TECHNICAL SUPPORT DOCUMENT
FOR PRELIMINARY DETERMINATION
SABEY INTERGATE QUINCY, DATA CENTER
NOVEMBER 16, 2015

1. PROJECT DESCRIPTION

On October 7, 2014, the Washington State Department of Ecology (Ecology) received a Notice of Construction (NOC) application submittal from the Sabey Intergate Quincy, LLC., Intergate-Quincy Data Center (Sabey) located at 2200 M Street NE, Quincy, WA. Sabey is requesting approval for revisions to the August 26, 2011 Approval Order No. 11AQ-E424 (previous permit). The NOC application was determined to be incomplete and, on December 5, 2014, Ecology issued an incompleteness letter to Sabey. On March 5, 2015, Sabey provided a revised NOC application (Sabey's application) and a revised Second Tier Risk Analysis to Ecology. Sabey provided Ecology with supplemental information on March 12, April 1, April 2, May 6, May 22, and June 5, 2015. Sabey's application and Second Tier Risk Analysis were considered completed on June 23, 2015. Ecology has concluded that this project has satisfied all requirements of a second tier analysis.

The primary air contaminant sources at the facility consist of forty-four (44) electric generators powered by diesel engines to provide emergency backup power to the facility. Sabey data center space will be leased to independent tenants companies that require fully supported data storage and processing space. The project will be phased in over several years depending on customer demand. The phased project will include construction of 3 buildings, i.e., Phase 1, Phase 2, and Phase 3. Phase 1 construction of approximately 135,257 square feet (ft^2) Building C began under the previous permit, and houses ten of twelve planned electric generators with up to 2.0 Megawatts (MWe) capacity per engine. Phases 2 and 3 will include two additional buildings (Buildings A and B) each with approximately 186,660 ft^2 of space, and will each house sixteen electric generators of up to 2.0 Megawatts (MWe) per engine. Upon final build-out of all three Phases, Sabey will consists of forty-four (44) electric generators with a total capacity of up to approximately 88 MWe using a combination of Caterpillar, Cummins, and MTU engines with up to 2.0 MWe capacity per engine.

Sabey will also include 176 Munters Model PV-W35-PVT cooling units or equivalents to dissipate heat from electronic equipment at the facility. The cooling units are a source of particulate matter. Each of the units has a design recirculation rate of 80 gallons per minute (gpm) and an air flow rate of 21,000 cubic feet per minute (cfm).

Cooling system particulate matter emissions were calculated based on design and operating parameters for 176 Munters Model PV-W35-PVT. The cooling tower emissions contained in Table 1 has been overestimated by a factor of three times based on actual water usage calculations by the manufacturer.

1.1 Potential To Emit For Criteria Pollutants And Toxic Air Pollutants (TAPs)

Table 1 contains potential-to-emit (PTE) estimates for the diesel engines and cooling system pollutants at Sabey.

Table 1. Potential To Emit For Diesel Engine and Cooling Tower Emissions

Pollutant	Emission Factor	Facility Potential to Emit	References
Criteria Pollutants	**Units = lbs/hr (except where noted)**	**(TPY)**	**(a)**
NOx Total	18.9	23.9	Average of loads
NOx 100% load	41.9	na	(b)
NOx 75% load	22.5	na	(b)
NOx 50% load	15.3	na	(b)
NOx 25% load	9.4	na	(b)
NOx 10% load	6.49	na	(b)
VOC Total	1.0	1.43	Average of loads
VOC 100% load	0.91	na	(b)
VOC 75% load	1.11	na	(b)
VOC 50% load	1.13	na	(b)
VOC 25% load	0.95	na	(b)
VOC 10% load	1.0	na	(b)
CO Total	9.4	11.9	Average of loads
CO 100% load	16.9	na	(b)
CO 75% load	12.7	na	(b)
CO 50% load	8.75	na	(b)
CO 25% load	4.8	na	(b)
CO 10% load	4.05	na	(b)
PM	See DEEP and cooling tower emissions		(f)
SO_2	15 ppm	0.028	(c)
Lead	NA	Negligible	(d)
Ozone	NA	NA	(e)
Toxic Air Pollutants (TAPS)	**Units = Lbs/MMbtu (except where noted)**		(a)
Primary NO_2	10% total NOx	2.39	See NOx
Diesel Engine Exhaust Particulate (DEEP) Total	0.35 lb/hr	0.408	Average of loads
DEEP 100% load	0.23 lb/hr	na	(b)
DEEP 75% load	0.22 lb/hr	na	(b)
DEEP 50% load	0.27 lb/hr	na	(b)
DEEP 25% load	0.57 lb/hr	na	(b)
DEEP 10% load	0.45 lb/hr	na	(b)

CO	16.9 lb/hr	11.9	See CO
SO_2	15 ppm	0.028	(c)
Propylene	2.79E-03	4.2E-02	(g)
Acrolein	7.88E-06	1.9E-04	(g)
Benzene	7.76E-04	1.9E-02	(g)
Toluene	2.81E-04	5.08E-03	(g)
Xylenes	1.93E-04	3.49E-03	(g)
Napthalene	1.30E-04	3.1E-03	(g)
1,3 Butadiene	1.96E-05	4.7E-04	(g)
Formaldehyde	7.89E-05	1.43E-03	(g)
Acetaldehyde	2.52E-05	4.55E-04	(g)
Benzo(a)Pyrene	2.57E-07	2.32E-06	(g)
Benzo(a)anthracene	6.22E-07	1.12E-05	(g)
Chrysene	1.53E-06	2.76E-05	(g)
Benzo(b)fluoranthene	1.11E-06	2.01E-05	(g)
Benzo(k)fluoranthene	2.18E-07	1.97E-06	(g)
Dibenz(a,h)anthracene	3.46E-07	3.13E-06	(g)
Ideno(1,2,3-cd)pyrene	4.14E-07	3.74E-06	(g)
Cooling Tower Emissions			
PM10/PM2.5	7,500 mg/liter water concentration	2.32	(h)

(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) Emission factors (EFs) based on Caterpillar not-to-exceed (NTE) data and Tier 2 EFs, whichever is higher. For example, the NOx and PM maximum limits are based on Caterpillar NTE data of 41.9 lb/hr (100% load) and 0.57 lb/hr (25% load) respectively. Whereas the CO maximum limit is based on Tier 2 emission factors because they are higher than Caterpillar NTE data for CO. For CO, outage and combined test loads are at 100% load of 2190kWm. The maximum limit is calculated as follows: 2190 kWm x 3.5 g/kWm-hr x (1 lb/453.6 g).

(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) For this project, all PM emissions, including both the filterable "front-half" and the condensable "back-half" was conservatively considered to be diesel engine exhaust particulate (DEEP).

(g) 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/.

(h) Based on manufacturer (Munters) cooling unit maximum recirculation rate.

1.2 Maximum Operation Scenarios

Sabey's operation assumptions for their permit revision requests as presented in their application are listed table 2 below along with Ecology comments:

Table 2. Sabey Application Revision Requests

Sabey Application Assumptions/Requests	**Ecology Comments**
Short-term Emissions: • Short-term emission rate estimates for particulate matter (PM) and diesel engine exhaust particulate matter (DEEP) are now based on maximum emission rates (from the worst-case condition for DEEP emission under 25 percent load). This is the load at which Caterpillar's data	(a), (e)

indicate mass emission rates for PM are highest. AERMOD modeling for the 24-hour PM10 NAAQS is based on the 2nd-highest 24-hour value. The modeling for the 98th-percentile 24-hour PM2.5 NAAQS was based on the 1st-highest value in order to provide a conservatively high assessment. • Short-term emission rate estimates for nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs), and AP-42 (EPA 1995) gaseous toxic air pollutants (TAPs) are now based on the assumption that the generators always run at the operating load that would emit the maximum amount for these pollutants, which is 100 percent load for NOx and CO and 50% load for VOC, according to emission rates reported by Caterpillar.	
Annual Average Emissions: The annual-average emission rate estimates for PM, DEEP, NOx, CO, VOCs, and TAPs are based on 57.5 operating hours per year with an emission rate derived by averaging those rates reported by Caterpillar for 10 percent, 25 percent, 50 percent, 75 percent, and 100 percent loads. All permitted emissions allowed during a 3-year rolling average period were conservatively assumed to occur in a single 12-month period (as a "maximum theoretical annual emission" rate) to evaluate compliance with all annual National Ambient Air Quality Standards (NAAQS) and the annual Acceptable Source Impact Levels (ASILs). The 70-year average emission rate for DEEP, which is used to evaluate the 70-year DEEP cancer risk, was revised upward to include the initial emissions from generator commissioning and the emissions from periodic stack emission testing.	(a)
Power Outages and AERMOD Dispersion Factors: • Short-term dispersion factors (for averaging periods of 24 hours, 8 hours, or 1 hour) were derived from AERMOD for a runtime condition consisting of a 24-hour power outage, with all generators operating at only 25 percent load (the load at which the PM emission rate is highest). The annual-average dispersion factor was derived for a runtime scenario of all generators operating under random, variable load (between 10 and 100 percent), over the course of the entire year. ➢ AERMOD modeling for the 24-hour PM10 NAAQS is based on the 2nd-highest 24-hour value. For this runtime scenario, it would be theoretically possible to have two power outages per year, each lasting 17.5 hours per outage (35 hours / 2 outages = 15.5 hours/outage). ➢ The modeling for the 98th-percentile 24-hour PM2.5 NAAQS was based on the 1st-highest value in order to provide a conservatively high assessment. For this runtime scenario, it would be theoretically possible to have eight outages per year, each lasting 4.4 hours (35 hours / 8 outages = 4.4 hours/outage). ➢ The 1st-highest 1-hour NO_2 concentrations during a full power outage were modeled to assess compliance with the ASIL. Because a power outage could occur at any time on any day, all 44 new generators were modeled at their assigned loads continuously, for 24 hours per day and 365 days per year for the five years of meteorology used in the analysis. The AERMOD/PVMRM was set to indicate the 1st-highest 1-hour value for each separate modeling year. See also NO2 Limits Remain Unchanged and NO2 Modeling and Ambient Impacts in this table. ➢ For purposes of the statistical "Monte Carlo" analysis used to demonstrate compliance with the 1-hour NO_2 NAAQS it was assumed there would be power outages lasting at least one hour on 4 days per year. See also NO2 Limits Remain Unchanged and NO2 Modeling and Ambient Impacts in this table.	(a)
Cold Start Factors: The short-term and annual emission rates have been updated to account for the "black puff factors" applied to the first 15 minutes during each cold start. Those "black puff factors" were derived from the recent air quality permit application for the Microsoft Project Oxford Data Center (Landau Associates 2014) and correspond to 1.26 for PM and VOC emissions and 1.56 for CO emissions.	(b)
NO2 Limits Remain Unchanged: Sabey will continue to comply with a 1-hour NO2 limit of 990 lbs/hour as was required in the previous permit. This limit was developed by assuming that there would be 44 generators, each 2,000 kWe, operating at 75 percent load. Sabey believes there is a negligible potential for the actual emission rate to approach that limit because they have already installed six generators in Building	(a), (c)

C that are smaller and lower-emitting (1,500 kWe) than the permitted 2,000-kWe generators. Sabey's electrical systems are designed so most of the generators will operate at loads less than 75 percent during an outage. As an additional margin of safety, Sabey's stack emission testing to date has shown the actual NOx emission rates at high load have been much lower than the allowable limit of 41.9 lbs/hour. Therefore, Sabey believes that after full build-out of the data center, the actual NOx emissions will be lower than the 990 lbs/hour limit. Sabey proposed to revise the Approval Order to require keeping records of the calculated actual NOx emission rate during each unplanned outage or scheduled electrical bypass event, to demonstrate compliance with the 990 lbs/hour limit and make it an enforceable limit.	
NO2 Modeling and Ambient Impacts: The 1-hour NO2 impacts during a power outage (for comparison to the ASIL), and the 98th-percentile 1-hour NO2 impacts (for comparison to the NAAQS) were not remodeled. • NO2, as a TAP exceeds the ASIL and is addressed in Sections 5.3 and 6 of this TSD. • Sabey's 2011 Monte Carlo modeling demonstrated compliance with the 98th-percentile NO2 NAAQS with a safety margin. Sabey proposes that by retaining the current operational limits (runtime and load limits) for the most frequent scheduled routine activities (monthly testing and annual load bank testing) that comprise the typical 8th-highest daily NOx emission events each year, will ensure continued compliance with the NAAQS (using the 990 lb/yr limit).	(d)

(a) Ecology accepts this approach because it conservatively overestimates actual emissions.
(b) Ecology accepts the cold start black puff factors derived from the Microsoft Project Oxford Data Center.
(c) See footnote (b) of section 5.3 of this TSD.
(d) See background information about the 2011 Monte Carlo modeling in Section 5.2 of this TSD.
(e) Page 7 of the Sabey application states that VOC max hourly lb/hr emissions are at 100% load. However, table E-1 of application shows highest VOC hourly lb/hr emissions at 50% load. Spreadsheets from applicant titled "Ecology-submittal_ Fully-Flex Average PM-NOx-CO 2-6-2015" tab "T3 Outage+Bypass Emis" (cells B33 and C33) show that the applicant did use the highest hourly VOC lb/hr emissions (50% load) in their emission estimates.

The summary effect of accepting the requests based on the scenarios above is that Sabey has conservatively estimated emissions by assuming the following worst case conditions:

- Instead of load-based emission estimates, Sabey 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.
- Sabey assumed a worst case scenario in which 351,670 gallons of fuel would be used per year, when in reality, the permit limits fuel usage to 263,725 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 Sabey from operating those generators for two years.

2. APPLICABLE REQUIREMENTS

The proposal by Sabey 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 Sabey Data Center is regulated by the requirements specified in:

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

2.1 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 Sabey 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 Sabey (approximately 1.5 MWe to 2.0 MW or less). Instead, 40CFR60 requires the engines at Sabey to meet the Tier 2 emission levels of 40CFR89.112. 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 Sabey:

> *§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.*

Based on information provided by the applicant, Sabey will use engines that will use the following 2007 model year engines or later with 2.0 MWe (or smaller) sizes: Caterpillar Model 3516C rated 2.0 MWe; Caterpillar Model 3512C rated 1.5 MWe; Cummins QSK60-G14 NR2 rated 2.0 MWe; Cummins Inc QSK50-G5 NR2 rated 1.5 MWe; MTU 16V4000G43 rated 2.0 MWe; MTU 12V4000G43 rated 1.5 MWe.

Based on these specifications, each engine's displacement per cylinder were calculated and compared to subpart (b) of §60.4205 as follows:

2.1.1 Caterpillar Engine Model 3516C rated 2.0 MWe

Displacement is not listed among the manufacturer specifications for this engine. However, displacement can be calculated by multiplying the volume of a cylinder by the number of cylinders as follows:

$$\text{Displacement} = (\text{cross-sectional area of cylinder} = \pi r^2) \times (\text{cylinder height}) \times (\#\ \text{cylinders})$$

The bore of an engine represents the cylinder diameter and the stroke represents the cylinder height. Substituting bore/2 for radius, and the stroke height, the equation for calculating the volume of an engine cylinder is:

$$[\text{Cylinder Volume} = \pi/4 \times (\text{bore})^2 \times (\text{stroke})]$$ [1]

Simplifying and using a metric units conversion factor, the equation for total displacement becomes:

$$\text{Displacement} = 0.7854 \times \text{bore(cm)}^2 \times \text{stroke(cm)} \times (\#\ \text{cylinders}) \times (1\ \text{Liter}/1000\ \text{cm}^3)$$

Using this equation, and plugging in the manufacturer specifications for bore (170mm), stroke (190mm), and 16 cylinders, this engine's total displacement and displacement per cylinder are calculated as follows:

$$\text{Total Displacement} = 0.7854 \times (170/10)^2 \times (190/10) \times 16\ \text{cylinders} \times (1/1000)$$

Total Displacement = 69.0 Liters.

$$\text{Displacement per cylinder} = 0.7854 \times (170/10)^2 \times (190/10) \times (1/1000)$$

Displacement per cylinder = 4.31 liters/cylinder.

2.1.2 Caterpillar Engine Model 3512C rated 1.5 MWe

The specification sheet for this engine lists displacement as 51.8 liters, with 12 cylinders total. The single cylinder displacement for this engine is therefore 4.32 liters/cylinder.

2.1.3 Cummins Engine QSK60 rated 2.0 MWe

The specification sheet for this engine lists displacement as 60.1 liters, with 16 cylinders total. The single cylinder displacement for this engine is therefore 3.76 liters/cylinder.

2.1.4 Cummins Engine QSK50 rated 1.5 MWe

The specification sheet for this engine lists displacement as 50.2 liters, with 16 cylinders total. The single cylinder displacement for this engine is therefore 3.14 liters/cylinder.

2.1.5 MTU Engine 16V4000G43 rated 2.0 MWe

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[1] HPBooks Auto Math Handbook., Lawlor, John., The Berkeley Publishing Group, A division of Penguin Putnam Inc. (www.penguinputnam.com), 1992, p. 2.

The specification sheet for this engine lists displacement as 76.3 liters, with 16 cylinders total. The single cylinder displacement for this engine is listed as 4.77 liters/cylinder.

2.1.6 MTU Engine 12V4000G43 rated 2.0 MWe

The specification sheet for this engine lists displacement as 57.3 liters, with 12 cylinders total. The single cylinder displacement for this engine is listed as 4.77 liters/cylinder.

Thus, because Sabey will use engines with a displacement of less than the *§60.4205 (b)* limit of 30 liters per cylinder, and are for emergency purposes only, the engines are therefore 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.***
>
> Thus, based on the power ratings listed in *40 CFR 60.4202(a),* and because the engines to be used at Sabey will also have less than 10 liters per cylinder displacement, the engines are required to meet the applicable 40CFR89 Tier 2 emission standards.

2.2 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 are outlined in Sections 4 of the Approval Order. The five-mode stack testing in Condition 4 of the permit is required to demonstrate compliance with 40CFR89(112 & 113) g/kW-hr EPA Tier 2 average emission limits via the 5 individual operating loads (10%, 25%, 50%, 75% and 100%) according to Table 2 of Appendix B to Subpart E of 40CFR89, or according to any other applicable EPA requirement in effect at the time the engines are installed. For this permit, engine selection testing will be determined as follows:

3.1 NEW ENGINE STACK TESTING:

Because Sabey 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 Sabey has performed on a subset of the 10 engines already installed at the time of this permit.

3.2 PERIODIC STACK TESTING:

Every 60 months after the first testing performed starting with engines tested after the date of this permit, Sabey shall test at least one 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 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

BACT is defined[2] 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.[3] 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.

4.1 BACT ANALYSIS FOR NOx FROM DIESEL ENGINE EXHAUST

Sabey 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

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

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

Sabey'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, and 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.

Sabey has evaluated the cost effectiveness of installing and operating SCR systems on each of the proposed diesel engines by taking into account direct costs (equipment, sales tax, shipping, installation, etc..) and indirect costs (startup, performance tests, etc..). Assuming a mid-range California Area Resource Board (CARB) annual operation and maintenance cost estimate to account for urea, fuel for pressure drop, increased inspections, and periodic OEM visits, the use of SCR systems would cost approximately $37,100 per ton of NOx removed from the exhaust stream each 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 $43,600 for NOx alone or $29,200 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 Sabey 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. See also Section 4.2.1.3 (Three-Way Catalysts).

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 effect 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, could 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, Approval Condition 2.8 in the permit requires that 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. Sabey 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

Sabey 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.

Sabey 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 $1.9 million per ton of engine exhaust particulate removed from the exhaust stream at Sabey each year. DPFs also remove CO and VOCs at costs of approximately $69,500 and $661,100 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 $60,900 per ton of pollutants removed per 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.

Sabey 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 Sabey followed for engines within this application (including for SCR-only, DPF-only, and Tier 4 capable integrated control system technologies).

- Sabey obtained the following recent DOC equipment costs: $30,828 for a stand-alone catalyzed DOC per single 2.0 MWe generator. For thirty two (32) 2.0 MWe generators, this amounts to $986,496. According to the vendor, DOC control efficiencies for this unit are CO, HC, and PM are 80%, 70%, and 20% respectively.
- The subtotal becomes $1,287,442 after accounting for shipping ($49,325), WA sales tax ($64,122), and direct on-site installation ($187,499).
- After adding indirect installation costs, the total capital investment amounts to: $1,502,245. 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 $182,094.
- At the control efficiencies provided from the vendor, the annual tons per year of emissions for CO (11.9 tpy), HC (1.43 tpy), and PM (0.42 tpy) become 9.51 tpy, 1.00 tpy, and 0.08 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 ($182,094 divided by 9.51 tpy for CO, etc..).

The corresponding annual DOC cost effectiveness value for carbon monoxide destruction alone is approximately $19,100 per ton. If particulate matter and hydrocarbons are individually considered, the cost effectiveness values become $2.2 million and $182,000 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 $17,200 per ton of combined pollutants removed per year.

These annual estimated costs (for DOC use alone) provided by Sabey are conservatively low estimates that take into account installation, tax, shipping, and other capital costs as mentioned above, but assume no greater than mid-range CARB estimates for operational, labor and maintenance costs.

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 NOx in gasoline engines, but is only effective for CO and VOC control in diesel engines. According to DieselNet, an online information service covering technical and business information for diesel engines, published by Ecopoint Inc. of Ontario, Canada (https://www.dieselnet.com):

> *"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."*

As noted by the applicant, diesel engine stack tests at another data center in Washington State (Titan Data Center in Moses Lake, WA), showed that TWC control increased the emission rate for nitrogen dioxide (NO2). This technology is therefore rejected as a control option.

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. Sabey 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***

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

4.3.2. ***BACT Determination for Sulfur Dioxide***

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

Because no changes are proposed for cooling tower operations or emission estimates, a BACT analysis was not performed. The following BACT determination from the previous Sabey permit is continued into this permit: "maintaining the water droplet drift rate from cooling systems and drift eliminators to a maximum drift rate of 0.001% of the circulating water flow rate."

4.5 BEST AVAILABLE CONTROL TECHNOLOGY FOR TOXICS

Best Available Control Technology for Toxics (tBACT) means BACT, as applied to toxic air pollutants.[4] For 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 Sabey 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 $1.9 million per ton removed.
- The minimum estimated costs to control NO2 is estimated to be $370,700 per ton removed.
- The minimum estimated costs to control CO is estimated to be $19,100 per ton removed.
- For the other TAPS above SQERs, the minimum estimated costs per ton removed would be as follows: $14 million for benzene; $81 million for naphthalene; $552 million for 1,3-butadiene; and $1.4 billion for acrolein.

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 below represents tBACT for the proposed project.

Table 4 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
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

[4] WAC 173-460-020

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
PAH (no TEF)	Compliance with the VOC BACT requirement
PAH (apply TEF)	Compliance with the VOC BACT requirement
Cooling Tower Emissions (TAPs as PM)	Compliance with 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.

5.1 AERMOD Assumptions:

- 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. [Note: The Engine Operating Restrictions listed in Table 3.2 of the Approval Order were based on 2011 Monte Carlo modeling for the 98th-percentile 1-hr NO2 NAAQS. The 2011 modeling used 2004-2008 meteorological data (see Section 5.2 of this TSD)].
- 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.
- Each generator was modeled with a stack height of 48- feet above local ground.
- The data center buildings, in addition to the individual generator enclosures were included to account for building downwash.
- 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.
- 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%.
- 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.

- AERMOD Meteorological Pre-processor (AERMET) was used to estimate boundary layer parameters for use in AERMOD.
- AERSURFACE was used to determine the percentage of land use type around the facility based on albedo, Bowen ratio, and surface roughness parameters.

5.2 Background Information for 2011 Monte Carlo Modeling

As explained in the TSD for the previous permit, a Monte Carlo statistical analysis was used to determine operational limits to address NO2. Portions of the following information from that TSD are re-presented below and updated as applicable to the current Approval Order.

5.2.1 "Monte Carlo" Statistical Analysis For Demonstrating Compliance with the 1-Hour NO_2 NAAQS

The 1-hour NO_2 NAAQS is based on the 3-year rolling average of the 98th percentile of the daily maximum 1-hour NO_2 impacts. Data centers operate their generators on an intermittent basis under a wide range of engine loads, under a wide range of meteorological conditions. As such it is difficult to determine whether high-emitting generator runtime regimes coincide with meteorological conditions giving rise to poor dispersion, and trigger an exceedance of the 1-hour NO_2 NAAQS at any given location beyond the facility boundary. This issue has been recognized by EPA when they stated that "[m]odeling of intermittent emission units, such as emergency generators, and/or intermittent emission scenarios, such as startup/shutdown operations, has proven to be one of the main challenges for permit applicants undertaking a demonstration of compliance with the 1-hour NO_2 NAAQS".[5]

To address this problem, Ecology developed a statistical re-sampling technique, that we loosely call the "Monte Carlo analysis". This technique performs a statistical analysis of the AERMOD-derived ambient NO_2 impacts caused by individual generator operating regimes, each of which exhibits its own NOx emission rates at various locations throughout the facility. The randomizing function of the Monte Carlo analysis allows inspection of how the combination of sporadic generator operations, sporadic generator emissions at various locations, and variable meteorology affect the modeled 98th-percentile concentrations at modeling receptors placed within the facility and outside the facility boundary.

The first step in the Monte Carlo NO_2 analysis was to use the AERMOD/PVMRM model for each representative generator runtime regime by each tenant at the Sabey facility. To do so, 14 different generator operating regimes proposed by Sabey were each modeled separately with AERMOD, using 5 years of meteorology (2004- 2008). For each of the 14 AERMOD runs, the number of calendar days per year of operation for that generator operating regime was established. To test the effect of initial startup and commissioning testing on ambient air quality, the NOx-emitting scenarios corresponding to the initial startup testing were included in the 2004 meteorological set. For all 5 years of modeling, it was assumed that all of the tenants conducted their scheduled

[5] http://www.epa.gov/ttn/scram/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

maintenance each year. For each of the 5 modeling years, the existing emissions contributed by the existing Ask.com facility were included in the analysis. For each of the 5 modeling years, it was assumed there would be 4 random days on which power outages lasted at least 1 hour.

The Monte Carlo method then randomly selected the days on which the generators operated in each regime, combined the modeled concentrations on those days across all operating regimes and iterated the process 1000 times, so as to obtain a distribution of the possible concentrations at each receptor.

5.2.2 AERMOD Modeling of Individual Runtime Scenarios

In order to conduct the Monte Carlo analysis, the hierarchy of individual generator runtime events was clustered into 15 separate AERMOD runs, which are described in the Table 5. The NOx emissions from the offsite background sources are also listed in Table 5. For each of the 15 independent AERMOD scenarios, the number of calendar days of generator runtime was established. The two yellow-highlighted rows on the right side of Table 5 show the number of calendar days per year of generator runtime for each AERMOD scenario.

Table 5. AERMOD Runs Used for Monte Carlo Analysis

Tenant	No. of Installed Gens	Runtime Regime	Monte Carlo Days/yr	Day of Regime	% Load	kWm	No. Running Gens	Hrs/Day	kWmhrs/ day	E.F.	Nox lbs/hour	Monte Carlo AERMOD Run	Monte Carlo Days/yr
All	44	Full Power Outage, 75% Load	4	1	75%	1650	44	1	72600	6.2	991	1	4
Bldg B	16	Bldg B Main Switchgear	1		75%	1650	16	1	26400	6.2	361	2	1
B-1	8	Startup: Int. Sys Test Day 2	1		75%	1650	8	1	13200	6.2	180	3	1
C-3	6	Transf. Maint., 75%	2	1	75%	1650	2	1	3300	6.2	45.1	4	2
A-1	8	Transf. Maint., 75%	2	1	75%	1650	2	1	3300	6.2	45.1	5	2
A-2	8	Transf. Maint., 75%	2	1	75%	1650	2	1	3300	6.2	45.1	6	2
B-2	4	Transf. Maint., 75%	2	1	75%	1650	2	1	3300	6.2	45.1	7	2
C-1	3	Annual Test, 100% load		1	100%	2191		1	2191	8.68			
C-2	3	Annual Test, 100% load		1	100%	2191		1	0	8.68			
C-3	6	Annual Test, 100% load	12	1	100%	2191	1	1	0	8.68	41.9	8	12
A-1	8	Annual Test, 100% load		1	100%	2191		1	2191	8.68			
A-2	8	Annual Test, 100% load	16	1	100%	2191	1	1	0	8.68	41.9	9	16
B-1	8	Annual Test, 100% load		1	100%	2191		1	2191	8.68			
B-2	4	Annual Test, 100% load		1	100%	2191		1	0	8.68			
B-3	4	Annual Test, 100% load		1	100%	2191		1	0	8.68			
B-1	4	Startup: Mfr Testing Day 1			100%	2191		1	0	8.68			
B-1	4	Startup: Funct. Perf Test	24		100%	1135	1	1	0	8.68	41.9	10	24
C-1	3	Montly Test, 50% Load		1	50%	1135		1	1135	6.12			
C-1	3	Corrective Testing, 50% load		1	50%	1135		1	0	6.12			
C-2	3	Montly Test, 50% Load		1	50%	1135		1	0	6.12			
C-2	3	Corrective Testing, 50% load		1	50%	1135		1	0	6.12			
C-3	6	Montly Test, 50% Load		1	50%	1135		1	0	6.12			
C-3	6	Corrective Testing, 50% load	45	1	50%	1135	1	1	0	6.12	15.3	11	45
A-1	8	Montly Test, 50% Load		1	50%	1135		1	1135	6.12			
A-1	8	Corrective Testing, 50% load		1	50%	1135		1	0	6.12			
A-2	8	Montly Test, 50% Load		1	50%	1135		1	0	6.12			
A-2	8	Corrective Testing, 50% load	38	1	50%	1135	1	1	0	6.12	15.3	12	38
B-1	8	Montly Test, 50% Load		1	50%	1135		1	1135	6.12			
B-1	8	Corrective Testing, 50% load		1	50%	1135		1	0	6.12			
B-2	4	Montly Test, 50% Load		1	50%	1135		1	0	6.12			
B-2	4	Corrective Testing, 50% load		1	50%	1135		1	0	6.12			
B-3	4	Montly Test, 50% Load		1	50%	1135		1	0	6.12			
B-3	4	Corrective Testing, 50% load		1	50%	1135		1	0	6.12			
B-1	4	Startup: Int. Sys Test Day 1	53		50%	1135	1	1	0	6.12	15.3	13	53
CELITE	1	Continuous Operation	365		--		--				8.6	14	365
Intuit	9	Outage			90%		7				200		
Yahoo	23	Outage	8		90%		19				544	1	4
Intuit	9	Annual tests			100%		1				32.0		
Yahoo	23	Annual tests	15		100%		1				32.0	15	15

5.2.3 Monte Carlo NO_2 Results

The results of the Monte Carlo analysis are listed in Table 6. For each modeling year, the Monte Carlo analysis lists the 98^{th}-percentile daily 1-hour NO_2 concentration at the maximally impacted receptor. Compliance is demonstrated by the median value of the five modeling years. As listed in Table 6, the maximum impact at or beyond the Sabey property line (or on the tenant building rooftops) is 111 μg/m^3. Figure 1 shows the location of that maximally impacted receptor, which is on the east property line in unpopulated industrially-zoned land roughly midway between the northeast and southeast property corners.

Table 6. Monte Carlo NO_2 Results

Receptor Location	98^{th}-Percentile Daily 1-Hour NO_2, ug/m3					
	2004	**2005**	**2006**	**2007**	**2008**	**Median (2004-2008)**
Property Line and Beyond (Eastern property line)	114	111	108	108	111	111
Within Sabey Property (rooftop of Tenant A-2)	63	63	63	62	59	63

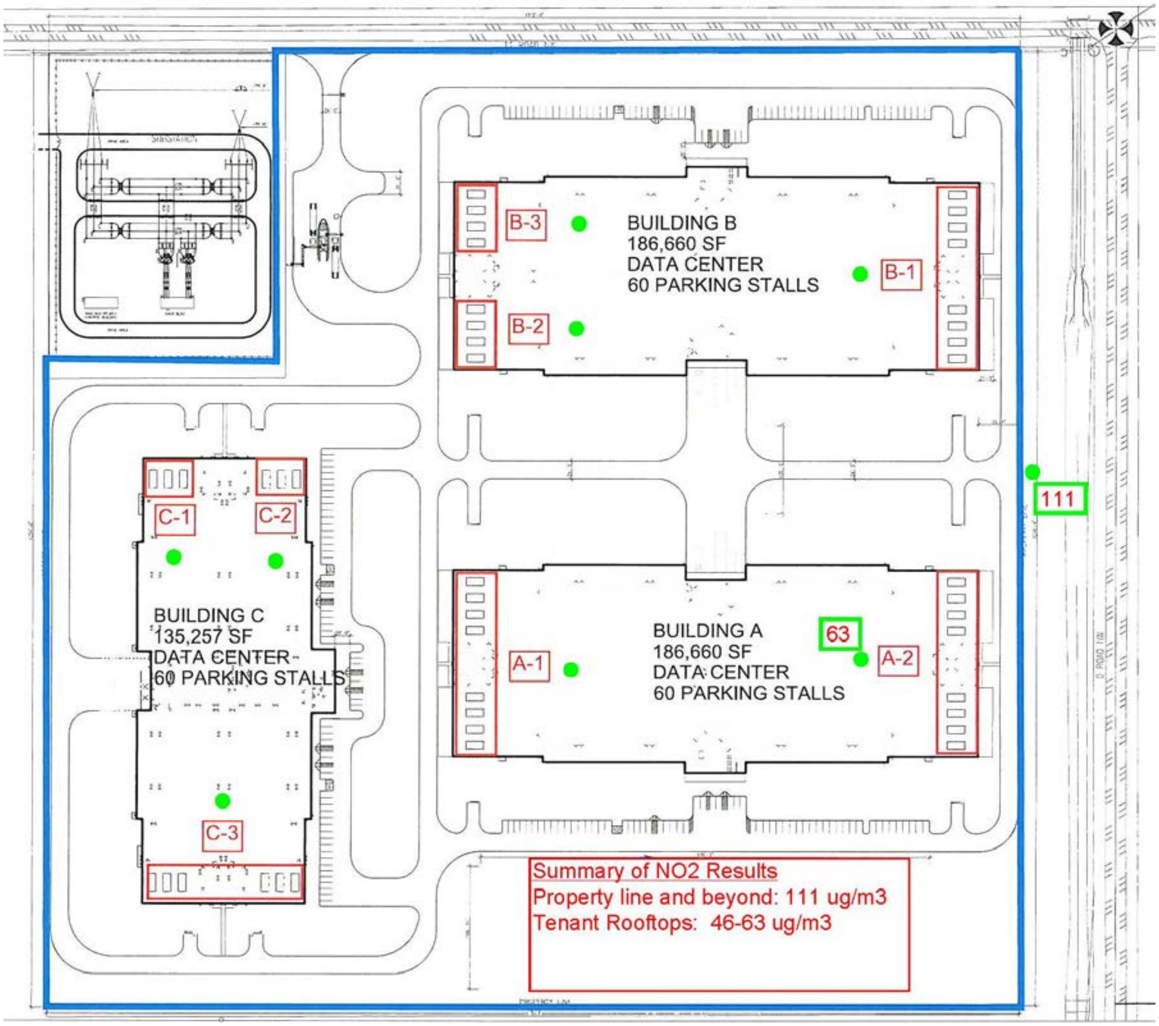

Figure 1. Locations of Maximum Modeled 98th-Percentile 1-Hour NO_2 Impacts.

5.2.4 Updates to 2011 Monte Carlo Results

Between 2011 and the time of this permit preparation, another data center (Vantage) has been constructed to the north of Sabey. In addition, available updated regional background emissions of 15.6 ug/m3were used.[6] Sabey also assumed that Vantage emissions would contribute up to an additional 10% of the total Monte Carlo maximum impact of 111 ug/m3 or 11 ug/m3. Based on 2012 Vantage AERMOD modeling performed by consultant ICF International, this is a conservatively high estimate. According to the 2012 modeling, local 1-hour NO2 background at the maximum Vantage receptor caused by combined data center emissions from nearby Sabey, Yahoo, and Intuit data centers was only 0.02 ug/m3. The combined emissions from Sabey and regional sources would be as follows:

Impact from Sabey and Offsite-Sources	122 $\mu g/m^3$ (111 $\mu g/m^3$ +11 $\mu g/m^3$ Vantage)
Regional Background:	15.6 $\mu g/m^3$
Total NO_2 Concentration	148.6 $\mu g/m^3$
Allowable NAAQS:	188 $\mu g/m^3$

Consistent with the 2011 Monte Carlo results, Sabey could emit up to approximately 160 ug/m3 (161.4 ug/m3) and still be in compliance with the 1-hr NO2 NAAQS of 188 ug/m3 (15.6ug/m3 + 11ug/m3 + 161.4 ug/m3 = 188 ug/m3 ≤ 188 ug/m3). Considering Sabey's conservative Vantage background emission estimate of 11 ug/m3, it is possible that Sabey emissions above 161.4 ug/m3 would still be in compliance with the NAAQS. However, Sabey has agreed to use the conservative Vantage background estimate as a safety buffer for compliance with the 1-hr NO2 NAAQS.

Based on this analysis, it is concluded the intermittent NOx emissions from the Intergate-Quincy Data Center, combined with the emissions from other local sources and regional background, would not cause ambient impacts exceeding the allowable NAAQS limit at any point at or beyond the fenced facility boundary or on the tenant building rooftops within the facility. As shown in Table 5, the lb/hr emission rate at which the 1-hr NO2 NAAQS is met, is at 991 lb/hr. For this reason, Approval Order Condition 8.4 places a limit on NOx at 990 lb/yr.

[6] Provided by Washington State University, Northwest International Air Quality Environmental Science and Technology Consortium, NW AIRQUEST, Lookup 2009-2011 design values of criteria pollutants. Lookup values from the NW AIRQUEST website on June 3, 2015: http://lar.wsu.edu/nw-airquest/lookup.html

5.3 Ambient Impact Results

Except for diesel engine exhaust particulate (DEEP) and NO2 which are predicted to exceed its ASIL, AERMOD model results show that no NAAQS or ASIL will be exceeded at or beyond the property boundary. The applicant's modeling results are provided below:

Criteria Pollutant	Standards in μg/m³ NAAQS(e) Primary	Standards in μg/m³ NAAQS(e) 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	45.1	DEEP_011915	85.0	130.2 (c)
Particulate Matter ($PM_{2.5}$)						
Annual average (d)	12	15	0.327 (c)	DEEP_011515	6.5	6.8 (c)
1st-highest 24-hour average for cooling towers and electrical bypass	35	35	12.1	DEEP_011915	22.2	34.3 (c)
Carbon Monoxide (CO)						
8-hour average	10,000 (9 ppm)		3,014	DEEP_011915	482	3,496
1-hour average	40,000 (35 ppm)		6,223	DEEP_011915	842	7,065
Nitrogen Oxides (NO_2)						
Annual average (d)	100 (53 ppb)	100	15.8	2011 Monte Carlo files	2.8	18.6
1-hour average	188 (100 ppb)	--	161 (max allowed) (b)	2011 Monte Carlo files	26.6 [15.6 regional + 11 local (Vantage)]	<188
Sulfur Dioxide (SO_2)						
3-hour average	--	1,300 (0.5 ppm)	See note (f)			
1-hour average	195 (75 ppb)	--	See note (f)			

Toxic Air Pollutant	ASIL (μg/m³)	Averaging Period	1st-Highest Ambient Concentration (μg/m³)	AERMOD Filename
DEEP (d)	0.00333	Annual average	0.307	DEEP_011515
NO_2	470	1-hour average	960	(b)
CO	23,000	1-hour average	7,065	DEEP_011915

S02	660	1-hour average	See note (f)	
Acrolein	0.06	24-hour average	0.017	DEEP_011915
Benzene (d)	0.0345	Annual Average	0.012	DEEP_011515
1,3-Butadiene (d)	0.00588	Annual Average	0.00031	DEEP_011515
Naphthalene (d)	0.0294	Annual Average	0.0021	DEEP_011515

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 include emissions from: proposed generators, nearby data centers, and other background sources including highways and the Railroad (see Section 6 of this TSD).
(b) 1-hour NO2 criteria pollutant emissions to be kept below 990 lbs/year to comply with NAAQS. Approval Condition 8.4 includes language to monitor this emission limit requirement. See Section 6 regarding NO2 as a TAP.
(c) The PM values take into account the following very small and yet very conservative estimated values of: 0.0996 ug/m3 for the 24-hour average (using 0.4 scale factor from conservative 1-hour estimate), and 0.0199 ug/m3 for the annual average (using 0.08 scale factor from conservative 1-hour estimate). Scale factors are from California Air Resources Board (CARB) *Appendix H Recommendations for Estimating Concentrations of Longer Averaging Periods from the Maximum One-Hour Concentration for Screening Purposes* http://www.arb.ca.gov/toxics/harp/docs/userguide/appendixH.pdf
(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) Based on nearby data center (Microsoft Oxford) S02 annual emissions of 0.047 tpy, which are estimated through modeling to cause ambient impacts of 5.7 ug/m3 (1-hr avg) and 4.4 ug/m3 (3-hr avg), Sabey, with emissions of 0.028 tpy are expected have ambient impacts far below the NAAQS. Sabey was not required to model SO2 for comparison to the ASIL because estimated emissions of 0.006 lb/hr (0.028 tpy) are below the WAC 173-460-150 small quantity emission rate of 0.457 lb/hr (2.0 tpy).

Sabey has demonstrated compliance with the national ambient air quality standards (NAAQS) and acceptable source impact levels (ASILs) except for DEEP and NO2. As required by WAC 173-460-090, emissions of DEEP and NO2 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) and NO2 from the forty-four (44) Sabey 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 and NO2 in accordance with WAC 173-460-090, and Sabey 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 Sabey's increased emissions of identified carcinogenic compounds. 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 Sabey's proposal in a community-wide basis, even though it is not required to do so by state law. Sabey reported the cumulative risks associated with Sabey and prevailing sources in their HIA document based on a cumulative modeling approach. The Sabey cumulative risk study is based on proposed generators, nearby data centers, and other background sources including highways and railroads.

Because Sabey requests that the 1st-highest NOx emission rate be retained at the current limit of 990 lbs/hour (or 99 lb/hr of NO2 per Condition 5.7 of Approval Order), Ecology's 2011 Technical Support Document for Second Tier Review of NO2 does not need to be repeated but can be re-used to satisfy this permit revision. The Sabey DEEP 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 44 generators and 176 cooling units will not have an adverse impact on air quality. Ecology finds that Sabey's Data Center has satisfied all requirements for NOC approval.

******END OF SABEY TSD** ****