1	lbs/hr				
	Warmed Up	4	4.04	0.833	13.5	lbs/hr	10.4	lbs/hr	1.311	g/sec
750 kWe @ 100%	Cold Start	1	15.83	0.167	2.6	lbs/hr				
	Warmed Up	1	1.33	0.833	1.1	lbs/hr	3.8	lbs/hr	0.473	g/sec
2.5 Mwe Reserve Gens at Zero Elec. Load (10% emission factors)	Cold Start	8	7.02	0.25	14.0	lbs/hr				
	Warmed Up	8	1.26	0.25	2.5	lbs/hr	2.1	lbs/hr	0.261	g/sec
Facility-Wide Emissions					574.9	lbs/hr	AERMOD value without Reserve Gens = 391 lbs/hr			

Table B-2-2E. NOx Emissions During Electrical Bypass

NAAQS SCENARIO 1A 100% - Polynomial Cherry-Picked NOx-NO2 NAAQS During 4-Gen Electrical Bypass at 100% Load

Gen Size	Cold Start Limit	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 1-hr weighted average lbs/hr			
2.5 Mwe @ 100%	Cold Start	4	50.6	0.1667	33.7	lbs/hr				
	Warmed Up	4	9.11	0.8333	30.4	lbs/hr	16.0	lbs/hr	2.021	g/sec
2.5 Mwe @ 85% polynomial fit	Cold Start	0	38.9	0.1667	0.0	lbs/hr				
	Warmed Up	0	5.2	0.8333	0.0	lbs/hr	#DIV/0!	lbs/hr	#DIV/0!	g/sec
Facility-Wide Emissions					64.1	lbs/hr				

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

Table B-2-5. - Mar-2016 Microsoft Data Center AP-42 Toxic Air Pollutant Emissions

Includes 5-9s Reserve Gens, 100% Load Limit

Fuel Type

Parameter	Value	Units
Fuel Type	EPA Diesel	
Fuel Density	7	lbs/gallon
Fuel Heat Content	137,000	BTU/gallon
Fuel Sulfur Content	15	ppm weight
Max Hourly Fuel Use	6187	Gal/HOUR
Max Daily Fuel Use	148,476	Gal/DAY
70-Yr Annual Fuel usage	603,100	Gal/YEAR
Max Hourly Heat Input	848	mmBTU/HOUR
Max Daily Heat Input	20,341	mmBTU/DAY

Max daily assumes one 24-hr power outage

Table XX. Tier-4 Summary of Controlled Emission Rates

Pollutant	Uncontrolled Emission Factor			Removal Effcy	Maximum Emission Rates (Total)		
	Factor	Units	Source		(lbs/hr)	(lbs/day)	(tons/year)
NOx	Tier 4 Engine with Cold Start Factors			Incorporated	0	0	0.00
PM2.5/DEEP	Tier 4 Engine with Cold Start Factors			Incorporated	0.0	0	0.000
CO	Tier 4 Engine with Cold Start Factors			Incorporated	0	0	0.0
VOC	Tier 4 Engine with Cold Start Factors			Incorporated	0.0	0	0.000
SO2	Fuel sulfur mass balance			Incorporated	1.30	31.2	0.063
Primary Nitrogen Dioxide (NO2)	10% of primary NOX			Incorporated	0.0	0	0.000
Benzene	7.76E-04	lbs/MMBTU	AP-42 Sec 3.4	90%	6.58E-02	1.58E+00	3.21E-03
Toluene	2.81E-04	lbs/MMBTU	AP-42 Sec 3.4	90%	2.38E-02	5.72E-01	1.16E-03
Xylenes	1.93E-04	lbs/MMBTU	AP-42 Sec 3.4	90%	1.64E-02	3.93E-01	7.97E-04
1,3-Butadiene	3.91E-05	lbs/MMBTU	AP-42 Sec 3.3	90%	3.31E-03	7.95E-02	1.62E-04
Formaldehyde	7.89E-05	lbs/MMBTU	AP-42 Sec 3.4	90%	6.69E-03	1.60E-01	3.26E-04
Acetaldehyde	2.52E-05	lbs/MMBTU	AP-42 Sec 3.4	90%	2.14E-03	5.13E-02	1.04E-04
Acrolein	7.88E-06	lbs/MMBTU	AP-42 Sec 3.4	90%	6.68E-04	1.60E-02	3.26E-05
Benzo(a)Pyrene	2.57E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	2.18E-05	5.23E-04	1.06E-06
Benzo(a)anthracene	6.22E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	5.27E-05	1.27E-03	2.57E-06
Chrysene	1.53E-06	lbs/MMBTU	AP-42 Sec 3.4	90%	1.30E-04	3.11E-03	6.32E-06
Benzo(b)fluoranthene	1.11E-06	lbs/MMBTU	AP-42 Sec 3.4	90%	9.41E-05	2.26E-03	4.59E-06
Benzo(k)fluoranthene	2.18E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	1.85E-05	4.43E-04	9.01E-07
Dibenz(a,h)anthracene	3.46E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	2.93E-05	7.04E-04	1.43E-06
Ideno(1,2,3-cd)pyrene	4.14E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	3.51E-05	8.42E-04	1.71E-06
Napthalene	1.30E-04	lbs/MMBTU	AP-42 Sec 3.4	90%	1.10E-02	2.64E-01	5.37E-04
Propylene	2.79E-03	lbs/MMBTU	AP-42 Sec 3.4	90%	2.36E-01	5.68E+00	1.15E-02

Carcinogenic VOC TAPs	4.25E-03
Non-Carcinogen VOC TAPs	1.35E-02

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

Quincy, Washington

Pollutant	CAS Number	SQER		Facility Emissions		SQER Exceeded?
Diesel Generator TAPs						
DEEP (Theoretical Max Annual)	None	0.639	lbs/yr	5,286	lbs/yr	Yes
CO	630-08-0	50.2	lbs/hour	126.0	lbs/hour	Yes
Ammonia	7664-41-7	9.3	lbs/day	518	lbs/day	Yes
SO2		1.45	lbs/hour	1.3	lbs/hour	No
NO2	10102-44-0	1.03	lbs/hour	57.5	lbs/hour	Yes
Benzene (Theoretical Max Annual)	71-43-2	6.62	lbs/yr	20.84	lbs/yr	Yes
Toluene	108-88-3	657	lbs/day	0.572	lbs/day	No
Xylenes	95-47-6	58	lbs/day	0.393	lbs/day	No
1,3-Butadiene (3x annual avg.)	106-99-0	1.13	lbs/yr	1.06	lbs/yr	No
Formaldehyde (3x annual avg.)	50-00-0	32	lbs/yr	2.14	lbs/yr	No
Acetaldehyde (3x annual avg.)	75-07-0	71	lbs/yr	0.69	lbs/yr	No
Acrolein	107-02-8	0.00789	lbs/day	0.016	lbs/day	Yes
Benzo(a)Pyrene (3x annual avg.)	50-32-8	0.174	lbs/yr	7.0E-03	lbs/yr	No
Benzo(a)anthracene (3x annual avg.)	56-55-3	1.74	lbs/yr	1.5E-02	lbs/yr	No
Chrysene (3x annual avg.)	218-01-9	17.4	lbs/yr	3.8E-02	lbs/yr	No
Benzo(b)fluoranthene (3x annual avg.)	205-99-2	1.74	lbs/yr	2.8E-02	lbs/yr	No
Benzo(k)fluoranthene (3x annual avg.)	207-08-9	1.74	lbs/yr	5.4E-03	lbs/yr	No
Dibenz(a,h)anthracene (3x annual avg.)	53-70-3	0.16	lbs/yr	8.6E-03	lbs/yr	No
Ideno(1,2,3-cd)pyrene (3x annual avg.)	193-39-5	1.74	lbs/yr	1.0E-02	lbs/yr	No
Napthalene (3x annual avg.)	91-20-3	5.64	lbs/yr	3.53	lbs/yr	No
Propylene	115-07-1	394	lbs/yr	5.68	lbs/yr	No
Cooling Tower TAPs						
Fluoride	---	1.71	lbs/day	0.0260	lbs/day	No
Manganese	---	0.0053	lbs/day	0.00252	lbs/day	No
Copper	---	0.219	lbs/hour	3.5E-05	lbs/hour	No
Chloroform	67-66-3	8.35	lbs/year	0.526	lbs/year	No
Bromo Dichloromethane	75-27-4	5.18	lbs/year	0.526	lbs/year	No
Bromoform	75-25-2	174	lbs/year	13.8	lbs/year	No

Shaded rows indicate the emission rate exceeds the SQER

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

Table B-2-4

Mar-2016 Summary of Revised Ambient Impact Analysis Including 8 New Reserve Generators Using As-Built Stack Parameters (Includes Monte Carlo NO2-NAAQS)

Line	Pollutant and Averaging Time	Emission Rate Conditions	AERMOD Dispersion Factor: AERMOD File	AERMOD Dispersion Factor: AERMOD ug/m3	AERMOD Dispersion Factor: Emiss. Rate	AERMOD Dispersion Factor: Disp. Factor	AERMOD Dispersion Factor: Units	Modeled Stack Conditions	Emission Rates forDec-2015 Revision Application: Emission Rate (includes 3x factor for annual values)	Emission Rates forDec-2015 Revision Application: Emission Rate Units	Ambient Impacts, ug/m3: Oxford Increment (Includes 3x factor for annual average values)	Ambient Impacts, ug/m3: Regional and Local Background (Inc. cooling towers)	Ambient Impacts, ug/m3: Total Ambient Impact	Ambient Impacts, ug/m3: NAAQS or ASIL
PM10-NAAQS (Emissions Based on 10% Load; AERMOD based on 10% load)														
1	24-hr during facility-wide outage	lbs/day facility-wide	PM10_081915	26.5	355	0.075	(ug/m3)/(lbs/day)	AZ bldg stack ht. = 35.6 ft. 10% load temp. and flow	357	lbs/day	26.6	89	116	150
PM2.5-NAAQS (Emissions Based on 10% Load; AERMOD based on 10% load)														
2	1st-high 24-hr during electrical bypass. "Application scenario"; 4 generators operating simultaneously	lbs/day, Worst case 4 generators at AZ Bldgs closest to NE boundary (scenario described in the permit application)	PM2.5_081915(a-e)	This value was directly modeled, without using dispersion factors				AZ bldg stack ht. = 35.6 ft. 10% load temp. and flow; 4 gens at AZ bldgs closest to NE property corner	38.7	lbs/day	**8.4**	**21.7**	**30.2**	**35**
3	PM2.5 Annual NAAQS - 1/3 * Theoretical maximum annual (1)		DEEP_081815	0.125	0.725	0.172	(ug/m3)/(tpy)	AZ bldg stack ht. = 35.6 ft. 10% load temp. and flow	**0.88**	tons/yr	0.152	6.75	6.9	12
Carbon Monoxide-NAAQS (Emissions Based on 100% Load; AERMOD based on 100% load)														
4	1-hr during facility-wide outage	lbs/hr facility-wide	CO_081915	255	67.8	3.761	(ug/m3)/(lbs/hr)	AZ bldg stack ht. = 35.6 ft. 100% load temp. and flow	112	lbs/hr	421	842	1,263	40,000
5	8-hr during facility-wide outage	lbs/hr facility-wide	CO_081915	124	67.8	1.829	(ug/m3)/(lbs/hr)	AZ bldg stack ht. = 35.6 ft. 100% load temp. and flow	112	lbs/hr	205	482	687	10,000
Nitrogen Dioxide (Emissions Based on 100% Load; AERMOD based on 100% load Except 10% Load For Reserve Generators)														
6	1-hr NO2 NAAQS. Monte Carlo stochastic analysis. No restrictions on cold-start.	lbs/hr from individual activities. Cold start during electrical bypass. 4 days/yr of cold start power outage. Electrical bypass includes 4 gens at a time in each AZ building, 2 days per year for each building.	NO2-NAAQS Monte Carlo	AZ bldg stack ht. = 40 ft. Monte Carlo stochastic model. Power outage includes 37primary gens at 100% load,reserve gens at 10% load. 4-gen electrical bypass at each AZ building includes 4 gens at 100% load.withh all generators under cold-start conditions. 4 days/yr of power outage. Electrical bypass includes 4 gens at a time in each AZ building, 2 days per year for each building.							**100**	**16**	**116**	**188**
7	NO2 ASIL, 1st-highest 1-hr during facility-wide outage	lbs/hr facility-wide	NO2_081915	This value was directly modeled, without using dispersion factors				AZ bldg stack ht. = 40 ft. All primary generators opereate at 100% load. Eight reserve geneators operate at idle. Each gen subject to 10-minute cold start.	**575**	lbs/hr	**606**	**1-hr NO2 ASIL = 470**		
8	Annual NO2 NAAQS - Theoretical maximum annual (1)	facility-wide annual, 3x the annual average to account for 3-year rolling		15.9	81.06	0.196	(ug/m3)/(tpy)	AZ bldg stack ht. = 35.6 ft. Max emissions based on 100% load; AERMOD temp. and flow based on 100% load	**99**	tons/yr	19.4	2.8	22.2	100
DEEP Concentrations and DEEP Cancer Risk (Emissions Based on 10% Load; AERMOD based on 10% load)														
9	DEEP ASIL - Theoretical maximum annual DEEP at MIBR (1)	facility-wide annual, 3x the annual average to account for 3-year rolling	DEEP_081815	This value was directly modeled, without using dispersion factors				AZ bldg stack ht. = 40 ft. 10% load temp. and flow	**0.88**	tons/yr	0.152	Annual DEEP ASIL = 0.0033.		
10	DEEP Cancer Risk at Maximum MIBR Home North of Data Center	70-year annual average	DEEP_081815	AERMOD value at the MIBR home = 0.018 ug/m3. We applied the DEEP URF of 300 x 10-6 risk per ug/m3				AZ bldg stack ht. = 40 ft. 10% load temp. and flow	0.814	tons/yr	5.40	WAC 460 limit = 10-per-million. The MIBR risk value presented in the Feb-2015 DEEP Risk Report was higher (5.73-per-million)		
Miscellaneous TAPs With Emission Rates Exceeding SQERs (Emissions based on 100% load; AERMOD based on 100% load)														
11	Ammonia 24-hr at MIBR (ultra-worst case)	lbs/day facility-wide	CO_081915	78.3	1622	0.048	(ug/m3)/(lbs/day)	AZ bldg stack ht. = 35.6 ft. Max emissions based on 100% load; AERMOD temp. and flow based on 100% load	518	lbs/day	**25.0**	Ammonia 24-hr ASIL = 70.8		
12	Acrolein 24-hr at MIBR (ultra-worst case)	lbs/day facility-wide	CO_081915	78.3	1622	0.048	(ug/m3)/(lbs/day)	AZ bldg stack ht. = 35.6 ft. Max emissions based on 100% load; AERMOD temp. and flow based on 100% load	0.016	lbs/day	**0.000762**	Acrolein 24-hr ASIL = 0.06		
13	Benzene Theoretical maximum annual at MIBR (1)	facility-wide annual, 3x the annual average to account for 3-year rolling	CO_081915	30	296	0.101	(ug/m3)/(tpy)	AZ bldg stack ht. = 35.6 ft. Max emissions based on 100% load; AERMOD temp. and flow based on 100% load	**1.04E-02**	tons/yr	**0.00106**	Annual Benzene ASIL = 0.0345		

Note 1. Theoretical maximum annual calculations assume the allowable emissions over the 3-year rolling period occur in one year

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

TABLE B-2-5. MONTE CARLO EMISSION HEIRARCHY AND NO2-NAAQS MODEL RUNS
MICROSOFT PROJECT OXFORD DATA CENTER
Includes 5-9s Reserve Generators and 100% load limit

Day of Ranking	Number of Operating Days per Year	Runtime Scenario	Engine Condition	Facility Wide Nox Emission Rate, lb/hr	AERMOD Run	1st-highest 1-hour NO2 Impact at Max Receptor, ug/m3
1-4	4	Power Outage	37 primary gens at 100% load; 8 gens at 10% load	575	MC1	606
5-8	4. Assumes each AZ building is subject to transformer maintenance every year.	Bypass Scenario 1, represents two AZ buildings at NE quadrant	4 gens in one AZ buiding at 100% load	63.9	MC2	272
9-12	4. Assumes each AZ building is subject to transformer maintenance every year.	Bypass Scenario 2, represents two AZ buildings at NW quadrant	4 gens in one AZ buiding at 100% load	63.9	MC3	188
13-16	4. Assumes each AZ building is subject to transformer maintenance every year.	Bypass Scenario 3, represents two AZ buildings at SW quadrant	4 gens in one AZ buiding at 100% load	63.9	MC4	191
17-20	4. Assumes each AZ building is subject to transformer maintenance every year.	Bypass Scenario 4, represents two AZ buildings at SE quadrant	4 gens in one AZ buiding at 100% load	63.9	MC5	258

--

Trigger value to exceed the 98th percentile NO2-NAAQS = NAAQS limit - background = 188 - 16 = 172 ug/m3.

Modeling includes 5-9x Reserve Generators and 100% load limit.

Table B-2-7 - Ammonia and Acrolein Emission Estimate (Incl. 5-9s Reserve)

CAT guarantee = 15 ppmv @ 15% O2 (add 1.2 safety factor)
Use EPA Method 19 F-factors and 100% load during a power outage

Fuel usage at 100% Load

	No. Gens	Load	Diesel Rate, gal/hr	Daily Fuel, gal/day			
2.5 Mwe gens	32	100%	173.5	133,248			
2.5 Mwe Reserve gens; 30 minutes at 10% load	8	100%	173.5	694			
2.0 Mwe gens	4	100%	138	13,248			
750 kWe gen	1	100%	53.6	1,286			
Facility-Wide fuel usage, gal/day				148,476			
Distillate heat content, BTU/gal				135,000			
Facility-Wide Heat Input, MMBtu/day				20,044			
Method 19 Fd, dscf/MMBtu at 68 F				9,190			
Facility-Wide Flue Gas, dscf/day at zero oxygen, 68 F				184,207,246		3,553.38	dscfm/genset
Oxygen Content for Ammonia Limit, %				15			
Oxygen Factor (20.9)/(20.9-%O2)				3.54			
Facility-Wide Flue Gas, dscf/day at 15% oxygen, 68 F				652,530,752		12,587.40	dscfm/genset
Estimated Flue Gas Temp (Manifold minus 200), deg F				715			
Facility-Wide Flue Gas, actual scf/day at 15% oxygen, Stack Temp				1,452,128,093		28,011.73	dacfm/gen at 15% O2, stack temp
Molar Volume at STP, ft3/lbmol				359			
Molar Volume at stack conditions, ft3/lbmol				857			
Flue Gas lbmoles/day				1,693,704.79			
Allowable Ammonia Concentration, ppmv at 15%				15			
Ammonia lbmoles/day				25.41			
Ammonia molec wt, lbs/lbmol				17			
Facility-Wide Ammonia Emission Rate, lbs/day				432	facility-wide lbs/day	518	facility-wide lbs/day inc. 1.20 safety factor
Allowable Ammonia Emissions, Each 2500 kWe gens, lbs/hr				0.50	lbs/hr ea. 2.5 MW gen	0.61	lbs/hr ea. 2.5 MW gen inc. 1.20 safety factor
Allowable Ammonia Emissions, Each 2000 kWe gens, lbs/hr				0.40	lbs/hr ea. 2.0 MW gen	0.48	lbs/hr ea. 2.0 MW gen inc. 1.20 safety factor
Allowable Ammonia Emissions, Each 750 kWe gens, lbs/hr				0.16	lbs/hr ea. 750 kW gen	0.19	lbs/hr ea. 750 kW gen inc. 1.20 safety factor

Acrolein Emissions During Facility-Wide Power Outage (daily lbs/day)

AP-42 Acrolein emission factor, lbs/MMBtu	7.88E-06
Ultra-worst case facility-wide fuel usage, MMBtu/day	20,044
Ultra-worst case Acrolein emissions after 90% DOC, lbs/day	0.0158

Annual Ammonia	1724	lbs/yr facility-wide	2069	lbs/yr facility-wide incl. 1.2 safety factor

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

TABLE B-2-8. CORRECTED AS-BUILT STACK HEIGHTS AND CATERPILLAR AS-BUILT STACK PARAMETERS
MICROSOFT OXFORD DATA CENTER
DEC 2015 CORRECTIONS

				Tier-2 Engine Data at Exhaust Manifold From Caterpillar Spec Sheets				Adjustment for Tier-4 Stack Exhaust Parameters vs. Tier-2 Manifold Parameters (From Vantage Data Center Stack Test Data)		Tier-4 Exhaust Stack Parameters for AERMOD Modeling			
Gen Size	Stack Ht, feet	Stack Inside Diameter, inches	Height of permanent building structure, not including rooftop mechanical equipment	100% load Actual Flowrate at Generator exhaust manifold, acfm	10% load Actual Flowrate at Generator exhaust manifold, acfm	100% load stack temp at generator exhaust manifold, deg F	10% load stack temp at generator exhaust manifold, deg F	Adjustment for Stack Exhaust Flowrate	Adjustments for Stack Exhaust Temperature	100% load Actual Flowrate , acfm	10% load Actual Flowrate, acfm	100% load stack temp , deg F	10% load stack temp, deg F
2500 kWe	40	22	Height of AZ Buildings = 28.5 feet	19,582	4,800	915	647	0.924	-147	18,094	4,435	768	500
2000 kWe	40	22	Height of CNR buildings = 20.8 feet	15,293	4,478	752	553	0.924	-147	14,131	4,138	605	406
750 kWe	35.6	12	Height of administration building = 23.8 feet	5,610	1,660	949	532	0.924	-147	5,184	1,534	802	385

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

Table D-1. Caterpillar 3516C HD 2,500 ekW Generator (DM8266)

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN	EKW	2,500	1,875	1,250	625	250
ENGINE POWER	BHP	3,633	2,760	1,889	1,029	497
PERCENT LOAD	%	100%	75%	50%	25%	10%
Exhaust Temperature	C	491	459	455	444	342
TOTAL NOX (AS NO2)	LB/HR	50.59	31.09	15.44	7.87	7.02
Estimated Reduction	%	85%	90%	90%	90%	85%
Post Catalyst NOx (as NO2)	LB/HR	7.59	3.11	1.54	0.79	1.05
TOTAL CO	LB/HR	6.01	2.88	2.41	3.30	4.62
Estimated Reduction	%	80%	80%	80%	80%	80%
Post Catalyst CO	LB/HR	1.20	0.58	0.48	0.66	0.92
TOTAL HC	LB/HR	1.10	1.10	1.20	0.90	0.96
Estimated Reduction	%	85%	80%	80%	80%	70%
Post Catalyst HC	LB/HR	0.165	0.220	0.240	0.180	0.288
PART MATTER	LB/HR	0.41	0.27	0.29	0.31	0.31
Estimated Reduction	%	85%	85%	85%	85%	85%
Post Catalyst PM	LB/HR	0.062	0.041	0.044	0.047	0.047
PART MATTER (Front & Back)	**LB/HR**	**0.227**	**0.261**	**0.284**	**0.227**	**0.335**
Added Safety Factor*	**20%**	**0.272**	**0.313**	**0.340**	**0.272**	**0.401**

** Recommend adjusting field measured Total Particulate Matter which includes both Front half and Back half PM from the current 0.288 lbs/hr to 0.40 lbs/hr in order to compensate for engines not fully burned in, load variation, engine to engine variation and site/weather variations.*

Table D-2. Caterpillar 3516C 2,000 ekW Generator (DM8263)

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN	EKW	2,000	1,500	1,000	500	200
ENGINE POWER	BHP	2,937	2,212	1,521	839	411
PERCENT LOAD	%	100%	75%	50%	25%	10%
Exhaust Temperature	C	400	363	346	339	289
TOTAL NOX (AS NO2)	LB/HR	42.10	22.52	12.78	9.30	6.46
Estimated Reduction	%	92%	93%	93%	90%	0%
Post Catalyst NOx (as NO2)	LB/HR	3.37	1.58	0.89	0.93	6.46
TOTAL CO	LB/HR	3.45	1.87	2.00	3.91	3.95
Estimated Reduction	%	80%	80%	80%	80%	80%
Post Catalyst CO	LB/HR	0.69	0.37	0.40	0.78	0.79
TOTAL HC	LB/HR	0.93	1.13	1.13	0.90	0.98
Estimated Reduction	%	85%	80%	80%	80%	70%
Post Catalyst HC	LB/HR	0.140	0.226	0.226	0.180	0.294
PART MATTER	LB/HR	0.23	0.22	0.27	0.57	0.45
Estimated Reduction	%	85%	85%	85%	85%	85%
Post Catalyst PM	LB/HR	0.035	0.033	0.041	0.086	0.068
PART MATTER (Front & Back)	**LB/HR**	**0.174**	**0.259**	**0.267**	**0.266**	**0.362**
Added Safety Factor*	**20%**	**0.209**	**0.311**	**0.320**	**0.319**	**0.434**

** Recommend adjusting field measured Total Particulate Matter which includes both Front half and Back half PM from the current 0.288 lbs/hr to 0.40 lbs/hr in order to compensate for engines not fully burned in, load variation, engine to engine variation and site/weather variations.*

Table D-3. Caterpillar C27 750 ekW Generator (DM9071)

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN	EKW	750	563	375	188	75
ENGINE POWER	BHP	1,141	878	618	361	201
PERCENT LOAD	%	100%	75%	50%	25%	10%
Exhaust Temperature	C	509	489	452	366	278
TOTAL NOX (AS NO2)	LB/HR	15.83	9.17	5.82	4.02	2.89
Estimated Reduction	%	93%	92%	92%	90%	0%
Post Catalyst NOx (as NO2)	LB/HR	1.11	0.73	0.47	0.40	2.89
TOTAL CO	LB/HR	1.15	1.51	1.45	1.19	1.22
Estimated Reduction	%	80%	80%	80%	80%	70%
Post Catalyst CO	LB/HR	0.23	0.30	0.29	0.24	0.37
TOTAL HC	LB/HR	0.12	0.18	0.21	0.19	0.22
Estimated Reduction	%	85%	80%	80%	70%	60%
Post Catalyst HC	LB/HR	0.018	0.036	0.042	0.057	0.088
PART MATTER	LB/HR	0.10	0.13	0.33	0.26	0.17
Estimated Reduction	%	85%	85%	85%	85%	85%
Post Catalyst PM	LB/HR	0.015	0.020	0.050	0.039	0.026
PART MATTER (Front & Back)	**LB/HR**	**0.033**	**0.056**	**0.092**	**0.096**	**0.114**
Added Safety Factor*	**20%**	**0.040**	**0.067**	**0.110**	**0.115**	**0.136**

** Recommend adjusting field measured Total Particulate Matter which includes both Front half and Back half PM from the current 0.288 lbs/hr to 0.40 lbs/hr in order to compensate for engines not fully burned in, load variation, engine to engine variation and site/weather variations.*

Table C1-1 (Corrected to Include Black Puff Factors)
Caterpillar 3516C HD 2,500 ekW Generator (DM8266)
RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN	EKW	2,500		1,875	1,250	625	250
ENGINE POWER	BHP	3,633		2,760	1,889	1,029	497
PERCENT LOAD	%	100%	85%	75%	50%	25%	10%
Exhaust Temperature	C	491		459	455	444	342
TOTAL NOX (AS NO2)	LB/HR	50.59	38.9	31.1	15.4	7.87	7.02
Estimated Reduction	%	85%		90%	90%	90%	85%
Post Catalyst NOx (as NO2)	LB/HR	7.59		3.11	1.54	0.79	1.05
Post-Catalyst Plus 20% Safety Factor	LB/HR	9.11	5.88	3.73	1.85	0.94	1.26
TOTAL CO	LB/HR	6.01		2.88	2.41	3.30	4.62
Black Puff Factor		1.56		1.56	1.56	1.56	1.56
Cold-Start Incl. Black Puff Factor		9.38	6.4	4.49	3.76	5.15	7.21
Estimated Reduction	%	80%		80%	80%	80%	80%
Post Catalyst CO	LB/HR	1.20		0.58	0.48	0.66	0.92
Post-Catalyst Plus 20% Safety Factor	LB/HR	1.44	1.0	0.69	0.58	0.79	1.11
TOTAL HC	LB/HR	1.10		1.10	1.20	0.90	0.96
Black Puff Factor		1.26		1.26	1.26	1.26	1.26
Cold-Start Incl. Black Puff Factor		1.39		1.39	1.51	1.13	1.21
Estimated Reduction	%	85%		80%	80%	80%	70%
Post Catalyst HC	LB/HR	0.165		0.220	0.240	0.180	0.288
Post-Catalyst Plus 20% Safety Factor	LB/HR	0.20		0.26	0.29	0.22	0.35
PART MATTER	LB/HR	0.41		0.27	0.29	0.31	0.31
Estimated Reduction	%	85%		85%	85%	85%	85%
Post Catalyst PM	LB/HR	0.062		0.041	0.044	0.047	0.047
COLD-START PART MATTER FRONT HALF (Front Half = 1.26 Black Puff x Post-DPF PSV)	LB/HR	0.077		0.051	0.055	0.059	0.059
COLD-START PART MATTER BACK HALF (2x Post-Catalyst HC)	LB/HR	0.33		0.44	0.48	0.36	0.576
COLD-START PART MATTER (Front & Back, Incl. Black Puff Factor)	**LB/HR**	0.407		0.491	0.535	0.419	0.635
WARMED-UP PART MATTER (Front & Back)	**LB/HR**	**0.227**		**0.261**	**0.284**	**0.227**	**0.335**
WARMED-UP PM; Added Safety Factor*	**20%**	**0.272**		**0.313**	**0.340**	**0.272**	**0.401**
		100%	85%	75%	50%	25%	10%

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.

Table C1-2 (Corrected to Include Black Puff Factors)
Caterpillar 3516C 2,000 ekW Generator (DM8263)
RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN	EKW	2,000	1,500	1,000	500	200
ENGINE POWER	BHP	2,937	2,212	1,521	839	411
PERCENT LOAD	%	100%	75%	50%	25%	10%
Exhaust Temperature	C	400	363	346	339	289
TOTAL NOX (AS NO2)	LB/HR	42.10	22.52	12.78	9.30	6.46
Estimated Reduction	%	92%	93%	93%	90%	0%
Post Catalyst NOx (as NO2)	LB/HR	3.37	1.58	0.89	0.93	6.46
Post-Catalyst Plus 20% Safety Factor	LB/HR	4.04	1.89	1.07	1.12	7.75
TOTAL CO	LB/HR	3.45	1.87	2.00	3.91	3.95
Black Puff Factor		1.56	1.56	1.56	1.56	1.56
Cold-Start Incl. Black Puff Factor		5.38	2.92	3.12	6.10	6.16
Estimated Reduction	%	80%	80%	80%	80%	80%
Post Catalyst CO	LB/HR	0.69	0.37	0.40	0.78	0.79
Post-Catalyst Plus 20% Safety Factor	LB/HR	0.83	0.45	0.48	0.94	0.95
TOTAL HC	LB/HR	0.93	1.13	1.13	0.90	0.98
Black Puff Factor		1.26	1.26	1.26	1.26	1.26
Cold-Start Incl. Black Puff Factor		1.17	1.42	1.42	1.13	1.23
Estimated Reduction	%	85%	80%	80%	80%	70%
Post Catalyst HC	LB/HR	0.140	0.226	0.226	0.180	0.294
Post-Catalyst Plus 20% Safety Factor	LB/HR	0.17	0.27	0.27	0.22	0.35
PART MATTER	LB/HR	0.23	0.22	0.27	0.57	0.45
Estimated Reduction	%	85%	85%	85%	85%	85%
Post Catalyst PM	LB/HR	0.035	0.033	0.041	0.086	0.068
COLD-START PART MATTER FRONT HALF (Front Half = 1.26 Black Puff x Post-DPF PSV)	LB/HR	0.043	0.042	0.051	0.108	0.085
COLD-START PART MATTER BACK HALF (2x Post-Catalyst HC)	LB/HR	0.33	0.44	0.48	0.36	0.576
COLD-START PART MATTER (Front & Back, Incl. Black Puff Factor)	**LB/HR**	0.373	0.482	0.531	0.468	0.661
PART MATTER (Front & Back)	**LB/HR**	**0.174**	**0.259**	**0.267**	**0.266**	**0.362**
Added Safety Factor*	**20%**	**0.209**	**0.311**	**0.320**	**0.319**	**0.434**

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

Table C1-3

Caterpillar C27 750 ekW Generator (DM9071)

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN	EKW	750	563	375	188	75
ENGINE POWER	BHP	1,141	878	618	361	201
PERCENT LOAD	%	100%	75%	50%	25%	10%
Exhaust Temperature	C	509	489	452	366	278
TOTAL NOX (AS NO2)	LB/HR	15.83	9.17	5.82	4.02	2.89
Estimated Reduction	%	93%	92%	92%	90%	0%
Post Catalyst NOx (as NO2)	LB/HR	1.11	0.73	0.47	0.40	2.89
Post-Catalyst Plus 20% Safety Factor	LB/HR	1.33	0.88	0.56	0.48	3.47
TOTAL CO	LB/HR	1.15	1.51	1.45	1.19	1.22
Estimated Reduction	%	80%	80%	80%	80%	70%
Post Catalyst CO	LB/HR	0.23	0.30	0.29	0.24	0.37
Post-Catalyst Plus 20% Safety Factor	LB/HR	0.28	0.36	0.35	0.29	0.44
TOTAL HC	LB/HR	0.12	0.18	0.21	0.19	0.22
Estimated Reduction	%	85%	80%	80%	70%	60%
Post Catalyst HC	LB/HR	0.018	0.036	0.042	0.057	0.088
Post-Catalyst Plus 20% Safety Factor	LB/HR	0.02	0.04	0.05	0.07	0.11
PART MATTER	LB/HR	0.10	0.13	0.33	0.26	0.17
Estimated Reduction	%	85%	85%	85%	85%	85%
Post Catalyst PM	LB/HR	0.015	0.020	0.050	0.039	0.026
COLD-START PART MATTER FRONT HALF (Front Half = 1.26 Black Puff x	LB/HR	0.019	0.025	0.062	0.049	0.032
COLD-START PART MATTER BACK HALF (2x Post-Catalyst HC)	LB/HR	0.33	0.44	0.48	0.36	0.576
COLD-START PART MATTER (Front & Back, Incl. Black Puff Factor)	**LB/HR**	0.349	0.465	0.542	0.409	0.608
PART MATTER (Front & Back)	**LB/HR**	**0.033**	**0.056**	**0.092**	**0.096**	**0.114**
Added Safety Factor*	**20%**	**0.040**	**0.067**	**0.110**	**0.115**	**0.136**

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\c-Mar16 AppB Emissions and Ambient\[C-Apr-2016_5-9s_emission calcs and NAAQS-ASIL Modeling.xlsx]B2.4 - X-Q NAAQS-ASIL

Table 2 - 2500 kWe Generators Curve Fits

Load	Cold, lbs/hr	Warm, lbs/hr
10%	7.02	1.26
25%	7.87	0.94
50%	15.4	1.85
75%	31.1	3.73
100%	50.6	9.11
	-59.018	41.393
	100.93	-76.495
	6.1789	57.826
	-4.8391	-15.965
	7.3471	2.3506
90%	42.9	6.2
85%	38.9	5.2
80%	34.9	4.4
95%	46.8	7.5
65%	24.0	2.8
71%	28.2	3.3
88%	41.3	5.8

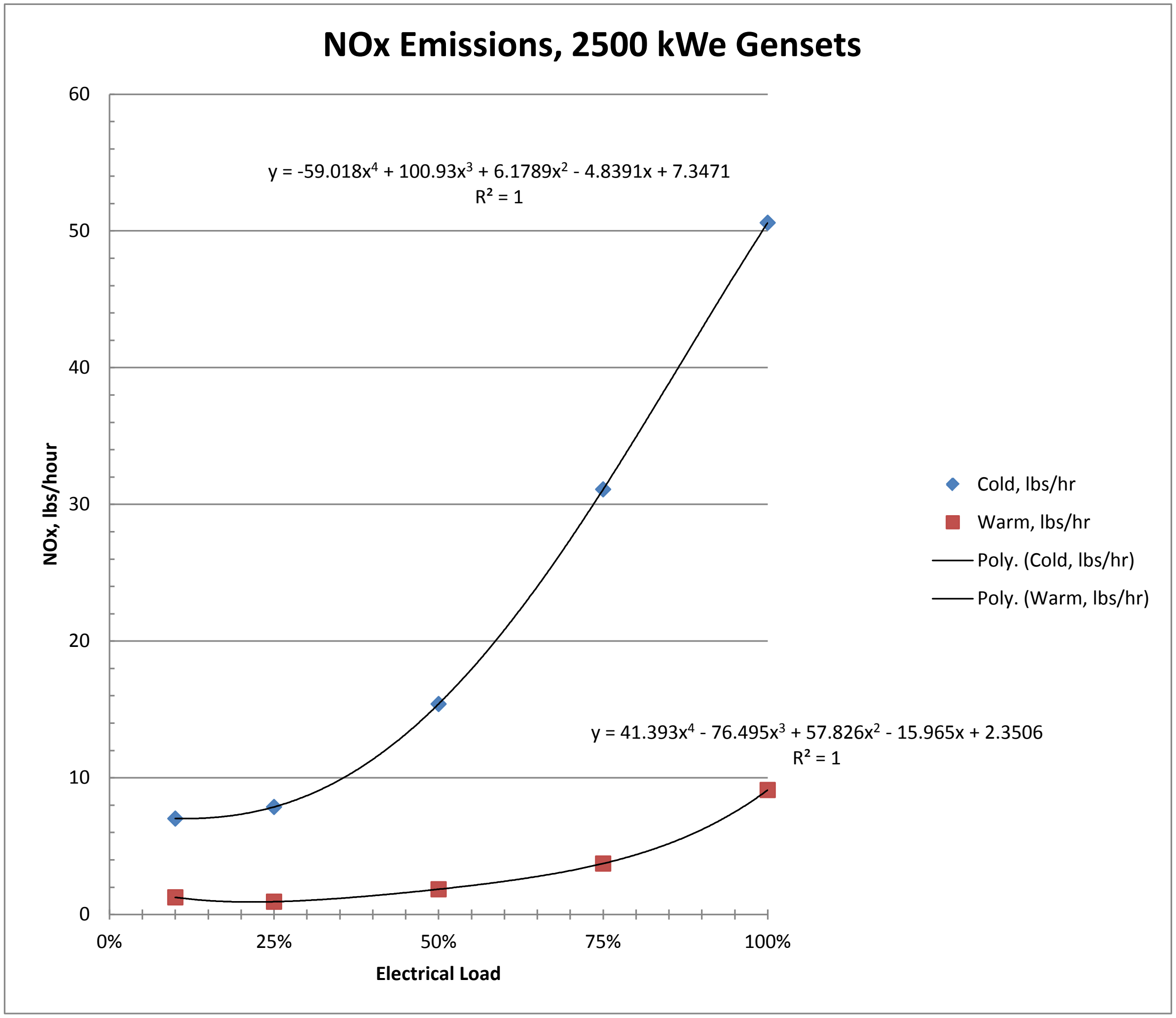
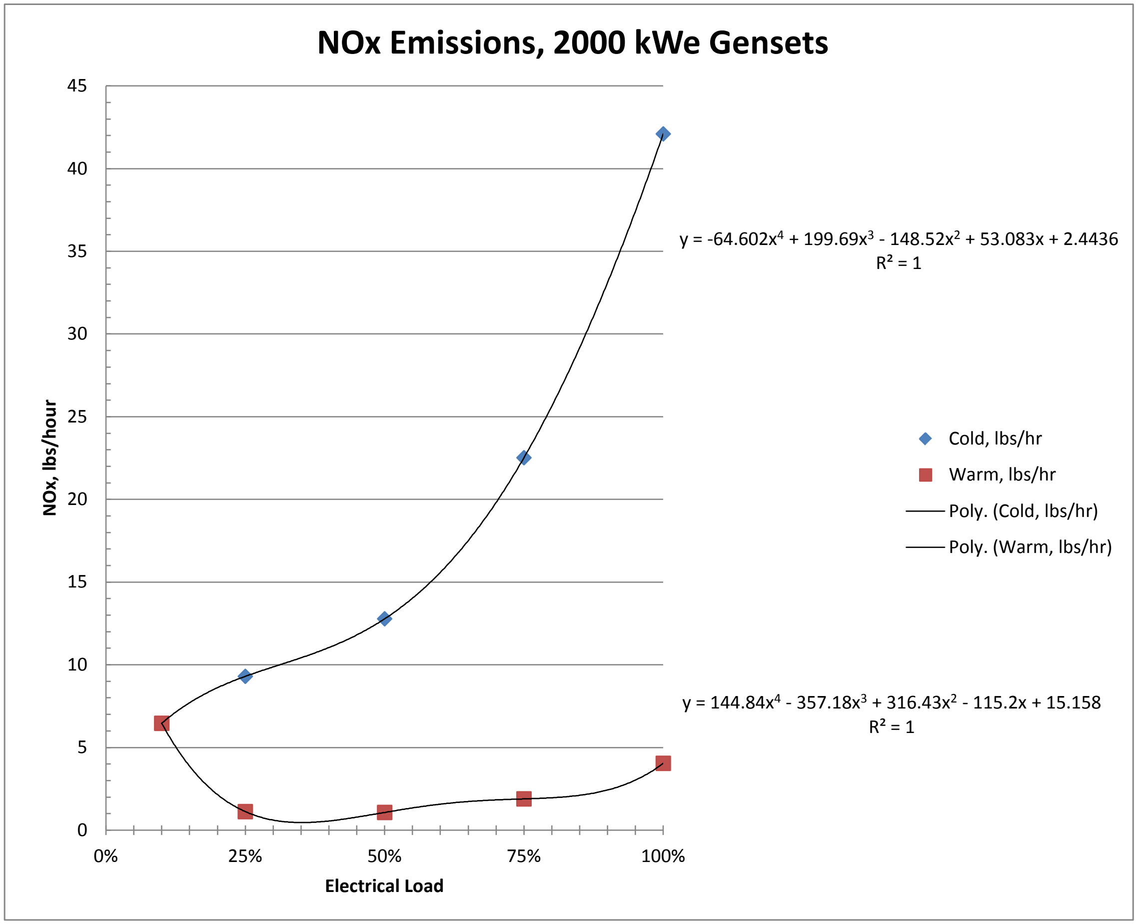


Table 3 - 2000 kWe Generators Curve Fits

Load	Cold, lbs/hr	Warm, lbs/hr
10%	6.46	6.46
25%	9.3	1.12
50%	12.78	1.07
75%	22.52	1.89
100%	42.1	4.04
	-64.602	144.84
	199.69	-357.18
	-148.52	316.43
	53.083	-115.2
	2.4436	15.158
90%	33.1	2.4
85%	29.2	2.1
80%	25.6	2.0
95%	37.4	3.0
100%	42.1	4.0
88%	31.5	2.3



ATTACHMENT B-3

March 2016 BACT Cost-Effectiveness Calculations

From:	Parker, Steve
To:	Jim Wilder
Cc:	Rockwell_David@cat.com; Ralph Wintersberger (wintersberger_ralph@cat.com); Jones, Courtney; John Radick
Subject:	RE: Reminder: Microsoft Oxford: "Quantity discount" for emission control costs for multiple generators
Date:	Tuesday, March 29, 2016 9:02:39 AM

Hello Jim,
Sorry for the delay.
[redacted] is no longer employed by NCPS. The cost of the equipment did account for the quantity discount.
Please be advise the pricing for this contract expires December 31, 2016.

Thank you

Steve Parker
Area Sales Manager
NC Power Systems
(O) 425-656-4593
(M) 425-941-8022

From: Jim Wilder [mailto:JWilder@landauinc.com]
Sent: Tuesday, March 29, 2016 8:52 AM
To: Jim Wilder <JWilder@landauinc.com>; Briody, Brant <BBriody@NCPowerSystems.com>
Cc: Rockwell_David@cat.com; Ralph Wintersberger (wintersberger_ralph@cat.com) <wintersberger_ralph@cat.com>; Parker, Steve <SParker@NCPowerSystems.com>; Jones, Courtney <CJones@NCPowerSystems.com>; John Radick <John.Radick@microsoft.com>
Subject: Reminder: Microsoft Oxford: "Quantity discount" for emission control costs for multiple generators

Hello guys - This is a reminder. Can you please respond to my question below? When Brant provided equipment costs for emission control devices back in 2013, did the prices account for "quantity discount" to provide roughly 16 generators at a time?

We need your answer before we can complete our revised air quality application.

Thanks for your help!

Jim Wilder, Landau Associates
425-329-0320

From: Jim Wilder
Sent: Monday, March 21, 2016 12:23 PM
To: Briody, Brant
Cc: Rockwell_David@cat.com; Ralph Wintersberger (wintersberger_ralph@cat.com); Parker, Steve; Jones, Courtney; Jim Wilder; John Radick
Subject: Microsoft Oxford: "Quantity discount" for emission control costs for multiple generators

Hello Brant - back in 2013 you sent me the preceding email with per-generator budgetary prices for CAT generator emission controls. We are now submitting another air quality application for the 8 new "5-9s" reserve generators and some minor operational changes at Microsoft Oxford. Ecology is now asking for additional information about these budgetary prices.

Ecology's question is, did the per-generator equipment prices you provided account for "quantity discount", to provide up to 16 generators at a time?

Thanks for your help!
Jim Wilder, 425-329-0320

From: Briody, Brant [mailto:BBriody@NCPowerSystems.com]
Sent: Monday, November 11, 2013 1:43 PM
To: Jim Wilder
Cc: Rockwell_David@cat.com; Ralph Wintersberger (wintersberger_ralph@cat.com); Parker, Steve; Jones, Courtney; annclaude.coutu@urs.com
Subject: RE: Caterpillar Expedited Information Request

Hi Jim,
Here are the budgetary prices (**green font**) that you requested. Includes installation at the factory (units ready for factory witness testing). Excludes tear-down and shipping to jobsite.
The prices for the SCR and SCR with DPF include a 375 gallon stainless DEF tank, fitted within the base frame by the UL142 fuel tank. The DEF tank will be heated and the lines from the tank to the injection lance will be insulated with heat trace to prevent crystallization of the DEF in temperatures below 20 F.

ROM cost, FOB at factory
For each control device we need estimated % removal PM, NOx, CO and NMHC
Need separate ROM costs for these control devices

- *Tier 4F aftermarket package (SCR + catalyzed DPF)* ***+ $308,450. (90% NOx, 90% CO, 70% HC, 85% PM)***
- *Stand-alone DOC by itself* ***+ $52,100 (90% CO, 80% HC, 20% PM)***
- *Stand-alone catalyzed DPF by itself* ***+ $129,200 (90% CO, 80% HC, 85% PM)***
- *Stand-alone SCR by itself* ***+ $200,600 (89% NOx)***

Thanks,

Brant Briody | Power Systems Sales Representative
N C Power Systems Co. | Tukwila, WA
425.656.4587 office | 206.510.3491 cell

From: Jim Wilder [mailto:JWilder@landauinc.com]
Sent: Wednesday, November 06, 2013 4:47 PM
To: Briody, Brant; annclaude.coutu@urs.com
Cc: Rockwell_David@cat.com; Ralph Wintersberger (wintersberger_ralph@cat.com); Parker, Steve;

Control Device	Cost-Effectiveness ($/ton)				
	PM (Front half plus Method 202 back half)	**CO**	**VOC**	**NOX**	**Combined Pollutants**
Tier-4F Capable Integrated Control System (Catalyzed DPF + SCR)	$839,678	$313,628	$1,463,920	$33,707	$28,793
Urea-SCR Alone	Ineffective	Ineffective	Ineffective	$16,209	$16,209
Catalyzed DPF Alone	$352,233	$131,562	$614,094	Ineffective	$82,861
Diesel Oxidation Catalyst Alone	$523,842	$53,251	$248,562	Ineffective	$40,468

Control Device	Cost-Effectiveness ($/ton)					
	DEEP (Front half plus Method 202 back half)	CO	Carcinogen VOC	NO2	Acrolein	Combined Pollutants
Tier-4F Capable Integrated Control System (Catalyzed DPF + SCR)	$839,678	$313,628	$77,677,470	$337,066	$10,138,457,408	$134,707
Urea-SCR Alone	Ineffective	Ineffective	Ineffective	$162,089	Ineffective	$162,089
Catalyzed DPF Alone	$352,233	$131,562	$32,584,592	Ineffective	$443,476,385	$94,620
Diesel Oxidation Catalyst Alone	$523,842	$53,251	$13,188,995	Ineffective	$1,721,426,645	$47,607

Table X. 2016 BACT Capital Cost for "Tier-4F Capable" System (SCR and Catalyzed DPF)

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2500 kWe emission control package	ROM cost estimate by Caterpillar		40	$308,450	$12,338,000
2000 kWe system	"0.6 rule" scaled from Caterpillar estimate for 2500 kWe		4	$269,798	$1,079,192
750 kWe system	"0.6 rule" scaled from Caterpillar estimate for 2500 kWe system		1	$149,781	$149,781
Combined systems FOB cost					$13,566,973
Instrumentation	Assume no cost	Assume no cost	0	0	0
Sales Tax	WA state tax	WA state tax	6.5%	--	$881,853
Shipping	0.05A	EPA Cost Manual	5.0%	--	$678,349
Subtotal Purchased Equipment Cost, PEC					$15,127,175
Direct Installation Costs					
Enclosure structural supports	Assume no cost	Assume no cost	0	$0	$0
Installation	1/2 of EPA Cost Manual	1/2 of EPA Cost Manual	2.5%	--	$378,179
Electrical	Assume no cost	Assume no cost	0	0	0
Piping	Assume no cost	Assume no cost	0	0	0
Insulation	Assume no cost	Assume no cost	0	0	0
Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs					$378,179
Site Preparation and Buildings (SP)	Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)					$15,505,355
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$378,179
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$378,179
Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$1,043,454
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$302,544
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$151,272
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$453,815
Subtotal Indirect Costs, IC					$2,707,443
Total Capital Investment (TCI = DC+IC)					$18,212,798
					TCI per gen $444,215

TCI/PEC
1.20

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table X. 2016 BACT Cost-Effectiveness for "Tier-4F Capable" System

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$18,212,798
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$1,165,801
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$364,256
Annual Property tax	1% of TCI (EPA Manual)		0.01	$182,128
Annual Insurance	1% of TCI (EPA Manual)		0.01	$182,128
Annual operation/labor/maintenance costs: Upperbound estimate would assume CARB's value of $3.00/hp/year and would result in $423,000/year. Lower bound estimate would assume zero annual O&M. Mid-range value would account for urea, fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. **For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.**				$0
Subtotal Direct Annual Costs				$728,512
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$1,894,313**
Uncontrolled emissions (Combined Pollutants)				104.9
Annual Tons Removed (Combined Pollutants)				65.79
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$28,793**

Annual O&M Cost Based on CARB Factors

Annual operation + maintenance (lowermost CARB estimate)	158,209	Installed hp	$3.00	$474,627

Criteria Pollutants Multi-Pollutant Cost-Effectiveness (Reasonable vs. Actual Control Cost)

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	56.20	$562,000	per year
CO	$5,000	6.04	$30,200	per year
VOC	$9,999	1.29	$12,939	per year
PM (FH+BH)	$23,200	2.26	$52,339	per year
Other				
Total Reasonable Annual Control Cost for Combined Pollutants			**$657,478**	**per year**
Actual Annual Control Cost			**$1,894,313**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

Criteria Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX	Combined Pollutants
Tier-2 Uncontrolled TPY	**3.07**	**11.60**	**2.260**	**88.0**	
Controlled TPY	**0.814**	**5.560**	**0.966**	**31.80**	
Tons Removed/Year	**2.26**	**6.04**	**1.294**	**56.2**	
Combined Uncontrolled Tons/yr	104.93				
Combined tons/yr Removed	65.79				
Overall Cold-Start Removal Effcy	73%	52%	57%	64%	
Annualized Cost ($/yr)	$1,894,313	$1,894,313	$1,894,313	$1,894,313	$1,894,313
Indiv Poll $/Ton Removed	$839,678	$313,628	$1,463,920	$33,707	$28,793

TAPs Multi-Pollutant Cost-Effectiveness (Reasonable vs. Actual Control Cost)

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NO2	$20,000	5.62	$112,400	per year
CO	$5,000	6.04	$30,200	per year
Carcinogen VOC	$9,999	0.0244	$244	per year
DEEP (FH+BH)	$23,200	2.256	$52,339	per year
Non-carcinogen VOC	$5,000	0.1219	$610	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$195,793**	**per year**
Actual Annual Control Cost			**$1,894,313**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

TAPs Removal Tonnages (Nominal-Controlled)

Pollutant	DEEP (FH+BH)	CO	Carcinogen VOC	NO2	Non Carcinogen VOC	Acrolein
Tier-2 Uncontrolled TPY	**3.07**	**11.60**	**0.0426**	**8.80**	**0.1355**	**0.00033**
Controlled TPY	**0.814**	**5.560**	**0.01821**	**3.18**	**0.01355**	**0.00014**
Tons Removed/Year	**2.256**	**6.04**	**0.0244**	**5.62**	**0.1219**	**0.000187**
Combined Uncontrolled Tons/yr	23.65					
Combined tons/yr Removed	14.06					
Overall Cold-Start Removal Effcy	73%	52%	57%	64%	90%	57%
Annualized Cost ($/yr)	$1,894,313	$1,894,313	$1,894,313	$1,894,313	$1,894,313	$1,894,313
Indiv Poll $/Ton Removed	$839,678	$313,628	$77,677,470	$337,066	$15,534,027	$10,138,457,408
Combined TAPs $/Ton Removed	$134,707					

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table X. 2016 BACT Capital Cost for Catalyzed DPF

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2500 kWe emission control package	ROM cost estimate by Caterpillar		40	$129,200	$5,168,000
2000 kWe system	"0.6 rule" scaled from Caterpillar estimate for 2500 kWe		4	$113,010	$452,040
750 kWe system	"0.6 rule" scaled from Caterpillar estimate for 2500 kWe system		1	$62,739	$62,739
Combined systems FOB cost					$5,682,778
Instrumentation	Assume no cost	Assume no cost	0	0	0
Sales Tax	WA state tax	WA state tax	6.5%	--	$369,381
Shipping	0.05A	EPA Cost Manual	5.0%	--	$284,139
Subtotal Purchased Equipment Cost, PEC					$6,336,298
Direct Installation Costs					
Enclosure structural supports	Assume no cost	Assume no cost	0	$0	$0
Installation	1/2 of EPA Cost Manual	1/2 of EPA Cost Manual	2.5%	--	$158,407
Electrical	Assume no cost	Assume no cost	0	0	0
Piping	Assume no cost	Assume no cost	0	0	0
Insulation	Assume no cost	Assume no cost	0	0	0
Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs					$158,407
Site Preparation and Buildings (SP)	Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)					$6,494,705
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$158,407
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$158,407
Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$448,311
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$126,726
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$63,363
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$190,089
Subtotal Indirect Costs, IC					$1,145,304
Total Capital Investment (TCI = DC+IC)					$7,640,009
					TCI per gen #DIV/0!

TCI/PEC
1.21

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table X. 2016 BACT Cost-Effectiveness for Catalyzed DPF

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$7,640,009
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$489,037
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$152,800
Annual Property tax	1% of TCI (EPA Manual)		0.01	$76,400
Annual Insurance	1% of TCI (EPA Manual)		0.01	$76,400
Annual operation/labor/maintenance costs: Upperbound estimate would assume CARB's value of $2.00/hp/year and would result in $282,000/year. Lower bound estimate would assume zero annual O&M. Mid-range value would account for fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. **For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.**				$0
Subtotal Direct Annual Costs				$305,600
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$794,637**
Uncontrolled emissions (Combined Pollutants)				104.9
Annual Tons Removed (Combined Pollutants)				9.59
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$82,861**

Annual O&M Cost Based on CARB Factors

Annual operation + maintenance (lowermost CARB estimate)	163,840	Installed hp	$2.00	$327,680

Criteria Pollutants Multi-Pollutant Cost-Effectiveness (Reasonable vs. Actual Control Cost)

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	0.00	$0	per year
CO	$5,000	6.04	$30,200	per year
VOC	$9,999	1.29	$12,939	per year
PM (FH+BH)	$23,200	2.26	$52,339	per year
Other				
Total Reasonable Annual Control Cost for Combined Pollutants			**$95,478**	**per year**
Actual Annual Control Cost			**$794,637**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

Criteria Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX	Combined Pollutants
Tier-2 Uncontrolled TPY	**3.07**	**11.60**	**2.26**	**88.00**	
Controlled TPY	**0.814**	**5.560**	**0.966**	**88.0**	
Tons Removed/Year	**2.26**	**6.04**	**1.294**	**0.0**	
Combined Uncontrolled Tons/yr	104.9				
Combined tons/yr Removed	9.59				
Quoted Removal Effcy	73%	52%	57%	0%	
Annualized Cost ($/yr)	$794,637	$794,637	$794,637	$794,637	
Indiv Poll $/Ton Removed	$352,233	$131,562	$614,094	#DIV/0!	$82,861

TAPs Multi-Pollutant Cost-Effectiveness (Reasonable vs. Actual Control Cost)

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NO2	$20,000	0.00	$0	per year
CO	$5,000	6.04	$30,200	per year
Carcinogen VOC	$9,999	0.0244	$244	per year
DEEP (FH+BH)	$23,200	2.256	$52,339	per year
Non-carcinogen VOC	$5,000	0.0776	$388	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$83,171**	**per year**
Actual Annual Control Cost			**$794,637**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

TAPs Removal Tonnages (Nominal-Controlled)

Pollutant	DEEP (FH+BH)	CO	Carcinogen VOC	NO2	Non Carcinogen VOC	Acrolein
Tier-2 Uncontrolled TPY	**3.07**	**11.60**	**0.0426**	**8.80**	**0.1355**	**0.000326**
Controlled TPY	**0.814**	**5.560**	**0.018**	**8.80**	**0.058**	**0.000139**
Tons Removed/Year	**2.256**	**6.04**	**0.0244**	**0.00**	**0.0776**	**0.000187**
Combined Uncontrolled Tons/yr	23.65					
Combined tons/yr Removed	8.40					
Overall Cold-Start Removal Effcy	73%	52%	57%	0%	57%	57%
Annualized Cost ($/yr)	$794,637	$794,637	$794,637	$794,637	$82,861	$82,861
Indiv Poll $/Ton Removed	$352,233	$131,562	$32,584,592	#DIV/0!	$1,068,069	$443,476,385
Combined TAPs $/Ton Removed	$94,620					

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table X. 2016 BACT Capital Cost for Urea-SCR By Itself

Cost Category		Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs						
Purchased Equipment Costs						
	2500 kWe emission control package	ROM cost estimate by Caterpillar		40	$200,600	$8,024,000
	2000 kWe system	"0.6 rule" scaled from Caterpillar estimate for 2500 kWe		4	$175,463	$701,851
	750 kWe system	"0.6 rule" scaled from Caterpillar estimate for 2500 kWe system		1	$97,410	$97,410
	Combined systems FOB cost					$6,516,610
	Instrumentation	Assume no cost	Assume no cost	0	0	0
	Sales Tax	WA state tax	WA state tax	6.5%	--	$423,580
	Shipping	0.05A	EPA Cost Manual	5.0%	--	$325,831
Subtotal Purchased Equipment Cost, PEC						$7,266,020
Direct Installation Costs						
	Enclosure structural supports	Assume no cost	Assume no cost	0	$0	$0
	Installation	1/2 of EPA Cost Manual	1/2 of EPA Cost Manual	2.5%	--	$181,651
	Electrical	Assume no cost	Assume no cost	0	0	0
	Piping	Assume no cost	Assume no cost	0	0	0
	Insulation	Assume no cost	Assume no cost	0	0	0
	Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs						$181,651
Site Preparation and Buildings (SP)		Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)						$7,447,671
Indirect Costs (Installation)						
	Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$181,651
	Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$181,651
	Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$511,254
	Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$145,320
	Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$72,660
	Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$217,981
Subtotal Indirect Costs, IC						$1,310,516
Total Capital Investment (TCI = DC+IC)						$8,758,186
						TCI per gen #DIV/0!

TCI/PEC
1.21

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table X. 2016 BACT Cost-Effectiveness for Urea-SCR By Itself

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$8,758,186
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$560,612
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$175,164
Annual Property tax	1% of TCI (EPA Manual)		0.01	$87,582
Annual Insurance	1% of TCI (EPA Manual)		0.01	$87,582
Annual operation/labor/maintenance costs: Upperbound estimate would assume CARB's value of $3.00/hp/year and would result in $423,000/year. Lower bound estimate would assume zero annual O&M. Mid-range value would account for urea, fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. **For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.**				$0
Subtotal Direct Annual Costs				$350,327
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$910,939**
Uncontrolled emissions (Combined Pollutants)				104.9
Annual Tons Removed (Combined Pollutants)				56.20
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$16,209**

Annual O&M Cost Based on CARB Factors

Annual operation + maintenance (lowermost CARB estimate)	163,840	Installed hp	$3.00	$491,520

Criteria Pollutants Multi-Pollutant Cost-Effectiveness (Reasonable vs. Actual Control Cost)

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	56.20	$562,000	per year
CO	$5,000	0.00	$0	per year
VOC	$9,999	0.00	$0	per year
PM (FH+BH)	$23,200	0.00	$0	per year
Other				
Total Reasonable Annual Control Cost for Combined Pollutants			**$562,000**	**per year**
Actual Annual Control Cost			**$910,939**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

Criteria Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX	Combined Pollutants
Tier-2 Uncontrolled TPY	**3.07**	**11.60**	**2.26**	**88.00**	
Controlled TPY	**3.070**	**11.600**	**2.260**	**31.8**	
Tons Removed/Year	**0.00**	**0.00**	**0.000**	**56.2**	
Combined Uncontrolled Tons/yr	104.9				
Combined tons/yr Removed	56.20				
Quoted Removal Effcy	0%	0%	0%	64%	
Annualized Cost ($/yr)	$910,939	$910,939	$910,939	$910,939	
Indiv Poll $/Ton Removed	#DIV/0!	#DIV/0!	#DIV/0!	$16,209	$16,209

TAPs Multi-Pollutant Cost-Effectiveness (Reasonable vs. Actual Control Cost)

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NO2	$20,000	5.62	$112,400	per year
CO	$5,000	0.00	$0	per year
Carcinogen VOC	$9,999	0.0000	$0	per year
DEEP (FH+BH)	$23,200	0.000	$0	per year
Non-carcinogen VOC	$5,000	0.0000	$0	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$112,400**	**per year**
Actual Annual Control Cost			**$910,939**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

TAPs Removal Tonnages (Nominal-Controlled)

Pollutant	DEEP (FH+BH)	CO	Carcinogen VOC	NO2	Non Carcinogen VOC	Acrolein
Tier-2 Uncontrolled TPY	**3.07**	**11.60**	**0.0426**	**8.80**	**0.1355**	**0.000326**
Controlled TPY	**3.070**	**11.600**	**0.043**	**3.18**	**0.135**	**0.000326**
Tons Removed/Year	**0.000**	**0.00**	**0.0000**	**5.62**	**0.0000**	**0.000000**
Combined Uncontrolled Tons/yr	23.65					
Combined tons/yr Removed	5.62					
Overall Cold-Start Removal Effcy	0%	0%	0%	64%	0%	0%
Annualized Cost ($/yr)	$910,939	$910,939	$910,939	$910,939	$16,209	$16,209
Indiv Poll $/Ton Removed	#DIV/0!	#DIV/0!	#DIV/0!	$162,089	#DIV/0!	#DIV/0!
Combined TAPs $/Ton Removed	$162,089					

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table X. 2016 BACT Capital Cost for DOC By Itself

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2500 kWe emission control package	ROM cost estimate by Caterpillar		40	$52,100	$2,084,000
2000 kWe system	"0.6 rule" scaled from Caterpillar estimate for 2500 kWe		4	$45,571	$182,285
750 kWe system	"0.6 rule" scaled from Caterpillar estimate for 2500 kWe system		1	$25,299	$25,299
Combined systems FOB cost					$2,291,585
Instrumentation	Assume no cost	Assume no cost	0	0	0
Sales Tax	WA state tax	WA state tax	6.5%	--	$148,953
Shipping	0.05A	EPA Cost Manual	5.0%	--	$114,579
Subtotal Purchased Equipment Cost, PEC					$2,555,117
Direct Installation Costs					
Enclosure structural supports	Assume no cost	Assume no cost	0	$0	$0
Installation	1/2 of EPA Cost Manual	1/2 of EPA Cost Manual	2.5%	--	$63,878
Electrical	Assume no cost	Assume no cost	0	0	0
Piping	Assume no cost	Assume no cost	0	0	0
Insulation	Assume no cost	Assume no cost	0	0	0
Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs					$63,878
Site Preparation and Buildings (SP)	Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)					$2,618,995
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$63,878
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$63,878
Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$192,325
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$51,102
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$25,551
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$76,654
Subtotal Indirect Costs, IC					$473,388
Total Capital Investment (TCI = DC+IC)					$3,092,383
					TCI per gen #DIV/0!

TCI/PEC
1.21

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table X. 2016 BACT Cost-Effectiveness for DOC By Itself

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$3,092,383
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$197,943
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$61,848
Annual Property tax	1% of TCI (EPA Manual)		0.01	$30,924
Annual Insurance	1% of TCI (EPA Manual)		0.01	$30,924
Annual operation/labor/maintenance costs: Upperbound estimate would assume CARB's value of $0.20/hp/year and would result in $28,000/year. Lower bound estimate would assume zero annual O&M. Mid-range value would account for fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. **For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.**				$0
Subtotal Direct Annual Costs				$123,695
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$321,639**
Uncontrolled emissions (Combined Pollutants)				104.9
Annual Tons Removed (Combined Pollutants)				7.95
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$40,468**

Annual O&M Cost Based on CARB Factors

Annual operation + maintenance (lowermost CARB estimate)	163,840	Installed hp	$0.20	$32,768

Criteria Pollutants Multi-Pollutant Cost-Effectiveness (Reasonable vs. Actual Control Cost)

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	0.00	$0	per year
CO	$5,000	6.04	$30,200	per year
VOC	$9,999	1.29	$12,939	per year
PM (FH+BH)	$23,200	0.61	$14,245	per year
Other				
Total Reasonable Annual Control Cost for Combined Pollutants			**$57,384**	**per year**
Actual Annual Control Cost			**$321,639**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

Criteria Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX	Combined Pollutants
Tier-2 Uncontrolled TPY	**3.07**	**11.60**	**2.26**	**88.00**	
Controlled TPY	**2.456**	**5.560**	**0.966**	**88.0**	
Tons Removed/Year	**0.61**	**6.04**	**1.294**	**0.0**	
Combined Uncontrolled Tons/yr	104.9				
Combined tons/yr Removed	7.95				
Quoted Removal Effcy	20%	52%	57%	0%	
Annualized Cost ($/yr)	$321,639	$321,639	$321,639	$321,639	$321,639
Indiv Poll $/Ton Removed	$523,842	$53,251	$248,562	#DIV/0!	$40,468

TAPs Multi-Pollutant Cost-Effectiveness (Reasonable vs. Actual Control Cost)

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NO2	$20,000	0.00	$0	per year
CO	$5,000	6.04	$30,200	per year
Carcinogen VOC	$9,999	0.0244	$244	per year
DEEP (FH+BH)	$23,200	0.614	$14,245	per year
Non-carcinogen VOC	$5,000	0.0776	$388	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$45,077**	**per year**
Actual Annual Control Cost			**$321,639**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

TAPs Removal Tonnages (Nominal-Controlled)

Pollutant	DEEP (FH+BH)	CO	Carcinogen VOC	NO2	Non Carcinogen VOC	Acrolein
Tier-2 Uncontrolled TPY	**3.07**	**11.60**	**0.0426**	**8.80**	**0.1355**	**0.000326**
Controlled TPY	**2.456**	**5.560**	**0.018**	**8.80**	**0.058**	**0.000139**
Tons Removed/Year	**0.614**	**6.04**	**0.0244**	**0.00**	**0.0776**	**0.000187**
Combined Uncontrolled Tons/yr	23.65					
Combined tons/yr Removed	6.76					
Overall Cold-Start Removal Effcy	20%	52%	57%	0%	57%	57%
Annualized Cost ($/yr)	$321,639	$321,639	$321,639	$321,639	$321,639	$321,639
Indiv Poll $/Ton Removed	$523,842	$53,251	$13,188,995	#DIV/0!	$4,145,886	$1,721,426,645
Combined TAPs $/Ton Removed	$47,607					

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table B-2-1B. Mar-2016 70-year Average Emisions (Added 5-9s Reserve Generators Dec-2015)

Conditions Used for Feb-2015 DEEP Second Tier Risk Report: Ultra-Worst-Case Theoretical Maximum-Year Facility-Wide Emissions (DEEP + HC = all runtime at 10%; NOx + CO = all runtime at 100%; Fuel and AP-42 TAPs = 100% load)

Cherry-Picked Max 10%-100%; Each Stack Test = 45 hours

No. of events per year

Gen #	Load Condition	Elec Load	Total No. Gens	W	M	S	Correct Tests	Outage	Cool	Elec Bypass	Initial Comm	Stack Test
2500 kWe; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	32		10	2	4				1	1
	Warmed up		32		10	2	4				1	1
	Cold start		32					3		1		
	Warmed up		32		10	2	4	3		1		
	Cold start		32	52								
	Warmed up		32	52	10	2	4		18			
5-9s Reserve Gens, 2500 kWe	Cold start	All runtime at maximum possible emission rate for any load	8	52	10	2	4	3	0	0	1	1
	Warmed up		8	52	10	2	4	3	0	0	1	1
2000 kWe CNR Gens; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	4		10	2	4				1	1
	Warmed up		4		10	2	4				1	1
	Cold start		4					3		1		
	Warmed up		4		10	2	4	3		1		
	Cold start		4	52								
	Warmed up		4	52	10	2	4		18			
750 kWe Admin Gen; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	1		10	2	4				1	1
	Warmed up		1		10	2	4				1	1
	Cold start		1					3		1		
	Warmed up		1		10	2	4	3		1		
	Cold start		1	52								
	Warmed up		1	52	10	2	4		18			
				52					18			
				40					15			

Duration of each event (hrs) and **Hours at Each Runtime Mode**

Gen # / Load Condition	Dur. W	Dur. M	Dur. S	Dur. Correct Tests	Dur. Outage	Dur. Cool	Dur. Elec Bypass	Dur. Initial Comm	Dur. Stack Test	Hrs W	Hrs M	Hrs S	Hrs Correct Tests	Hrs Outage	Hrs Cool	Hrs Elec Bypass	Hrs 48 hrs Initial Comm	Hrs Stack Test	Total hrs/yr
2500 kWe – Cold start		0.250	0.250	0.250				0.25	0.0121	0	2.50	0.50	1.00	0	0		0.25	0.012	4.26
2500 kWe – Warmed up		0.111	0.195	0.528				0.464	0.109	0	1.11	0.39	2.11	0	0		0.464	0.109	4.19
2500 kWe – Cold start					0.250		0.250			0	0	0	0	0.75	0	0.25	0.00	0	1.00
2500 kWe – Warmed up		0.194	0.278	0.61	7.75		15.75			0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94
2500 kWe – Cold start	0.25									13.00	0	0	0	0	0		0.00	0	13.00
2500 kWe – Warmed up	0.25	0.194	0.278	0.61		0.167				13.00	1.94	0.56	2.44	0	3.01		0.000	0	20.95
5-9s Reserve – Cold start	0.25	0.250	0.250	0.25	0.25	0	0	0.25	0.0080	13.00	2.5	0.5	1.0	0.75	0	0	0	0.008	18.01
5-9s Reserve – Warmed up	0.25	0.500	0.751	1.750	0.25	0	0	0.464	0.0723	13.00	5.00	1.50	7.00	0.75	0	0	0	0.0723	27.79
2000 kWe CNR – Cold start		0.250	0.250	0.250				0.25	0.032	0	2.50	0.50	1.00	0	0		0.25	0.032	4.28
2000 kWe CNR – Warmed up		0.111	0.195	0.528				0.464	0.289	0	1.11	0.39	2.11	0	0		0.464	0.289	4.37
2000 kWe CNR – Cold start					0.250		0.250			0	0	0	0	0.75	0	0.25	0.00	0	1.00
2000 kWe CNR – Warmed up		0.194	0.278	0.61	7.75		15.75			0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94
2000 kWe CNR – Cold start	0.25									13.00	0	0	0	0	0		0.00	0	13.00
2000 kWe CNR – Warmed up	0.25	0.194	0.278	0.61		0.167				13.00	1.94	0.56	2.44	0	3.01		0.000	0	20.95
750 kWe Admin – Cold start		0.250	0.250	0.250				0.25	0.0643	0	2.50	0.50	1.00	0	0		0.25	0.0643	4.31
750 kWe Admin – Warmed up		0.111	0.195	0.528				0.464	0.579	0	1.11	0.39	2.11	0	0		0.464	0.6	4.66
750 kWe Admin – Cold start					0.250		0.250			0	0	0	0	0.75	0	0.25	0.00	0	1.00
750 kWe Admin – Warmed up		0.194	0.278	0.61	7.75		15.75			0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94
750 kWe Admin – Cold start	0.25									13.00	0	0	0	0	0		0.00	0	13.00
750 kWe Admin – Warmed up	0.25	0.194	0.278	0.61		0.167				13.00	1.94	0.56	2.44	0	3.00		0.000	0	20.94

Fuel Usage and **Pollutant Emissions**

Gen # / Load Condition	Each Genset Fuel Gal/Hr	Facility-Wide Fuel Gal/Year	Each Genset PM lbs/hr	Facility Wide PM Tons/yr	Each Genset NOX lbs/hr	Each Genset NOx lbs/yr	Each Genset NOx Tons/yr	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Each Genset CO lbs/yr	Each Genset CO Tons/yr	Facility Wide CO Tons/yr	Each Genset HC lbs/hr	Each Genset HC lbs/yr	Each Genset HC Tons/yr	Facility-Wide HC Tons/yr
2500 kWe – Cold start	174	23,731	0.64	0.043	50.60	215.66	0.108	3.45	9.38	39.98	0.020	0.64	1.21	5.16	0.003	0.08
2500 kWe – Warmed up	174	23,319	0.401	0.027	9.11	38.15	0.019	0.61	1.44	6.03	0.003	0.10	0.350	1.47	0.001	0.02
2500 kWe – Cold start	174	5,568	0.64	0.0102	50.60	50.60	0.025	0.81	9.38	9.38	0.005	0.15	1.21	1.21	0.001	0.019
2500 kWe – Warmed up	174	244,675	0.401	0.28	9.11	400.32	0.200	6.41	1.44	63.28	0.032	1.01	0.350	15.38	0.008	0.25
2500 kWe – Cold start	174	72,384	0.64	0.132	50.60	657.80	0.329	10.52	9.38	121.94	0.061	1.95	1.21	15.73	0.008	0.252
2500 kWe – Warmed up	174	116,644	0.401	0.134	9.11	190.85	0.095	3.05	1.44	30.17	0.015	0.48	0.350	7.33	0.004	0.117
5-9s Reserve – Cold start	174	25,067	0.64	0.046	50.60	911	0.456	3.64	9.38	168.92	0.084	0.68	1.21	21.79	0.011	0.087
5-9s Reserve – Warmed up	174	38,680	0.401	0.045	9.11	253	0.127	1.01	1.44	40.01	0.020	0.16	0.350	9.73	0.005	0.039
2000 kWe CNR – Cold start	138	2,364	0.660	0.006	42.1	180.27	0.090	0.36	6.16	26.38	0.013	0.05	1.23	5.27	0.003	0.011
2000 kWe CNR – Warmed up	138	2,411	0.434	0.004	4.04	17.65	0.009	0.04	0.95	4.15	0.002	0.01	0.35	1.53	0.001	0.00
2000 kWe CNR – Cold start	138	552	0.660	0.00132	42.1	42.10	0.021	0.08	6.16	6.16	0.003	0.01	1.23	1.23	0.001	0.0025
2000 kWe CNR – Warmed up	138	24,257	0.434	0.038	4.04	177.53	0.089	0.36	0.95	41.75	0.021	0.08	0.35	15.38	0.008	0.03
2000 kWe CNR – Cold start	138	7,176	0.660	0.017	42.1	547.30	0.274	1.09	6.16	80.08	0.040	0.16	1.23	15.99	0.008	0.0320
2000 kWe CNR – Warmed up	138	11,564	0.434	0.018	4.04	84.63	0.042	0.17	0.95	19.90	0.010	0.04	0.35	7.33	0.004	0.0147
750 kWe Admin – Cold start	53.6	231	0.608	0.00131	15.80	68.17	0.034	0.03	1.90	8.20	0.004	0.00	0.28	1.21	0.001	0.0006
750 kWe Admin – Warmed up	53.6	250	0.136	0.00032	1.33	6.20	0.003	0.00	0.44	2.05	0.001	0.00	0.11	0.51	0.000	0.0003
750 kWe Admin – Cold start	53.6	54	0.608	0.00030	15.80	15.80	0.008	0.01	1.90	1.90	0.001	0.00	0.28	0.28	0.000	0.0001
750 kWe Admin – Warmed up	53.6	2,355	0.136	0.0030	1.33	58.44	0.029	0.03	0.44	19.33	0.010	0.01	0.11	4.83	0.002	0.0024
750 kWe Admin – Cold start	53.6	697	0.608	0.0040	15.80	205.40	0.103	0.10	1.90	24.70	0.012	0.01	0.28	3.64	0.002	0.0018
750 kWe Admin – Warmed up	53.6	1,123	0.136	0.0014	1.33	27.85	0.014	0.01	0.44	9.21	0.005	0.00	0.11	2.30	0.001	0.0012
Total		603,100														

For PM, 0.167-hr cold start period revised to 0.25 hours

70-yr average stack testing. Assume each test = 45 hrs (10% cold, 90% warm). Test 6 of the 32 AZ gens, test 2 of the 4 CNR gens; test the single Admin gen; test 1 of the 8 Reserve gens. Distribute stack testing over 70-years.

70-yr average Commissioning: 50 hours/generator, distributed over 70 years = 50/70 = 0.714 hrs/yr/gen. Assume 0.25 hrs/yr/gen cold-start

	PM	NOx	CO	VOC
Total Facility-Wide TPY	0.814	31.8	5.56	0.966
Existing Permit	0.536	8.60	15.60	0.80
Net Increase	52%	270%	-64%	21%

	87.34
Hrs/yr/gen routine annual excluding commissioning and stack testing	86.77
Cold-Start Hours	15.86
Total Runtime	87.34
Percentage Cold-Start	18%

DEEP Emissions for AERMOD Input (Excluding Reserve gens)

2.5 Mwe	0.629	tpy	32		0.000566	g/sec each gen
2.0 Mwe	0.0842	tpy	4		0.000606	g/sec each gen
0.75 Mwe	0.0103	tpy	1		0.000296	g/sec each gen
TOTAL	0.723	tpy				

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

4/1/2016, 4:26 PM

Table ____. Tier-2 Mar-2016 70-year Average Emisions (Added 5-9s Reserve Generators Dec-2015)

Conditions Used for Jan-2016 DEEP Second Tier Risk Report: Ultra-Worst-Case Theoretical Maximum-Year Facility-Wide Emissions (DEEP + HC = all runtime at 10%; NOx + CO = all runtime at 100%; Fuel and AP-42 TAPs = 100% load)

Cherry-Picked Max 10%-100%; Each Stack Test = 45 hours

Gen #	Load Condition	Elec Load	Total No. Gens	No. of events per year: W	M	S	Correct Tests	Outage	Cool	Elec Bypass	Initial Comm	Stack Test	Duration of each event (hrs): W	M	S	Correct Tests	Outage	Cool	Elec Bypass	Initial Comm	Stack Test
2500 kWe; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	32		10	2	4				1	1		0.250	0.250	0.250				0.25	0.0121
	Warmed up		32		10	2	4				1	1		0.111	0.195	0.528				0.464	0.109
	Cold start		32					3		1							0.250		0.250		
	Warmed up		32		10	2	4	3		1				0.194	0.278	0.61	7.75		15.75		
	Cold start		32	52									0.25								
	Warmed up		32	52	10	2	4		18				0.25	0.194	0.278	0.61		0.167			
5-9s Reserve Gens, 2500 kWe	Cold start	All runtime at maximum possible emission rate for any load	8	52	10	2	4	3	0	0	1	1	0.25	0.250	0.250	0.25	0.25	0	0	0.25	0.0080
	Warmed up		8	52	10	2	4	3	0	0	1	1	0.25	0.500	0.751	1.750	0.25	0	0	0.464	0.0723
2000 kWe CNR Gens; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	4		10	2	4				1	1		0.250	0.250	0.250				0.25	0.032
	Warmed up		4		10	2	4				1	1		0.111	0.195	0.528				0.464	0.289
	Cold start		4					3		1							0.250		0.250		
	Warmed up		4		10	2	4	3		1				0.194	0.278	0.61	7.75		15.75		
	Cold start		4	52									0.25								
	Warmed up		4	52	10	2	4		18				0.25	0.194	0.278	0.61		0.167			
750 kWe Admin Gen; All runtime at cherry-picked maximum emission rate and load	Cold start	All runtime at maximum possible emission rate for any load	1		10	2	4				1	1		0.250	0.250	0.250				0.25	0.0643
	Warmed up		1		10	2	4				1	1		0.111	0.195	0.528				0.464	0.579
	Cold start		1					3		1							0.250		0.250		
	Warmed up		1		10	2	4	3		1				0.194	0.278	0.61	7.75		15.75		
	Cold start		1	52									0.25								
	Warmed up		1	52	10	2	4		18				0.25	0.194	0.278	0.61		0.167			

Gen #	Load Condition	Hours at Each Runtime Mode: W	M	S	Correct Tests	Outage	Cool	Elec Bypass	48 hrs Initial Comm	Stack Test	Total hrs/yr	Fuel Usage: Each Genset Fuel Gal/Hr	Facility-Wide Fuel Gal/Year
2500 kWe	Cold start	0	2.50	0.50	1.00	0	0		0.25	0.012	4.26	174	23,731
	Warmed up	0	1.11	0.39	2.11	0	0		0.464	0.109	4.19	174	23,319
	Cold start	0	0	0	0	0.75	0	0.25	0.00	0	1.00	174	5,568
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94	174	244,675
	Cold start	13.00	0	0	0	0	0		0.00	0	13.00	174	72,384
	Warmed up	13.00	1.94	0.56	2.44	0	3.01		0.000	0	20.95	174	116,644
5-9s Reserve Gens, 2500 kWe	Cold start	13.00	2.5	0.5	1.0	0.75	0	0	0	0.008	18.01	174	25,067
	Warmed up	13.00	5.00	1.50	7.00	0.75	0	0	0	0.0723	27.79	174	38,680
2000 kWe CNR Gens	Cold start	0	2.50	0.50	1.00	0	0		0.25	0.032	4.28	138	2,364
	Warmed up	0	1.11	0.39	2.11	0	0		0.464	0.289	4.37	138	2,411
	Cold start	0	0	0	0	0.75	0	0.25	0.00	0	1.00	138	552
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94	138	24,257
	Cold start	13.00	0	0	0	0	0		0.00	0	13.00	138	7,176
	Warmed up	13.00	1.94	0.56	2.44	0	3.01		0.000	0	20.95	138	11,564
750 kWe Admin Gen	Cold start	0	2.50	0.50	1.00	0	0		0.25	0.0643	4.31	53.6	231
	Warmed up	0	1.11	0.39	2.11	0	0		0.464	0.6	4.66	53.6	250
	Cold start	0	0	0	0	0.75	0	0.25	0.00	0	1.00	53.6	54
	Warmed up	0	1.94	0.56	2.44	23.25	0	15.75	0.000	0	43.94	53.6	2,355
	Cold start	13.00	0	0	0	0	0		0.00	0	13.00	53.6	697
	Warmed up	13.00	1.94	0.56	2.44	0	3.00		0.000	0	20.94	53.6	1,123
													603,100

Gen #	Load Condition	Pollutant Emissions: Each Genset PM lbs/hr	Facility Wide PM Tons/yr	Each Genset NOX lbs/hr	Each Genset NOx lbs/yr	Each Genset NOx Tons/yr	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Each Genset CO lbs/yr	Each Genset CO Tons/yr	Facility Wide CO Tons/yr	Each Genset HC lbs/hr	Each Genset HC lbs/yr	Each Genset HC Tons/yr	Facility-Wide HC Tons/yr
2500 kWe	Cold start	1.91	0.130	50.60	215.66	0.108	3.45	9.38	39.98	0.020	0.64	1.39	5.92	0.003	0.09
	Warmed up	1.670	0.112	50.60	211.91	0.106	3.39	6.01	25.17	0.013	0.40	1.260	5.28	0.003	0.08
	Cold start	1.91	0.0306	50.60	50.60	0.025	0.81	9.38	9.38	0.005	0.15	1.39	1.39	0.001	0.022
	Warmed up	1.670	1.17	50.60	2,223.52	1.112	35.58	6.01	264.10	0.132	4.23	1.260	55.37	0.028	0.89
	Cold start	1.91	0.397	50.60	657.80	0.329	10.52	9.38	121.94	0.061	1.95	1.39	18.07	0.009	0.289
	Warmed up	1.670	0.560	50.60	1,060.02	0.530	16.96	6.01	125.90	0.063	2.01	1.260	26.40	0.013	0.422
5-9s Reserve Gens, 2500 kWe	Cold start	1.91	0.138	50.60	911	0.456	3.64	9.38	168.92	0.084	0.68	1.39	25.03	0.013	0.100
	Warmed up	1.670	0.186	50.60	1,406	0.703	5.62	6.01	167.00	0.084	0.67	1.260	35.01	0.018	0.140
2000 kWe CNR Gens	Cold start	2.140	0.018	42.1	180.27	0.090	0.36	6.16	26.38	0.013	0.05	1.42	6.08	0.003	0.012
	Warmed up	1.700	0.015	42.1	183.89	0.092	0.37	3.95	17.25	0.009	0.03	1.13	4.94	0.002	0.01
	Cold start	2.140	0.00428	42.1	42.10	0.021	0.08	6.16	6.16	0.003	0.01	1.42	1.42	0.001	0.0028
	Warmed up	1.700	0.149	42.1	1,850.00	0.925	3.70	3.95	173.57	0.087	0.35	1.13	49.66	0.025	0.10
	Cold start	2.140	0.056	42.1	547.30	0.274	1.09	6.16	80.08	0.040	0.16	1.42	18.46	0.009	0.0369
	Warmed up	1.700	0.071	42.1	881.95	0.441	1.76	3.95	82.75	0.041	0.17	1.13	23.67	0.012	0.0473
750 kWe Admin Gen	Cold start	0.700	0.00151	15.80	68.17	0.034	0.03	2.36	10.18	0.005	0.01	0.28	1.21	0.001	0.0006
	Warmed up	0.550	0.00128	15.80	73.60	0.037	0.04	1.51	7.03	0.004	0.00	0.22	1.02	0.001	0.0005
	Cold start	0.700	0.00035	15.80	15.80	0.008	0.01	2.36	2.36	0.001	0.00	0.28	0.28	0.000	0.0001
	Warmed up	0.550	0.0121	15.80	694.30	0.347	0.35	1.51	66.35	0.033	0.03	0.22	9.67	0.005	0.0048
	Cold start	0.700	0.0046	15.80	205.40	0.103	0.10	2.36	30.68	0.015	0.02	0.28	3.64	0.002	0.0018
	Warmed up	0.550	0.0058	15.80	330.90	0.165	0.17	1.51	31.62	0.016	0.02	0.22	4.61	0.002	0.0023

For PM, 0.167-hr cold start period revised to 0.25 hours

70-yr average stack testing. Assume each test = 45 hrs (10% cold, 90% warm). Test 6 of the 32 AZ gens, test 2 of the 4 CNR gens; test the single Admin gen; test 1 of the 8 Reserve gens. Distribute stack testing over 70-years.

70-yr average Commissioning: 50 hours/generator, distributed over 70 years = 50/70 = 0.714 hrs/yr/gen. Assume 0.25 hrs/yr/gen cold-start

52 18

40 15

87.34

Hrs/yr/gen routine annual excluding commissioning and stack testing 86.77

Cold-Start Hours	15.86	
Total Runtime	87.34	
Percentage Cold-Start	18%	

	PM	NOx	CO	VOC
Total Facility-Wide TPY	3.07	88.0	11.6	2.26
Existing Permit	0.536	8.60	15.60	0.80
Net Increase	472%	924%	-26%	182%

DEEP Emissions for AERMOD Input (Excluding Reserve gens)

2.5 Mwe	2.404	tpy	32	0.002163	g/sec each gen
2.0 Mwe	0.3137	tpy	4	0.002258	g/sec each gen
0.75 Mwe	0.0255	tpy	1	0.000735	g/sec each gen
TOTAL	2.743	tpy			

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table B-2-5.   - Mar-2016 Microsoft Data Center AP-42 Toxic Air Pollutant Emissions

Includes 5-9s Reserve Gens, 100% Load Limit

Fuel Type

Parameter	Value	Units
Fuel Type	EPA Diesel	
Fuel Density	7	lbs/gallon
Fuel Heat Content	137,000	BTU/gallon
Fuel Sulfur Content	15	ppm weight
Max Hourly Fuel Use	6187	Gal/HOUR
Max Daily Fuel Use	148,476	Gal/DAY
Annual Fuel usage	604,557	Gal/YEAR
Max Hourly Heat Input	848	mmBTU/HOUR
Max Daily Heat Input	20,341	mmBTU/DAY
Annual Heat Input	82,824	mmBTU/YEAR

Max daily assumes one 24-hr power outage

Table XX. Tier-4 Summary of Controlled Emission Rates

Pollutant	Uncontrolled Emission Factor: Factor	Units	Source	Removal Effcy	Maximum Emission Rates (Total): (lbs/hr)	(lbs/day)	(tons/year)
NOx	Tier 4 Engine with Cold Start Factors			Incorporated	0	0	0.00
PM2.5/DEEP	Tier 4 Engine with Cold Start Factors			Incorporated	0.0	0	0.000
CO	Tier 4 Engine with Cold Start Factors			Incorporated	0	0	0.0
VOC	Tier 4 Engine with Cold Start Factors			Incorporated	0.0	0	0.000
SO2	Fuel sulfur mass balance			Incorporated	1.30	31.2	0.063
Primary Nitrogen Dioxide (NO2)	10% of primary NOX			Incorporated	0.0	0	0.000
Benzene	7.76E-04	lbs/MMBTU	AP-42 Sec 3.4	90%	6.58E-02	1.58E+00	3.21E-03
Toluene	2.81E-04	lbs/MMBTU	AP-42 Sec 3.4	90%	2.38E-02	5.72E-01	1.16E-03
Xylenes	1.93E-04	lbs/MMBTU	AP-42 Sec 3.4	90%	1.64E-02	3.93E-01	7.99E-04
1,3-Butadiene	3.91E-05	lbs/MMBTU	AP-42 Sec 3.3	90%	3.31E-03	7.95E-02	1.62E-04
Formaldehyde	7.89E-05	lbs/MMBTU	AP-42 Sec 3.4	90%	6.69E-03	1.60E-01	3.27E-04
Acetaldehyde	2.52E-05	lbs/MMBTU	AP-42 Sec 3.4	90%	2.14E-03	5.13E-02	1.04E-04
Acrolein	7.88E-06	lbs/MMBTU	AP-42 Sec 3.4	90%	6.68E-04	1.60E-02	3.26E-05
Benzo(a)Pyrene	2.57E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	2.18E-05	5.23E-04	1.06E-06
Benzo(a)anthracene	6.22E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	5.27E-05	1.27E-03	2.58E-06
Chrysene	1.53E-06	lbs/MMBTU	AP-42 Sec 3.4	90%	1.30E-04	3.11E-03	6.34E-06
Benzo(b)fluoranthene	1.11E-06	lbs/MMBTU	AP-42 Sec 3.4	90%	9.41E-05	2.26E-03	4.60E-06
Benzo(k)fluoranthene	2.18E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	1.85E-05	4.43E-04	9.03E-07
Dibenz(a,h)anthracene	3.46E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	2.93E-05	7.04E-04	1.43E-06
Ideno(1,2,3-cd)pyrene	4.14E-07	lbs/MMBTU	AP-42 Sec 3.4	90%	3.51E-05	8.42E-04	1.71E-06
Napthalene	1.30E-04	lbs/MMBTU	AP-42 Sec 3.4	90%	1.10E-02	2.64E-01	5.38E-04
Propylene	2.79E-03	lbs/MMBTU	AP-42 Sec 3.4	90%	2.36E-01	5.68E+00	1.16E-02

Carcinogenic VOC TAPs 4.26E-03
Non-Carcinogen VOC TAPs 1.35E-02

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

Table 4;   Table B-2-3
Mar-2016 Facility-Wide Emission Rates for Toxic Air Pollutants
Microsoft Project Oxford Data Center, December-2015 Permit Revision
Quincy, Washington

Pollutant	CAS Number	SQER		Facility Emissions		SQER Ratio	SQER Exceeded?
Diesel Generator TAPs							
DEEP (3x annual avg.)	None	0.639	lbs/yr	9	lbs/yr	13	**Yes**
CO	630-08-0	50.2	lbs/hour	#DIV/0!	lbs/hour	#DIV/0!	**Yes**
Ammonia	7664-41-7	9.3	lbs/day	17	lbs/day	1.8	**Yes**
SO2		1.45	lbs/hour	1.3	lbs/hour	0.90	No
NO2	10102-44-0	1.03	lbs/hour	57.5	lbs/hour	56	**Yes**
Benzene (3x annual avg.)	71-43-2	6.62	lbs/yr	19.28	lbs/yr	2.91	**Yes**
Toluene	108-88-3	657	lbs/day	0.572	lbs/day	0.00087	No
Xylenes	95-47-6	58	lbs/day	0.393	lbs/day	0.0068	No
1,3-Butadiene (3x annual avg.)	106-99-0	1.13	lbs/yr	0.97	lbs/yr	0.86	No
Formaldehyde (3x annual avg.)	50-00-0	32	lbs/yr	1.96	lbs/yr	0.061	No
Acetaldehyde (3x annual avg.)	75-07-0	71	lbs/yr	0.63	lbs/yr	0.0088	No
Acrolein	107-02-8	0.00789	lbs/day	0.016	lbs/day	2.03	**Yes**
Benzo(a)Pyrene (3x annual avg.)	50-32-8	0.174	lbs/yr	6.4E-03	lbs/yr	0.0367	No
Benzo(a)anthracene (3x annual avg.)	56-55-3	1.74	lbs/yr	1.5E-02	lbs/yr	0.0089	No
Chrysene (3x annual avg.)	218-01-9	17.4	lbs/yr	3.8E-02	lbs/yr	0.00218	No
Benzo(b)fluoranthene (3x annual avg.)	205-99-2	1.74	lbs/yr	2.8E-02	lbs/yr	0.0159	No
Benzo(k)fluoranthene (3x annual avg.)	207-08-9	1.74	lbs/yr	5.4E-03	lbs/yr	0.00311	No
Dibenz(a,h)anthracene (3x annual avg.)	53-70-3	0.16	lbs/yr	8.6E-03	lbs/yr	0.054	No
Ideno(1,2,3-cd)pyrene (3x annual avg.)	193-39-5	1.74	lbs/yr	1.0E-02	lbs/yr	0.0059	No
Napthalene (3x annual avg.)	91-20-3	5.64	lbs/yr	3.23	lbs/yr	0.57	No
Propylene	115-07-1	394	lbs/yr	5.68	lbs/yr	0.014	No
Cooling Tower TAPs							
Fluoride	---	1.71	lbs/day	0.0260	lbs/day	0.015	No
Manganese	---	0.0053	lbs/day	0.00252	lbs/day	0.48	No
Copper	---	0.219	lbs/hour	3.5E-05	lbs/hour	0.0002	No
Chloroform	67-66-3	8.35	lbs/year	0.526	lbs/year	0.063	No
Bromo Dichloromethane	75-27-4	5.18	lbs/year	0.526	lbs/year	0.102	No
Bromoform	75-25-2	174	lbs/year	13.8	lbs/year	0.07936	No

Shaded rows indicate the emission rate exceeds the SQER

C:\Users\jwilder\Desktop\C-MSFT\c-Mar2016 NOC Letter\MWB review\[c-Mar-2016 Revised BACT Emission Calculations.xlsx]DOC Annualized

SEPTEMBER 9, 2016 SUPPLEMENTARY MATERIAL:

The following supplementary materials is pasted from a spreadsheet provided by Microsoft on September 9, 2016. It addresses the estimated emissions if reserve generators run at zero load continuously during a power outage instead of stopping after 30 minutes as noted in the April 2016 application. Although the emissions are greater than estimated in Microsoft's April 2016 application, Microsoft is agreeing to maintain emissions at the lower April 2016 estimates. Microsoft believes there is enough conservatism (over-estimated emissions) built into the April emissions (those listed in the permit and TSD), that allows them to agree to those lower emission limits. Emissions from the April application are used in the preliminary determination. Except for a reference to this supporting material on the first page of the TSD, the preliminary determination and supporting technical support document (TSD) remain unchanged as a result of this supplementary material.

Table B-2-2 (Sep 2016 to Include Continuous Reserve Generators)
Revised Emission Calculations with Continuously-Operated Reserve Gens
Microsoft Oxford Data Center

Summary Comparison of PM10 and NOx Emissions During Power Outage

Scenario	Generator Conditions	PM10, lbs/day	NOx, lbs/hr
PM10: April-2016 Permit Application	All gens at 10%; reserve gens shut down after 30 minutes	357	--

PM10: Revised Worst Case with continuous reserve gens	All gens at 10%; reserve gens operate continuously for 24 hours Including 1 hour of "Wet Stack Purge" at 30%	432	--
PM10: Most Likely	Primary Gens = 85%. Reserves run 23 hrs continuously at 10%, plus 1 hour "Wet Stack Purge" at 30%	335	--
1-hr NOx: Apr-2016 Permit Application	Primary gens = 100%. Reserve gens = 10% and shut down after 30 min	--	575 lbs/hr, used as basis for Condition 5.4
1-hr NOx: Revised Worst Case with continuous reserve gens	Primary gens = 100%. Reserve gens = 10% and run continuously for the entire 60 minutes	--	580
1-hr Nox: Allowable operating conditions to comply with 575 lbs/hr Condition 5.4	Cold Start. Primary gens reduced to 99%. Reserve gens = 10% and run continuously for the entire 60 minutes	--	568
1-hr NOx: Warmed up condition including 10-minute "Wet Stack Purge"	Warmed up, 4 hours into the outage Primary gens at warmed-up 100%. Reserves run 50 minutes at warmed-up 10%, then undergo 10-minute "wet stack purge" at warmed-up 30% .	--	318

Table B-2-2A-1. PM10 Emissions During Outage (Apri-2016 Permit Application, All Gens at 10% Load to Maximize lbs/hr Emission Rate)

Ultra-Worst Case PM10-NAAQS During Facility-Wide Power Outage at 10%

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 24-hr weighted average lbs/day			
2.5 Mwe (10%)	Cold Start	32	0.635	0.25	5.1	lbs/day				
	Warmed Up	32	0.401	23.75	304.8	lbs/day	9.7	lbs/day	0.0509	g/sec
2.0 Mwe (10%)	Cold Start	4	0.661	0.25	0.66	lbs/day				
	Warmed Up	4	0.434	23.75	41.2	lbs/day	10.5	lbs/day	0.0550	g/sec
750 kWe (10%)	Cold Start	1	0.608	0.25	0.2	lbs/day				
	Warmed Up	1	0.136	23.75	3.2	lbs/day	3.4	lbs/day	0.0178	g/sec
30 minutes of 2.5 Mwe Reserve Gens (10%)	Cold Start	8	0.635	0.25	1.3	lbs/day				
	Warmed Up	8	0.401	0.25	0.80	lbs/day	0.259	lbs/day	0.00136	g/sec
Permit Application Facility-Wide 24-hr Emissions During Outage					357	lbs/day				

Table B-2-2A-2. PM10 Emissions During Outage (Revised Worst Case; Reserve Gens Run 24 Hours Including 1hr Wet-Stack Purge)

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 24-hr weighted average lbs/day			
	Cold Start	32	0.635	0.25	5.1	lbs/day				
2.5 Mwe (10%)	Warmed Up	32	0.401	23.75	304.8	lbs/day	9.7	lbs/day	0.0509	g/sec
	Cold Start	4	0.661	0.25	0.66	lbs/day				
2.0 Mwe (10%)	Warmed Up	4	0.434	23.75	41.2	lbs/day	10.5	lbs/day	0.0550	g/sec
	Cold Start	1	0.608	0.25	0.2	lbs/day				
750 kWe (10%)	Warmed Up	1	0.136	23.75	3.2	lbs/day	3.4	lbs/day	0.0178	g/sec
23 hours of 2.5 Mwe Reserve Gens at 10% Load	Cold Start	8	0.635	0.25	1.3	lbs/day				
	Warmed Up	8	0.401	22.75	72.98	lbs/day				
Reserve Gens Wet-Stack Purge; 1 hours of 2.5 Mwe Reserve Gens at 30% Load	Cold Start	0	0	0	0.0	lbs/day				
	Warmed Up	8	0.29	1	2.32	lbs/day	#DIV/0!	lbs/day	#DIV/0!	g/sec
Permit Application Facility-Wide 24-hr Emissions During Outage					432	lbs/day				

Table B-2-2A-3. PM10 Emissions During Outage (Most-Likely, All Primary Gens at 85%; Reserve Gens at 10% Except for 1 hr of 30% Wet-Stack Purge)

Ultra-Worst Case PM10-NAAQS During Facility-Wide Power Outage at 10%

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 24-hr weighted average lbs/day			
2.5 Mwe at 85% Load	Cold Start	32	0.457	0.25	3.7	lbs/day				
	Warmed Up	32	0.297	23.75	225.7	lbs/day	7.2	lbs/day	0.0377	g/sec
2.0 Mwe at 85% Load	Cold Start	4	0.438	0.25	0.44	lbs/day				
	Warmed Up	4	0.27	23.75	25.7	lbs/day	6.5	lbs/day	0.0343	g/sec
750 kWe at 85% Load	Cold Start	1	0.608	0.25	0.2	lbs/day				
	Warmed Up	1	0.136	23.75	3.2	lbs/day	3.4	lbs/day	0.0178	g/sec
23 hours of 2.5 Mwe Reserve Gens at 10% Load	Cold Start	8	0.635	0.25	1.3	lbs/day				
	Warmed Up	8	0.401	22.75	72.98	lbs/day				
Reserve Gens Wet-Stack Purge; 1 hours of 2.5 Mwe Reserve Gens at 30% Load	Cold Start	0	0	0	0.0	lbs/day				
	Warmed Up	8	0.29	1	2.32	lbs/day	#DIV/0!	lbs/day	#DIV/0!	g/sec
Most_Likely Facility-Wide 24-hr Emissions During Outage					335	lbs/day				

Table B-2-2D-1. 100%-Idle Reserve NOx Emissions During Outage (Apr-2016 Permit Application; Calcs Used to Derive 575 lbs/hr limit in Condition 5.4)

REVISED NO2-ASIL EMISSION RATES - Facility-Wide Power Outage at 100% Loads

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 1-hr weighted average lbs/hr			
2.5 Mwe @ 100%	Cold Start	32	50.6	0.167	270.4	lbs/hr				
	Warmed Up	32	9.1	0.833	242.6	lbs/hr	16.0	lbs/hr	2.022	g/sec
2.0 Mwe @ 100%	Cold Start	4	42.1	0.167	28.1	lbs/hr				
	Warmed Up	4	4.04	0.833	13.5	lbs/hr	10.4	lbs/hr	1.311	g/sec
750 kWe @ 100%	Cold Start	1	15.83	0.167	2.6	lbs/hr				
	Warmed Up	1	1.33	0.833	1.1	lbs/hr	3.8	lbs/hr	0.473	g/sec
2.5 Mwe Reserve Gens For 30 minutes at Zero Elec. Load (10% emission factors)	Cold Start	8	7.02	0.25	14.0	lbs/hr				
	Warmed Up for 15 min	8	1.26	0.25	2.5	lbs/hr	2.1	lbs/hr	0.261	g/sec
Facility-Wide Emissions					575	lbs/hr				

Table B-2-2D-2. 100%-Idle Reserve NOx Emissions During Outage (Worst-Case; Reserve Gens Run Continuous 1 hour)

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 1-hr weighted average lbs/hr			
2.5 Mwe @ 100%	Cold Start	32	50.6	0.167	270.4	lbs/hr				
	Warmed Up	32	9.1	0.833	242.6	lbs/hr	16.0	lbs/hr	2.022	g/sec
2.0 Mwe @ 100%	Cold Start	4	42.1	0.167	28.1	lbs/hr				
	Warmed Up	4	4.04	0.833	13.5	lbs/hr	10.4	lbs/hr	1.311	g/sec
750 kWe @ 100%	Cold Start	1	15.83	0.167	2.6	lbs/hr				
	Warmed Up	1	1.33	0.833	1.1	lbs/hr	3.8	lbs/hr	0.473	g/sec
Continuous 2.5 Mwe Reserve Gens For 60 minutes at Zero Elec. Load (10% emission factors)	Cold Start	8	7.02	0.25	14.0	lbs/hr				
	Warmed Up for 15 min	8	1.26	0.75	7.6	lbs/hr	2.7	lbs/hr	0.341	g/sec
Facility-Wide Emissions					580	lbs/hr				

Table B-2-2D-3. Cold-Start 99%-Idle Reserve NOx Emissions During Outage (Stay Within 575 lbs/hr; Primary AZ Gens at 99% Load; serves at 10%)

Gen Size	Engine Temp	No. of	Lbs/hour	Duration,	Subtotal Emissions	Emission Units	Each Engine 1-hr weighted average lbs/hr

		Gens		hours						
2.5 Mwe @ 99%	Cold Start	32	49.9	0.167	266.7	lbs/hr				
	Warmed Up	32	8.8	0.833	234.6	lbs/hr	15.7	lbs/hr	1.975	g/sec
2.0 Mwe @ 100%	Cold Start	4	42.1	0.167	28.1	lbs/hr				
	Warmed Up	4	4.04	0.833	13.5	lbs/hr	10.4	lbs/hr	1.311	g/sec
750 kWe @ 100%	Cold Start	1	15.83	0.167	2.6	lbs/hr				
	Warmed Up	1	1.33	0.833	1.1	lbs/hr	3.8	lbs/hr	0.473	g/sec
2.5 Mwe Reserve Gens For 60 minutes at Zero Elec. Load (10% emission factors)	Cold Start	8	7.02	0.25	14.0	lbs/hr				
	Warmed Up for 45 min	8	1.26	0.75	7.6	lbs/hr	2.7	lbs/hr	0.341	g/sec
Facility-Wide Emissions					568	lbs/hr				

Table B-2-2D-4. Warmed-Up NOx Emissions During Outage w/ Wet-Stack Purge (Primary Gens at 100%; Reserves at 30% for 10 min)

Gen Size	Engine Temp	No. of Gens	Lbs/hour	Duration, hours	Subtotal Emissions	Emission Units	Each Engine 1-hr weighted average lbs/hr	
2.5 Mwe @ 100%	Cold Start	0	0	0	0.0	lbs/hr	#DIV/0!	lbs/hr

	Warmed Up	32	9.1	1	291.2	lbs/hr			#DIV/0!	g/sec
2.0 Mwe @ 100%	Cold Start	0	0	0	0.0	lbs/hr				
	Warmed Up	4	4.04	1	16.2	lbs/hr	#DIV/0!	lbs/hr	#DIV/0!	g/sec
750 kWe @ 100%	Cold Start	0	0	0	0.0	lbs/hr				
	Warmed Up	1	1.33	1	1.3	lbs/hr	#DIV/0!	lbs/hr	#DIV/0!	g/sec
2.5 Mwe Reserve Gens For 50 minutes at Zero Elec. Load (10% emission factors)	Cold Start	0	0	0	0.0	lbs/hr				
	Warmed Up for 50 min	8	1.26	0.833	8.4	lbs/hr				
Wet-Stack Purge 2.5 Mwe Reserve Gens For 10 minutes at 30% Load)	Cold Start	0	0	0	0.0	lbs/hr				
	Warmed Up for 10 min	8	1.0	0.167	1.3	lbs/hr	#DIV/0!	lbs/hr	#DIV/0!	g/sec
Facility-Wide Emissions					318.4	lbs/hr				