TECHNICAL SUPPORT DOCUMENT
FOR PRELIMINARY DETERMINATINO FOR APPROVAL ORDER NO. 16AQ-E012, AMENDMENT 1

YAHOO HOLDINGS, INC. DATA CENTER
xx, 2017

1. PROJECT DESCRIPTION

On October 19, 2015, the Washington State Department of Ecology (Ecology) received a Notice of Construction (NOC) application submittal from the Yahoo Holdings, Inc. Data Center (Yahoo), located at 1010 Yahoo Way, and 1500 M Street NE Quincy, WA. Yahoo requesting approval for revisions to the March 28, 2011 Approval Order No. 11AQ-E399 (previous permit) which covers the existing Yahoo Quincy Data Center facilities. The October 19, 2015 application was for additional engines referred to as Project Genesis. Project Genesis is located adjacent to and is considered a part of the existing Yahoo data center structures at this location. The NOC application requested a new permit to cover existing Yahoo data center facilities in addition to Project Genesis. The existing Yahoo data centers facilities and Project Genesis are referred hereafter as Yahoo or Yahoo Quincy Data Center. The NOC application was determined to be incomplete and, on November 19, 2015, Ecology issued an incompleteness letter to Yahoo. On December 7, 2015, Yahoo provided supplemental NOC and Second Tier Risk Analysis information to Ecology. Yahoo's NOC application and Second Tier Risk Analysis were considered complete on December 23, 2015. Ecology has concluded that this project has satisfied all requirements of a second tier analysis. Yahoo submitted an administrative amendment application, received by Ecology engineers on June 13, 2017. The amended permit includes revisions to installation scheduling, updates to the facility name, and also minor corrections for consistency with the December 23, 2015 application. The application was considered complete on July 11, 2017. For the purposes of scheduled phasing of Project Genesis engines, initial phase engine Unit ID #14, is not a Project Genesis engine, but is included in the Genesis phased schedule because it was not yet installed at the time of the June 2017, application.

The primary air contaminant sources at the facility consist of a total of 23 existing and 25 new electric generators powered by diesel engines to provide emergency backup power to the facility. The existing 23 generators/engines (engines) and related facilities (cooling towers, building etc…) were permitted under Approval Order 11AQ-E399 and are incorporated into this new Approval Order along with Project Genesis. Project Genesis consists of direct evaporative cooling units, air cleaning systems, boiler heating, a 196,969 square feet building complex, along with the 25 new engines. 20 of the new engines will provide the main data center support and will be rated at 2.0 megawatt electrical capacity (MWe). The data center will also have 4 reserve engines rated at 2.75 MWe and 1 administrative support engine rated at 2.75 MWe. Upon final build-out, Yahoo will consist of forty-eight (48) electric generators with a total capacity of up to approximately 99.75 MWe using a combination of Caterpillar, Cummins, and MTU engine options.

The existing engines R through 12 are supported by 6 Evapco Model USS 212-636 cooling units to dissipate heat from electronic equipment at the facility. Each unit has two cooling towers and two fans. Each tower has a design recirculation rate of 2,460 gallons per minute (gpm) and an air flow rate of 290,700 cubic feet per minute (cfm). Project Genesis will also include direct evaporative cooling units or equivalents. The cooling units for engines 13 through R3 and Project Genesis are not a source of air emissions.

To avoid Title V major thresholds of Nitrogen Oxides (NOx), and Nitrogen Dioxide (NO2), this facility requested that existing generators R through 12 reduce allowable annual hours from 200 to 100 hours. The facility is considered a synthetic minor source as described in footnote k of Table 1.1.

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

Table 1.1 contains potential-to-emit (PTE) estimates in tons per year (TPY) by the applicant for Project Genesis and for entire Yahoo facility (including Project Genesis).

Table 1 Total Facility and Project Genesis(j) Potential To Emit Estimates					
Pollutant	**Emission Factor (for the engine rating listed)**			**Total Facility PTE (Project Genesis PTE)**	**References**
Criteria Pollutants	**Units = lbs/hr; except where noted**			**TPY**	**(a)**
NOx	6.12 g/kW-hr	44.34 (2.0 MWe)	74.40 (2.75 MWe)	95 (62.9)	(b),(k)
VOC	0.28 g/kW-hr	1.14 (2.0 MWe)	2.91 (2.75 MWe)	2.8 (1.9)	(b)
CO	3.5 g/kW-hr	5.02 (2.0 MWe)	14.30 (2.75 MWe)	17.9 (8.8)	(b)
Total PM10/PM2.5 (filterable and condensable)	See DEEP and cooling tower emissions for specific contributions			7.6 (3.44)	(f),(i)
SO_2	15 ppm			0.025 (0.0001)	(c)
Lead	NA			Negligible (Negligible)	(d)
Ozone	NA			NA (NA)	(e)
Toxic Air Pollutants (TAPS)	**Units = Lbs/MMbtu (except where noted)**			**TPY**	(a)
Primary NO_2	10% of NOx			9.5 (6.3)	See NOx
DEEP	0.20 g/kW-hr	0.88 lbs/hr (2.0 MWe)	0.91 lbs/hr (2.75 MWe)	1.8 (1.12)	(b),(i)

CO	3.5 g/kW-hr	17.9 (8.8)	(b)
SO_2	15 ppm	0.025 (0.0001)	(c)
Propylene	2.79E-03	1.3E-01 (7.7E-02)	(g)
Acrolein	7.88E-06	3.5E-04 (2.2E-04)	(g)
Benzene	7.76E-04	3.5E-02 (2.2E-02)	(g)
Toluene	2.81E-04	1.3E-02 (7.8E-03)	(g)
Xylenes	1.93E-04	8.6E-03 (5.4E-03)	(g)
Napthalene	1.30E-04	5.8E-03 (5.8E-03)	(g)
1,3 Butadiene	1.96E-05	1.8E-03 (1.1E-03)	(g)
Formaldehyde	7.89E-05	3.5E-03 (2.2E-03)	(g)
Acetaldehyde	2.52E-05	1.1E-03 (7.0E-04)	(g)
Benzo(a)Pyrene	2.57E-07	1.2E-05 (7.1E-06)	(g)
Benzo(a)anthracene	6.22E-07	2.8E-03 (1.7E-05)	(g)
Chrysene	1.53E-06	6.9E-05 (4.2E-05)	(g)
Benzo(b)fluoranthene	1.11E-06	5.0E-05 (3.1E-05)	(g)
Benzo(k)fluoranthene	2.18E-07	9.8E-05 (6.1E-06)	(g)
Dibenz(a,h)anthracene	3.46E-07	1.6E-05 (9.6E-06)	(g)
Ideno(1,2,3-cd)pyrene	4.14E-07	1.9E-05 (1.1E-05)	(g)
Cooling Tower Emissions	**Units = mg/liter water concentration**		
PM10/PM2.5	7,500	2.11 tpy	(h),(j)
Arsenic	0.002	0.00263 lb/yr	(h),(j)
Barium	0.013	0.0171 lb/yr	(h),(j)
Cadmium	0.003	0.00395 lb/yr	(h),(j)
Chromium III	0.0047	0.00618 lb/yr	(h),(j)
Copper	0.0032	0.00421 lb/yr	(h),(j)
Iron	0.0665	0.0875 lb/yr	(h),(j)
Lead	0.0005	0.000658 lb/yr	(h),(j)
Manganese	0.002	0.00263 lb/yr	(h),(j)
Mercury	0.0003	0.000395 lb/yr	(h),(j)

(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 (PSD) projects such as at Yahoo per WAC 173-400-110(5)(b).

(b) Project Genesis emission factors (EFs) based on manufacturer not-to-exceed (NTE) data and Tier 2 EFs from 40 CFR 89.112a. For NTE data, emission factors for Caterpillar, Cummins, and MTU were used, whichever is higher. For example, the VOC, PM, and CO NTE emission for the 2.75 MWe engines are based on Caterpillar NTE data of 2.91 lb/hr (10% load) and 0.91 lb/hr (25% load), and 14.3 lb/hr (75% load) respectively. Whereas for NOx, the Cummins NTE value of 74.4 lb/hr (100% load) is the highest NTE value. Tier 2 EFs are as follows: 6.4 g/kW-hr for NOx plus non-methane hydrocarbons (NMHC); 3.5 g/kW-hr for CO; and 0.20 g/kW-hr for PM. The total NOx, NMHC, CO, and PM emissions for all 48 certified engines meet the Tier 2 g/kW-hr emission factor limits listed. 2.0 MWe engines installed prior to 2016 have an emission factor of 46.2 lb/hr for NOx, and 4.62 lb/hr for NO2.

(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) PM emissions are conservatively considered to be PM10 emissions, and PM10 emissions are conservatively considered to be PM2.5. Total facility PTE emissions of particulate (including filterable PLUS condensable) for all 48 engines and cooling towers would be approximately 7.6 tpy. As noted in the application, "the cumulative NAAQS air modeling demonstration does account for condensable PM from all existing and proposed emergency generators."

(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 (Evapco) cooling unit maximum recirculation rate as presented in TSD of Approval Order 11AQ-E399. Cooling tower emissions listed in previous TSD as 4,210 lbs/yr, which is approximately equivalent to 2.11 tpy.
(i) DEEP is defined in Washington Administrative Code (WAC) 173-460-150 as "Diesel Engine Exhaust, Particulate." DEEP includes only the filterable portion of PM2.5.
(j) Project Genesis emissions are only listed (in parenthesis) if they have estimated emissions for the listed pollutant or source.
(k) SM-80 Sources: Minor sources that have taken an enforceable limit to remain minor sources, called synthetic minor sources, that emit or have the potential to emit (PTE) at or above 80 percent of the Title V major source threshold (GUIDANCE ON FEDERALLY-REPORTABLE VIOLATIONS FOR CLEAN AIR ACT STATIONARY SOURCES September 2014; https://www.epa.gov/sites/production/files/2013-10/documents/caastationary-guidance.pdf).

1.2 Maximum Operation Scenarios

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

Table 2. Yahoo Application Revision Requests

Yahoo Application Assumptions/Requests	Ecology Comments
Existing Engines R through R3 and Local Background Emissions Sources: • ***Worst Case Emissions and Power Outages.*** For purposes of demonstrating compliance with the national ambient air quality standards (NAAQS) and acceptable source impact levels (ASILs), it was assumed that the Yahoo Data Center [excluding Project Genesis] would experience 48 hours over 2 consecutive days of power outage, and would operate with the restrictions of Table 3.2 of the permit. • ***Decreased Engine Runtime for Engines R through 12:*** Yahoo has requested to consolidate engines R through R3 by having them adhere to the same operation restrictions as engines 13 through R3. The implications of this request are as follows: ➢ Engines R through 12 will no longer be allowed to operate 200 hours per year but will operate 100 hours per year similar to engines 13 through R3. ➢ Engines R through 12 will no longer be allowed to operate at an average full load rate of 100%, but will operate at more restrictive loads similar to engines 13 through R3. • ***Local Background Emissions Sources:*** Local background values for PM2.5, PM10, and NO2 consisted of the ambient impacts, at Project Genesis' maximum impact location, caused by emissions from the nearby emergency generators and industrial emission sources at the existing Yahoo Data Center, Sabey Data Center, Vantage Data Center, Intuit Data Center, and the Celite facility. Emissions from each of these facilities were assumed to be equal to their respective permit limits. The location and date of the maximum impact caused by Project Genesis' proposed new generators were determined, and AERMOD was used to model the "local background" ambient impacts at the same location and date caused by simultaneous activity at each of the adjacent data centers and industrial facility. The modeled "local background" sources were as follows: ➢ 24-Hour PM2.5. It was assumed that the existing cooling towers in the vicinity and the Celite facility would operate at their permitted limits. ➢ 1-Hour NO2. It was assumed that the Celite facility would operate at its permitted limit. ➢ 24-hour PM10 (Power Outage). It was assumed that each nearby data center would operate at its permitted rate during a power outage on the same day that the Project Genesis facility would operate during a power outage, while the Celite facility would emit at its permitted rate.	(a),(b),(c)

For Project Genesis Engines: During a power outage at the site, 20 2.0-MW emergency generators and one 2.75-MW generator will activate in order to supplement power to the server system and the administrative building. If there is a problem with one or more of the 2.0-MW generators, one or more of the "reserve" 2.75-MW generators will engage the load. • ASIL considerations with 1-hour and 24-hour averaging periods: Impacts were modeled for the worst-case screening scenario of a power outage lasting 24 hours per day for 365 days per year for 5 years, with AERMOD automatically selecting the highest 1-hour and 24-hour [TAP] impacts. The annual [TAP] impacts were modeled based on the maximum requested generator runtimes and generator loads. • Emissions considerations for modeling of pollutants (including TAPs with annual averaging periods): assumed (per engine) 84 hours (3.5 days) of power outages. Emission rates were calculated for criteria pollutants and TAPs based on peak hourly (worst-case maximum) and long-term (annual maximum) operating scenarios. • Worst-case 1-hour considerations for modeling to determine the worst-case ambient impacts for carbon monoxide (CO) and sulfur dioxide (SO2), each with a 1-hour averaging period. Twenty five generators were modeled as if operating 24 hours per day, 365 days per year, based on conservative consideration that an outage could occur at any time of day or night and any time of year. This scenario also took into account cold start emission factors. • Worst-case 3-hour, 8-hr, and 24-hr considerations for modeling to determine the worst-case ambient impacts for CO, SO2, and PM10. Twenty five generators were modeled as if operating 24 hours per day, 365 days per year and assumed a worst-case unplanned power outage scenario (3.5 days). This scenario also took into account cold start emission factors. • PM2.5 (see below) • NO2 (see below)	(b),(f)
PM2.5 24-Hour NAAQS Modeling Setup: The PM2.5 24-hour NAAQS is based on the 98th percentile of ambient impacts during a 3-year rolling average period. The worst-case modeling setup assumes testing 2.75-MW engines for 8 hours (one at a time) operating during daylight hours (7:00 a.m. to 7:00 p.m.). Eight cold start events are assumed to occur per day for this simulation event. The 8-hour emissions total for this event was divided by 12 hours to develop the hourly emission rate input into AERMOD.	(e)
NO2 1-hour NAAQS Modeling Setup: The NO2 1-hour NAAQS is based on the 98th percentile of the daily highest 1-hour ambient impacts during a 3-year rolling average period. The same screening-level approach, as described for evaluation of the PM2.5 24-hour NAAQS, was used to evaluate the NO2 1-hour NAAQS. Table 13 lists and ranks each of the 1-hour operating regimes for NO2 emissions from the Project Genesis site. The ranked 8th-highest hour would also be during an annual load bank or monthly maintenance testing event. Emissions from a single cold-start event were included in the input emission rate and the air dispersion model was set up as if operating during daylight hours (7:00 a.m. to 7:00 p.m.). ➢ The ambient NO2 concentrations were modeled using the Plume Volume Molar Ratio Method (PVMRM) option to demonstrate compliance with the 1-hour and annual NAAQS and ASIL for NO2. This AERMOD option calculated ambient NO2 concentrations surrounding the site by applying a default NO2/NOx equilibrium ratio of 0.90 and a NO2/NOx in-stack ratio of 0.1. ➢ The estimated ambient ozone concentration of 49 parts per billion was the AERMOD input level for all corresponding NO2 modeling setups. This value was taken from the NW AIRQUEST 2009-2011 design value of criteria pollutants website, provided by the Washington State University's Northwest International Air Quality Environmental Science and Technology Consortium, for the Quincy, Washington area (WSU website 2015).	(e)
Cold start/black puff factors: As noted in Yahoo's application: "emissions of criteria pollutants (PM, CO, NOx, and total VOCs) and volatile TAPs associated with cold-startup were scaled up using a 'black puff' emission factor in order to account for slightly higher cold-start emissions during the first minute of each scheduled cold-start. These 'black puff' factors are based on short-term concentration trends for VOC, CO, and NOx emissions immediately following cold-start by a large diesel backup generator that were measured by the California Energy Commission in its	(d)

document, *Air Quality Implications of Backup Generators in California* (CEC 2005)." The 60-second cold start/black puff factors used for this application are: PM+HC factor = 4.3; NOx factor = 0.94, CO factor = 9.0.	

(a) Ecology accepts the more restrictive operation limits for engines R through 12 requested by Yahoo.
(b) Ecology accepts this approach because it is conservatively based on worst-case scenarios.
(c) Existing engine power outage information based on TSD of Approval Order 11AQ-E399.
(d) Ecology accepts the cold start black puff factors derived for this project.
(e) Emission impact estimates via modeling are based on the 98th percentile 3-yr average, which is consistent with the NAAQS standard.
(f) For the NO2 annual NAAQS, which are not based on 3-year averages, if all emissions occurred in 1-year, within a three-year period, the NAAQS standard would still be met because annual ambient NO^2 impacts (13 ug/m^3) are more than three times less than the NO2 annual NAAQS (100 ug/m^3).

2. APPLICABLE REQUIREMENTS

The proposal by Yahoo 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 Yahoo 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 Yahoo 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 Yahoo (approximately 2.0 MWe to 2.75 MW). Instead, 40CFR60 requires the engines at Yahoo 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 Yahoo:

§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, Yahoo is either using or will use the following engines discussed in Sections 2.1.1 through 2.1.7 with 2.0 MWe or 2.75 MWe sizes. Sections 2.1.1 through 2.1.6 cover 2007 and later model year engines and section 2.1.7 covers pre-2007 model year engines. 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: [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:

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

$$\text{Total Displacement} = 69.0\ \text{Liters.}$$

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

$$\text{Displacement per cylinder} = 4.31\ \text{liters/cylinder.}$$

2.1.2 Caterpillar Engine Model C175-16 rated 2.75 MWe

[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 84.67 liters, with 16 cylinders total. The single cylinder displacement for this engine is therefore 5.29 liters/cylinder.

2.1.3 Cummins Engine DQKAB rated 2.0 MWe

According to the specification sheet for this engine, it has 16 cylinders total. Using this equation above, and plugging in the manufacturer specifications for bore (159mm), stroke (190mm), and 16 cylinders, this engine's total displacement and displacement per cylinder are calculated as follows:

$$\text{Total Displacement} = 0.7854 \text{ x } (159/10)^2 \text{ x } (190/10) \text{ x } 16 \text{ cylinders x } (1/1000)$$

$$\text{Total Displacement} = 60.4 \text{ Liters.}$$

The single cylinder displacement for this engine is therefore 3.76 liters/cylinder.

2.1.4 Cummins Engine DQLF rated 2.75 MWe

According to the specification sheet for this engine, it has 18 cylinders total. Using this equation above, and plugging in the manufacturer specifications for bore (170 mm), stroke (190 mm), and 18 cylinders, this engine's total displacement and displacement per cylinder are calculated as follows:

$$\text{Total Displacement} = 0.7854 \text{ x } (170/10)^2 \text{ x } (190/10) \text{ x } 18 \text{ cylinders x } (1/1000)$$

$$\text{Total Displacement} = 77.6 \text{ Liters.}$$

The single cylinder displacement for this engine is therefore 4.31 liters/cylinder.

2.1.5 MTU Engine 16V4000 DS2000 rated 2.0 MWe

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 20V4000 DS2800 rated 2.75 MWe

The specification sheet for this engine lists displacement as 95.4 liters, with 20 cylinders total. The single cylinder displacement for this engine is listed as 4.77 liters/cylinder.

Thus, because Yahoo Project Genesis 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.

2.1.7 MTU Detroit Diesel 16V4000 G83 B3

The existing engines R through R3 use MTU Detroit Diesel 16V4000 G83 B3 engines. 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.

Some of these engines have manufacture dates as early as December 2006, which pre-dates the Tier 2 requirement date of January 1, 2007 mentioned in 40CFR60 above. However, the 1/1/2007 date was intended as a harmonization date for all stationary and non-road regulations. Table 1 of 40CFR89.112 shows the same tier 2 engine requirements for model year 2006 engines as engines manufactured after January 1, 2007. Footnote 1 on Table 1 of 40CFR89.112 states the following: *"The model years listed indicate the model years for which the specified tier of standards take effect."* Therefore, in accordance with table 1 of 40CFR89.112 which shows tier 2 requirements for model year 2006, Ecology is requiring the existing pre-2007 engine at Yahoo to follow current Tier 2 requirements (6.4 g/kW-hr for NOx plus NMHC; 3.5 g/kW-hr for CO; and 0.20 g/kW-hr for PM).

2.1.8 Tier 2 Emission Requirements Summary

Thus, based on the power ratings listed in *40 CFR 60.4202(a)*, the Tier 2 engine requirements in 40CFR89.112 for 2006 and later engines, and because the engines to be used at Yahoo will also have less than 10 liters per cylinder displacement, the 48 engines at Yahoo are required to meet the 40CFR89.112 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 Yahoo 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 Yahoo has performed on existing 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, Yahoo 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. To reduce potentially unnecessary stack testing emissions for engine categories that have already been tested under “new engine stack testing” requirements, Ecology is allowing and alternative to testing at all 5 loads. To demonstrate that the engines satisfy the engine manufacturer’s not to exceed emissions rates for the loads tested, Yahoo may test at the single load point the engines have operated at during the preceding 5 year period, and at the highest load the engines have supported or at 100%, if the highest load is less than 90%.

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

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

Yahoo 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

Yahoo'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-

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[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.

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.

Yahoo 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..). Annual operation and maintenance cost estimates to account for urea, fuel for pressure drop, increased inspections, and periodic OEM visits based on EPA manual EPA/452/B-02-001, would cost approximately $14,400 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 $25,200 for NOx alone or $22,300 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 Yahoo 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 affect on CO emissions but can increase hydrocarbon emissions. This technology is rejected because there is no indication that it is commercially available and/or effective for new large diesel engines.

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

- ***NOx Adsorbers:*** NOx adsorbing technologies (some of which are known as SCONOx or EMx^{GT}) use a catalytic reactor method similar to SCR. SNONOx uses a regenerated catalytic bed with two materials, a precious metal oxidizing catalyst (such as platinum) and potassium carbonate. The platinum oxidizes the NO into NO2 which can be adsorbed onto the potassium carbonate. While this technology can achieve NOx reductions up to 90% (similar to an SCR), it is rejected because it has significantly higher capital and operating costs than an SCR. Additionally, it requires a catalyst wash every 90 days, and has issues with diesel fuel applications, (the GT on EMx^{GT} indicates gas turbine application). A literature search did not reveal any indication that this technology is commercially available for stationary backup diesel generators.
- ***Raper-NOx****:* This technology consists of passing exhaust gas through cyanic acid crystals, causing the crystals to form isocyanic acid which reacts with the NOx to form CO2, nitrogen and water. This technology is considered a form of SNCR, but questions about whether stainless steel tubing acted as a catalyst during development of this technology, 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 2.7 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. Yahoo 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

Yahoo 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.

Yahoo 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 $123,600 per ton of engine exhaust particulate removed from the exhaust stream at Yahoo each year. Catalyzed DPFs, which include a diesel oxidation catalyst, also remove CO and VOCs. However, for this project, DPFs and DOCs were evaluated separately (see Section 4.2.1.2 for DOC BACT).

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.

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

- Yahoo obtained the following recent DOC equipment costs: $32,000 and $54,000 for stand-alone catalyzed DOC per single 2.0 MWe and 2.75 MWe generators respectively (plus $3,667/generator for parts). For thirty two (5) 2.0 MWe, and 20 2.75 MWe generators, this amounts to $1,001,667. According to the applicant, DOC control efficiencies for this unit are CO, HC, and PM are 85%, 80%, and 20% respectively.
- The subtotal becomes $1,416,858 after accounting for shipping ($50,083), WA sales tax ($65,108), and direct on-site installation ($300,000).
- After adding indirect installation costs, the total capital investment amounts to: $1,634,668. 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 $170,025.
- At the control efficiencies provided, the annual tons per year of emissions for CO (8.79 tpy), HC (1.88 tpy), and PM (3.44 tpy) become 7.47 tpy, 1.5 tpy, and 0.69 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 ($170,025 divided by 7.47 tpy for CO, etc..).

The corresponding annual DOC cost effectiveness value for carbon monoxide destruction alone is approximately $22,800 per ton. If particulate matter and hydrocarbons are individually considered, the cost effectiveness values become $113,000 and $247,100 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 $17,600 per ton of combined pollutants removed per year.

These annual estimated costs (for DOC use alone) provided by Yahoo are conservatively low estimates that take into account installation, tax, shipping, and other capital costs as mentioned above, but assume low range CARB estimates for operational, labor and maintenance costs, which could be up to $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 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. Yahoo 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***

Yahoo did not find any add-on control options commercially available and feasible for controlling sulfur dioxide emissions from diesel engines. Yahoo proposed BACT for sulfur dioxide is the use of ultra-low sulfur diesel fuel (15 ppm by weight of sulfur). Ecology agrees with the applicant’s proposed BACT for SO2.

4.4 BACT ANALYSIS FOR PM FROM COOLING TOWERS

According to the applicant, “no known contaminants will be introduced into the surrounding atmosphere” for cooling units to be used for Project Genesis. Also, because no changes are proposed for existing cooling tower operations or emission estimates, a BACT analysis was not performed. The following BACT determination from the previous Yahoo 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 Yahoo considered for BACT, the minimum estimated costs as applied to tBACT are as follows:

- The minimum estimated cost to control diesel engine exhaust particulate is estimated to be $0.4 million per ton removed.
- The minimum estimated costs to control NO2 is estimated to be $150,000 per ton removed.

[4] WAC 173-460-020

- The minimum estimated cost to control CO is estimated to be $22,800 per ton removed.
- For the other TAPS above SQERs, the minimum estimated cost per ton removed would be as follows: $10 million for benzene; $59 million for naphthalene; $198 million for 1,3-butadiene; and $980 million 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
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
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.
- 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 applicable stack height of above local ground (20 ft for engines R through 12; 30 ft for engines 13 through R3; 42 ft for the 25 Project Genesis engines).
- 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 12.5-meter grid spacing along the facility boundary extending to a distance of 150 meters from each facility boundary. A grid spacing of 25 meters was used for distances of 150 meters to 400 meters from the boundary. A grid spacing of 50 meters was used for distances from 400 meters to 900 meters from the boundary. A grid spacing of 100 meters was used for distances from 900 meters to 2000 meters from the boundary. A grid spacing of 300 meters was used for distances from 2000 meters to 4500 meters from the boundary. A grid spacing of 600 meters was used for distances from 4500 meters to 6000 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.
- As noted in the application, "the cumulative NAAQS air modeling demonstration does account for condensable PM from all existing and proposed emergency generators."

5.2 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:

	Standards in μg/m³		Maximum Ambient Impact Concentration (μg/m³)	AERMOD	Background Concentrations (μg/m³) (a)	Maximum Ambient Impact Concentration Added to Background (μg/m³) (If Available)
	NAAQS(b)					
Criteria Pollutant	Primary	Secondary		Filename		
Particulate Matter (PM_{10})						
1st-Highest 24-hour average during power outage with cooling towers	150	150	56	PM10_101115, PM10_101115b PM10_101215, PM10_101315	80	136
Particulate Matter ($PM_{2.5}$)						
Annual average	12	15	0.47	PM10_101115,	7.6	8

1st-highest 24-hour average for cooling towers and electrical bypass	35	35	12.6 (includes local background)	PM10_101115b PM25_100515-COPY	21 (includes regional background only)	34
Carbon Monoxide (CO)						
8-hour average	10,000 (9 ppm)		326	CO_100715b CO_100715a	3,308	3,634
1-hour average	40,000 (35 ppm)		637		5,776	6,413
Nitrogen Oxides (NO_2)						
Annual average	100 (53 ppb)	100	7.71	NOx_101215, NOx_101215b NOx_100715	5.4	13
1-hour average	188 (100 ppb)	--	105 (includes local background)		16 (includes regional background only)	121
Sulfur Dioxide (SO_2)						
3-hour average	--	1,300 (0.5 ppm)	1.6	SO2_100615a SO2_100615b	2.1	3.7
1-hour average	195 (75 ppb)	--	2.3		2.6	4.9
Toxic Air Pollutant	**ASIL (μg/m³)**	**Averaging Period**	**1st-Highest Ambient Concentration (μg/m³)**	**AERMOD Filename**		
DEEP	0.00333	Annual average	0.15	DEEP_100615a		
NO_2	470	1-hour average	859	NO2_100715		
CO	23,000	1-hour average	637	CO_100715a		
S02	660	1-hour average	4.9	(d)		
Acrolein	0.06	24-hour average	0.0067	Acrolein_101415		
Benzene	0.0345	Annual Average	0.0029	(c)		
1,3-Butadiene	0.00588	Annual Average	0.00015	(c)		
Naphthalene	0.0294	Annual Average	0.00048	(c)		

Notes:
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 except where noted. Regional background concentrations obtained from WSU NW Airquest website http://lar.wsu.edu/nw-airquest/lookup.html. Local background values for PM2.5, PM10, and NO2 consisted of the ambient impacts, at Project Genesis' maximum impact location, caused by emissions from the nearby emergency generators and industrial emission sources at the existing Yahoo Data Center, Sabey Data Center, Vantage Data Center, Intuit Data Center, and the Celite facility.

(b) Ecology interprets compliance with the National Ambient Air Quality Standards (NAAQS) as demonstrating compliance with the Washington Ambient Air Quality Standards (WAAQS).

(c) A dispersion factor was used to approximate the control emissions impact.

(d) Yahoo was not required to model SO2 for comparison to the ASIL for Project Genesis, because estimated emissions of 0.9 lb/hr are below the WAC 173-460-150 small quantity emission rate of 1.45 lb/hr.

Yahoo Project Genesis 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 were further evaluated as explained 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 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 Yahoo Project Genesis 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 Yahoo's increased emissions of identified carcinogenic compounds. 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 Yahoo's Project Genesis proposal in a community-wide basis, even though it is not required to do so by state law. Yahoo reported the cumulative risks associated with Yahoo Project Genesis and prevailing sources in their HIA document based on a cumulative modeling approach.

As part of the community-wide approach, the Yahoo Project Genesis second-tier health impact assessment (HIA) considered the cumulative impacts of DEEP and NO2 from the proposed generators, nearby existing permitted sources, and other background sources including State Route (SR) 28 and the adjacent railroad line. The Yahoo Project Genesis DEEP and NO2 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 48 generators and 12 cooling cells will not have an adverse impact on air quality. Ecology finds that Yahoo's Data Center has satisfied all requirements for NOC approval.

******END OF YAHOO TSD** ****