DRAFT TECHNICAL SUPPORT DOCUMENT
FOR PRELIMINARY DETERMINATION OF APPROVAL ORDER NO. 15AQ-E609
MICROSOFT OXFORD DATA CENTER

1. PROJECT DESCRIPTION

On December 11, 2014, Ecology received a Notice of Construction (NOC) application submittal from the Microsoft Corporation (Microsoft**)** requesting revisions to Approval Order 14AQ-E537 (dated August 15, 2014) for the Oxford Data Center located at Industrial Park #5, west of Road R NW at the end of Port Industrial Parkway in Quincy, WA. The following information comprises the legal description of the facility provided by the applicant:

LOTS 2, 3, 4, 5, AND TRACT A, AMENDED PORT DISTRICT INDUSTRIAL PARK NO. 6 BINDING SITE PLAN, ACCORDING TO THE BINDING SITE PLAN THEREOF FILED IN VOLUME 2 OF BINDING SITE PLANS, PAGES 64 AND 65, RECORDS OF GRANT COUNTY, WASHINGTON. FARM UNITS 216 AND 217, IRRIGATION BLOCK 73, OXFORD BASIN PROJECT, ACCORDING TO THE PLAT THEROF FILED NOVEMBER 29, 1951, RECORDS OF GRANT COUNTY, WASHINGTON. STARTING AT THE NORTHWEST CORNER OF SAID FARM UNIT 216, IRRIGATION BLOCK 73, THE TRUE POINT OF BEGINNING, THENCE 173 (feet) EAST ALONG THE NORTH LINE OF SAID FARM UNIT; THENCE 242 FEET SOUTH OF A LINE PERPENDICULAR TO THE NORTH LINE OF SAID FARM UNIT; THENCE WEST 173 FEET; THENCE NORTH 242 FEET TO THE TRUE POINT OF BEGINNING.

The NOC application was determined to be incomplete, and on January 7, 2015 Ecology issued an incompleteness letter to Microsoft. On February 2, 2015 Microsoft provided a revised NOC application to Ecology. Microsoft provided a revised Second-Tier Risk Analysis for Diesel Engine Exhaust, Particulate (DEEP) emissions to Ecology on February 20, 2015. The application was considered complete on March 17, 2015. Microsoft provided supplemental materials to Ecology on March 19, 2015 and April 20, 2015. Ecology has concluded that this project has satisfied all requirements of a second tier analysis. The previous Approval Order (14AQ-E537) is rescinded and replaced entirely with Approval Order (15AQ-E609).

Oxford 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 activity zone buildings designated AZ-3A, AZ-3B, AZ-3C, AZ-3D. Building construction for the Phase 1 generators and cooling towers began before the end of 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 completion of commissioning of the final generator for Phase 1. Project Oxford phases 1 & 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. Each cooling tower has four cells and four fans. Each of the eight activity zone building will have four cooling towers for a total of thirty two (32) SPX-Marley model MD5008PAF2 cooling towers. Each of the thirty two individual cooling towers has a design recirculation rate of 950 gallons per minute (gpm) and an air flow rate of 143,600 cubic feet per minute (cfm).

1.1 Potential to Emit for Criteria Pollutants and Toxic Air Pollutants (TAPS)

Table 1 contains potential to emit (PTE) estimates. Compared with the August 15, 2014 permit, some facility pollutant emission limits have increased, some have stayed the same, and emissions limits of one pollutant (carbon monoxide) have decreased by approximately 11 tons per year. In spite of changes to emission limits, the new permit still requires that each engine must be equipped with selective catalytic reduction (SCR) and catalyzed diesel particulate filter (DPF) air pollution controls to meet the emission requirements of EPA Tier 4 engines.

Table 1. Potential To Emit For Phases 1 & 2 (TPY)

Pollutant	**Emission Factor**	**Facility Potential to Emit**	**References**
Criteria Pollutants	**Units = g/kW-hr (except where noted)**	**(TPY)**	(a)
NO_x	(0.67) and Caterpillar based emission factors	27.0	(b),
VOC	(0.19) and Caterpillar based emission factors	0.84	(a),(b),(e)
CO	(3.5) and Caterpillar based emission factors	4.7	(b)
$PM_{2.5}$	(0.03) and Caterpillar based emission factors (See note j for cooling towers)	3.7	(b),(j)
PM_{10}	NA (See note j for cooling towers)	13.5	(f),(j)
SO_2	15 ppm	0.057	(c)
Lead	NA	Negligible	(d)
Ozone	NA	NA	(e)
Toxic Air Pollutants (TAPS)	**Units = lbs/MMBTU (except where noted)**		(a)
Primary NO_2	(0.67 g/Kw-hr) and Caterpillar based emission factors.	2.7	(b),(h)
Ammonia	15ppmv	1.03	(b),(g)
Diesel Engine Exhaust Particulate (DEEP)	(0.03 g/kW-hr) and Caterpillar based emission factors	0.73	(b)
Carbon monoxide	(3.5 g/kW-hr) and Caterpillar based emission factors	4.7	(b)
Sulfur dioxide	15 ppm	0.057	(c)
Benzene	7.76E-04	2.9E-03	(i)
Toluene	2.81E-04	1.0E-03	(i)
Xylenes	1.93E-04	7.2E-04	(i)
1,3 Butadiene	3.91E-05	1.5E-04	(i)
Formaldehyde	7.89E-05	2.9E-04	(i)
Acetaldehyde	2.52E-05	9.4E-05	(i)
Acrolein	7.88E-06	2.9E-05	(i)
Benzo(a)Pyrene	2.57E-07	9.5E-07	(i)
Benzo(a)anthracene	6.22E-07	2.3E-06	(i)

Chrysene	1.53E-06	5.7E-06	(i)
Benzo(b)fluoranthene	1.11E-06	4.1E-06	(i)
Benzo(k)fluoranthene	2.18E-07	8.1E-07	(i)
Dibenz(a,h)anthracene	3.46E-07	1.3E-06	(i)
Ideno(1,2,3-cd)pyrene	4.14E-07	1.5E-06	(i)
Napthalene	1.30E-04	4.8E-04	(i)
Propylene	2.79E-03	1.04E-02	(i)
Fluoride	0.31 mg/L	4.8E-03	(j)
Manganese	0.03 mg/L	4.6E-04	(j)
Copper	0.01 mg/L	1.6E-04	(j)
Chloroform	0.0004 mg/L	2.6E-04	(k)
Bromodichloromethane	0.0004 mg/L	2.6E-04	(k)
Bromoform	0.0105 mg/L	6.9E-03	(k)

(a) The current list of EPA criteria pollutants (http://www.epa.gov/airquality/urbanair/; last updated December 22, 2014) that have related National Ambient Air Quality Standards (NAAQS) (http://www.epa.gov/air/criteria.html; last updated October 21, 2014). VOC is not a criteria pollutant but is included here per note (e). Toxic Air Pollutants (TAPs) are defined as those in WAC 173-460. Greenhouse gas is not a criteria pollutant or a TAP and is exempt from New Source Review requirements for non Prevention of Significant Deterioration projects such as at Oxford Data Center per WAC 173-400-110(5)(b).

(b) Potential to Emit (PTE) estimates are based on one or more of the following: manufacturer 5-load final Tier 4 compliant engine test data (for NOx, VOC, CO, and PM2.5), Caterpillar test data, 1.20 safety factor, and applicable cold start (CS) factors for catalyst warm-up periods and black puff factors from California Energy Commission's *Air Quality Implications of Backup Generators in California"* CEC-500-2005-049; July 2005 (see section 2.1.2).

(c) Applicants estimated emissions based on fuel sulfur mass balance assuming 0.00150 weight percent sulfur fuel.

(d) EPA's AP-42 document does not provide an emission factor for lead emissions from diesel-powered engines. Lead emissions are presumed to be negligible.

(e) Ozone is not emitted directly into the air, but is created when its two primary components, volatile organic compounds (VOC) and oxides of nitrogen (NOx), combine in the presence of sunlight. *Final Ozone NAAQS Regulatory Impact Analysis EPA-452/R-08-003*, March 2008, Chapter 2.1. http://www.epa.gov/ttnecas1/regdata/RIAs/452_R_08_003.pdf

(f) All PM emissions from the generator engines is considered $PM_{2.5}$, and all $PM_{2.5}$ from the generator engines is considered DEEP.

(g) Based on 15 parts per million volume-dry (ppmvd) emission factor and facility operating parameters. .

(h) NO2 is assumed to be 10% of total NOx emitted.

(i) EPA AP-42 § 3.3 or 3.4 from: Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors http://www.epa.gov/ttn/chief/ap42/.

(j) Trace metals in city industrial wastewater as provided in application for cooling tower emissions. Total particulate matter from cooling towers based on the following study: *Calculating Realistic PM10 Emissions from Cooling Towers", Reisman and Frisbie, Environmental Progress, July 2002*.

(k) Concentration in cooling tower makeup water as provided in application for cooling tower emissions.

1.2 Maximum Operation Scenarios Based on Final Tier 4 Compliant Engines

Microsoft conservatively estimated emission limits by assuming a worst case scenario as follows:

- Instead of load-based emission estimates, Microsoft conservatively over-estimated emissions at the load that causes the highest emissions, when in reality, the facility will operate engines at a range of loads and not solely at the load with highest emissions. As a result, even though permitted emission limits have increased, actual pollutant emissions will be less than the emission limits allowed by the permit.
- Microsoft assumed a worst case scenario in which 541,888 gallons of fuel would be used per year, when in reality, the permit limits fuel usage to 431,000 gallons per year.
- The new permit emission estimates assume the worst-case scenario that the 3-year rolling average permitted emission limits are released entirely within a single year. In reality, this is unlikely, because it would prohibit Microsoft from operating generators for two years.

Except for initial commissioning, the total hours of engine runtime allowed by Approval Condition 3.2 is slightly less (86 hours per 3-year rolling average) than what was allowed in the

August 15, 2014 permit (86.5 hours per 3-year rolling average); and 15.5 hours less during a stack testing year as explained in section 2.2 of this TSD. A summary of scenarios considered is provided below:

Scenario	**PM, TPY**	**NOx, TPY**	**CO, TPY**	**HC, TPY**
Ultra-Conservative Worst-Case Year, All Runtime at Maximum Possible Emission Rate (100% load for NOx/CO; 10% load for DEEP/HC)	0.725	27.0	4.70	0.84
Ultra-Conservative Theoretical Max Year, Excluding Stack Emission Testing Required to be Done at Multiple Loads	0.708	25.6	3.47	0.73
More-Realistic Maximum Theoretical Year Including Triennial Stack Emission Testing, Each Activity Assigned a Realistic Load Range	0.692	9.5	2.84	0.73
70-Year Average Condition, Actual Distribution of Runtimes, "Mid-Load" Assumed to Be Average of All Loads from 10%-75%	0.632	n/a	n/a	n/a

Cold start adjustment factors are used to approximate the additional emissions from cold engines burning off the accumulated fuel and crankcase oil on cold cylinders. The PM and VOC cold start factor adjustments for these calculations are provided below:

VOC/PM Black Puff Cold-Start Adjustment Factors

Load	Spike Area (ppm-sec)	Steady-State Area (ppm-sec)	Total Area (ppm-sec)	Black Puff Factor
10%	6300	27000	33300	1.189
80%	6300	18000	24300	1.259
100%	6300	18000	24300	1.259

The CO cold start factor adjustments for these calculations are provided below:

CO Black Puff Cold-Start Adjustment Factors

Load	Spike Area (ppm-sec)	Steady-State Area (ppm-sec)	Total Area (ppm-sec)	Black Puff Factor
10%	15000	18000	33000	1.455
80%	15000	12000	27000	1.556
100%	15000	12000	27000	1.556

A NOx cold start factor of 1.0 was assumed because California Energy Commission tests (see *Air Quality Implications of Backup Generators in California”* CEC-500-2005-049; July 2005); do not show short term NOx spikes during cold starts.

Due to the way black-puff cold-start factors were calculated, annual facility-wide PTE emissions for CO and VOC were slightly underestimated by approximately 0.006 tpy and 0.004 tpy respectively. Ecology determines these differences to be negligible. Because Microsoft will be using diesel particulate filters, the applicant believes that use of a black-puff cold-start factor for DEEP conservatively overestimates facility emissions, but they have included them anyway.

Other cold-start related adjustments were also included in the application to account for heat-up times for catalysts in the add-on controls (see section 4 regarding add-on controls) listed below:

Catalyst Delay Cold Start Adjustment		
Control Device	Applicability	Adjustment
SCR catalyst and DPF oxidation catalyst	• Cold start under idle load (less than or equal to 10%) for VOC, CO, and NOx	15 minutes at emission levels equivalent of generator equipped with Tier 2 level emission controls followed by final Tier 4 compliant emissions
	• Cold start under high load for VOC, CO, and NOx	10 minutes at emission levels equivalent of generator equipped with Tier 2 level emission controls followed by final Tier 4 compliant emissions

Ecology also asked Microsoft to demonstrate compliance with the NAAQS during a year with both commissioning and up to four stack tests (worst-case stack testing scenario). On April 20, 2015, Microsoft presented such a scenario as follows:

- 258 hours of operation for each of 37 generators (assuming that the 3-year rolling average of 86 hours per year of routine operations all occur in a single 12-month period)
- 45 hours of operation for stack testing on four generators (i.e., the worst-case scenario if one of the generators were to fail its stack test)
- 50 hours of operation for the commissioning of generators, up to a total of 18 generators commissioned in one year.

Pollutant	**January 2015 Worst-Case Emission Rate (TPY)**	**Commissioning Exclusion Scenario Emission Ratio**	**Commissioning Exclusion Scenario Annual Emission Rate (TPY)**
PM/DEEP	0.725	1.11	0.805
NOx	27.02	1.11	30.0
CO	4.696	1.11	5.21
VOC	0.839	1.11	0.931

This scenario is unlikely and would only occur in one year. Even though Microsoft has not requested emission limits above the January 2015 worst-case emission rates, this analysis demonstrates that even if Microsoft did operate in such a scenario, the facility emissions would still comply with the NAAQS (See Section 5 of this TSD).

2. APPLICABLE REQUIREMENTS

The proposal by Microsoft qualifies as a new source of air contaminants as defined in Washington Administrative Code (WAC) 173-400-110 and WAC 173-460-040, and requires Ecology approval. The installation and operation of the Oxford Data Center is regulated by the requirements specified in:

2.1 Chapter 70.94 Revised Code of Washington (RCW), Washington Clean Air Act,
2.2 Chapter 173-400 Washington Administrative Code (WAC), General Regulations for Air Pollution Sources,
2.3 Chapter 173-460 WAC, Controls for New Sources of Toxic Air Pollutants, and

2.4 40 CFR Part 60 Subpart IIII and 40 CFR 63 Subpart ZZZZ* (* See section 3.4.2)

All state and federal laws, statutes, and regulations cited in this approval shall be the versions that are current on the date the final approval order is signed and issued.

2.4.1 Support for permit Approval Condition 2.1 regarding applicability of 40CFR Part 60 Subpart IIII:

As noted in the applicability section of 40CFR1039 (part 1039.1.c), that regulation applies to non-road compression ignition (diesel) engines and; *(c) The definition of nonroad engine in 40 CFR 1068.30 excludes certain engines used in stationary applications.* According to the definition in 40CFR1068.30(2)(ii): *An internal combustion engine is not a nonroad engine if it meets any of the following criteria: The engine is regulated under 40 CFR part 60, (or otherwise regulated by a federal New Source Performance Standard promulgated under section 111 of the Clean Air Act (42 U.S.C. 7411)).* Because the engines at Oxford are regulated under 40CFR60 subpart IIII (per 40CFR60.4200), they are not subject to 40CFR1039 requirements except as specifically required within 40CFR60.

Some emergency engines with lower power rating are required by 40CFR60 to meet 40CFR1039 Tier 4 emission levels, but not emergency engines with ratings that will be used at Oxford (0.750 MWe, 2.0 MWe, and 2.5 MWe). Instead, 40CFR60 requires the engines at Oxford to meet the Tier 2 emission levels of 40CFR89.112 (see section 4 with respect to add-on controls). The applicable sections of 40CFR60 for engine owners are pasted below in italics with bold emphasis on the portions requiring Tier 2 emission factors for emergency generators such as those at Oxford:

§60.4205 What emission standards must I meet for emergency engines if I am an owner or operator of a stationary CI internal combustion engine?

> *(b) Owners and operators of 2007 model year and later emergency stationary CI ICE with a displacement of less than 30 liters per cylinder that are not fire pump engines must comply with the emission standards for new nonroad CI engines in §60.4202* (see below), *for all pollutants, for the same model year and maximum engine power for their 2007 model year and later emergency stationary CI ICE.*

(Note: Based on information provided by the applicant, Oxford will use the following engines specifications: August, 2013 Caterpillar Model C27ATAAC rated 0.75 MWe; February, 2013 Caterpillar Model 3516C-TA rated 2.0 MWe; November 2012, Caterpillar Model 3516C-HD-TA rated 2.5 MWe. Based on these specifications, the 0.750 MWe engine has 27.03 liters displacement over 12 cylinders, or 2.25 liters per cylinder; the 2.0 MWe engines have 69.00 liters displacement over 16 cylinders, or 4.31 liters per cylinder; and the 2.5 MWe engines have 78.08 liters displacement over 16 cylinders, or 4.88 liters per cylinder. Thus, because the specified engines at Oxford will all have a displacement of less than 30 liters per cylinder, and are for emergency purposes only, they are required to meet *§60.4202* manufacturer requirements listed below).

§60.4202 What emission standards must I meet for emergency engines if I am a stationary CI internal combustion engine manufacturer?

> *(a) Stationary CI internal combustion engine manufacturers must certify their 2007 model year and later emergency stationary CI ICE with a maximum engine power* ***less than or equal to 2,237 KW*** *(3,000 HP) and a displacement of less than 10 liters per cylinder that are not fire pump engines to the emission standards specified in paragraphs (a)(1) through (2) of this section.*
>
> *(1) For engines with a maximum engine power less than 37 KW (50 HP):*
>
> *(i) The certification emission standards for new nonroad CI engines for the same model year and maximum engine power in 40 CFR 89.112 and 40 CFR 89.113 for all pollutants for model year 2007 engines, and*
>
> *(ii) The certification emission standards for new nonroad CI engines in 40 CFR 1039.104, 40 CFR 1039.105, 40 CFR 1039.107, 40 CFR 1039.115, and table 2 to this subpart, for 2008 model year and later engines.*
>
> ***(2) For engines with a maximum engine power greater than or equal to 37 KW (50 HP), the certification emission standards for new nonroad CI engines for the same model year and maximum engine power in 40 CFR 89.112 and 40 CFR 89.113 for all pollutants beginning in model year 2007.***

(Note: Thus, as outlined in previous note, and based on the power ratings listed in *40 CFR 60.4202(a),* the 0.75 MWe and 2.0 MWe engines at Oxford are required to meet the applicable 40CFR89 Tier 2 emission standards.)

> *(b) Stationary CI internal combustion engine manufacturers must certify their 2007 model year and later emergency stationary CI ICE with a maximum engine power* ***greater than 2,237 KW*** *(3,000 HP) and a displacement of less than 10 liters per cylinder that are not fire pump engines to the emission standards specified in paragraphs (b)(1) through (2) of this section.*
>
> *(1) For 2007 through 2010 model years, the emission standards in table 1 to this subpart, for all pollutants, for the same maximum engine power.*
>
> ***(2) For 2011 model year and later, the certification emission standards for new nonroad CI engines for engines of the same model year and maximum engine power in 40 CFR 89.112 and 40 CFR 89.113 for all pollutants.***

(Note: Thus, as outlined previously, and based on the power ratings listed in *40 CFR 60.4202(b),* the 2.5 MWe engines at Oxford are required to meet the applicable 40CFR89 Tier 2 emission standards.)

2.4.2 Support for permit Approval Condition 1.2 regarding applicability of 40 CFR 60.4211(f):

The emergency engine generators approved for operation by the Order are to be used solely for those purposes authorized for emergency generators under 40 CFR 60, Subpart IIII. The permit allows emergency use consistent with the hourly operation requirements described in 40 CFR 60.4211(f), except that there shall be no operation of this equipment to produce power for demand-response arrangements, peak shaving arrangements, nor to provide power as part of a financial arrangement with another entity, nor to supply power to the grid. Operating generators for uses beyond what is allowed in Approval Condition 1.2 goes beyond the intended use of emergency generators for data center back-up power only. Approval Condition 1.2 is consistent with the provisions of other data center permits in Quincy.

2.4.3 Support for Approval Condition 8.5.3. This Condition is required for the following reasons (but not necessarily limited to these reasons only):

Recording the reason for operating engines is consistent with the provisions of other data center permits in Quincy. In order to demonstrate compliance with 40 CFR 60.4211(f), this Approval Condition requires that Microsoft record the reason for operating the engines at the Oxford Data Center (including for emergency use). In addition to demonstrating compliance 40CFR60.4211(f), this condition is also required to show compliance with Approval Conditions 1.2 and 3.2., and because of its importance to Ecology and the Quincy community. Condition 8.5.3 simplifies recording the purpose of engine use to recording only the following reasons for operating: EMERGENCY SITUATIONS, STACK TESTING, COMMISSIONING, MAINTENANCE CHECKS, READINESS TESTING, DEVIATION OF VOLTAGE OR FREQUENCY, or UNSPECIFIED NON-EMERGENCY SITUATIONS. 40CFR60.4211(f)(2), allows up to 100 hours of engine operation per calendar year. Per 40CFR60.4211(f)(3), up to 50 hours of engine operation per calendar year of "UNSPECIFIED NON-EMERGENCY SITUATIONS" can be used, but those hours must be borrowed from the 100 hours allowed under 40CFR60.4211(f)(2).

2.4.4 Support for Approval Condition 9.6 regarding applicability of the annual report described in 40 CFR 60.4214(d):

40 CFR 60.4214(d) has specific annual reporting requirements for facilities that may "operate" engines for uses such as those allowed under 40CFR60.4211(f)(2)(iii). By requiring Microsoft to "follow the annual report requirements of 40 CFR 60.4214(d)," Approval Condition 9.6 suffices to address that specific annual reporting requirement.

2.4.5 Support for complying with 40 CFR 63 Subpart ZZZZ from Section 3 of TSD:

According to section 40 CFR 63 Subpart ZZZZ section 636590 part (c) and (c)(1), sources such as this facility, are required to meet the requirements of 40 CFR 60 IIII and "*no further requirements apply for such engines under this* (40 CFR 63 Subpart ZZZZ) *part.*"

3. **SOURCE TESTING**

Source testing requirements outlined in Table 4 of the Approval Order, provide two testing approaches. A five-load approach for PM, NOx, CO, and VOC, where PM is considered to be DEEP at size PM2.5 or smaller, which tests only for the filterable particulate matter to be consistent with California Code of Regulations § 93115.14 *ATCM for Stationary CI Engines – Test Methods* (measuring front half particulate only). However, a single-load test at the load with the maximum emission rate will also be performed for these pollutants (and ammonia) under this permit. For PM2.5, the single load test takes into account both the filterable and condensable PM emissions.
Instead of source testing two engines every three years (as required in the August 15, 2014 permit), one engine will be tested every three years, and will require an additional engine to be tested per Condition 4.4.4 of the Approval Order than what was required in the August 15, 2014 permit. As a result of these changes, the minimum number of engines to be source tested is 9 engines over a 25 year period, instead of 8 engines over a 10-year period as was required in the August 15, 2014 permit. In addition, instead of allowing 60 hours of stack testing in a testing year (30-hours per engine x 2 engines), this new permit will allow only 45 hours per testing year. As a result, each generator will be operated approximately 0.5 hours less per year and total generator use will be operated approximately 15.5 hours less per stack testing year (every three years). If Approval Condition 4.4.4 of the permit is satisfied for discontinued stack testing, total annual generator usage will decrease by at least 45 hours every three years after approximately 25 years (or 15 hours less per year on average).

Ecology is including a conditional test method (CTM) option for ammonia in the permit, because it is an EPA method (EPA CTM-027) that Ecology considers a viable test option to review performance of SCR catalyst beds and ammonia injection (slip).

According to Approval Order 4.2, any emission testing performed to verify conditions of the permit 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) which addresses audit samples. However, Approval Order 4.2 specifically states that "40 CFR 60.8(g) may be required by Ecology at their discretion." According to 40 CFR 60.8(g):

> *"The compliance authority responsible for the compliance test may waive the requirement to include an audit sample if they believe that an audit sample is not necessary."*

Ecology will not require audit samples for test methods specifically exempted in 40 CFR 60.8(g) such as Methods, 7E, 10, 18, 25A, and 320. For non-exempted test methods, Ecology believes that the two-test sampling approach required in Table 4 of the Order is a valid reason to waive audit sampling, because it provides two types of filterable particulate tests and also provides additional information (condensable particulate emissions) for one of the tests. However, Ecology may choose, at their discretion, to require audit sampling for stack tests conducted using any or all of the following particulate matter test methods: Methods 5, 201A, or 202.

4. SUPPORT FOR BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

As noted in Condition 2.2 of the Approval Order, 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. Ecology does not consider this control equipment to be Best Available Control Technology (BACT) at Oxford because of the reasons outlined in this section. BACT cost estimates were updated as of March 2015 for the draft preliminary determination of Approval Order 15AQ-E609, to reflect costs based on the applicant's estimated "Ultra-Conservative Worst-Case" Tier-4 controlled emission and uncontrolled tier-2 emissions.

BACT is defined[1] as "*an emission limitation based on the maximum degree of reduction for each air pollutant subject to regulation under chapter 70.94 RCW emitted from or which results from any new or modified stationary source, which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes and available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of each such pollutant. In no event shall application of the "best available control technology" result in emissions of any pollutants which will exceed the emissions allowed by any applicable standard under 40 CFR Part 60 and Part 61. If the Administrator determines that technological or economic limitations on the application of measurement methodology to a particular emissions unit would make the imposition of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology. Such standard shall, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and shall provide for compliance by means which achieve equivalent results.*

For this project, Ecology is implementing the "top-down" approach for determining BACT for the proposed diesel engines. The first step in this approach is to determine, for each proposed emission unit, the most stringent control available for a similar or identical emission unit. If that review can show that this level of control is not technically or economically feasible for the proposed source (based upon the factors within the BACT definition), then the next most stringent level of control is determined and similarly evaluated. This process continues until the BACT level under consideration cannot be eliminated by any substantial or unique technical, environmental, or economic objections.[2] The "top-down" approach shifts the burden of proof to the applicant to justify why the proposed source is unable to apply the best technology available. The BACT analysis must be conducted for each pollutant that is subject to new source review.

The proposed diesel engines and/or cooling towers will emit the following regulated pollutants which are subject to BACT review: nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter (PM_{10} and $PM_{2.5}$), and sulfur dioxide. BACT for toxics (tBACT) is included in Section 4.5.

---

[1] RCW 70.94.030(7) and WAC 173-400-030(12)

[2] J. Craig Potter, EPA Assistant Administrator for Air and Radiation memorandum to EPA Regional Administrators, "Improving New Source Review (NSR) Implementation", December 1, 1987.

4.1 BACT ANALYSIS FOR NOx FROM DIESEL ENGINE EXHAUST

Microsoft reviewed EPA's RACT/BACT/LAER Clearinghouse (RBLC) database to look for controls recently installed on internal combustion engines. The RBLC provides a listing of BACT determinations that have been proposed or issued for large facilities within the United States, Canada and Mexico.

4.1.1 BACT Options for NOx

Microsoft's review of the RBLC found that urea -based selective catalytic reduction (SCR) was the most stringent add-on control option demonstrated on diesel engines. The application of the SCR technology for NOx control was therefore considered the top-case control technology and evaluated for technical feasibility and cost-effectiveness. The most common BACT determination identified in the RBLC for NOx control was compliance with EPA Tier 2 standards using engine design, including exhaust gas recirculation (EGR) or fuel injection timing retard with turbochargers. Other NOx control options identified by Ecology through a literature review include: selective non-catalytic reduction (SNCR), non-selective catalytic reduction (NSCR), water injection, as well as emerging technologies. Ecology reviewed these options and addressed them below.

4.1.1.1 ***Selective Catalytic Reduction.*** The SCR system functions by injecting a liquid reducing agent, such as urea, through a catalyst into the exhaust stream of the diesel engine. The urea reacts with the exhaust stream converting nitrogen oxides into nitrogen and water. SCR can reduce NOx emissions by approximately 90 percent.

For SCR systems to function effectively, exhaust temperatures must be high enough (about 200 to 500^{o}C) to enable catalyst activation. For this reason, SCR control efficiencies are expected to be relatively low during the initial minutes after engine start up, especially during maintenance, testing and storm avoidance loads. Minimal amounts of the urea-nitrogen reducing agent injected into the catalyst does not react, and is emitted as ammonia. Optimal operating temperatures are needed to minimize excess ammonia (ammonia slip) and maximize NOx reduction. SCR systems are costly. Most SCR systems operate in the range of 290^{o}C to 400^{o}C. Platinum catalysts are needed for low temperature range applications (175^{o}C – 290^{o}C); zeolite can be used for high temperature applications (560^{o}C); and conventional SCRs (using vanadium pentoxide, tungsten, or titanium dioxide) are typically used for temperatures from 340^{o}C to 400^{o}C.

Microsoft has evaluated the cost effectiveness of installing and operating SCR systems on each of the proposed diesel engines. Assuming no direct annual maintenance, labor, and operation costs, the analysis indicates that the use of SCR systems would cost approximately $14,300 per ton of NOx removed from the exhaust stream each year; or $20,300 per ton, taking into account California Area Resource Board (CARB) estimated direct costs, which could potentially be up to $423,000 per year. If SCR is combined with a Tier 4 capable integrated control system, which includes SCR, as well as control technologies for other pollutants such PM, CO, and VOC (see section 4.3), the cost estimate would be approximately $30,000 for NOx alone or $26,000 per ton of combined pollutants removed per year.

Ecology concludes that while SCR is a demonstrated emission control technology for diesel engines, and preferred over other NOx control alternatives described in subsection 4.1.1.3., it is not economically feasible for this project. Furthermore, although NOx is a criteria pollutant, the only NOx that currently have NAAQS is NO2. Cost per ton removal of NO2 is an order of magnitude more expensive than for NOx, and is addressed under tBACT in section 4.5.

Therefore, Ecology agrees with the applicant that this NOx control option can be excluded as BACT (both as SCR alone and as part of Tier 4 capable integrated control system, which includes a combination of SCR with other control technologies for other pollutants).

*4.1.1.2.**Combustion Controls, Tier 2 Compliance, and Programming Verification.***
Diesel engine manufacturers typically use proprietary combustion control methods to achieve the overall emission reductions needed to meet applicable EPA tier standards. Common general controls include fuel injection timing retard, turbocharger, a low-temperature aftercooler, use of EPA Tier-2 certified engines operated as emergency engines as defined in 40 CFR§60.4219, and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII. Although it may lead to higher fuel consumption, injection timing retard reduces the peak flame temperature and resulting NOx emissions. While good combustion practices are a common BACT approach, for the Oxford Data Center engines however, a more specific approach, based on input from Ecology inspectors after inspecting similar data centers, is to obtain written verification from the engine manufacturer that each engine of the same make, model, and rated capacity installed at a facility use the same electronic Programmable System Parameters, i.e., configuration parameters, in the electronic engine control unit. These BACT options are considered further in section 4.1.2.

*4.1.1.3. **Other Control Options***. Other NOx control options listed in this subsection were considered but rejected for the reasons specified:

*4.1.1.3.1. **Selective Non-Catalytic Reduction (SNCR)**:* This technology is similar to that of an SCR but does not use a catalyst. Initial applications of Thermal DeNOx, an ammonia based SNCR, achieved 50 percent NOx reduction for some stationary sources. This application is limited to new stationary sources because the space required to completely mix ammonia with exhaust gas needs to be part of the source design. A different version of SNCR called NOxOUT, uses urea and has achieved 50-70 percent NOx reduction. Because the SNCR system does not use a catalyst, the reaction between ammonia and NOx occurs at a higher temperature than with an SCR, making SCR applicable to more combustion sources. Currently, the preferred technology for back-end NOx control of reciprocating internal combustion engine (RICE) diesel applications, appears to be SCR with a system to convert urea to ammonia.

*4.1.1.3.2. **Non-Selective Catalytic Reduction (NSCR):*** This technology uses a catalyst without a reagent and requires zero excess air. The catalyst causes NOx to give up its oxygen to products of incomplete combustion (PICs), CO and hydrocarbons, causing the pollutants to destroy each other. However, if oxygen is present, the PICs will burn up without destroying the NOx. While NSCR is used on most gasoline automobiles, it is not immediately applicable to diesel engines because diesel exhaust oxygen levels vary widely depending on engine load. NSCR might be more applicable to boilers. Currently, the preferred technology for back-end NOx control of reciprocating internal combustion engine (RICE) diesel applications, appears to be SCR with a system to convert urea to ammonia.

4.1.1.3.3. ***Water Injection:*** Water injection is considered a NOx formation control approach and not a back-end NOx control technology. It works by reducing the peak flame temperature and therefore reducing NOx formation. Water injection involves emulsifying the fuel with water and increasing the size of the injection system to handle the mixture. This technique has minimal affect on CO emissions but can increase hydrocarbon emissions. This technology is rejected because there is no indication that it is commercially available and/or effective for new large diesel engines.

4.1.1.3.4. ***Other Emerging Technologies****:* Emerging technologies include: NOx adsorbers, RAPER-NOx, ozone injection, and activated carbon absorption.

- ***NOx Adsorbers:*** NOx adsorbing technologies (some of which are known as SCONOx or EMx^{GT}) use a catalytic reactor method similar to SCR. SNONOx uses a regenerated catalytic bed with two materials, a precious metal oxidizing catalyst (such as platinum) and potassium carbonate. The platinum oxidizes the NO into NO2 which can be adsorbed onto the potassium carbonate. While this technology can achieve NOx reductions up to 90% (similar to an SCR), it is rejected because it has significantly higher capital and operating costs than an SCR. Additionally, it requires a catalyst wash every 90 days, and has issues with diesel fuel applications, (the GT on EMx^{GT} indicates gas turbine application). A literature search did not reveal any indication that this technology is commercially available for stationary backup diesel generators.
- ***Raper-NOx****:* This technology consists of passing exhaust gas through cyanic acid crystals, causing the crystals to form isocyanic acid which reacts with the NOx to form CO2, nitrogen and water. This technology is considered a form of SNCR, but questions about whether stainless steel tubing acted as a catalyst during development of this technology, would make this another form of SCR. To date, it appears this technology has never been offered commercially.
- ***Ozone Injection:*** Ozone injection technologies, some of which are known as LoTOx or BOC, use ozone to oxidize NO to NO2 and further to NO3. NO3 is soluble in water and can be scrubbed out of the exhaust. As noted in the literature, ozone injection is a unique approach because while NOx is in attainment in many areas of the United States (including Quincy, WA), the primary reason to control NOx is because it is a precursor to ozone. Due to high additional costs associated with scrubbing, this technology is rejected.
- ***Activated Carbon Absorption with Microwave Regeneration.*** This technology consists of using alternating beds of activated carbon by conveying exhaust gas through one carbon bed, while regenerating the other carbon bed with microwaves. This technology appears to be successful in reducing NOx from

diesel engine exhaust. However, it is not progressing to commercialization and is therefore rejected.

4.1.2. BACT determination for NOx

Ecology determines that BACT for NOx is the use of EPA Tier-2 certified engines operated as emergency engines as defined in 40 CFR§60.4219, and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII. In addition, 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. "Installed at the facility" could mean at the manufacturer or at the data farm because the engine manufacturer service technician sometimes makes the operational parameter modification/correction to the electronic engine controller at the data farm. Microsoft will install engines consistent with this BACT determination. Ecology believes this is a reasonable approach in that this BACT requirement replaces a more general, common but related BACT requirement of "good combustion practices."

Note: Because control options for PM, CO, and VOCs, are available as discussed in BACT section 4.2., which are less costly per ton than the Tier 4 capable integrated control system option for those pollutants, both the SCR-only option as well as the Tier 4 capable integrated control system option are not addressed further within BACT.

4.2 BACT ANALYSIS FOR PM, CO AND VOC FROM DIESEL ENGINE EXHAUST

Microsoft reviewed the available published literature and the RBLC and identified the following demonstrated technologies for the control of particulate matter (PM), carbon monoxide (CO), and volatile organic compounds (VOC) emissions from the proposed diesel engines:

4.2.1. BACT Options for PM, CO, and VOC from Diesel Engine Exhaust

4.2.1.1 ***Diesel Particulate Filters (DPFs)***. These add-on devices include passive and active DPFs, depending on the method used to clean the filters (i.e., regeneration). Passive filters rely on a catalyst while active filters typically use continuous heating with a fuel burner to clean the filters. The use of DPFs to control diesel engine exhaust particulate emissions has been demonstrated in multiple engine installations worldwide. Particulate matter reductions of up to 85% or more have been reported. Therefore, this technology was identified as the top case control option for diesel engine exhaust particulate emissions from the proposed engines.

Microsoft has evaluated the cost effectiveness of installing and operating DPFs on each of the proposed diesel engines. The analysis indicates that the use of DPFs would cost approximately $391,000per ton of engine exhaust particulate removed from the exhaust stream at Oxford each year. DPFs also remove CO and VOCs at costs of approximately $70,000and $409,000 per ton per year respectively. If the cost effectiveness of DPF use is evaluated using the total amount of PM, CO, and VOCs reduced, the cost estimate would be approximately $52,000 per ton of pollutants removed per year.

These annual estimated costs (for DPF use alone) provided by Microsoft are conservatively low estimates that take into account installation, tax, and shipping capital costs but assume a lower bound estimate for operational, labor and maintenance costs of $0, whereas an upper bound CARB estimate could potentially amount to an additional $282,000/year.

Ecology concludes that use of DPF is not economically feasible for this project. Therefore, Ecology agrees with the applicant that this control option can be rejected as BACT.

*4.2.1.2.**Diesel Oxidation Catalysts***. This method utilizes metal catalysts to oxidize carbon monoxide, particulate matter, and hydrocarbons in the diesel exhaust. Diesel oxidation catalysts (DOCs) are commercially available and reliable for controlling particulate matter, carbon monoxide and hydrocarbon emissions from diesel engines. While the primary pollutant controlled by DOCs is carbon monoxide, DOCs have also been demonstrated to reduce diesel engine exhaust particulate emissions, and also hydrocarbon emissions.

Microsoft has evaluated the cost effectiveness of installing and operating DOCs on each of the proposed diesel engines. The following DOC BACT cost details are provided as an example of the BACT and tBACT cost process that Microsoft followed for engines within this application (including for SCR-only, DPF-only, and Tier 4 capable integrated control system technologies).

- Microsoft obtained the following recent DOC equipment costs from a vendor on November 11, 2013: ($52,100 for a stand-alone catalyzed DOC per single 2.5MWe generator; add scaled amounts of $25,299 for a single 0.750 MWe generator, and $45,571 for four 2.0 MWe generators). For thirty two (32) 2.5MWe generators, four (4) 2.0MWe generators, and one (1) 0.750 MWe generators, this amounts to $1,874,785. According to the vendor, DOC control efficiencies for this unit are CO, HC, and PM are 90%, 80%, and 20% respectively.
- The subtotal becomes $2,142,645 after accounting for shipping ($93,739), WA sales tax ($121,861), and direct on-site installation ($52,260).
- After adding indirect installation costs, the total capital investment amounts to: $2,533,450. Indirect installation costs include but are not limited to: startup fees, contractor fees, and performance testing.
- Annualized over 25 years and included with direct annual costs based on EPA manual EPA/452/B-02-001, the total annual cost (capital recovery and direct annual costs) is estimated to be $263,504.
- At the control efficiencies provided from the vendor, the annual tons per year of emissions for CO (10.3 tpy), HC (1.99 tpy), and PM (1.85 tpy) become 9.27 tpy, 1.59 tpy, and 0.37 tpy removed respectively.

- The last step in estimating costs for a BACT analysis is to divide the total annual costs by the amount of pollutants removed ($263,504 divided by 9.27 tpy for CO, etc..).

The corresponding annual DOC cost effectiveness value for carbon monoxide destruction alone is approximately $28,000per ton. If particulate matter and hydrocarbons are individually considered, the cost effectiveness values become $712,000 and $165,000 per ton of pollutant removed annually, respectively. If the cost effectiveness of using DOC is evaluated using the total amount of carbon monoxide, particulate matter and hydrocarbons reduced, the cost estimate would be approximately $23,000per ton of pollutants removed per year.

These annual estimated costs (for DOC use alone) provided by Microsoft are conservatively low estimates that take into account installation, tax, shipping, and other capital costs as mentioned above, but assume a lower bound estimate for operational, labor and maintenance costs of $0, whereas an upper bound CARB estimate could potentially amount to an additional $28,000 per year.

Ecology concludes that use of DOC is not economically feasible for this project. Therefore, Ecology agrees with the applicant that these control option can be rejected as BACT.

4.2.3 <u>**BACT Determination for PM, CO, and VOC**</u>

Ecology determines BACT for particulate matter, carbon monoxide and volatile organic compounds is restricted operation of EPA Tier-2 certified engines operated as emergency engines as defined in 40 CFR§60.4219, and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII. Microsoft will install engines consistent with this BACT determination.

4.3 BACT ANALYSIS FOR SULFUR DIOXIDE FROM DIESEL ENGINE EXHAUST

4.3.1. BACT Options for SO2

Microsoft did not find any add-on control options commercially available and feasible for controlling sulfur dioxide emissions from diesel engines. Microsoft's proposed BACT for sulfur dioxide is the use of ultra-low sulfur diesel fuel (15 ppm by weight of sulfur).

4.3.2. <u>**BACT Determination for Sulfur Dioxide**</u>

Ecology determines that BACT for sulfur dioxide is the use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.

4.4 BACT ANALYSIS FOR PM FROM COOLING TOWERS

The direct contact between the cooling water and air results in entrainment of some of the liquid water into the air. The resulting drift droplets contain total dissolved solids (TDS) in the cooling tower water, which can evaporate into air as particulate matter. For the Oxford facility, the recirculation water in the cooling towers will be pre-softened using the proprietary Water Conservation Technology International (WCTI) “pre-treatment system” to replace scale-forming mineral compounds (e.g., calcium and magnesium) with other non-toxic, non-scaling mineral compounds (e.g., sodium), which will allow the cooling towers to be operated with very high “cycles of concentration.” Microsoft analyzed the industrial wastewater used in the cooling towers, which includes trace metals and chlorine disinfection byproducts, and estimates that cooling tower TAP emissions from all cooling towers combined (after implementing their proposed BACT in section 4.4.1.1) will not exceed the respective small quantity emission rates (SQERs) for any TAP.

4.4.1. BACT Options for PM from Cooling Towers

Microsoft reviewed the available published literature and the RBLC and identified drift eliminators as demonstrated technologies for the control of particulate matter (PM), from the proposed cooling towers. Drift eliminators can reduce the amount of drift, and therefore the amount of particulate matter released into the air.

4.4.1.1. *Cooling Towers with 0.0005 Percent Drift Efficiency*

Microsoft proposes to use high-efficiency drift eliminators that will achieve a liquid droplet drift rate of no more than 0.0005 percent of the recirculation flow rate within each cooling tower. Microsoft estimates that by using a 0.0005 percent drift rate and a total dissolved solids (TDS) concentration of 69,000 mg/L, only 13 percent of the solid evaporated drift particles will be smaller than 2.5 microns in diameter (PM2.5), and 56 percent will be smaller than PM10 (based on sizing approach presenting in: “*Calculating Realistic PM10 Emissions from Cooling Towers", Reisman and Frisbie, Environmental Progress, July 2002).* Microsoft’s original application dated January 17, 2014 stated that a cooling tower with 0.0005 percent drift efficiency is the most efficient drift eliminator that is commercially available.

4.4.1.2. *Cooling Towers with 0.0003 Percent Drift Efficiency*

In Ecology’s 2/26/2014 incompleteness letter for the original January 2014 application, Ecology noted that a cooling tower with 0.0003 percent drift rate was in use at the Harquahala power plant in Arizona, which is regulated by the Maricopa County Air Pollution Control District (APCD). Because of this, Ecology asked Microsoft to defend or revise the claim in the original application stating that a cooling tower with 0.0005 percent drift efficiency is the most efficient drift eliminator that is commercially available. Upon review, Microsoft’s consultant (Landau Associates) learned that the 0.0003 percent drift cooling tower at Harquahala is custom built for that large utility electric power plant. It has a water recirculation rate of 15,000 gpm, and is not comparable to what is needed at Oxford, which has a water recirculation rate of only 950 gpm. When Microsoft requested price quotes for cooling towers with 0.0003 percent drift efficiency for the cooling towers to be used at the Oxford Data Center, venders responded that a cooling tower with 0.0003 percent drift efficiency is not a commercially available product because it is below field measurement capabilities, and could not be proven. According to EPA’s BACT/LAER Clearinghouse database, Microsoft found BACT levels for cooling towers from 0.005 percent and 0.0005 percent. Of 30 cooling towers identified between 2003-2013, twenty-four had BACT determinations of

0.0005%, and six had BACT determinations from between 0.005 percent to 0.0005 percent.

Thus, Ecology considers this information to be a reasonable justification to accept high efficiency drift eliminators rated at 0.0005 percent drift to be the most efficient drift eliminators that are commercially available for the induced-draft mechanical cooling towers to be used at Oxford. Therefore, no other control options are considered.

4.4.2. BACT Determination for PM from Cooling Towers

Ecology accepts as BACT for particulate matter, cooling tower drift eliminators that can achieve a 0.0005 percent rate. These are the most efficient drift eliminators that are commercially available for the induced-draft mechanical cooling towers to be used at Oxford. As noted in this Technical Support Document (section 4), federal regulations require that BACT decisions are made on a *case-by-case* basis. This specific BACT decision is based on the information provided in section (4.4), including consideration of the high TDS content resulting from the anti-scaling WCTI approach used by Oxford.

4.5 BEST AVAILABLE CONTROL TECHNOLOGY FOR TOXICS

Best Available Control Technology for Toxics (tBACT) means BACT, as applied to toxic air pollutants (TAPs).[3] One of the TAPs, Ammonia, is used as part of the SCR control technology described in section 4.1.1.1. Another data center in Quincy has used a tBACT for ammonia of 15 per million volume-dry (ppmvd) at 15% Oxygen (O2) per engine to address ammonia slip. Although BACT and tBACT are considered on a case-by-case basis as described in section 4, Ecology has decided, and Microsoft has agreed on a similar tBACT for ammonia as listed in Table 4.5. For the rest of the TAPs that exceed small quantity emission rates (SQERs), the procedure for determining tBACT followed the same procedure used above for determining BACT. Of the technologies Microsoft considered for BACT, the minimum estimated costs as applied to tBACT are as follows:

- The minimum estimated costs to control diesel engine exhaust particulate is estimated to be $414,000 per ton removed.
- The minimum estimated costs to control NO2 is estimated to be $143,000 per ton removed.
- The minimum estimated costs to control CO is estimated to be $28,000 per ton removed.
- The minimum estimated costs to control acrolein, which could be treated with the VOC treatment listed under BACT, is estimated to be greater than $1 billion per ton.
- The minimum estimated costs to control benzene, which could be treated with the VOC treatment listed under BACT, is estimated to be greater than $11 million per ton.

Under state rules, tBACT is required for all toxic air pollutants for which the increase in emissions will exceed de minimis emission values as found in WAC 173-460-150. Based on the information presented in this TSD, Ecology has determined that Table 4.5 below represents tBACT for the proposed project.

---

[3] WAC 173-460-020

Table 4.5. tBACT Determination

Toxic Air Pollutant	**tBACT**
Primary NO_2	Compliance with the NOx BACT requirement
Diesel Engine Exhaust Particulate	Compliance with the PM BACT requirement
Carbon monoxide	Compliance with the CO BACT requirement
Sulfur dioxide	Compliance with the SO_2 BACT requirement
Ammonia	Ammonia emissions shall not exceed 15 per million volume-dry (ppmvd) at 15% Oxygen (O2) per engine.
Benzene	Compliance with the VOC BACT requirement
Toluene	Compliance with the VOC BACT requirement
Xylenes	Compliance with the VOC BACT requirement
1,3 Butadiene	Compliance with the VOC BACT requirement
Formaldehyde	Compliance with the VOC BACT requirement
Acetaldehyde	Compliance with the VOC BACT requirement
Acrolein	Compliance with the VOC BACT requirement
Benzo(a)Pyrene	Compliance with the VOC BACT requirement
Benzo(a)anthracene	Compliance with the VOC BACT requirement
Chrysene	Compliance with the VOC BACT requirement
Benzo(b)fluoranthene	Compliance with the VOC BACT requirement
Benzo(k)fluoranthene	Compliance with the VOC BACT requirement
Dibenz(a,h)anthracene	Compliance with the VOC BACT requirement
Ideno(1,2,3-cd)pyrene	Compliance with the VOC BACT requirement
Napthalene	Compliance with the VOC BACT requirement
Propylene	Compliance with the VOC BACT requirement
Fluoride	Compliance with PM Cooling Tower BACT requirement
Manganese	Compliance with PM Cooling Tower BACT requirement
Copper	Compliance with PM Cooling Tower BACT requirement
Chloroform	Compliance with PM Cooling Tower BACT requirement
Bromodichloromethane	Compliance with PM Cooling Tower BACT requirement
Bromoform	Compliance with PM Cooling Tower BACT requirement

5. AMBIENT AIR MODELING

Ambient air quality impacts at and beyond the property boundary were modeled using EPA's AERMOD dispersion model, with EPA's PRIME algorithm for building downwash.

The AERMOD model used the following data and assumptions:

5.1 Five years of sequential hourly meteorological data (2001–2005) from Moses Lake Airport were used. Twice-daily upper air data from Spokane were used to define mixing heights.
5.2 The AMS/EPA Regulatory Model Terrain Pre-processor (AERMAP) was used to obtain height scale, receptor base elevation, and to develop receptor grids with terrain effects. For area topography required for AERMAP, Digital topographical data (in the form of Digital Elevation Model files) were obtained from www.webgis.com.
5.3 Each generator was modeled with a stack height of 46- feet above local ground.
5.4 The data center buildings, in addition to the individual generator enclosures were included to account for building downwash.

5.5 The receptor grid for the AERMOD modeling was established using a 10-meter grid spacing along the facility boundary extending to a distance of 350 meters from each facility boundary. A grid spacing of 25 meters was used for distances of 350 meters to 800 meters from the boundary. A grid spacing of 50 meters was used for distances from 500 meters to 2000 meters from the boundary. A grid spacing of 100 meters was used for distances beyond 2000 meters from the boundary.

5.6 1-hour NO_2 concentrations at and beyond the facility boundary were modeled using the Plume Volume Molar Ratio Method (PVMRM) module, with default concentrations of 49 parts per billion (ppb) of background ozone, and an equilibrium NO_2 to NOx ambient ratio of 90%.

5.7 Dispersion modeling is sensitive to the assumed stack parameters (i.e., flowrate and exhaust temperature). The stack temperature and stack exhaust velocity at each generator stack were set to values corresponding to the engine loads for each type of testing and power outage.

5.8 AERMOD Meteorological Pre-processor (AERMET) was used to estimate boundary layer parameters for use in AERMOD.

5.9 AERSURFACE was used to determine the percentage of land use type around the facility based on albedo, Bowen ratio, and surface roughness parameters.

5.10 Because regional background data is not available for all pollutants, annual average regional background concentrations for PM10 listed in the table below are based on available PM2.5 annual average regional background data from the source noted in footnote (a) of the table.

Except for diesel engine exhaust particulate which is predicted to exceed its ASIL, AERMOD model results show that no NAAQS or ASIL will be exceeded at or beyond the property boundary. The modeling results as listed in the application are provided below:

Criteria Pollutant	**Standards in µg/m^3**		**Maximum Ambient Impact Concentration (µg/m^3)**	**AERMOD Filename**	**Background Concentrations (µg/m^3) (a)**	**Maximum Ambient Impact Concentration Added to Background (µg/m^3) (If Available)**
	NAAQS(e)					
	Primary	**Secondary**				
Particulate Matter (PM_{10})						
1st-Highest 24-hour average during power outage with cooling towers	150	150	24	PM10- 111314d	89	113
Particulate Matter ($PM_{2.5}$)						
Annual average	12	15	0.33 (0.36 f)	PM10- 111314d	6.75	7.08 (7.11 f)
1st-highest 24-hour average for cooling towers and electrical bypass	35	35	12.7	PM25-111314a-c	21.71	34
Carbon Monoxide (CO)						
8-hour average	10,000		226	CO- 111314e	482	708

1-hour average	40,000		459	CO-111314e	842	1,301
Nitrogen Oxides (NO_2)						
Annual average (b)	100	100	12.1 (13.4 f)	NOx-120413a	2.8	14.9 (16.2 f)
1-hour average	188	--	172	NOx-112413b-f	16	188
Sulfur Dioxide (SO_2)						
3-hour average	--	1,300	2.3	SO2-120413a	2.1	4.4
1-hour average	60	--	3.1	SO2-120413a	2.6	5.7

Toxic Air Pollutant	**ASIL (µg/m^3)**	**Averaging Period**	**1st-Highest Ambient Concentration (µg/m^3)**	**AERMOD Filename**
DEEP	0.00333	Annual average	0.325 (0.36 f)	DEEP-121613a (d)
NO_2	470	1-hour average	433	NOx-112413a
CO	23,000	1-hour average	459	CO- 11314a
Ammonia	70.8	24-hour average	35	(c)
Acrolein	0.06	24-hour average	0.001	(c)
Benzene	0.0345	Annual Average	0.0013 (0.0014 f)	(d)

Notes:
µg/m^3 = Micrograms per cubic meter.
ppm = Parts per million.
ASIL = Acceptable source impact level.
DEEP = Diesel engine exhaust, particulate
(a) Sum of "regional background" plus "local background" values. Regional background concentrations obtained from WSU NW Airquest website. Local background concentrations derived from AERMOD modeling and include emissions from: Con Agra Foods, Microsoft Columbia Data Center, and the Dell Data Center (see Section 6 of this TSD).
(b) For the purpose of determining the 3-year average, five separate models were run (one for each year of meteorological data) to determine the 98th percentile concentration for each year based on the NAAQS.
(c) A dispersion factor was used to calculate the 24-hour average concentration of ammonia and acrolein in ambient air based on the 1st highest PM 24-hour average model.
(d) Annually averaged concentrations are based on the theoretical maximum annual concentration, which assumes the worst-case scenario that the 3-year rolling average permit limit is released entirely within a single year.
(e) Ecology interprets compliance with the National Ambient Air Quality Standards (NAAQS) as demonstrating compliance with the Washington Ambient Air Quality Standards (WAAQS).
(f) Microsoft estimated the one-time maximum emissions as explained in Section 1.2 of this TSD. The values in parenthesis reflect those one-time values (thus do not represent 70-year exposure levels for DEEP).

Microsoft has demonstrated compliance with the national ambient air quality standards (NAAQS) and acceptable source impact levels (ASILs) except for DEEP. As required by WAC 173-460-090, emissions of DEEP are further evaluated in the following section of this document.

6. SECOND TIER REVIEW FOR DIESEL ENGINE EXHAUST PARTICULATE

Proposed emissions of diesel engine exhaust, particulate (DEEP) from the thirty seven (37) Oxford engines exceed the regulatory trigger level for toxic air pollutants (also called an Acceptable Source Impact Level, (ASIL)). A second tier review was required for DEEP in accordance with WAC 173-460-090, and Oxford was required to prepare a health impact assessment (HIA). The HIA presents an evaluation of both non-cancer hazards and increased cancer risk attributable to Oxford's increased emissions of all identified carcinogenic compounds (including DEEP and numerous other constituents), nitrogen dioxide, ammonia, carbon monoxide, benzene, and acrolein. Oxford also reported the cumulative risks associated with Oxford and prevailing sources in their HIA document based on a cumulative modeling approach. The Oxford cumulative risk study is based on proposed generators, nearby existing permitted data center sources, and other background sources including highways and railroads.

Large diesel-powered backup engines emit DEEP, which is a high priority toxic air pollutant in the state of Washington. In light of the rapid development of other data centers in the Quincy area, and recognizing the potency of DEEP emissions, Ecology decided to evaluate Oxford's proposal in a separate community-wide basis modeling effort, even though it is not required to do so by state law. The Ecology community-wide evaluation approach considers the cumulative impacts of DEEP emissions resulting from Oxford's project, prevailing background emissions from existing permitted data centers, and other DEEP sources in Quincy, beyond what was considered in the Oxford cumulative modeling effort.

The Oxford HIA document along with a brief summary of Ecology's review will be available on Ecology's website.

7. CONCLUSION

Based on the above analysis, Ecology concludes that operation of the 37 generators and 32 cooling towers will not have an adverse impact on air quality. Ecology finds that Microsoft's Oxford Data Center has satisfied all requirements for NOC approval.

******END OF MICROSOFT OXFORD TSD** ****