TECHNICAL SUPPORT DOCUMENT
APPROVAL ORDER NO. 17AQ-E002
MICROSOFT MWH DATA CENTER

1. PROJECT DESCRIPTION

On January 27, 2014, Ecology received a Notice of Construction (NOC) application submittal from the Microsoft Corporation (Microsoft), the permittee, requesting approval for a permit application for Phases 1 and 2 of a new facility originally named the Oxford Data Center (Oxford) 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, and the application was considered complete on June 3, 2014. After a public comment period from June 19, 2014, through July 29, 2014, with a hearing and public meeting held in Quincy on July 24, 2014, Approval Order 14AQ-E537 was issued on August 15, 2014. Microsoft appealed the permit on September 1, 2014. Microsoft worked with Ecology through the NOC application process to address the concerns of their appeal and withdrew their appeal on September 22, 2015, before the appeal hearing date scheduled for January 2016.

On December 11, 2014, Ecology received an NOC application submittal from Microsoft requesting revisions to Approval Order 14AQ-E537. 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. The application was considered complete on March 17, 2015. Ecology provided a public comment period from May 18, 2015, through July 13, 2015, with a hearing and public meeting held in Quincy on July 9, 2015. Ecology received comments during the comment period and Ecology prepared responses to the comments. In September 2015, Ecology was prepared to issue the comments along with Approval Order 15AQ-E609 to replace Approval Order 14AQ-E537, but at Microsoft's request, Ecology did not issue the permit. Microsoft informed Ecology of additional changes that the facility was making from what was previously requested. Microsoft informed Ecology they were going to request those additional changes in another NOC application.

On January 13, 2016, Ecology received NOC application submittal from the Microsoft Corporation (MSN**)** requesting revisions to Approval Order 14AQ-E537 (dated August 15, 2014), for the newly named MWH Data Center (FKA: Oxford) located at Industrial Park #5, west of Road R NW at the end of Port Industrial Parkway in Quincy, WA. The NOC application was determined to be incomplete, and on March 10, 2016, Ecology issued an incompleteness letter to Microsoft. On April 13, 2016, Ecology received a revised NOC application from Microsoft, with supplementary materials provided on September 9, 2016. The NOC application was considered complete on September 20, 2016.

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.

In the revised permit, Ecology has concluded that this project has satisfied all NOC requirements including those regarding second tier analysis for two toxic air pollutants (TAPs) (diesel engine exhaust particulate (DEEP) and nitrogen dioxide (NO_2)). The previous Approval Order (14AQ-E537) is rescinded and replaced entirely with this Approval Order.

MWH will contain four Phase 1 activity zone (AZ) buildings designated AZA, AZB, AZC, AZD, four core network room (CNR) buildings, an administrative building, and four Phase 2 activity zone buildings designated AZA, AZB, AZC, AZD. MWH Phases 1 & 2 will have forty (40) 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.

Eight (8) of the 40 combined Phases 1 and 2 engines rated 2.5 MWe will be reserve emergency generators (reserve engines). The words “engine” or “generator” are used synonymously through the remainder of this permit to refer to the overall unit.

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 airflow rate of 143,600 cubic feet per minute (cfm).

1.1. Potential to Emit for Criteria Pollutants and TAPS

Table 1 contains potential to emit (PTE) estimates. To achieve these emissions levels as listed in the permit, the permit 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	33.0	(b),(e)
VOC	(0.19) and Caterpillar based emission factors	1.033	(a),(b),(e)
CO	(3.5) and Caterpillar based emission factors	7.3	(b)
$PM_{2.5}$	(0.03) and Caterpillar based emission factors (See note j for cooling towers)	3.8	(b),(j)
PM_{10}	NA (See note j for cooling towers)	13.6	(f),(j)
SO_2	15 ppm	0.069	(c)
Lead	NA	Negligible	(d)
Ozone	NA	NA	(e)
Toxic Air Pollutants (TAPS)	**Units = lb/MMBTU (except where noted)**		(a)
Primary NO_2	(0.67 g/Kw-hr) and Caterpillar based emission factors.	3.3	(b),(h)
Ammonia	15ppmv	1.14	(b),(g)
Diesel Engine Exhaust Particulate (DEEP)	(0.03 g/kW-hr) and Caterpillar based emission factors	0.814	(b),(f)
Carbon monoxide	(3.5 g/kW-hr) and Caterpillar based emission factors	7.3	(b)
Sulfur dioxide	15 ppm	0.069	(c)
Benzene	7.76E-04	3.5E-03	(i)
Toluene	2.81E-04	1.3E-03	(i)
Xylenes	1.93E-04	8.6E-04	(i)
1,3 Butadiene	3.91E-05	1.8E-04	(i)
Formaldehyde	7.89E-05	3.5E-04	(i)
Acetaldehyde	2.52E-05	1.1E-04	(i)
Acrolein	7.88E-06	3.5E-05	(i)
Benzo(a)Pyrene	2.57E-07	1.2E-06	(i)
Benzo(a)anthracene	6.22E-07	2.8E-06	(i)
Chrysene	1.53E-06	6.9E-06	(i)
Benzo(b)fluoranthene	1.11E-06	5.0E-06	(i)
Benzo(k)fluoranthene	2.18E-07	9.8E-07	(i)
Dibenz(a,h)anthracene	3.46E-07	1.6E-06	(i)
Ideno(1,2,3-cd)pyrene	4.14E-07	1.9E-06	(i)
Napthalene	1.30E-04	5.8E-04	(i)
Propylene	2.79E-03	1.3E-02	(i)

Table 1. Potential To Emit For Phases 1 & 2 (TPY)			
Pollutant	**Emission Factor**	**Facility Potential to Emit**	**References**
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 list of EPA criteria pollutants that have related National Ambient Air Quality Standards (NAAQS). 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 minor New Source Review requirements 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 are 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

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 VOC cold start factor adjustments for these calculations are provided below:

VOC 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 NO_X 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 NO_X spikes during cold starts.

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 NO_X	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 NO_X	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 worst-year scenario with the following set of assumptions:

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

Although this scenario is unlikely and would only occur in one year, Microsoft has shown that 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 MWH 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 40 CFR 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 MWH 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 MWH (0.750 MWe, 2.0 MWe, and 2.5 MWe). Instead, 40CFR60 requires the engines at MWH 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 MWH:

§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, MWH 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 MWH 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 MWH are required to meet the applicable 40 CFR 89 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 MWH 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 MWH Data Center (including for emergency use). In addition to demonstrating compliance 40 CFR 60.4211(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 8.6.3 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. 40 CFR 60.4211(f)(2), allows up to 100 hours of engine operation per calendar year. Per 40 CFR 60.4211(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 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 and test method options outlined in Table 4 of the Approval Order requires a five-load test for PM, NO_X, CO, and VOC. PM is considered to be DEEP at size $PM_{2.5}$ 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).

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).

Ecology also includes the partial dilution probe method from 40 CFR 1065 as an option. Use of this test more closely simulates the test that manufacturers are required to use to meet NSPS requirements, and will potentially reduce testing time compared to other test options. By reducing testing time, engine emissions from stack testing will be reduced.

For this permit, engine selection testing will be determined as follows:

3.1. New Engine Stack Testing

Because Microsoft can utilize multiple engine manufacturer and make options, Conditions 4.2 and 4.3 require testing of at least one engine from each manufacturer and each size engine from each manufacturer, immediately after commissioning any new proposed engine. These conditions apply in addition to the testing Microsoft has performed on existing engines already installed at the time of this permit. Because Microsoft tested multiple 2.5 MWe engines in 2016, Ecology did not require additional 2.5 MWe engine testing except for at least one reserve engine as described in Condition 4.4.9. In addition, Ecology is requiring that at least one 2.0 MWe engine and the 0.75 MWe engine be tested within 12 months of the date of the permit.

3.2. Periodic Stack Testing

Every 60 months after the first testing performed starting with engines tested after the date of this permit, Microsoft shall test at least one 2.5 MWe engine, including the engine with the most operating hours as long as it is a different engine from that which was tested during the previous 60 month interval testing.

3.3. Audit Sampling

According to Condition 4.2, audit sampling per 40 CFR 60.8(g), may be required by Ecology at their discretion. 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, 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."

Although Ecology believes that audit sampling is not necessary for certified engines, Ecology may choose at any time to require audit sampling for any stack tests conducted. Audit sampling could include, but would not necessarily be limited to, the following 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 MWH because of the reasons outlined in this section. BACT cost estimates were updated as of April 2016.

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,

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

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 (NO_X), carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter (PM_{10} and $PM_{2.5}$), and sulfur dioxide (SO_2). BACT for toxics (tBACT) is included in Section 4.5.

4.1. BACT Analysis for NO_X 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 NO_X

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 NO_X 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 NO_X control was compliance with EPA Tier 2 standards using engine design, including exhaust gas recirculation (EGR) or fuel injection timing retard with turbochargers. Other NO_X 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 NO_X emissions by approximately 90 percent.

For SCR systems to function effectively, exhaust temperatures must be high enough (about 200 to 500°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 NO_X reduction. SCR systems are costly. Most SCR systems operate in the range of 290°C to 400°C.

[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.

Platinum catalysts are needed for low temperature range applications (175°C–290°C); zeolite can be used for high temperature applications (560°C); and conventional SCRs (using vanadium pentoxide, tungsten, or titanium dioxide) are typically used for temperatures from 340°C to 400°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 have a lower cost range of approximately $12,000 to $16,000 per ton of NO_X removed from the exhaust stream each year; or higher, if taking into account California Area Resource Board (CARB) estimated operation, labor, and maintenance 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 $24,000 to $33,700 for NO_X alone or $20,000 to $28,800 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 NO_X 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 NO_X that currently have NAAQS is NO_2. Cost per ton removal of NO_2 is an order of magnitude more expensive than for NO_X, and is addressed under tBACT in Section 4.5.

Therefore, Ecology agrees with the applicant that this NO_X 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 MWH 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 NO_X 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 NO_X 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 NO_XOUT uses urea, and has achieved 50–70 percent NO_X reduction. Because the SNCR system does not use a catalyst, the reaction between ammonia and NO_X occurs at a higher temperature than with an SCR, making SCR applicable to more combustion sources. Currently, the preferred technology for back-end NO_X 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 NO_X 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 NO_X. 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 NO_X control of reciprocating internal combustion engine (RICE) diesel applications appears to be SCR with a system to convert urea to ammonia. See also Section 4.2.1.3 (Three-Way Catalysts).

4.1.1.3.3. Water injection

Water injection is considered a NO_X formation control approach and not a back-end NO_X control technology. It works by reducing the peak flame temperature and therefore reducing NO_X 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 NO_X adsorbers, RAPER-NO_X, ozone injection, and activated carbon absorption.

- **NO_X Adsorbers:** NO_X adsorbing technologies (some of which are known as $SCONO_X$ or EMx^{GT}) use a catalytic reactor method similar to SCR. $SNONO_X$ 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 NO_2, which can be adsorbed onto the potassium carbonate. While this technology can achieve NO_X reductions up to 90 percent (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-NO_X:** This technology consists of passing exhaust gas through cyanic acid crystals, causing the crystals to form isocyanic acid, which reacts with the NO_X to form CO_2, 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 NO_2 and further to NO_3. NO_3 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 NO_X is in attainment in many areas of the United States (including Quincy, WA), the primary reason to control NO_X is that 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 NO_X from diesel engine exhaust. However, it is not progressing to commercialization and is therefore rejected.

4.1.2. BACT determination for NO_X

Ecology determines that BACT for NO_X 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 PM, CO, and 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

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 percent 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 $304,000 to $352,000 per ton of engine exhaust particulate removed from the exhaust stream at MWH each year. DPFs also remove CO and VOCs at costs of approximately $76,000 to $131,000 and $440,000 to $614,000 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 $53,500 to $82,900 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 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 2.5 MWe generator; add scaled amounts of $25,299 for a single 0.750 MWe generator, and $45,571 for four 2.0 MWe generators). For forty (40) 2.5 MWe generators, four (4) 2.0 MWe generators, and one (1) 0.750 MWe generators, this amounts to $2,291,585. According to the vendor, DOC control efficiencies for this unit are CO, HC, and PM are 90%, 80%, and 20%, respectively.

- The subtotal becomes $2,555,117 after accounting for shipping ($114,579), WA sales tax ($148,953), and direct on-site installation ($63,878).

- After adding indirect installation costs, the total capital investment amounts to $3,092,383. 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 $321,639.

- At the control efficiencies provided from the vendor, the annual tons per year (tpy) of emissions for CO (11.6 tpy), HC (2.26 tpy), and PM (3.07 tpy) become 10.4 tpy, 1.8 tpy, and 0.61 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 ($321,639 divided by 10.4 tpy for CO, etc.).

The corresponding annual DOC cost-effectiveness value for CO destruction alone is approximately $30,800 to $40,500 per ton. If PM and hydrocarbons were individually considered, the cost-effectiveness values would be equal to or exceed $524,000 and $178,000 per ton of pollutant removed annually, respectively. If the cost-effectiveness of using DOC is evaluated using the total amount of CO, PM, and hydrocarbons reduced, the cost estimate would be approximately $25,000 to $40,500 per 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.

4.2.1.3. Three-way catalysts

Three-way catalyst (TWC) technology can control CO, VOC, and NO_X in gasoline engines. However, Ecology concludes that a three-way catalyst is not feasible for this project and can be rejected as BACT based on a review of the following literature:[3]

> "The TWC catalyst, operating on the principle of non-selective catalytic reduction of NOx by CO and HC, requires that the engine is operated at a nearly stoichiometric air to-fuel (A/F) ratio… In the presence of oxygen, the three-way catalyst becomes ineffective in reducing NOx. For this reason, three-way catalysts cannot be employed for NOx control on diesel applications, which, being lean burn engines, contain high concentrations of oxygen in their exhaust gases at all operating conditions."

4.2.2. BACT determination for PM, CO, and VOC

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 SO_2

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).

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[3] DieselNet, an online information service covering technical and business information for diesel engines, published by Ecopoint Inc. of Ontario, Canada (https://www.dieselnet.com).

4.3.2. BACT determination for SO_2

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 MWH 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 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 ($PM_{2.5}$), and 56 percent will be smaller than PM_{10} (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 February 26, 2014, incompleteness letter for the original January 2014 Microsoft “Oxford” application (the name at the time); 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 MWH, 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 MWH 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 percent, 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 MWH. 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 MWH. 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 MWH.

4.5. Best Available Control Technology for Toxics

Best Available Control Technology for Toxics (tBACT) means BACT, as applied to TAPs.[4] 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 ppmvd at 15 percent oxygen (O_2) 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 (DEEP) is estimated to be $300,000 per ton removed.

[4] WAC 173-460-020.

- The minimum estimated cost to control NO_2 is estimated to be $116,000 per ton removed.
- The minimum estimated cost to control CO is estimated to be $31,000 per ton removed.
- The minimum estimated costs to control acrolein, which could be treated with the VOC treatment listed under BACT, are estimated to be greater than approximately $200 million per ton.
- The minimum estimated costs to control benzene, which could be treated with the VOC treatment listed under BACT, are estimated to be greater than approximately $2 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.

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

Table 4.5. tBACT Determination	
Toxic Air Pollutant	**tBACT**
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 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 2.5 MWe generator was modeled with a stack height of 40 feet above local ground; each 2.0 MWe generator was modeled with a stack height of 40 feet above local ground; the 0.750 MWe generator was modeled with a stack height of 35 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. 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.

5.7. One-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 NO_X ambient ratio of 90 percent.

5.8. As described in the application, AERMOD modeling results showed the highest 1-hour NO_2 impact occurs at the unpopulated northern property line of the facility. In order for the MWH Data Center to exceed the 1-hour NO_2 NAAQS on any given day at any given receptor location, the following events must occur simultaneously:

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

Ecology's stochastic Monte Carlo statistical package was used to evaluate the 8th highest daily 1-hour NO_2 impacts caused by randomly occurring emissions distributed throughout the data center. The stochastic Monte Carlo analysis considered conservatively high occurrences of two runtime events (power outages and maintenance activities).

5.8.1. Power outage – 1-hour NO_2 NAAQS compliance

As described in the application: A conservatively high four calendar days per year of facility-wide power outages (with the 37 primary generators operating at 100 percent load while the eight new reserve generators operate at 10 percent load). In reality, power outages at the Quincy data centers occur infrequently, so a facility-wide power outage is unlikely to actually occur more than one day per year. The emission rates assume every generator is subject to a cold start.

5.8.2. Maintenance – 1-hour NO_2 NAAQS compliance

As described in the application: 16 days per year of electrical bypass maintenance randomly distributed at various locations within the data center (with each day of electrical bypass consisting of four generators at 100 percent load). This frequency is equivalent to two days per year of electrical bypass at each of the eight AZ buildings. That frequency is conservatively high, because Microsoft plans its transformer and switchgear maintenance in a manner so no AZ building is likely to require more than 1 day per year of electrical bypass. Furthermore, Microsoft plans to conduct transformer and switchgear maintenance at each building on a 3-year cycle, rather than annually as modeled for this analysis. The emission rates assume every generator is subject to a cold start.

5.8.3. Monte Carlo results for 1-hour NO_2 NAAQS compliance

Using conservative assumptions, the Monte Carlo model predicts the data center will comply with the 98th percentile NO_2 NAAQS:

- MWH-only 98th percentile impact 100 µg/m3
- Regional plus local background 16 µg/m3
- Cumulative impact 116 µg/m3
- Allowable NAAQS limit 188 µg/m3

Using more realistic operation assumptions, the Monte Carlo model predicts the data center will comply with an even greater margin below the 98th percentile NO_2 NAAQS:

- MWH-only 98th percentile impact 27 µg/m3
- Regional plus local background 16 µg/m3
- Cumulative impact 43 µg/m3
- Allowable NAAQS limit 188 µg/m3

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

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

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/m³ NAAQS(d) Primary	Standards in µg/m³ NAAQS(d) Secondary	Maximum Ambient Impact Concentration (µg/m³)	AERMOD Filename	Background Concentrations (µg/m³) (a)	Maximum Ambient Impact Concentration Added to Background (µg/m³) (If Available)
Particulate Matter (PM_{10})						
1st-Highest 24-hour average during power outage with cooling towers	150	150	26.6	PM10_081915	89	116
Particulate Matter ($PM_{2.5}$)						
Annual average	12	15	0.152	DEEP_081815	6.75	6.9
1st-highest 24-hour average for cooling towers and electrical bypass	35	35	8.4	PM25_081915(a-e)	21.7	30.2
Carbon Monoxide (CO)						
8-hour average	10,000		205	CO_081915	482	687
1-hour average	40,000		421	CO_081915	842	1,263

Criteria Pollutant	Standards in µg/m³ NAAQS(d) Primary	Secondary	Maximum Ambient Impact Concentration (µg/m³)	AERMOD Filename	Background Concentrations (µg/m³) (a)	Maximum Ambient Impact Concentration Added to Background (µg/m³) (If Available)
Nitrogen Oxides (NO_2)						
Annual average (b),(c)	100	100	19.4	NO2_081915	2.8	22.2
1-hour average	188	--	100	NO2-NAAQS Monte Carlo	16	116
Sulfur Dioxide (SO_2)						
3-hour average	--	1,300	NA	NA	NA	<1,300
1-hour average	195	--	NA	NA	NA	<195

Toxic Air Pollutant	ASIL (µg/m³)	Averaging Period	1st-Highest Ambient Concentration (µg/m³)	AERMOD Filename
DEEP	0.00333	Annual average	0.152	DEEP_081815
NO_2	470	1-hour average	606	NO2_081915
CO	23,000	1-hour average	1,263	CO_081915
Ammonia	70.8	24-hour average	25	CO_081915
Acrolein	0.06	24-hour average	0.001	CO_081915
Benzene	0.0345	Annual Average	0.001	CO_081915

Notes:
N/A = not applicable and/or not provided
µg/m³ = 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.
(b) For 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) 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.
(d) Ecology interprets compliance with the National Ambient Air Quality Standards (NAAQS) as demonstrating compliance with the Washington Ambient Air Quality Standards (WAAQS).

Microsoft has demonstrated compliance with the NAAQS and 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 DEEP and NO_2 from the thirty-seven (37) MWH engines exceed the regulatory trigger level for TAPs (also called an ASIL). A second tier review was required for DEEP and NO_2 in accordance with WAC 173-460-090, and MWH was required to prepare a health impact assessment (HIA). The HIA presents an evaluation of both noncancer hazards and increased cancer risk attributable to MWH's increased emissions of all identified carcinogenic compounds (including DEEP, NO_2, and numerous other constituents), ammonia, carbon monoxide, benzene, and acrolein. MWH also reported the DEEP and NO_2 cumulative risks associated with MWH and prevailing sources in their HIA document based on a cumulative modeling approach. The MWH cumulative risk study is based on proposed generators, nearby existing permitted data center sources, and other background sources including highways and railroads. The MWH 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 45 generators and 32 cooling towers will not have an adverse impact on air quality. Ecology finds that Microsoft's MWH Data Center has satisfied all requirements for NOC approval.