LANDAU ASSOCIATES

February 2, 2015

Washington State Department of Ecology
4601 North Monroe Street
Spokane, Washington 99205

Attn: Mr. Greg Flibbert

**RE: REVISED REQUEST FOR APPROVAL ORDER REVISIONS (APPROVAL ORDER NO. 14AQ-E537)**
**MICROSOFT OXFORD DATA CENTER**
**QUINCY, WASHINGTON**

Dear Greg:

On behalf of Microsoft Corporation (Microsoft), this revised letter requests several amendments to Approval Order No. 14AQ-E537 ("the Approval Order") for the Oxford Data Center in Quincy, Washington. This revised letter incorporates comments received from the Washington State Department of Ecology (Ecology) in the Incompleteness Letter dated January 7, 2015 (Ecology 2015[1]) and our follow-up meeting with Ecology staff on January 15, 2015.

A Notice of Construction (NOC) application form, signed by Microsoft's Responsible Official, is provided as Appendix A. A check for $1,500 has been sent to the Cashiering Unit for this application. The proposed amendments and the reasons Microsoft believes they are necessary are presented below and in our redline of the Approval Order (Appendix B of this letter). This letter and the modeling demonstration included as Appendix C document that the proposed revisions satisfy the conditions required by Washington Administrative Code (WAC) 173-400-111(8) for Ecology to approve this request.

## BACKGROUND INFORMATION

Microsoft is currently constructing the Oxford Data Center. Permitted emission sources include emergency diesel generators and drift particulate emissions from rooftop cooling units. Ecology published the Preliminary Determination for comment on June 16, 2014. Microsoft submitted written comments to Ecology on July 29, 2014. Ecology issued the final Approval Order on August 15, 2014. Ecology declined to adopt several of the amendments that are the subject of this application, but stated

[1] Ecology. 2015. Letter: *Re: Incompleteness Letter, Microsoft Oxford Data Center, NOC Application Received December 11, 2014*. From Gary Huitsing, P.E., Washington State Department of Ecology, to John Radick, Microsoft Corporation. January 7.

that many of the changes would have merit, if Ecology could propose them for public comment. This application presents an opportunity to propose for comment a small set of amendments that are necessary to ensure that the data center can comply with its permit.

## REQUESTED REVISIONS TO APPROVAL ORDER

Appendix B provides a redline of the current approval order. This section provides additional explanation for several of the edits proposed 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 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 75 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 C shows that the National Ambient Air Quality Standards (NAAQS) and Chapter 173-460 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 no more than three engines operate at loads exceeding 85 percent during any 1 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. Nor is there any reason to list permitted activities at each load. Listing authorized activities for each load range is pointless when each activity can occur within any load range.

**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.[2] The redline edits proposed in Appendix B come from Kay Shirey's July 1 email to Matt Cohen.

**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 (Microsoft Comments at 5-6). Ecology found this request to be "reasonable" (see Ecology's Response to Comments at 18). The amendments proposed in Appendix B that address source test intensity come from a redline version that Kay Shirey sent to Matt Cohen on July 1, 2004. 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 engines. Microsoft proposes an edit to Condition 4.4.4 to add one more source test as requested by Ecology.

Second, since filing the original 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 Caterpillar Emissions Data, Appendix D 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 U.S. 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

---

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

Caterpillar estimates peak emissions will occur, unless the peak emission rate occurs at idle.[3] 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.

The proposed edits to Table 4 will drastically reduce the carbon monoxide (CO) and non-methane hydrocarbon (NMHC) emission limits, and slightly increase the PM emission limits for all three engine models. The emission limits for nitrogen oxides ($NO_x$) appear much higher, but the apparent increase results mostly from setting a limit at 100 percent load, rather than 80 percent load. If Ecology set the limit at Caterpillar's estimate of $NO_x$ emissions at 75 percent load plus a 20 percent safety factor, the single load limit for the 2,500-kilowatt (kW) engine would be 3.73 pounds per hour (lbs/hr), as compared with the 3.37 lb/hr limit currently in effect (compare Appendix D's 2,500-kW generator $NO_x$ estimate with Table 4 of the Approval Order).

**Condition 5.2 – Facility-Wide Annual Emission Limits**

As described in Appendix C, 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 diesel engine exhaust particulate matter (DEEP) emission rate now assumes that each of the 37 generators operates for 86 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 generators operates for 86 hours per year exclusively at 100 percent load, which is the load at which the $NO_x$ emission rate is highest.

Condition 5.2 is 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 C 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

[3] 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.

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 also account for inclusion of the "black-puff" factors for CO and volatile organic compounds (VOCs).

Appendix C 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. The modeled DEEP cancer risk has now increased from the original value of 4.2-per-million up to 5.6-per-million at the maximally impacted residence. However, as described in Appendix C the forecast cancer risk is still much lower than Ecology's second-tier threshold of 10-per-million and Ecology's community-wide target level of 100-per-million for the city of Quincy. The increased value for the modeled DEEP cancer risk is the result of the extremely conservative assumption that every generator operates exclusively at 10 percent load, which is an operating regime that would not actually be technically feasible at any data center.

**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 shall be included in the overall runtime limit set by Condition 3.2.1.

**Condition 8.5.3 – Recordkeeping Requirements**

Microsoft requests that Condition 8.5.3, requiring Microsoft to log the "reason for operating" each time any generator starts up, be deleted. The reason for operating an engine has no regulatory significance, unless the reason for operating is to provide emergency demand response as authorized by 40 CFR 60.4211(f), in which case Condition 8.7 requires Microsoft to report annual non-emergency operating hours. Of greater practical significance, Microsoft has not yet developed a way to automatically record the reason for operating an engine. As a result, each instance of engine operation would require an operator to manually log the reason for starting the engine, a burdensome exercise at a data center with 37 engines.

## 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 contained 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 C 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 32 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 PM emission limits will not trigger any new permitting requirements or emission standards.

## ITEMIZED RESPONSES TO ECOLOGY'S REQUESTS IN INCOMPLETENESS LETTER DATED JANUARY 7, 2015

This section provides our itemized responses to Ecology's queries in the Incompleteness Letter dated January 7, 2015 (Ecology 2015).

*Comment: Provide copies of spreadsheets and AERMOD modeling files.*

Revised calculation spreadsheets have been emailed to Ecology, and DVDs of the AERMOD modeling runs were delivered to Clint Bowman of Ecology.

*Comment: Incorporate Caterpillar's recommended operation and maintenance protocol for low-load generator operation.*

Microsoft requests that Section 6 of the Approval Order be revised to require Microsoft to include the referenced materials in the required operation and maintenance manual.

*Comment: Clarify "Black-puff" cold start factors vs. Caterpillar's recommended 1.2 safety factor.*

We have applied Caterpillar's recommended 1.2 safety factor to Caterpillar's estimates of all warmed-up emission rates at all loads, because its estimates are based on engineering judgment regarding the likely removal efficiencies of the emission control package. The 1.2 safety factor for the warmed-up condition was used in all emission calculations and AERMOD modeling. The 1.2 safety factor is also included in our requested single-load emission limits in Table 4 of the Approval Order. We did not apply any Caterpillar safety factor to the cold-start emissions because the cold-start emissions are based on "Not-to-Exceed" or "Potential Site Variation" Tier 2 emission data that are well understood.

The "black-puff" cold-start factors are independent of Caterpillar's recommended 1.2 safety factor for the warmed-up, controlled emission rates. The emission calculations in our original December 2014 revision application applied the 1.26 "black-puff" cold-start factor for the first 10 minutes of cold-start particulate emissions, but we inadvertently neglected to apply any "black-puff" factors to the initial cold-start CO or VOC emissions. Based on our meeting with Ecology, the emission calculations were revised to assume a 15-minute cold-start period for PM, CO and VOCs, and the same "black-puff" factors were used in our June 2014 application: 1.26 for PM and VOCs, and 1.56 for CO. These adjustments caused a slight increase in annual and short-term emissions [e.g., the annual DEEP emission rate increased from the original 0.717 tons per year (TPY) up to 0.725 TPY].

*Comment: The NOC application received by Ecology on December 11, 2014 included criteria pollutant emissions increase much above the NSR thresholds contained in WAC 1730455-120(2)(a) subject to a $1500 review fee. The correct review fee of $1500 was received on December 16, 2014 by Ecology Cashiering.*

Ecology is correct that Microsoft submitted its December 11 application under WAC 173-400-111(8) ("Change of conditions or revisions to orders of approval"). The company asks Ecology to approve revisions to the approval conditions for a facility currently under construction. We read WAC 173-455-120(3) to allow Ecology to recover the cost of the time invested by its permitting staff in reviewing the application, and Microsoft is prepared to reimburse Ecology for those costs.

*Comment: Because Microsoft's requested permit revision causes an increase in DEEP emissions, please provide a complete, revised Second-Tier Risk Analysis Report.*

As requested, we are submitting with this response a revised Health Impact Assessment for diesel particulate matter that models potential data center emissions against a baseline of zero.

*Comment: Clarify how Caterpillar's recommended 1.2 safety factor affects the permit requirement that all engines must achieve the EPA Tier 4(Final) emission standard based on the weighted average of the 5-load emission test.*

Caterpillar's recommended 1.2 safety factor has no effect on the Approval Order permit condition requiring that all engines must achieve the Tier 4 (Final) emission standard based on the 5-load weighted average stack test. As shown in the handout distributed during our meeting on January 15, 2015, Appendix A of our June 2014 Notice of Construction Supporting Information Report presented Caterpillar's demonstration of the load-specific emission control removal efficiencies required to achieve the Tier 4 (Final) limits, without adding the 1.2 safety factor. Microsoft's bid specification required compliance with the 5-load Tier 4 (Final) standard, and Caterpillar's bid provided a performance guarantee.

We used Caterpillar's 1.2 safety factor to develop the single-load emission limits specified by Table 4 of the Approval Order, and we used the 1.2 safety factor on the warmed-up emission rates to develop short-term and annual-average emission rates used for the AERMOD ambient impact assessment.

*Comment: Clarify why the previous January 2014 AERMOD runs were used to develop "dispersion factors" for annual DEEP and 1-hour $NO_2$, but new dispersion factors for CO, $PM_{10}$ and $PM_{2.5}$ were developed from new AERMOD modeling runs from November 2014.*

Our January 2014 AERMOD run for annual-average DEEP set the stack temperature and velocity by assuming that any time a generator activates it always operates at conservatively low values corresponding to 12 percent generator load. This is a very conservative assumption because Microsoft expects the generators will actually operate at 50 to 85 percent during outages or electrical bypass. For this January 2015 resubmittal, our ultra-worst-case DEEP emissions assume that the generators will always run at 10 percent load, which is essentially the same load condition assumption we made for our January 2014 AERMOD runs. Therefore, we used the January 2014 AERMOD runs to calculate "dispersion coefficients" for modeling of facility-wide power outages at 10 percent load for the purposes of modeling annual DEEP, annual $PM_{2.5}$, and benzene.

Our January 2014 AERMOD runs used to model 1-hour nitrogen dioxide ($NO_2$) impacts during a facility-wide power outage or four-generator electrical bypass maintenance assumed stack temperatures and flow rates at 80 percent load. Our worst-case emission calculations for our 2015 resubmittal assumes that the worst-case $NO_x$ emissions always occur at 100 percent load, during which time the stack temperature and flow rate will both be higher than the AERMOD values we assumed for the previous 80 percent load modeling. We used the January 2014 AERMOD runs (80 percent load) to model the ultra-worst case ambient impacts at 100 percent load because we understand that the low stack temperature and flow rate at 80 percent load will result in a conservative overprediction of the actual ambient impacts at 100 percent load.

In November 2014, we re-ran AERMOD for 24-hour $PM_{10}$ (facility-wide power outage) and $1^{st}$-high 24-hour $PM_{2.5}$ (four-generator electrical bypass), both at 10 percent load, because our January

2014 modeling runs had assumed 80 percent load. We also used the 24-hour $PM_{10}$ (10 percent load) AERMOD run to develop the dispersion factor for ammonia and acrolein.

*Comment: Because the permitted annual runtimes and annual-average emission rates are based on 3-year rolling totals, evaluate the theoretical-maximum annual average ambient impacts that might occur if Microsoft theoretically emitted all of the allowable 3-year rolling total emissions in one single year.*

This resubmittal presents the theoretical-maximum, annual-average AERMOD results for $PM_{2.5}$, $NO_2$ (for comparison to the annual NAAQS), DEEP, and benzene (for comparison to the annual acceptable source impact levels) as three times higher than the regular annual-average values based on the 3-year rolling emission rates. However, for the DEEP cancer risk assessment we used the regular annual-average concentrations (without the 3x multiplier) because it is most appropriate to evaluate DEEP cancer risk based on the 70-year average rather than the theoretical-maximum annual impacts.

## ITEMIZED RESPONSES TO DISCUSSION POINTS DURING MEETING ON JANUARY 15, 2015

This section provides our itemized responses to Ecology's queries expressed during our meeting on January 15, 2015.

*Meeting Comment: Revise emission calculations to assume a 15-minute cold-start period.*

The cold-start period used to calculate the annual-average emission rates was revised to 15 minutes for all pollutants and all generator loads, and we revised the cold-start period used to calculate 24-hour $PM_{10}$ and $PM_{2.5}$ emission rates to 15 minutes. Our previous calculation spreadsheet assumed only a 10-minute period. This slightly increased the annual-average DEEP emission rate (from the previous 0.717 TPY up to 0.725 TPY).

*Meeting Comment: For AERMOD modeling of the 24-hour $PM_{2.5}$ NAAQS, confirm if the reported AERMOD dispersion factor is for the $1^{st}$-high, $4^{th}$-high, or $8^{th}$-high value.*

Our January 2014 AERMOD run, which was used to develop the 24-hour $PM_{2.5}$ dispersion factor, was the $1^{st}$-high value. This means that the modeled 24-hour $PM_{2.5}$ ambient impact is conservatively high because the NAAQS is based on the $8^{th}$-highest value.

*Meeting Comment: Confirm that Microsoft still accepts the current Approval Order condition requiring the 5-load weighted average emission test to demonstrate compliance with the EPA Tier 4 (Final) emission standard.*

Microsoft continues to accept the general concept of Approval Order Condition 4.4 and Table 4, which require the five-load test to demonstrate compliance with the EPA Tier 4 (Final) limits. However, Microsoft continues to request that the required test frequency be reduced, with only one engine in any year subject to that test, initially and once every 3 years.

* * * * *

Ecology asked Microsoft to present its proposed amendments in the form of a WAC 173-400-111(8) application to revise the Approval Order, and Microsoft is following Ecology's procedural guidance. This application should not be construed, however, as a waiver of positions presented in the Pollution Controls Hearing Board appeal. Microsoft continues to believe that the Approval Order contains errors that, if not corrected, would make it difficult for the data center to operate in compliance with its air permit. Microsoft looks forward to working with Ecology to resolve these concerns.

We thank you for your prompt attention to these requested permit revisions. Please call me if you have any additional questions about this matter.

LANDAU ASSOCIATES, INC.

James Wilder

Jim Wilder, P.E.
Senior Associate

JMW/ccy

**APPENDICES**

Appendix A: Signed Air Permit Revision Application Form
Appendix B: Redline Showing Proposed Revisions to Approval Order 14AQ-E537
Appendix C: Revised Emission Calculations and Ambient Impact Assessment
Appendix D: Caterpillar Emissions Data

cc: Gary Huitsing, Washington State Department of Ecology

APPENDIX A

# Signed Air Permit Revision Application Form

DEPARTMENT OF ECOLOGY State of Washington

# Air Permit Revision Application (Microsoft Oxford)

This application applies statewide for facilities under the Department of Ecology's jurisdiction. Submit this form for review of your project to construct a new or modified source of air emissions. Please refer to Ecology Forms ECY 070-410a-g, "Instructions for NOC Application," for general information about completing the application.

Ecology offers up to two hours of free pre-application assistance. We encourage you to schedule a pre-application meeting with the contact person specified for the location of your proposal, below. If you use up your two hours of free pre-application assistance, we will continue to assist you after you submit Part 1 of the application and the application fee. You may schedule a meeting with us at any point in the process.

Upon completion of the application, please enclose a check for the initial fee and mail to:

**Department of Ecology**
**Cashiering Unit**
**P.O. Box 47611**
**Olympia, WA 98504-7611**

*For Fiscal Office Use Only:*
001-NSR-216-0299-000404

| **Check the box for the location of your proposal.** For assistance, call the contact listed below: | | |
|---|---|---|
| | **Ecology Permitting Office** | **Contact** |
| ☐ CRO | **Chelan, Douglas, Kittitas, Klickitat, or Okanogan County**<br>Ecology Central Regional Office – Air Quality Program | Lynnette Haller<br>(509) 457-7126<br>lynnette.haller@ecy.wa.gov |
| ☒ ERO | **Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Stevens, Walla Walla or Whitman County**<br>Ecology Eastern Regional Office – Air Quality Program | Greg Flibbert<br>(509) 329-3452<br>gregory.flibbert@ecy.wa.gov |
| ☐ NWRO | **San Juan County**<br>Ecology Northwest Regional Office – Air Quality Program | David Adler<br>(425) 649-7082<br>david.adler@ecy.wa.gov |
| ☐ IND | **For actions taken at Kraft and Sulfite Paper Mills and Aluminum Smelters**<br>Ecology Industrial Section – Waste 2 Resources Program<br>Permit manager: ____________________ | Garin Schrieve<br>(360) 407-6916<br>garin.schrieve@ecy.wa.gov |
| ☐ NWP | **For actions taken on the US Department of Energy Hanford Reservation**<br>Ecology Nuclear Waste Program | Philip Gent<br>(509) 372-7983<br>philip.gent@ecy.wa.gov |

DEPARTMENT OF ECOLOGY
State of Washington

# Air Permit Revision Application (Microsoft Oxford)

Check the box below for the fee that applies to your application.

**New project or equipment:**

| | |
|---|---|
| ☐ | **$1,500: Basic project** initial fee covers up to 16 hours of review. |
| ☐ | **$10,000: Complex project** initial fee covers up to 106 hours of review. |

**Change to an existing permit or equipment:**

| | |
|---|---|
| ☐ | **$200: Administrative or simple change** initial fee covers up to 3 hours of review<br>Ecology may determine your change is complex during completeness review of your application. If your project is complex, you must pay the additional $675 before we will continue working on your application. |
| ☒ | **$1,500 (Revised from $875): Complex change** initial fee covers up to 10 hours of review |
| ☐ | **$350** flat fee: **Replace or alter control technology equipment under WAC 173-400-114**<br>Ecology will contact you if we determine your change belongs in another fee category. You must pay the fee associated with that category before we will continue working on your application. |

| | |
|---|---|
| Read each statement, then check the box next to it to acknowledge that you agree. | |
| ☒ | The initial fee you submitted may not cover the cost of processing your application. Ecology will track the number of hours spent on your project. If the number of hours Ecology spends exceeds the hours included in your initial fee, Ecology will bill you $95 per hour for the extra time. |
| ☒ | You must include all information requested by this application. Ecology may not process your application if it does not include all the information requested. |
| ☒ | Submittal of this application allows Ecology staff to visit and inspect your facility. |


If you need this document in a format for the visually impaired, call the Air Quality Program at 360-407-6800. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

DEPARTMENT OF ECOLOGY
State of Washington

# Air Permit Revision Application (Microsoft Oxford)

## Part 1: General Information

### I. Project, Facility, and Company Information

| |
|---|
| 1. Project Name<br>Microsoft MWH-01 Data Center |
| 2. Facility Name<br>Microsoft MWH-01 Data Center |
| 3. Facility Street Address<br>Industrial Park #5, at the end of Port Industrial Parkway and west of Road R NW |
| 4. Facility Legal Description<br>See enclosed survey legal description |
| 5. Company Legal Name (if different from Facility Name)<br>Microsoft Corporation |
| 6. Company Mailing Address (street, city, state, zip)<br>One Microsoft Way, Redmond WA 98052 |

### II. Contact Information and Certification

| | |
|---|---|
| 1. Facility Contact Name (who will be onsite)<br>Hoffman Construction Company | |
| 2. Facility Contact Mailing Address (if different than Company Mailing Address)<br>805 SW Broadway, Suite 2100, Portland, Oregon 97205 | |
| 3. Facility Contact Phone Number<br>503-572-2858 | 4. Facility Contact E-mail<br>Mike-Lindell@hoffmancorp.com |
| 5. Billing Contact Name (who should receive billing information)<br>Mike Lindell | |
| 6. Billing Contact Mailing Address (if different than Company Mailing Address) | |
| 7. Billing Contact Phone Number<br>503-572-2858 | 8. Billing Contact E-mail<br>Mike-Lindell@hoffmancorp.com |
| 9. Consultant Name (optional – if 3rd party hired to complete application elements)<br>James Wilder | |
| 10. Consultant Organization/Company<br>Landau Associates | |
| 11. Consultant Mailing Address (street, city, state, zip)<br>130 2nd Avenue Edmonds, WA 98020 | |
| 12. Consultant Phone Number<br>206/631-8685 | 13.Consultant E-mail<br>jwilder@landauinc.com |
| 14. Responsible Official Name and Title (who is responsible for project policy or decision-making)<br>John Radick, Senior Program Manager | |
| 16. Responsible Official Phone<br>206-898-1689 | 17. Responsible Official E-mail<br>John.radick@microsoft.com |
| 18. Responsible Official Certification and Signature<br>I certify, based on information and belief formed after reasonable inquiry, the statements and information in this application are true, accurate and complete.<br><br>Signature John Radick Date 12/10/14 | |

DEPARTMENT OF ECOLOGY State of Washington

# Air Permit Revision Application (Microsoft Oxford)

## Part 2: Technical Information

The Technical Information may be sent with this application form to the Cashiering Unit, or may be sent directly to the Ecology regional office with jurisdiction along with a copy of this application form.

For all sections, check the box next to each item as you complete it.

### III. Project Description

Please attach the following to your application.

- ☒ Written narrative describing your proposed project.
- ☐ Projected construction start and completion dates.
- ☐ Operating schedule and production rates.
- ☐ List of all major process equipment with manufacturer and maximum rated capacity.
- ☐ Process flow diagram with all emission points identified.
- ☐ Plan view site map.

- ☐ Manufacturer specification sheets for major process equipment components.
- ☐ Manufacturer specification sheets for pollution control equipment.
- ☐ Fuel specifications, including type, consumption (per hour & per year) and percent sulfur.

**Note to Ecology: Microsoft is requesting revisions to certain conditions in the NOC Approval Order.**

### IV. State Environmental Policy Act (SEPA) Compliance

**Check the appropriate box below.**

☒ SEPA review is complete:
Include a copy of the final SEPA checklist and SEPA determination (e.g., DNS, MDNS, EIS) with your application. We assume this permit revision does not trigger additional SEPA review.

☐ SEPA review has not been conducted:

☐ If review will be conducted by another agency, list the agency. You must provide a copy of the final SEPA checklist and SEPA determination before Ecology will issue your permit.
Agency Reviewing SEPA:

# Air Permit Revision Application (Microsoft Oxford)

☐ If the review will be conducted by Ecology, fill out a SEPA checklist and submit it with your application. You can find a SEPA checklist online at www.ecy.wa.gov/programs/sea/sepa/docs/echecklist.doc

**V. Emissions Estimations of Criteria Pollutants** **See attached letter describing requested permit revisions and corresponding emission increases.**

**Does your project generate criteria air pollutant emissions?** ☒ Yes ☐ No

If yes, please provide the following information regarding your criteria emissions in your application.

☒ The names of the criteria air pollutants emitted (i.e., $NO_x$, $SO_2$, CO, $PM_{2.5}$, $PM_{10}$, TSP, VOC, and Pb)

☒ Potential emissions of criteria air pollutants in tons per hour, tons per day, and tons per year (include calculations)

☒ If there will be any fugitive criteria pollutant emissions, clearly identify the pollutant and quantity No fugitives are expected.

**VI. Emissions Estimations of Toxic Air Pollutants** **See attached letter describing requested permit revisions and corresponding emission increases.**

**Does your project generate toxic air pollutant emissions?** ☒ Yes ☐ No

If yes, please provide the following information regarding your toxic air pollutant emissions in your application.

☒ The names of the toxic air pollutants emitted (specified in WAC 173-460-150[1])

☒ Potential emissions of toxic air pollutants in pounds per hour, pounds per day, and pounds per year (include calculations)

☒ If there will be any fugitive toxic air pollutant emissions, clearly identify the pollutant and quantity. No fugitives expected.

**VII. Emission Standard Compliance**

☒ Provide a list of all applicable new source performance standards, national emission standards for hazardous air pollutants, national emission standards for hazardous air pollutants for source categories, and emission standards adopted under Chapter 70.94 RCW.

**Does your project comply with all applicable standards identified?** ☒ Yes ☐ No

**VIII. Best Available Control Technology**

☐ Provide a complete evaluation of Best Available Control Technology (BACT) for your proposal. We assume the small requested emission increases are not enough to affect the BACT determination.

---

[1] http://apps.leg.wa.gov/WAC/default.aspx?cite=173-460-150

## IX. Ambient Air Impacts Analyses

Please provide the following:

☒ Ambient air impacts analyses for Criteria Air Pollutants (including fugitive emissions)

☒ Ambient air impacts analyses for Toxic Air Pollutants (including fugitive emissions)

☒ Discharge point data for each point included in air impacts analyses (include only if modeling is required). We revised the previous AERMOD runs to reflect the possible reduced stack temperature and flowrate if the generators operate at low load. A diskette of the modified AERMOD runs has been provided to Ecology.

**Does your project cause or contribute to a violation of any ambient air quality standard or acceptable source impact level?** ☒ Yes ☐ No. Yes, the originally permitted project exceeded the ASIL for DEEP, and the requested revisions will slightly increase the Potential to Emit for DEEP. See the attached letter for documentation on the revised DEEP emission rates, the revised hand-scaled estimates of the DEEP ambient concentrations, and the revised hand-scaled estimates of community DEEP cancer impacts at key receptor locations. The revised DEEP cancer risks are still far below any of Ecology's allowable limits or guideline values.

APPENDIX B

# Redline Showing Proposed Revisions to Approval Order 14AQ-E537

Microsoft's revised requested revisions, response to Huitsing incompleteness letter, January 30, 2015 STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

Comment [A1]: This second set of requested revisions reflects our responses to Gary Huitsing's Incompleteness Letter.

IN THE MATTER OF APPROVING A NEW) APPROVAL ORDER No. 14AQ-E537
AIR CONTAMINANT SOURCE FOR )
**MICROSOFT CORPORATION** )
**THE OXFORD DATA CENTER** )

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

On January 27, 2014, Ecology received a Notice of Construction (NOC) application submittal from the Microsoft Corporation (MSN**),** requesting approval for Phases 1 and 2 of a new facility named 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 an incompleteness letter was issued on February 26, 2014. A revised NOC application was received on March 17, 2014. The application was considered complete on June 3, 2014. Microsoft submitted an application to revise certain permit conditions on December XX, 2014.

**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** |
| Ph 1/AZ-4A | | | | |
| " | | | | |
| " | | | | |
| " | | | | |
| Ph 1/AZ-4B | | | | |
| " | | | | |
| " | | | | |
| " | | | | |
| Ph 1/AZ-4C | | | | |
| " | | | | |
| " | | | | |
| " | | | | |
| Ph 1/AZ-4D | | | | |

| 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 2/AZ-3A | | | | |
| " | | | | |
| " | | | | |
| " | | | | |
| Ph 2/AZ-3B | | | | |
| " | | | | |
| " | | | | |
| " | | | | |
| Ph 2/AZ-3C | | | | |
| " | | | | |
| " | | | | |
| " | | | | |
| Ph 2/AZ-3D | | | | |
| " | | | | |
| " | | | | |
| " | | | | |

| 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 |

| Table 1.4. Cooling Towers for Phases 1 & 2 | | | |
|---|---|---|---|
| Phase/Building | # Cooling Towers | # Cells per Tower | Total # Cooling Tower Cells |
| 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. The 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 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.

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 Tower** | **Total Facility Emissions** |
| Total particulate matter (PM) | All $PM_{2.5}$ | 23 | 23.7 ~~23.5~~ |
| PM smaller than 10 microns in diameter ($PM_{10}$) | All $PM_{2.5}$ | 12.8 | 13.5 ~~13.3~~ |
| PM smaller than 2.5 microns in diameter ($PM_{2.5}$)[a] | 0.73 ~~0.72~~ ~~.536~~ | 2.99 | 3.7 ~~3.53~~ |
| Carbon monoxide (CO) | 4.7 ~~3.5~~ ~~15.6~~ | 0 | 4.7 ~~3.5~~ ~~15.6~~ |
| Nitrogen oxides ($NO_X$) | 27.4 ~~25.8~~ ~~8.6~~ | 0 | 27.4 ~~25.8~~ ~~8.6~~ |
| Volatile organic compound (VOC) | 0.84 ~~0.74~~ ~~8.0E-01~~ | Negligible | 0.84 ~~0.74~~ ~~0.8~~ |
| Sulfur dioxide ($SO_2$) | 4.7E-02 | 0 | 4.7E-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). | | | |

Comment [A2]: Second set of revised emission rates reflect the assumption of a 15-minute cold-start period, as requested by Gary Huitsing.

| Table 2.2. Toxic Air Pollutants Potential To Emit for Phases 1 & 2 (TPY) | | | |
|---|---|---|---|
| **Pollutant** | **Main Generator Engines** | **Cooling Tower** | **Total Facility Emissions** |
| CO | 4.7 ~~3.5~~ ~~15.6~~ | 0 | 4.7 ~~3.5~~ ~~15.6~~ |
| Ammonia | 1.03 ~~0.71~~ | 0 | 1.03 ~~0.71~~ |
| DEEP[a] | 0.72 ~~5.36E-01~~ | 0 | 0.72 ~~5.36E-01~~ |
| $SO_2$ | 4.7E-02 | 0 | 4.7E-02~~4.7E-02~~ |
| Primary nitrogen dioxide ($NO_2$)[b] | 2.6 ~~8.6E-01~~ | 0 | 2.6 ~~8.7E-01~~ |
| Benzene | 2.9~~4~~E-03 | 0 | 2.9E-03~~2.4E-03~~ |
| Toluene | 1.0E-03~~8.6E-04~~ | 0 | 1.0E-03~~8.6E-04~~ |
| Xylenes | 7.2~~5.9~~E-04 | 0 | 7.2E-04~~5.9E-04~~ |
| 1,3 Butadiene | 1.5~~1.2~~E-04 | 0 | 1.5E-04~~1.2E-04~~ |
| Formaldehyde | 2.9~~2.4~~E-04 | 0 | 2.9E-04~~2.4E-04~~ |
| Acetaldehyde | 9.4~~7.7~~E-05 | 0 | 9.4E-05~~7.7E-05~~ |
| Acrolein | 2.9~~2.4~~E-05 | 0 | 2.9E-05~~2.4E-05~~ |
| Benzo(a)pyrene | 9.5~~7.9~~E-07 | 0 | 9.5E-07~~7.9E-07~~ |
| Benzo(a)anthracene | 2.3~~1.9~~E-06 | 0 | 2.3E-06~~1.9E-06~~ |

| Table 2.2. Toxic Air Pollutants Potential To Emit for Phases 1 & 2 (TPY) | | | |
|---|---|---|---|
| Pollutant | Main Generator Engines | Cooling Tower | Total Facility Emissions |
| Chrysene | 5.7~~4.7~~E-06 | 0 | 5.7E-06~~4.7E-06~~ |
| Benzo(b)fluoranthene | 4.1~~3.4~~E-06 | 0 | 4.1E-06~~3.4E-06~~ |
| Benzo(k)fluoranthene | 8.1~~6.7~~E-07 | 0 | 8.1E-07~~6.7E-07~~ |
| Dibenz(a,h)anthracene | 1.3~~1.1~~E-06 | 0 | 1.3E-06~~1.1E-06~~ |
| Ideno(1,2,3-cd)pyrene | 1.5~~1.3~~E-06 | 0 | 1.5E-06~~1.3E-06~~ |
| Napthalene | 4.8~~4.0~~E-04 | 0 | 4.8E-04~~4.0E-04~~ |
| Propylene | 1.4E-02~~8.5E-03~~ | 0 | 1.4E-02~~8.5E-03~~ |
| 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 |

| Table 2a.1 BACT Determinations | |
|---|---|
| **Pollutant(s)** | **BACT Determination** |
| | CFR Section 60.4219.<br>b. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.<br>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.<br>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 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 emissions. Ecology has concluded that this project has satisfied all requirements of a second tier analysis.

**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. 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.

1.2. 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 2.5 MWe engine, 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 exhaust stack dimensions shall be greater than or equal to 46 feet above ground level, no more than 18 inches in diameter, and approximately 16 feet above roof height. The four 2.0 MWe engine-generator exhaust stack heights shall be greater than or equal to 46 feet above ground level, no more than 16 inches in diameter, and approximately 16 feet above roof height. The one 0.750 MWe engine-generator exhaust stack height shall be greater than or equal to 46 feet above ground level, no more than 14 inches in diameter, and approximately 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 431,000 gallons per year and 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.

3.2. Except as provided in Approval Condition 3.3, the thirty-seven (37) Project Oxford Data Center 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, e~~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.

3.2.2. ~~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~~3.2.2.1 Daily generator usage shall not exceed a maximum limit of 160 generator hours ~~192 MWe hours~~ per calendar day, except during up to four days per year of emergency power outage.

~~3.2.2.3~~3.2.2.2 ~~Maximum hourly generator usage shall be limited to n~~No more than three ~~four~~ 2.5 MWe generators shall operate~~ing~~ simultaneously during any given hour at a load exceeding 85 percent~~ except during emergency power outages~~.

~~3.2.3. One hundred percent load: for monthly load bank testing, semiannual load bank testing, and as needed generator corrective maintenance, eEach 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.

**Comment [A4]:** The edits proposed to Condition 3.2 address the fact that the generators operate not just at idle, 80 and 100 percent, but at a range of loads between 10 and 100 percent. Further, all operations performed by the engines (e.g. "corrective engine testing") can occur at any load. As a result, it is not feasible to set operating hour limits for specific loads, and there is no reason to list permitted operations for each load range, because the same operations would appear in each subsection of Condition 3.2.

**Comment [A5]:** Changed the terminology to 36-month rolling average

**Comment [A6]:** This condition was proposed by Microsoft in June to protect the 24 hour PM 2.5 NAAQS. Appendix C, Attachment C-1, Table C1-5 shows that the 160 generator hour per day limit achieves that objective, while giving Microsoft more operating flexibility.

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 satisfyApproval 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.~~ For stack testing, one generator shall be tested every three years, operating no more than 45 hours per testing event. Each testing event shall be conducted according to the testing requirements in Approval Condition 4. Additional hours needed for retesting to satisfy Approval Condition 4.4 shall be deducted from the pre-approved hours in Approval Condition 3.3. Additional operation of the engines for the purpose of emissions testing beyond the operating hour and fuel consumption limits authorized by this Order will be considered by Ecology upon request in writing.

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

3.4.1. 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. 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 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[1] | Test Method | Emission Limits | Compliance Test Frequency |
|---|---|---|---|---|
| PM | Five-load weighted avg. | EPA Method 5 or 201a | 0.03 g/kW-hr | Test ~~two different~~one engine~~s~~ at both load tests within 12 months of engine startup. Test ~~two~~one different untested engine~~s~~ every 3 years. |
| | ~~Single~~ 50% load ~~(78%-82%)~~ | EPA Method 5 or 201a, and EPA Method 202 | 0.11 lb/hr (0.75 MWe) | |
| | | | ~~0.21~~0.32 lb/hr (2.0 MWe) | |
| | | | ~~0.288~~0.34 lb/hr (2.5 MWe) | |
| $NO_X$ | Five-load weighted avg. | EPA Method 7E | 0.67 g/kW-hr | Test ~~two different~~one engine~~s~~ at both load tests within 12 months of engine startup. Test ~~two~~one different untested engine~~s~~ every 3 years. |
| | ~~Single~~100% load ~~78%-82%~~ | EPA Method 7E | ~~1.8~~1.33 lb/hr (0.75 MWe) | |
| | | | ~~2.6~~4.04 lb/hr (2.0 MWe) | |
| | | | ~~3.37~~9.11 lb/hr (2.5 MWe) | |
| CO | Five-load weighted avg. | EPA Method 10 | 3.5 g/kW-hr | Test ~~two different~~one engine~~s~~ at both load tests within 12 months of engine startup. Test ~~two~~one different untested engine~~s~~ every 3 years. |
| | ~~Single~~ 100% load ~~78%-82%~~ | EPA Method 10 | ~~0.75~~0.28 lb/hr (0.75 MWe) | |
| | | | ~~10.1~~0.83 lb/hr (2.0 MWe) | |

[1] The actual engine load during each test run must be within +/- 2% of the target load.

**Comment [A7]:** This language was proposed by Kay Shirey to Matt Cohen in a July 1 email, to address Microsoft's concerns about intensity of source testing. Part of Ecology's proposal was to increase the minimum number of tests that Microsoft must perform before requesting approval to discontinue testing. That change appears in Condition 4.4.4.

| | | | | |
|---|---|---|---|---|
| | | | ~~15.04~~1.44 lb/hr (2.5 MWe) | |
| NMHC/ VOC | Five-load weighted avg. | EPA Method 25A and EPA Method 18 | 0.19 g/kW-hr | Test ~~two different~~one engine~~s~~ at both load tests within 12 months of engine startup. Test ~~two~~one different untested engine~~s~~ every 3 years. |
| | ~~Single~~50% load ~~78%-82%~~ | EPA Method 25A and Method 18 | ~~0.1~~0.05 lb/hr (0.75 MWe) | |
| | | | ~~0.8~~0.27 lb/hr (2.0 MWe) | |
| | | | ~~0.8~~0.29 lb/hr (2.5 MWe) | |
| Ammonia | ~~Single-~~75% load ~~(78%-82%)~~ | BAAQMD Method ST-1B or EPA Method 320 | 0.19 ~~0.16~~ lb/hr (0.75 MWe) | Test ~~two different~~one engine~~s~~ at both load tests within 12 months of engine startup. Test ~~two~~one different untested engine~~s~~ every 3 years. |
| | | | 0.48 ~~0.40~~ lb/hr (2.0 MWe) | |
| | | | 0.61 ~~0.50~~ lb/hr (2.5~~0~~ MWe) | |

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, ~~T~~the 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. Each run must last at least 60 minutes. 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 a 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 (5)~~ six (6) 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-six~~seven~~ (26~~27~~) 2.5 MWe engines.

**Comment [A8]:** Ecology proposed this edit in response to Microsoft's request to reduce the intensity of source testing.

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

The thirty-two (32) 2.5 MWe engine-generators, 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 (specified ~~as rolling monthly 3-year~~36-month rolling averages): 13.5 ~~13.3~~ tons per year (tpy) of PM10; 3.7 ~~3.53~~ tpy of PM2.5; 4.7~~3.5~~ ~~15.6~~ tpy of CO; 27.4 ~~25.8~~ ~~8.6~~ tpy of NOx; 0.84 ~~0.74~~ ~~0.8~~ tpy of VOC; 0.047 tpy of SO2; 0.73 ~~0.72~~ ~~0.536~~ tpy of DEEP; 2.74 ~~2.58~~ ~~0.86~~ tpy of NO2; and 0.86~~0.71~~ tpy of ammonia.

5.3. Visual emissions from each diesel electric generator 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 shall comply with the emission limits in Table 4.

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.

**Comment [A9]:** Added the specification of 36-month averages, to reflect the 36-month rolling average runtime limit in Condition 3.2.1. Our revised ambient modeling evaluated theoretical-maximum annual impacts 3x higher than the 3-yr rolling average.

**Comment [A10]:** Second set of revised emission rates reflect the assumption of a 15-minute cold-start period, as requested by Gary Huitsing.

**Comment [A11]:** Low-load provisions added as requested by Gary Huitsing.

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,~~
8.5.4 duration of operation, and
8.5.5 the percent of generator electrical load.

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

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~~.

9.3 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 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 annual report required 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 generator 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**<br>Attn: Appeals Processing Desk<br>300 Desmond Drive SE<br>Lacey, WA 98503 | **Department of Ecology**<br>Attn: Appeals Processing Desk<br>P.O. Box 47608<br>Olympia, WA 98504-7608 |

| | |
|---|---|
| **Pollution Control Hearings Board**<br>1111 Israel Road SW, Suite 301<br>Tumwater, WA 98501 | **Pollution Control Hearings Board**<br>P.O. Box 40903<br>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 day of August 2014, at Spokane, Washington.

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 C

# Revised Emission Calculations and Ambient Impact Assessment

# APPENDIX C (Revised February 2, 2015)
# REVISED EMISSION CALCULATIONS & AMBIENT IMPACT ASSESSMENT
# AIR QUALITY APPROVAL ORDER REVISION APPLICATION
# MICROSOFT PROJECT OXFORD DATA CENTER
# QUINCY, WASHINGTON

This appendix presents the revised generator runtime scenarios, revised emission calculations, and revised AERMOD ambient air quality dispersion modeling to support the air quality permit revision application for the Microsoft Project Oxford Data Center in Quincy, Washington.

## REVISED LOAD-SPECIFIC EMISSION ESTIMATES FROM CATERPILLAR

This revised analysis uses new 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 new Caterpillar data provide its estimates of load-specific emission rates for total particulate matter (combined front-half plus back-half). Appendix D shows Caterpillar's estimated emission rates, including its recommended safety factor of 1.20 applied to total particulate matter.

The adjusted per-generator hourly emission estimates, specified as 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 Attachment C-1 (Tables C1-1 through C1-3). 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 U.S. 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 particulate matter and volatile organic compounds, and 1.56 for carbon monoxide).

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 (Caterpillar's detailed emission forecasts are provided in Appendix D, and the basis for deriving these emission rates is provided in Attachment C-1 (Tables C1-1 through C1-3). The yellow-highlighted cells in Table 1 indicate the worst-case assumed load values that were used for the revised emission calculations and ambient impact modeling. In most cases, the calculated cold-start emissions (which represent the initial condition when the generator exhaust temperature is lower than the emission control catalysts' activation temperatures) specific to the Caterpillar engines are lower than the values used in the June 2014 application. For some pollutants (notably DEEP), the maximum hourly emission rate at any load within the range of 10 to 100 percent (which is the flexible range requested for the permit revision) is higher than the emission value for the discrete 80 percent load condition we applied to power outages in the June 2014 application.

## REVISED GENERATOR RUNTIME LIMITS AND OPERATING SCENARIOS

Microsoft requests that each generator 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, with the exception of the new allowable load limit specified by revised Condition 3.2.2.2 of the Approval Order: *"No more than three 2.5 MWe generators shall operate simultaneously during any given hour at an electrical load exceeding 85 percent."*

The operating scenarios used to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) and the Acceptable Source Impact Limits (ASILs) are as follows:

- To calculate the facility-wide annual emissions of particulate matter (PM), diesel engine exhaust particulate matter (DEEP) and volatile organic compounds (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 C-1, Table C1-4). Cold-start emissions were calculated by assuming every cold-start period lasts for 15 minutes. The AERMOD runs for DEEP ambient impacts were based on the original January 2014 modeling runs, which assume a stack temperature and flow rate corresponding to a 12 percent electrical load.
- 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 C-1, Table C1-4). Cold-start emissions were calculated by assuming every cold-start period lasts for 15 minutes. Even though the worst-case CO emissions will occur at 100 percent load, the January 2014 AERMOD run that assumed a stack temperature and flow rate equivalent to only a 12 percent load was used to evaluate the downwind CO impacts.
- To model compliance with the 24-hour $PM_{2.5}$ 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 C-1, Table C1-5 Part D). The new November 2014 AERMOD modeling run for this scenario included a stack temperature and flow rate equivalent to generators operating at 10 percent load. In that same worksheet, it is demonstrated that Microsoft could operate up to 6.8 generators at a time for 24 hours at 10 percent load, and the ambient impact would still be just below the NAAQS.
- To model compliance with the 1-hour nitrogen dioxide ($NO_2$) NAAQS, the four generators closest to the northeast facility boundary are assumed to operate simultaneously during electrical bypass maintenance, which is the same scenario evaluated in the original June 2014 application (see Attachment C-1, Table C1-5 Part C). Three of the generators are assumed to operate at 100 percent load, while the fourth generator operates at 85 percent load, which is the revised load configuration that complies with the proposed revision to Condition 3.2.2.2 of the Approval Order. The original January 2014 AERMOD modeling run was used to derive the dispersion factor for this scenario, which included stack temperature and flow rate values equivalent to generators operating at only 80 percent load. This assumption

overestimated the ambient $NO_2$ impacts because the actual stack temperature and flow rate at 85 to 100 percent loads will be higher than the assumed values at 80 percent load.

- To model compliance with the $NO_2$ ASIL, all 37 generators are assumed to operate simultaneously during a power outage (see Attachment C-1, Table C1-5 Part B). Three of the generators operate at 100 percent load, while the remaining generators operate at 85 percent load. The original January 2014 AERMOD modeling run was used to derive the dispersion factor for this scenario, which included a stack temperature and flow rate equivalent to generators operating at only 80 percent load. This assumption overestimated the ambient $NO_2$ impacts because the actual stack temperature and flow rate at 85 to 100 percent loads will be higher than the assumed values at 80 percent load.
- To model cancer risks caused by DEEP emissions, 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 DEEP emission rates are highest. The original January 2014 AERMOD run, which assumed a stack temperature and flow rate equivalent to generators operating at 12 percent load, was used to develop the dispersion factor for this scenario.

## REVISED EMISSION CALCULATIONS

Screenshots of the revised emission calculation spreadsheets used to calculate the revised emission rates are shown in Attachment C-1. Table 2 lists how the emission rates changed for each of the runtime scenarios used to evaluate compliance with the NAAQS and ASILs. 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 or toxic air pollutant (TAP) ambient threshold.

Table 3 lists the revised facility-wide 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).

## 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 has been provided to the Washington State Department of Ecology (Ecology) under separate cover.

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. That theoretical maximum-year analysis was applied to the annual-average NAAQS and ASILs by multiplying the normal annual-average values by a factor of 3.

Table 4 summarizes how the modeled ambient air quality impacts changed as a result of accounting for the flexible operating range of 10 to 100 percent, and using the new Caterpillar-specific emissions data.

The overall finding is that the modeled ambient impacts for some pollutants and averaging periods increased slightly compared to the values presented in our June 2014 application, but in all cases the modeled ambient impacts continue to be comfortably below all ambient limits. In some cases (notably DEEP), the modeled ambient impact increased slightly. Similarly, the 24-hour $PM_{2.5}$ impact at the Maximally Impacted Boundary Receptor (MIBR) increased slightly as a result of increasing the assumed emission rate and reducing the assumed stack temperature and flow rate, but the calculated impact (including local and regional background) is still below the NAAQS.

The ambient impacts for all TAPs other than DEEP are well below their respective ASILs. The ambient impact for DEEP continues to exceed its ASIL. The following section describes how the requested increase in allowable DEEP emissions affects the second-tier cancer risk analysis for DEEP. A complete revised Second-Tier Risk Analysis report for DEEP has been submitted to Ecology under separate cover.

## REVISED SECOND-TIER DEEP CANCER RISK RESULTS

A revised Second-Tier Risk Analysis report has been submitted under separate cover. Table 5 shows how the community-wide DEEP cancer risks at key receptor locations changed as a result of the increased potential-to-emit DEEP emission rate. The calculated potential-to-emit DEEP emission rate increased by 34 percent, so the calculated DEEP cancer risk at the Maximally Impacted Residential Receptor (MIRR) nearest the Oxford Data Center also increased by 34 percent, from the original 4.2-per-million up to 5.6-per-million, which is still well below Ecology's third-tier action level of 10-per-million. As listed in Table 5, the forecast cumulative DEEP impact at the maximally-exposed dwelling within the modeling domain remains unchanged at 45-per-million, which continues to be much lower than Ecology's guideline value of 100-per-million for the city of Quincy.

## SCREENSHOTS OF CALCULATION SPREADSHEETS

Attachment C-1 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 June 2014 application, except the cold-start emission rates at all loads have been revised to reflect Caterpillar's recommended emission rates for its specific engines, and the per-generator emission rates for each pollutant have been set at their maximum values for the load range 10 to 100 percent. The key changes to the calculations are as follows:

- Tables C1-1 through C1-3 in Attachment C-1 show the load-specific emission rates for each of the three generator size classes, based on new information provided by Caterpillar. For each generator, emission forecasts have been provided for the cold-start condition (while the exhaust temperature is below the emission control catalysts' activation temperatures), and the fully warmed-up conditions. In some cases, these Caterpillar-specific cold-start emissions are lower than the cold-start values we used in the June 2014 application, which had been based on the maximum values for any generators supplied by any of Microsoft's bidders (either Caterpillar, Cummins, or MTU).
- Table C1-4 in Attachment C-1 shows the calculation of the theoretical maximum year emission rates for each pollutant. The commissioning runtime was set to zero. The runtime for source testing was set equal to one generator tested in that year for 45 hours. The emission rates for each pollutant were then set at the values corresponding to their maximum value anywhere within the load range 10 to 100 percent.
- Table C1-5 in Attachment C-1 provides calculation worksheets showing how Microsoft's proposed operational changes affect the calculated facility-wide emission rate for each key operating scenario used to demonstrate compliance with the ambient concentration limits (either the NAAQS or the ASILs). For each operating scenario, the cold-start emission rates were revised to reflect Caterpillar's recommended values, and the warmed-up per-generator emission rates were changed to reflect their maximum values anywhere in the range of 10 to 100 percent.
- Table C1-6 in Attachment C-1 lists the facility-wide emission rates for each key operational scenario used to demonstrate ambient air quality compliance.
- Table C1-7 in Attachment C-1 shows how the emission rates for ammonia slip, acrolein, and the other gaseous TAPs were calculated.
- Table C1-8 in Attachment C-1 shows the emission calculations for the other miscellaneous gaseous TAPs whose emission rates increased as a result of increasing the worst-case fuel usage associated with operating every generator at an assumed 100 percent load.
- Table C1-9 in Attachment C-1 summarizes the revised ambient air quality impacts for each operating scenario used to demonstrate compliance with the ambient limits (the NAAQS and ASILs). AERMOD dispersion factors for each pollutant and operating scenario were developed either from the original January 2014 AERMOD runs, or from new AERMOD runs executed to support this permit revision application. A DVD of the revised AERMOD modeling files has been provided to Ecology under separate cover.

## ATTACHMENTS

| | |
|---|---|
| Table 1: | Revised Caterpillar Load-Specific Emission Rates for Diesel Generators |
| Table 2: | Revised Emission Rates for Specific Generator Activities Used for NAAQS and ASIL Compliance Monitoring |
| Table 3: | Revised Facility-Wide Potential-to-Emit Caused by Requested Permit Revisions |
| Table 4: | Revised Cumulative Ambient Impacts Caused by Requested Permit Revisions |
| Table 5: | Revised Cumulative DEEP Cancer Risk Caused by Requested Permit Revisions |

Attachment C-1: Screenshots of January 2015 Revised Emission Calculation Spreadsheets

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

| Pollutant | Condition | 100% Load | Maximum Between 10%-75% Loads | 10% Load |
|---|---|---|---|---|
| 2.5 MWe 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 | 9.38 | 4.62 | 4.62 |
| | Warm | 1.4 | 1.11 | 1.109 |
| NMHC Including Black-Puff Cold-Start Factor | Cold | 1.10 | 1.20 | 1.21 |
| | Warm | 0.198 | 0.346 | 0.346 |
| PM Including Black-Puff Cold-Start Factor, Front Half Plus Back Half | Cold | 0.407 | 0.635 | 0.635 |
| | Warm | 0.272 | 0.401 | 0.401 |
| 2.0 Mwe 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 | 3.45 | 3.95 | 6.16 |
| | Warm | 0.8 | 0.95 | 0.948 |
| NMHC Including Black-Puff Cold-Start Factor | Cold | 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 | 0.373 | 0.661 | 0.661 |
| | Warm | 0.209 | 0.434 | 0.434 |
| 750 kWe 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 | 1.15 | 1.51 | 1.9 |
| | Warm | 0.3 | 0.44 | 0.439 |
| NMHC Including Black-Puff Cold-Start Factor | Cold | 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 | 0.349 | 0.608 | 0.608 |
| | Warm | 0.040 | 0.136 | 0.136 |

Yellow-highlighted cells indicate worst-case load-specific values used for emission calculations and ambient air quality impact modeling.

See Appendix D for Caterpillar's raw data for generator emission estimates. See Tables C1-1 through C1-3 in Attachment C-1 for details on the basis for deriving these emission estimates.

# TABLE 2
# REVISED EMISSION RATES FOR SPECIFIC GENERATOR ACTIVITIES USED FOR NAAQS AND ASIL COMPLIANCE MODELING
# MICROSOFT OXFORD DATA CENTER
# QUINCY, WASHINGTON

| Pollutant and Averaging Period | Operating Scenario | Calculated Emission Rates | | | Relative Emission Fraction |
|---|---|---|---|---|---|
| | | Original June 2014 Application | January 2015 Revision Application | Units | |
| Max-Year Annual DEEP | Maximum Year including all operations | 0.536 | 0.725 | tons/yr | 136% |
| Max-Year Annual NOx | Maximum Year including all operations | 8.61 | 27.4 | tons/yr | 318% |
| 1-hr $NO_2$ ASIL | 1-hr facility-wide power outage | 340.2 | 390 | lbs/hr | 123% |
| 98th-percentile 1-hr $NO_2$ NAAQS | 4-generator electrical bypass | 38.6 | 39.4 | lbs/hr | 102% |
| 98th-percentile 24-hr $PM_{2.5}$ NAAQS | 4-generator electrical bypass | 27.9 | 38.7 | lbs/day | 139% |
| 2nd-highest 24-hr $PM_{10}$ | 24-hr facility-wide power outage | 244 | 355 | lbs/day | 145% |
| 2nd-high 1-hr CO | 1-hr facility-wide power outage | 572 | 97 | lbs/hr | 17% |

**TABLE 3**
**REVISED FACILITY-WIDE POTENTIAL-TO-EMIT CAUSED BY REQUESTED PERMIT REVISIONS**
**MICROSOFT OXFORD DATA CENTER**
**QUINCY, WASHINGTON**

| Pollutant | Tons Per Year Emissions |
|---|---|
| Diesel Generators | |
| $NO_x$ | 27.4 |
| DEEP, $PM_{10}$, $PM_{2.5}$ from diesel exhaust (includes total PM as front-half plus back-half) | 0.73 (Maximum 12-month period) |
| CO | 4.7 |
| VOCs | 0.84 |
| Ammonia | 0.86 |
| $SO_2$ | 0.047 |
| Lead | Negligible |
| Cooling Tower Drift | |
| Cooling Tower Drift Total Suspended Particulates | 23 |
| Cooling Tower Drift $PM_{10}$ | 12.8 |
| Cooling Tower $PM_{2.5}$ | 2.99 |
| Combined Generators and Cooling Towers | |
| Facility-Wide Total Suspended Particulates | 23.7 |
| Facility-Wide $PM_{10}$ | 13.5 |
| Facility-Wide $PM_{2.5}$ | 3.7 |

# TABLE 4
# REVISED CUMULATIVE AMBIENT IMPACTS CAUSED BY REQUESTED PERMIT REVISIONS
# MICROSOFT OXFORD DATA CENTER
# QUINCY, WASHINGTON

| Pollutant and Averaging Time | Emission Rates for Jan-2014 Application: Emission Rate (includes 3x factor for annual values) | Emission Rate Units | Ambient Impacts ($\mu g/m^3$): Oxford Increment (Includes 3x factor for annual average values) | Regional and Local Background (Inc. cooling towers) | Total Ambient Impact | NAAQS or ASIL |
|---|---|---|---|---|---|---|
| $PM_{10}$ | | | | | | |
| 24-hr during facility-wide outage | 355.1 | lbs/day | 24 | 89 | 113 | 150 |
| $PM_{2.5}$ | | | | | | |
| **1st-high** 24-hr during electrical bypass | 65.8 | lbs/day | 12.7 | 21.71 | 34 | 35 |
| Theoretical maximum annual (a) | 2.175 | tons/yr | 0.325 | 6.75 | 7.1 | 12 |
| Carbon Monoxide | | | | | | |
| 1-hr during facility-wide outage | 96.5 | lbs/hr | 459 | 842 | 1,301 | 40,000 |
| 8-hr during facility-wide outage | 96.5 | lbs/hr | 226 | 482 | 708 | 10,000 |
| Nitrogen Dioxide | | | | | | |
| 1-hr NAAQS, **1st-highest** during electrical bypass | 42 | lbs/hr | 172 | 16 | 188 | 188 |
| $NO_2$ ASIL, 1st-highest 1-hr during facility-wide outage | 390 | lbs/hr | 433 | 1-hr $NO_2$ ASIL = 470 | | |
| Theoretical maximum annual (a) | 81.06 | tons/yr | 12.1 | 2.8 | 14.9 | 100 |
| Theoretical maximum annual DEEP (a) | 2.175 | tons/yr | 0.325 | Annual DEEP ASIL = 0.0033 | | |
| Ammonia 24-hr at MIBR (ultra-worst case) | 516 | lbs/day | 35 | Ammonia 24-hr ASIL = 70.8 | | |
| Acrolein 24-hr at MIBR (ultra-worst case) | 0.016 | lbs/day | 0.0011 | Acrolein 24-hr ASIL = 0.06 | | |
| Theoretical maximum annual Benzene (a) | 8.64E-03 | tons/yr | 0.0013 | Annual DEEP ASIL = 0.0033 | | |

(a) Theoretical maximum annual calculations assume the allowable emissions over the 3-year rolling period occur in 1 year.

# TABLE 5
# REVISED CUMULATIVE DEEP CANCER RISK CAUSED BY REQUESTED PERMIT REVISIONS
# MICROSOFT OXFORD DATA CENTER
# QUINCY, WASHINGTON

| Attributable To | Total PM (Front half plus back half): 70-Year Average Risk Per Million From DEEP Exposure at Various Receptor Locations | | | | | |
|---|---|---|---|---|---|---|
| | **Maximally Impacted Boundary Receptor (MIBR)** | **R-1 North Residence (MIRR)** | **C-1 Industrial Building (MICR)** | **I-1 Quincy Valley School** | **I-2 Quincy Valley Medical Center** | **R-2 Maximally Impacted House in Modeling Domain** |
| Project Oxford Generators (Total PM, front half plus back half) | 0.77 | 5.6 | 1.4 | 0.04 | 0.013 | 1.8 |
| Other Local Sources (Highways, railroads, data centers) | 0.23 | 6.2 | 5.0 | 0.28 | 0.57 | 43.4 |
| Cumulative (post-project) | 1.0 | 11.8 | 6.4 | 0.32 | 0.6 | 45 |

ATTACHMENT C-1

# Screenshots of January 2015 Revised Emission Calculation Spreadsheets

**TABLE 1 (Corrected 1-13-15 for black puff factors)**
**REVISED CATERPILLAR LOAD-SPECIFIC EMISSION RATES FOR DIESEL GENERATORS**
**MICROSOFT OXFORD DATA CENTER**

| Pollutant | Condition | lbs/hour at 100% Load | lbs/hour; Maximum Between 10%-75% Loads | lbs/hour at 10% Load |
|---|---|---|---|---|
| 2.5 MWe 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 MWe 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 kWe 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 |

Yellow-highlighted cells indicate worst-case load-specific values used for emission calculations and ambient air quality impact modeling.

See Appendix D for Caterpillar's raw data for generator emission estimates. See Tables C1-1 through C1-3 in Attachment C-1 for details on the basis for deriving these emission estimates.

Green-shaded cells were revised 1-13-2015 to account for black puff factors on the cold-start emission factors

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended  Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

## 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% | 75% | 50% | 25% | 10% |
| Exhaust Temperature | C | 491 | 459 | 455 | 444 | 342 |
| | | | | | | |
| TOTAL NOX (AS NO2) | LB/HR | 50.59 | 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 | 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 | 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 | 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** |

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomend

## 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** |

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended  Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

## 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** |

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended  Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

## Table C1-4 (Corrected 1-13-2015 to account for CO and VOC black puff cold start factors)

## 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)

## Max-Year; Cat-Recommended Emision Rates; Cherry-Picked Max 10%-100%; 1 Genset Tested Max Year Years (45 Hours testing)

| | | | | No. of events per year | | | | | | | | | Duration of each event (hrs) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gen # | Load Condition | Elec Load | Total No. Gens | W | M | S | Correct Tests | Outage | Cool | Elec Bypass | Initial Comm | Stack Test | 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 | | | | | | | 0.250 | 0.250 | 0.250 | | | | | |
| | Warmed up | | 32 | | 10 | 2 | 4 | | | | 0 | 1 | | 0.111 | 0.195 | 0.528 | | | | 0.14 | 0.2810 |
| | Cold start | | 32 | | | | | 3 | | 1 | | | | | | | 0.250 | | 0.250 | | |
| | Warmed up | | 32 | | 10 | 2 | 4 | 3 | | 1 | 0 | 1 | | 0.194 | 0.278 | 0.61 | 7.75 | | 15.75 | 0.43 | 0.84 |
| | Cold start | | 32 | 52 | | | | | | | | | 0.25 | | | | | | | | |
| | Warmed up | | 32 | 52 | 10 | 2 | 4 | | 18 | | 0 | 1 | 0.25 | 0.194 | 0.278 | 0.61 | | 0.167 | | 0.14 | 0.2810 |
| 2500 kWe; 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 | | | | | | | 0.250 | 0.250 | 0.250 | | | | | |
| | Warmed up | | 4 | | 10 | 2 | 4 | | | | 0 | 0 | | 0.111 | 0.195 | 0.528 | | | | 0.14 | |
| | Cold start | | 4 | | | | | 3 | | 1 | | | | | | | 0.250 | | 0.250 | | |
| | Warmed up | | 4 | | 10 | 2 | 4 | 3 | | 1 | 0 | 0 | | 0.194 | 0.278 | 0.61 | 7.75 | | 15.75 | 0.43 | |
| | Cold start | | 4 | 52 | | | | | | | | | 0.25 | | | | | | | | |
| | Warmed up | | 4 | 52 | 10 | 2 | 4 | | 18 | | 0 | 0 | 0.25 | 0.194 | 0.278 | 0.61 | | 0.167 | | 0.14 | |
| 2500 kWe; 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 | | | | | | | 0.250 | 0.250 | 0.250 | | | | | |
| | Warmed up | | 1 | | 10 | 2 | 4 | | | | 0 | 0 | | 0.111 | 0.195 | 0.528 | | | | 0.14 | |
| | Cold start | | 1 | | | | | 3 | | 1 | | | | | | | 0.250 | | 0.250 | | |
| | Warmed up | | 1 | | 10 | 2 | 4 | 3 | | 1 | 0 | 0 | | 0.194 | 0.278 | 0.61 | 7.75 | | 15.75 | 0.43 | |
| | Cold start | | 1 | 52 | | | | | | | | | 0.25 | | | | | | | | |
| | Warmed up | | 1 | 52 | 10 | 2 | 4 | | 18 | | 0 | 0 | 0.25 | 0.194 | 0.278 | 0.61 | | 0.167 | | 0.14 | |

| | | 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 (32 gens) | Cold start | 0 | 2.50 | 0.50 | 1.00 | 0 | 0 | | 0.00 | 0.00 | 4.00 |
| | Warmed up | 0 | 1.11 | 0.39 | 2.11 | 0 | 0 | | 0.000 | 0.2810 | 3.90 |
| | Cold start | 0 | 0 | 0 | 0 | 0.75 | 0 | 0.25 | 0.00 | 0.00 | 1.00 |
| | Warmed up | 0 | 1.94 | 0.56 | 2.44 | 23.25 | 0 | 15.75 | 0.000 | 0.844 | 44.79 |
| | Cold start | 13.00 | 0 | 0 | 0 | 0 | 0 | | 0.00 | 0.00 | 13.00 |
| | Warmed up | 13.00 | 1.94 | 0.56 | 2.44 | 0 | 3.01 | | 0.000 | 0.2810 | 21.23 |
| 2500 kWe (4 gens) | Cold start | 0 | 2.50 | 0.50 | 1.00 | 0 | 0 | | 0.00 | 0.00 | 4.00 |
| | Warmed up | 0 | 1.11 | 0.39 | 2.11 | 0 | 0 | | 0.000 | 0.00 | 3.62 |
| | Cold start | 0 | 0 | 0 | 0 | 0.75 | 0 | 0.25 | 0.00 | 0.00 | 1.00 |
| | Warmed up | 0 | 1.94 | 0.56 | 2.44 | 23.25 | 0 | 15.75 | 0.000 | 0.00 | 43.94 |
| | Cold start | 13.00 | 0 | 0 | 0 | 0 | 0 | | 0.00 | 0.00 | 13.00 |
| | Warmed up | 13.00 | 1.94 | 0.56 | 2.44 | 0 | 3.01 | | 0.000 | 0.00 | 20.95 |
| 2500 kWe (1 gen) | Cold start | 0 | 2.50 | 0.50 | 1.00 | 0 | 0 | | 0.00 | 0.00 | 4.00 |
| | Warmed up | 0 | 1.11 | 0.39 | 2.11 | 0 | 0 | | 0.000 | 0.00 | 3.62 |
| | Cold start | 0 | 0 | 0 | 0 | 0.75 | 0 | 0.25 | 0.00 | 0.00 | 1.00 |
| | Warmed up | 0 | 1.94 | 0.56 | 2.44 | 23.25 | 0 | 15.75 | 0.000 | 0.00 | 43.94 |
| | Cold start | 13.00 | 0 | 0 | 0 | 0 | 0 | | 0.00 | 0.00 | 13.00 |
| | Warmed up | 13.00 | 1.94 | 0.56 | 2.44 | 0 | 3.00 | | 0.000 | 0.00 | 20.94 |

| | | 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 (32 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 | 21,693 | 0.401 | 0.025 | 9.11 | 35.49 | 0.018 | 0.57 | 1.44 | 5.61 | 0.003 | 0.09 | 0.350 | 1.36 | 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 | 249,374 | 0.401 | 0.29 | 9.11 | 408.01 | 0.204 | 6.53 | 1.44 | 64.49 | 0.032 | 1.03 | 0.350 | 15.68 | 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 | 118,209 | 0.401 | 0.136 | 9.11 | 193.41 | 0.097 | 3.09 | 1.44 | 30.57 | 0.015 | 0.49 | 0.350 | 7.43 | 0.004 | 0.119 |
| 2500 kWe (4 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 |
| 2500 kWe (1 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 |
| | | | 541,888 | | | | | | | | | | | | | | |

| Jan-2015 Corrections to Cold Start for CO and VOC | | | | | |
|---|---|---|---|---|---|
| Corrected CO Cold Start | | | Corrected VOC Cold Start | | |
| 6.01 | 1.56 | 9.38 | 0.96 | 1.26 | 1.21 |
| 3.95 | 1.56 | 6.16 | 0.98 | 1.26 | 1.23 |
| 1.22 | 1.56 | 1.90 | 0.22 | 1.26 | 0.28 |

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

Max Stack testing = 1 gen x 45 hrs / 32 gens = 1.41 hrs/gen. Distributed: 0.281 at 100%; 0.844 at range of 12-82%; 0..281 at 10%.

Commissioning: none assumed for Max Year

For Monthly, Sem-annual, and Corrective Tests, the runtime hours were distributed evenly between 100%, 10%, and 12-82%

52 18

40 15

| | PM | NOx | CO | VOC |
|---|---|---|---|---|
| Total Facility-Wide TPY | 0.725 | 27.020 | 4.696 | 0.839 |
| Facility-Wide Minus Stack Testing TPY | 0.708 | 25.6 | 3.47 | 0.73 |
| Existing Permit | 0.536 | 8.60 | 15.60 | 0.80 |
| Net Increase | 35% | 214% | -70% | 5% |

87.91

Hrs/yr/gen routine annual excluding commissioning and stack testing 86.51

| | |
|---|---|
| Cold-Start Hours | 15.00 |
| Total Runtime | 87.91 |
| Percentage Cold-Start | 17% |

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

1/30/2015, 8:32 AM

## Table C1-5 (Corrected 1-13-15 for CO black puff factor)
## ASIL AND NAAQS IMPLICATIONS OF PROVIDING FLEXIBILITY AT "10-100%" LOAD; ULTRA-WORST CASE
## Microsoft Oxford Data Center
## Quincy, Washington

**B. 1-HOUR NO2-ASIL DURING POWER OUTAGE (Ultra-Worst Max 100%)**

Original June-2014 Application NOx-NO2 ASIL During Facility-Wide Power Outage at 80% Load

| Gen Size | Engine Temp | No. of Gens | Lbs/hour | Duration, hours | Subtotal Emissions | Emission Units |
|---|---|---|---|---|---|---|
| 2.5 Mwe | Cold Start | 32 | 40.95 | 0.167 | 218.8 | lbs/hr |
| | Warmed Up | 32 | 3.37 | 0.833 | 89.8 | lbs/hr |
| 2.0 Mwe | Cold Start | 4 | 26.4 | 0.167 | 17.6 | lbs/hr |
| | Warmed Up | 4 | 2.6 | 0.833 | 8.7 | lbs/hr |
| 750 kWe | Cold Start | 1 | 22.39 | 0.167 | 3.7 | lbs/hr |
| | Warmed Up | 1 | 1.8 | 0.833 | 1.5 | lbs/hr |
| Facility-Wide Emissions | | | | | 340.2 | lbs/hr |

Cherry-Picked NOx-NO2 ASIL During Facility-Wide Power Outage at 80-100% Loads

| Gen Size | Engine Temp | No. of Gens | Lbs/hour | Duration, hours | Subtotal Emissions | Emission Units | |
|---|---|---|---|---|---|---|---|
| 2.5 Mwe @ 100% | Cold Start | 3 | 50.6 | 0.167 | 25.4 | lbs/hr | |
| | Warmed Up | 3 | 9.1 | 0.833 | 22.7 | lbs/hr | |
| 2.5 Mwe @85% | Cold Start | 29 | 38.9 | 0.167 | 188.4 | lbs/hr | |
| | Warmed Up | 29 | 5.2 | 0.833 | 125.6 | lbs/hr | |
| 2.0 Mwe @ 85% | Cold Start | 4 | 25.6 | 0.167 | 17.1 | lbs/hr | |
| | Warmed Up | 4 | 2 | 0.833 | 6.7 | lbs/hr | |
| 750 kWe @ 80% | Cold Start | 1 | 15.8 | 0.167 | 2.6 | lbs/hr | |
| | Warmed Up | 1 | 1.33 | 0.833 | 1.1 | lbs/hr | |
| Facility-Wide Emissions | | | | | 389.6 | lbs/hr | 422 lbs/hr is the PSEL to just meet the ASIL |

| | | |
|---|---|---|
| Net Increase in Facility-Wide NOx During Outage | 14.52% | |
| Original NO2-ASIL Result, ug/m3 | 388 | |
| Revised "Cherry Picked" ASIL Result, ug/m3 | 468 | This new result is designed to just meet the ASIL |
| NO2 ASIL, ug/m3 | 470 | |

**C. 1-HOUR NO2-NAAQS (4-GEN ELECTRICAL BYPASS) (Cherry-Picked Max 100%)**

Original Jun-2014 Application, NOx-NO2 NAAQS During 4-Gen Electrical Bypass Transformer Maintenance at 80% Load

| Gen Size | Engine Temp | No. of Gens | Lbs/hour | Duration, hours | Subtotal Emissions | Emission Units |
|---|---|---|---|---|---|---|
| 2.5 Mwe @ 80% | Cold Start | 4 | 40.95 | 0.167 | 27.4 | lbs/hr |
| | Warmed Up | 4 | 3.37 | 0.833 | 11.2 | lbs/hr |
| Facility-Wide Emissions | | | | | 38.6 | lbs/hr |

Jun-2014 AERMOD NO2 increment at 38.6 lbs/hr NOx = 160 ug/m3
Allowable NO2 increment to just meet NAAQS = 172 ug/m3
Allowable Plant Site Emission Limit (PSEL) to just meet NAAQS = 38.6 lbs/hr x (172/160) = 42 lbs/hr NOx during 4-generator bypass

Cherry-Picked NOx-NO2 ASIL During 4-Gen Electrical Bypass at 85%-95% Load

| Gen Size | Engine Temp | No. of Gens | Lbs/hour | Duration, hours | Subtotal Emissions | Emission Units | |
|---|---|---|---|---|---|---|---|
| | Cold Start | 1 | 46.8 | 0.1667 | 7.8 | lbs/hr | 10-minute SCR delay at 85% load? |
| | Warmed Up | 1 | 7.5 | 0.8333 | 6.3 | lbs/hr | |
| 2.5 Mwe @ 95% | Warmed Up | 2 | 7.5 | 1 | 15.0 | lbs/hr | |
| 2.5 Mwe @ 85% | Warmed Up | 2 | 5.2 | 1 | 10.4 | lbs/hr | |
| Facility-Wide Emissions | | | | | 39.5 | lbs/hr | PSEL Emission < 42 lbs/hr will just meet the NAAQS |

Conclusion: Only 3 of the 4 generators can be run at > 85% load during electrical bypass, to keep the NOx emissions below the PSEL of 42 lbs/hr.

**D. 24-HOUR PM2.5 NAAQS (4-GEN ELECTRICAL BYPASS) (Cherry-Picked Maximum 10-75%; max = 10%)**

Original June-2014 PM2.5 NAAQS During 4-Gen Electrical Bypass Transformer Maintenance at 80% Load

| Gen Size | Engine Temp | No. of Gens | Lbs/hour | Duration, hours | Subtotal Emissions | Emission Units |
|---|---|---|---|---|---|---|
| 2.5 Mwe | Cold Start | 4 | 0.42 | 0.25 | 0.4 | lbs/day |
| | Warmed Up | 4 | 0.29 | 23.75 | 27.6 | lbs/day |
| Facility-Wide Emissions | | | | | 28.0 | lbs/day |

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 | | |
|---|---|---|---|---|---|---|---|---|
| 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 | | |
| Facility-Wide Emissions | | | | | 38.7 | lbs/day | 9.68 | lbs/gen/day |

**<u>Calculate allowable PM2.5 emission rate to just satisfy the 35 ug/m3 PM2.5-NAAQS</u>**

| | | |
|---|---|---|
| NAAQS minus 1 ug/m3 buffer | 34.0 | ug/m3 |
| Minus regional background | 21.0 | |
| <u>Minus "local background" (Oxford cooling towers + Dell + CDC)</u> | <u>0.71</u> | |
| Allowable PM2.5 increment caused solely by Oxford | 12.3 | ug/m3 |
| 1st-high 24-hr dispersion factor | 0.187 | (ug/m3)/(facility lbs/day) |
| Allowable facility-wide PM2.5 emission rate | 65.7 | facility lbs/day |

Target PM2.5 Rate to Meet 34 ug/m3 NAAQS (69.5 lbs/day): 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 | | |
|---|---|---|---|---|---|---|---|---|
| 2.5 Mwe | Cold Start | 6.8 | 0.635 | 0.25 | 1.1 | lbs/day | | |
| | Warmed Up | 6.8 | 0.401 | 23.75 | 64.8 | lbs/day | | |
| Facility-Wide Emissions | | | | | 65.8 | lbs/day | 9.68 | lbs/gen/day |

Daily generator usage limit = 6.8 gens x 24 hours/day = 163 gen-hours runtime per calendar day.

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

**E. 1-HOUR CO-NAAQS DURING POWER OUTAGE (Ultra-Worst Case 100%)**

Original June-2014 Application CO-NAAQS During Facility-Wide Power Outage at 80% Load

| Gen Size | Engine Temp | No. of Gens | Lbs/hour | Duration, hours | Subtotal Emissions | Emission Units |
|---|---|---|---|---|---|---|
| 2.5 Mwe | Cold Start | 32 | 23.4 | 0.167 | 125.0 | lbs/hr |
| | Warmed Up | 32 | 15.04 | 0.833 | 400.9 | lbs/hr |
| 2.0 Mwe | Cold Start | 4 | 15.7 | 0.167 | 10.5 | lbs/hr |
| | Warmed Up | 4 | 10.12 | 0.833 | 33.7 | lbs/hr |
| 750 kWe | Cold Start | 1 | 5.8 | 0.167 | 1.0 | lbs/hr |
| | Warmed Up | 1 | 1.5 | 0.833 | 1.2 | lbs/hr |
| Facility-Wide Emissions | | | | | 572.4 | lbs/hr |

Cherry-Picked 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 |
|---|---|---|---|---|---|---|
| 2.5 Mwe | Cold Start | 32 | 9.38 | 0.167 | 50.1 | lbs/hr |
| | Warmed Up | 32 | 1.44 | 0.833 | 38.4 | lbs/hr |
| 2.0 Mwe | Cold Start | 4 | 6.16 | 0.167 | 4.1 | lbs/hr |
| | Warmed Up | 4 | 0.95 | 0.833 | 3.2 | lbs/hr |
| 750 kWe | Cold Start | 1 | 1.9 | 0.167 | 0.3 | lbs/hr |
| | Warmed Up | 1 | 0.44 | 0.833 | 0.4 | lbs/hr |
| Facility-Wide Emissions | | | | | 96.5 | lbs/hr |

**F. 24-hr PM10-NAAQS DURING 24-HOUR POWER OUTAGE (Ultra-Worst Case 10%)**

Original June-2014 Application PM10-NAAQSL During Facility-Wide Power Outage at 80% Load

| Gen Size | Engine Temp | No. of Gens | Lbs/hour | Duration, hours | Subtotal Emissions | Emission Units |
|---|---|---|---|---|---|---|
| 2.5 Mwe | Cold Start | 32 | 0.362 | 0.167 | 1.9 | lbs/day |
| | Warmed Up | 32 | 0.288 | 23.833 | 219.6 | lbs/day |
| 2.0 Mwe | Cold Start | 4 | 0.265 | 0.167 | 0.2 | lbs/day |
| | Warmed Up | 4 | 0.21 | 23.833 | 20.0 | lbs/day |
| 750 kWe | Cold Start | 1 | 0.164 | 0.167 | 0.0 | lbs/day |
| | Warmed Up | 1 | 0.098 | 23.833 | 2.3 | lbs/day |
| Facility-Wide Emissions | | | | | 244.1 | lbs/day |

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 |
|---|---|---|---|---|---|---|
| 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 |
| 2.0 Mwe | Cold Start | 4 | 0.661 | 0.25 | 0.7 | lbs/day |
| | Warmed Up | 4 | 0.434 | 23.75 | 41.2 | lbs/day |
| 750 kWe | Cold Start | 1 | 0.608 | 0.25 | 0.2 | lbs/day |
| | Warmed Up | 1 | 0.136 | 23.75 | 3.2 | lbs/day |
| Facility-Wide Emissions | | | | | 355.1 | lbs/day |

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

## Table C1-6 (Corrected 1-13-15 for CO black puff factor)
## Net Increases in Emission Rates and AERMOD Scale Factors

| Pollutant and Averaging Period | Operating Scenario | Calculated Emission Rates | | | Relative Emission Fraction |
|---|---|---|---|---|---|
| | | June-2014 Application | Dec-2015 Revised Application | Units | |
| Max-Year Annual DEEP | Maximum Year including all operations | 0.536 | 0.73 | tons/yr | 136% |
| Max-Year Annual NOx | Maximum Year including all operations | 8.61 | 27.4 | tons/yr | 318% |
| 1-hr NO2 ASIL | 1-hr facility-wide power outage | 340.2 | 390 | lbs/hr | 115% |
| 98th-percentile 1-hr NO2 NAAQS | 4-generator electrical bypass | 38.6 | 39.4 | lbs/hr | 102% |
| 98th-percentile 24-hr PM2.5 NAAQS | 4-generator electrical bypass | 27.9 | 38.7 | lbs/day | 139% |
| 2nd-highest 24-hr PM10 | 24-hr facility-wide power outage | 244 | 355 | lbs/day | 145% |
| 2nd-high 1-hr CO | 1-hr facility-wide power outage | 572 | 96.5 | lbs/hr | 17% |

URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended  Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

## Table 7 - Ammonia and Acrolein Emission Estimate

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 | | | | |
| 2.0 Mwe gens | 4 | 100% | 138 | 13,248 | | | | |
| 750 kWe gen | 1 | 100% | 53.6 | 1,286 | | | | |
| Facility-Wide fuel usage, gal/day | | | | 147,782 | | | | |
| Distillate heat content, BTU/gal | | | | 135,000 | | | | |
| Facility-Wide Heat Input, MMBtu/day | | | | 19,951 | | | | |
| Method 19 Fd, dscf/MMBtu at 68 F | | | | 9,190 | | | | |
| Facility-Wide Flue Gas, dscf/day at zero oxygen, 68 F | | | | 183,346,235 | | | 3,536.77 | 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 | | | | 649,480,729 | | | 12,528.56 | dscfm/genset |
| Estimated Flue Gas Temp (Manifold minus 200), deg F | | | | 715 | | | | |
| Facility-Wide Flue Gas, actual scf/day at 15% oxygen, Stack Temp | | | | 1,445,340,638 | | | 27,880.80 | 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 | | | | 1,685,788.17 | | | | |
| Allowable Ammonia Concentration, ppmv at 15% | | | | 15 | | | | |
| Ammonia lbmoles/day | | | | 25.29 | | | | |
| Ammonia molec wt, lbs/lbmol | | | | 17 | | | | |
| Facility-Wide Ammonia Emission Rate, lbs/day | | | | 430 | facility-wide lbs/day | | 516 | 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 | 19,951 |
| Ultra-worst case Acrolein emissions after 90% DOC, lbs/day | 0.016 |
| | |

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

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended  Emission Calculations 1-15-2015.xlsx]T5-Cherry P

## Table 8 - Microsoft Data Center AP-42 Toxic Air Pollutant Emissions

***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 | 6158 | Gal/HOUR |
| Max Daily Fuel Use | 147,782 | Gal/DAY |
| Annual Fuel usage | 541,888 | Gal/YEAR |
| Max Hourly Heat Input | 844 | mmBTU/HOUR |
| Max Daily Heat Input | 20,246 | mmBTU/DAY |
| Annual Heat Input | 74,239 | 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 | 1.29 | 31.0 | 0.057 |
| 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% | 6.55E-02 | 1.57E+00 | 2.88E-03 |
| Toluene | 2.81E-04 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 2.37E-02 | 5.69E-01 | 1.04E-03 |
| Xylenes | 1.93E-04 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 1.63E-02 | 3.91E-01 | 7.16E-04 |
| 1,3-Butadiene | 3.91E-05 | lbs/MMBTU | AP-42 Sec 3.3 | 90% | 3.30E-03 | 7.92E-02 | 1.45E-04 |
| Formaldehyde | 7.89E-05 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 6.66E-03 | 1.60E-01 | 2.93E-04 |
| Acetaldehyde | 2.52E-05 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 2.13E-03 | 5.10E-02 | 9.35E-05 |
| Acrolein | 7.88E-06 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 6.65E-04 | 1.60E-02 | 2.93E-05 |
| Benzo(a)Pyrene | 2.57E-07 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 2.17E-05 | 5.20E-04 | 9.54E-07 |
| Benzo(a)anthracene | 6.22E-07 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 5.25E-05 | 1.26E-03 | 2.31E-06 |
| Chrysene | 1.53E-06 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 1.29E-04 | 3.10E-03 | 5.68E-06 |
| Benzo(b)fluoranthene | 1.11E-06 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 9.36E-05 | 2.25E-03 | 4.12E-06 |
| Benzo(k)fluoranthene | 2.18E-07 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 1.84E-05 | 4.41E-04 | 8.09E-07 |
| Dibenz(a,h)anthracene | 3.46E-07 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 2.92E-05 | 7.01E-04 | 1.28E-06 |
| Ideno(1,2,3-cd)pyrene | 4.14E-07 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 3.49E-05 | 8.38E-04 | 1.54E-06 |
| Napthalene | 1.30E-04 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 1.10E-02 | 2.63E-01 | 4.83E-04 |
| Propylene | 2.79E-03 | lbs/MMBTU | AP-42 Sec 3.4 | 90% | 2.35E-01 | 5.65E+00 | 1.04E-02 |

| | |
|---|---|
| Carcinogenic VOC TAPs | 3.82E-03 |
| Non-Carcinogen VOC TAPs | 1.21E-02 |

Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

**Table 5**
**Facility-Wide Emission Rates for Toxic Air Pollutants**
**Microsoft Project Oxford Data Center, January-2015 Permit Revision Application Response**
**Quincy, Washington**

| Pollutant | CAS Number | SQER | | Facility Emissions | | SQER Ratio | SQER Exceeded? |
|---|---|---|---|---|---|---|---|
| PM2.5/DEEP (3x annual avg.) | None | 0.639 | lbs/yr | 4,349 | lbs/yr | 6,806 | **Yes** |
| CO | 630-08-0 | 50.2 | lbs/hour | 106.8 | lbs/hour | 2.1 | **Yes** |
| Ammonia | 7664-41-7 | 9.3 | lbs/day | 17 | lbs/day | 1.8 | **Yes** |
| SO2 | | 1.45 | lbs/hour | 1.3 | lbs/hour | 0.89 | No |
| NO2 | 10102-44-0 | 1.03 | lbs/hour | 61.5 | lbs/hour | 60 | **Yes** |
| Benzene (3x annual avg.) | 71-43-2 | 6.62 | lbs/yr | 17.28 | lbs/yr | 2.61 | **Yes** |
| Toluene | 108-88-3 | 657 | lbs/day | 0.569 | lbs/day | 0.00087 | No |
| Xylenes | 95-47-6 | 58 | lbs/day | 0.391 | lbs/day | 0.0067 | No |
| 1,3-Butadiene (3x annual avg.) | 106-99-0 | 1.13 | lbs/yr | 0.87 | lbs/yr | 0.77 | No |
| Formaldehyde (3x annual avg.) | 50-00-0 | 32 | lbs/yr | 1.76 | lbs/yr | 0.055 | No |
| Acetaldehyde (3x annual avg.) | 75-07-0 | 71 | lbs/yr | 0.56 | lbs/yr | 0.0079 | No |
| Acrolein | 107-02-8 | 0.00789 | lbs/day | 0.016 | lbs/day | 2.02 | **Yes** |
| Benzo(a)Pyrene (3x annual avg.) | 50-32-8 | 0.174 | lbs/yr | 5.7E-03 | lbs/yr | 0.0329 | No |
| Benzo(a)anthracene (3x annual avg.) | 56-55-3 | 1.74 | lbs/yr | 1.4E-02 | lbs/yr | 0.0080 | No |
| Chrysene (3x annual avg.) | 218-01-9 | 17.4 | lbs/yr | 3.4E-02 | lbs/yr | 0.00196 | No |
| Benzo(b)fluoranthene (3x annual avg.) | 205-99-2 | 1.74 | lbs/yr | 2.5E-02 | lbs/yr | 0.0142 | No |
| Benzo(k)fluoranthene (3x annual avg.) | 207-08-9 | 1.74 | lbs/yr | 4.9E-03 | lbs/yr | 0.00279 | No |
| Dibenz(a,h)anthracene (3x annual avg.) | 53-70-3 | 0.16 | lbs/yr | 7.7E-03 | lbs/yr | 0.048 | No |
| Ideno(1,2,3-cd)pyrene (3x annual avg.) | 193-39-5 | 1.74 | lbs/yr | 9.2E-03 | lbs/yr | 0.0053 | No |
| Napthalene (3x annual avg.) | 91-20-3 | 5.64 | lbs/yr | 2.90 | lbs/yr | 0.51 | No |
| Propylene | 115-07-1 | 394 | lbs/yr | 5.65 | 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/1-hour | 3.5E-05 | lbs/1-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

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

## Table C1-9 (Corrected 1-13-2015 for CO black puff factor; 1-15-2015 for PM10 and PM2.5 Cold-Start Duration; 1-16-2015 for 3X Annual Avg.)

### AERMOD Disersion Factors and Ambient Impact Assessment for Project Oxford Data Center Permit Revision Application

### Quincy, Washington

| | | AERMOD Dispersion Factor (Jan-2014 and Nov-2104 Model Runs) | | | | | | Emission Rates for Jan-2014 Application | | Ambient Impacts, ug/m3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pollutant and Averaging Time | Emission Rate Units | AERMOD File | AERMOD ug/m3 | Emission Rate | Disp. Factor | Units | Modeled Stack Conditions | Emission Rate (includes 3x factor for annual values) | Emission Rate Units | Oxford Increment (Includes 3x factor for annual average values) | Regional and Local Background (Inc. cooling towers) | Total Ambient Impact | NAAQS or ASIL |
| PM10 | | | | | | | | | | | | | |
| 24-hr during facility-wide outage | lbs/day facility-wide | Nov-2014: PM10-111314d | 22.93 | 339.6 | 0.0675 | (ug/m3)/(lbs/day) | 12% load temp. and flow | 355.1 | lbs/day | 24 | 89 | 113 | 150 |
| PM2.5 | | | | | | | | | | | | | |
| 1st-high 24-hr during electrical bypass | lbs/day, 4 generators | Nov 2014: PM25-111314a-c | 6.92 | 37.0 | 0.187 | (ug/m3)/(lbs/day) | 12% load temp. and flow; 4 gens closest to NE property corner | 65.8 | lbs/day | 12.3 | 21.71 | 34.0 | 35 |
| **Theoretical maximum annual (1)** | **facility-wide annual, 3x the annual average to account for 3-year rolling** | | 0.077 | 0.516 | 0.149 | (ug/m3)/(tpy) | 12% load temp. and flow | 2.175 | tons/yr | 0.325 | 6.75 | 7.1 | **12** |
| Carbon Monoxide | | | | | | | | | | | | | |
| 1-hr during facility-wide outage | lbs/hr facility-wide | Nov 2014: CO-111314e | 67 | 14.1 | 4.75 | (ug/m3)/(lbs/hr) | 12% load temp. and flow | 96.5 | lbs/hr | 459 | 842 | 1,301 | 40,000 |
| 8-hr during facility-wide outage | lbs/hr facility-wide | Nov 2014: CO-111314e | 33 | 14.1 | 2.34 | (ug/m3)/(lbs/hr) | 12% load temp. and flow | 96.5 | lbs/hr | 226 | 482 | 708 | 10,000 |
| Nitrogen Dioxide | | | | | | | | | | | | | |
| 1-hr NAAQS, 1st-highest during electrical bypass | lbs/hr, 4 generators | | 160 | 39 | 4.10 | (ug/m3)/(lbs/hr) | 80% load temp. and flow; 4 gens closest to NE property corner | 42 | lbs/hr | 172 | 16 | 188 | 188 |
| NO2 ASIL, 1st-highest 1-hr during facility-wide outage | lbs/hr facility-wide | | 366 | 330 | 1.109 | (ug/m3)/(lbs/hr) | 80% load temp. and flow | 390 | lbs/hr | 433 | 1-hr NO2 ASIL = 470 | | |
| **Theoretical maximum annual (1)** | **facility-wide annual, 3x the annual average to account for 3-year rolling** | | 0.077 | 0.516 | 0.149 | (ug/m3)/(tpy) | Same as annual DEEP. 12% load temp. and flow | 81.06 | tons/yr | 12.1 | 2.8 | 14.9 | 100 |
| **Theoretical maximum annual DEEP at MIBR (1)** | **facility-wide annual, 3x the annual average to account for 3-year rolling** | | 0.077 | 0.516 | 0.149 | (ug/m3)/(tpy) | 12% load temp. and flow | 2.175 | tons/yr | 0.325 | Annual DEEP ASIL = 0.0033 | | |
| Ammonia 24-hr at MIBR (ultra-worst case) | lbs/day facility-wide | Nov-2014: PM10-111314d | 22.93 | 339.6 | 0.0675 | (ug/m3)/(lbs/day) | 12% load temp. and flow | 516 | lbs/day | 35 | Ammonia 24-hr ASIL = 70.8 | | |
| Acrolein 24-hr at MIBR (ultra-worst case) | lbs/day facility-wide | Nov-2014: PM10-111314d | 22.93 | 339.6 | 0.0675 | (ug/m3)/(lbs/day) | 12% load temp. and flow | 0.016 | lbs/day | 0.0011 | Acrolein 24-hr ASIL = 0.06 | | |
| **Theoretical maximum annual Benzene at MIBR (1)** | **facility-wide annual, 3x the annual average to account for 3-year rolling** | | 0.077 | 0.516 | 0.149 | (ug/m3)/(tpy) | Same as DEEP: 12% load temp. and flow | 8.64E-03 | tons/yr | 0.0013 | Annual DEEP ASIL = 0.0033 | | |

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

P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended  Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS AS

**C-3 Table 1** **High-Load NOx PSEL Options**

***Allowable Gens During 4-Building Electrical Bypass Maintenance (Non-Emergency PSEL = 41 lbs/hr)***

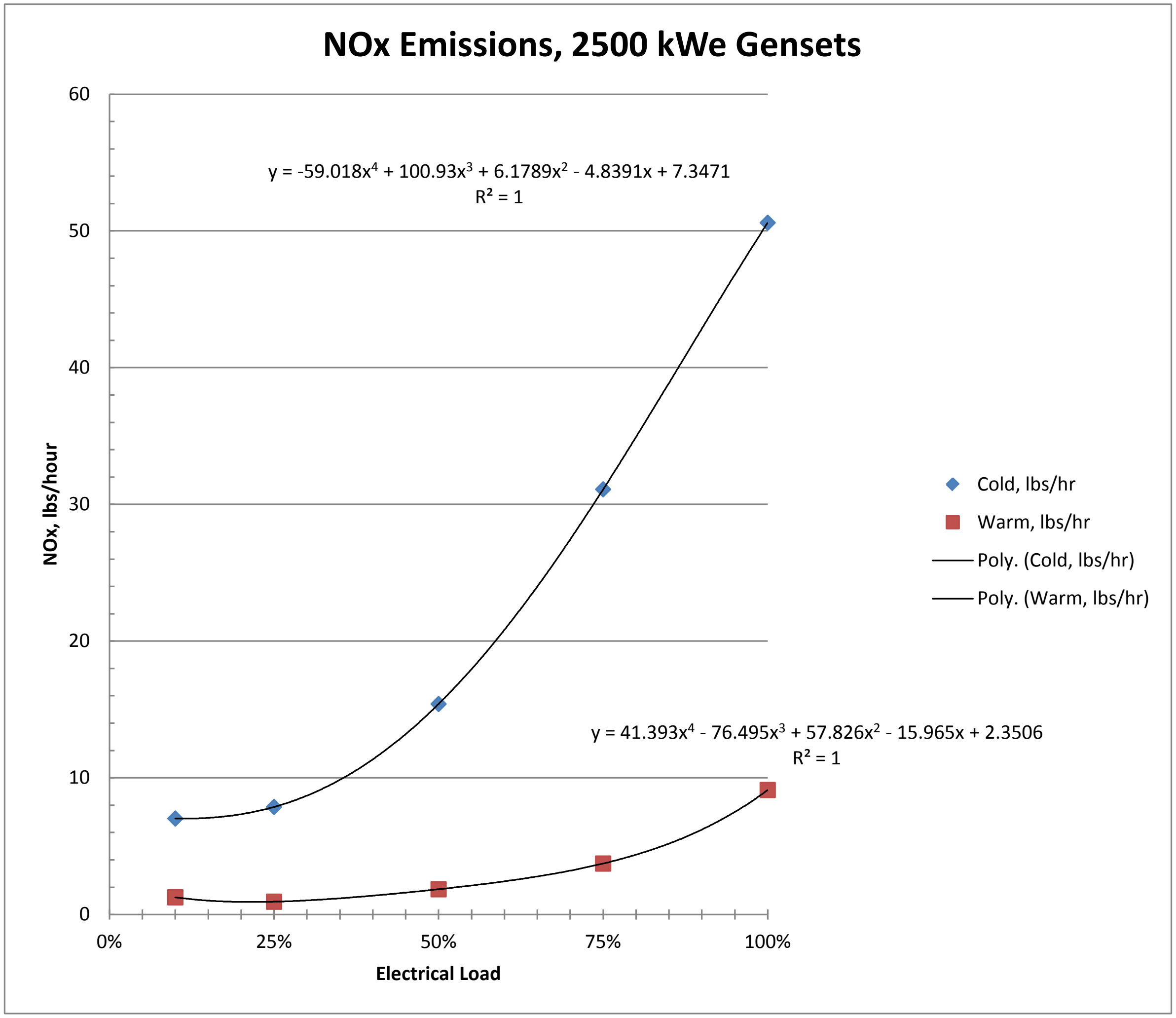
| Gen Load | Gen Size | No. Gens | Condition | Minutes | kWe-hrs Generated | Each Gen NOx, lbs/hr | Facility-Wide NOx, lbs/hr | Target lbs/hr 1st high = 41.1 6th high= 42.4 | Ratio | Allowable No. Gens | Allowable kWe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80% | 2500 | 1 | Cold | 10 | 333 | 34.9 | 5.8 | | | | |
| 80% | 2500 | 1 | Warm | 50 | 1,667 | 4.4 | 3.7 | | | | |
| 80% | 2500 | 8 | Warm | 50 | 13,333 | 4.4 | 29.3 | | | | |
| Facility-Wide | | | | | 15,333 | | 38.8 | 41.1 | 0.94444 | 9.5 | 16,235 |
| | | | | | | | | | | | |
| 85% | 2500 | 1 | Cold | 10 | 354 | 38.9 | 6.5 | | | | |
| 85% | 2500 | 1 | Warm | 50 | 1,771 | 5.2 | 4.3 | | | | |
| 85% | 2500 | 7 | Warm | 50 | 12,396 | 5.2 | 30.3 | | | | |
| Facility-Wide | | | | | 14,521 | | 41.2 | 41.1 | 1.00122 | 8.0 | 14,503 |
| | | | | | | | | | | | |
| 90% | 2500 | 1 | Cold | 10 | 375 | 42.9 | 7.2 | | | | |
| 90% | 2500 | 1 | Warm | 50 | 1,875 | 6.2 | 5.2 | | | | |
| 90% | 2500 | 5 | Warm | 50 | 9,375 | 6.2 | 25.8 | | | | |
| Facility-Wide | | | | | 11,625 | | 38.2 | 41.1 | 0.92822 | 6.5 | 12,524 |
| | | | | | | | | | | | |
| 95% | 2500 | 1 | Cold | 10 | 396 | 46.8 | 7.8 | | | | |
| 95% | 2500 | 1 | Warm | 50 | 1,979 | 7.5 | 6.3 | | | | |
| 95% | 2500 | 4 | Warm | 50 | 7,917 | 7.5 | 25.0 | | | | |
| Facility-Wide | | | | | 10,292 | | 39.1 | 41.1 | 0.95012 | 5.3 | 10,832 |
| | | | | | | | | | | | |
| 100% | 2500 | 1 | Cold | 10 | 417 | 50.6 | 8.4 | | | | |
| 100% | 2500 | 1 | Warm | 50 | 2,083 | 9.1 | 7.6 | | | | |
| 100% | 2500 | 3 | Warm | 60 | 7,500 | 9.1 | 27.3 | | | | |
| Facility-Wide | | | | | 10,000 | | 43.3 | 41.1 | 1.05393 | 3.8 | 9,488 |

***Allowable Gens During Facility-Wide Power Outage (Emergency PSEL = 423 lbs/hr)***

| Gen Load | Gen Size | No. Gens | Condition | Minutes | kWe-hrs Generated | Each Gen NOx, lbs/hr | Facility-Wide NOx, lbs/hr | Target lbs/hr | Ratio | Allowable No. 2500 kWe Gens | Allowable kWe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| 75% | 2500 | 15 | Cold | 10 | 4,688 | 31.1 | 78 | | | | |
| 75% | 2500 | 15 | Warm | 50 | 23,438 | 3.73 | 47 | | | | |
| 100% | 2500 | 17 | Cold | 10 | 7,083 | 50.6 | 143 | | | | |
| 100% | 2500 | 17 | Warm | 50 | 35,417 | 9.1 | 129 | | | | |
| 75% | 2000 | 4 | Cold | 10 | 1,000 | 22.52 | 15 | | | | |
| 75% | 2000 | 4 | Warm | 50 | 5,000 | 1.89 | 6 | | | | |
| 75% | 750 | 1 | Cold | 10 | 94 | 15.8 | 3 | | | | |
| 75% | 750 | 1 | Warm | 50 | 469 | 1.33 | 1 | | | | |
| Facility-Wide | | | | | 77,188 | | 422 | 422 | 0.99932 | 32.0 | 77,240 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| 80% | 2500 | 18 | Cold | 10 | 6,000 | 34.9 | 105 | | | | |
| 80% | 2500 | 18 | Warm | 50 | 30,000 | 4.4 | 66 | | | | |
| 100% | 2500 | 14 | Cold | 10 | 5,833 | 50.6 | 118 | | | | |
| 100% | 2500 | 14 | Warm | 50 | 29,167 | 9.1 | 106 | | | | |
| 80% | 2000 | 4 | Cold | 10 | 1,067 | 25.6 | 17 | | | | |
| 80% | 2000 | 4 | Warm | 50 | 5,333 | 2 | 7 | | | | |
| 80% | 750 | 1 | Cold | 10 | 100 | 15.8 | 3 | | | | |
| 80% | 750 | 1 | Warm | 50 | 500 | 1.33 | 1 | | | | |
| Facility-Wide | | | | | 78,000 | | 422 | 422 | 1.00097 | 32.0 | 77,925 |
| | | | | | | | | | | | |
| 85% | 2500 | 26 | Cold | 10 | 9,208 | 38.9 | 169 | | | | |
| 85% | 2500 | 26 | Warm | 50 | 46,042 | 5.2 | 113 | | | | |
| 100% | 2500 | 6 | Cold | 10 | 2,500 | 50.6 | 51 | | | | |
| 100% | 2500 | 6 | Warm | 50 | 12,500 | 9.1 | 46 | | | | |
| 85% | 2000 | 4 | Cold | 10 | 1,133 | 9.1 | 6 | | | | |
| 85% | 2000 | 4 | Warm | 50 | 5,667 | 9.1 | 30 | | | | |
| 85% | 750 | 1 | Cold | 10 | 106 | 15.8 | 3 | | | | |
| 85% | 750 | 1 | Warm | 50 | 531 | 1.33 | 1 | | | | |
| Facility-Wide | | | | | 77,688 | | 417 | 422 | 0.98928 | 32.3 | 78,530 |
| | | | | | | | | | | | |
| 90% | 2500 | 32 | Cold | 10 | 12,000 | 42.9 | 229 | | | | |
| 90% | 2500 | 32 | Warm | 50 | 60,000 | 6.2 | 165 | | | | |
| 100% | 2500 | 0 | Cold | 10 | - | 50.6 | 0 | | | | |
| 100% | 2500 | 0 | Warm | 50 | - | 9.1 | 0 | | | | |
| 90% | 2000 | 4 | Cold | 10 | 1,200 | 33.1 | 22 | | | | |
| 90% | 2000 | 4 | Warm | 50 | 6,000 | 2.4 | 8 | | | | |
| 90% | 750 | 1 | Cold | 10 | 113 | 15.8 | 3 | | | | |
| 90% | 750 | 1 | Warm | 50 | 563 | 1.33 | 1 | | | | |
| Facility-Wide | | | | | 79,875 | | 428 | 422 | 1.01408 | 31.6 | 78,766 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| 100% | 2500 | 32 | Cold | 10 | 13,333 | 50.6 | 270 | | | | |
| 100% | 2500 | 32 | Warm | 50 | 66,667 | 9.1 | 243 | | | | |
| 100% | 2000 | 4 | Cold | 10 | 1,333 | 42.1 | 28 | | | | |
| 100% | 2000 | 4 | Warm | 50 | 6,667 | 4.04 | 13 | | | | |
| 100% | 750 | 1 | Cold | 10 | 125 | 15.8 | 3 | | | | |
| 100% | 750 | 1 | Warm | 50 | 625 | 1.33 | 1 | | | | |
| Facility-Wide | | | | | 88,750 | | 558 | 422 | 1.32182 | 24.2 | 67,142 |

## 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 |
| 100% | 50.6 | 9.1 |




P:\1409\001\010\WIP\T\Emission Calcs\Preliminary Emissions Provided to Ecology & URS\[Revised-Corrected Cold-Start PM25-Cat-Stoel-Reccomended  Emission Calculations 1-15-2015.xlsx]T5-Cherry Pick NAAQS ASIL100%

APPENDIX D

# Caterpillar Emissions Data

## 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.*