TECHNICAL SUPPORT DOCUMENT
NOTICE OF CONSTRUCTION APPROVAL ORDER NO. 11AQ-E4XX
2011 TITAN DATA CENTER EXPANSION (GSF, DO)
APRIL 28, 2011

BACKGROUND: Existing tenants at the Titan Data Center

The Titan Data Center is located in a 120,000 ft^2 building consisting of three floors that are being prepared for tenant occupancy by companies that require fully supported data storage and processing space. Besides office space on the first floor utilized by the Titan Data Center, there are currently two tenants. ASK.com occupies sections of the first and second floors that are utilized for data storage and processing. The Department of Ecology Air Quality Program (AQP) issued ASK.com Notice of Construction (NOC) approval Order No. 07AQ-E236 on November 5, 2007, and amended the Order on December 4, 2007. The Order approved the installation and limited operation of two Caterpillar Model 3516CDITA emergency generators with a combined capacity of 5.0 MWe. The two ASK.com engines are limited to 672 hours per year of full standby operation, which equates to approximately 115,584 gallons of diesel fuel per year.

The Bonneville Power Administration occupies a relatively small space on the first floor that contains communications equipment. Emergency power is provided by two existing diesel fueled 650 kilowatt (kWe) generators that are owned and operated by the Titan Data Center. Those two generators were originally installed by the military in the 1960's, and pre-date air quality permitting requirements in Grant County. Phase 1 construction will replace emergency power from the two existing 650 kWe, and the two existing generators will be rendered inoperable and removed.

1. EXECUTIVE SUMMARY

RS Titan-Lotus,LLC submitted a NOC application on August 17, 2010 for a phased expansion of the Titan Data Center. The Titan Data Center expansion includes the addition of fourteen (14) new Cummins Model QSK60 and QSK78 engines used to power 2000DQKC and 2500DQLC diesel generator sets. The generator sets are rated at 2.0 and 2.5 electrical-megawatts (MWe), respectively, and will have a combined capacity of 32.5 MWe. Annual operations will be restricted by fuel consumption limitations. The generators will be installed in two construction phases. Phase 1 will consist of three (3) 2.0 MWe generators that will be installed upon approval. Phase 2 will consist of eleven (11) 2.0 to 2.5 MWe generators to be installed at the facility as independent tenant companies contract for space at the Titan Data Center. There was no other project equipment that required review under the state and federal air quality requirements.

Review of the August 17, 2010 NOC application was initiated on August 19, 2010 with a site visit to the Titan Data Center. An incompleteness determination on the NOC application was issued on August 27, 2010 by the permit team (Flibbert, Ogulei) in coordination with the Science and Engineering Section Manager (Johnston) and the Eastern Regional Office Section Manager

(Wood). Additional information was submitted by Titan on September 3 and 22, December 7, 2010, January 3 and 19, and April 11, 2011. The NOC application was considered complete on April 11, 2011. The draft Preliminary Determination (aka Proposed Decision) was submitted to HQ on April 18, 2011 to facilitate the completion of the second tier review.

2. PROJECT DESCRIPTION

2.1 The Titan Data Center is located in a 120,000 ft^2 building consisting of three floors that are being prepared for tenant occupancy by companies that require fully supported data storage and processing space. Besides office space on the first floor utilized by the Titan Data Center, there are currently two tenants. ASK.com and the Bonneville Power Administration occupy sections of the first and second floors. See the Background Section in this document for additional information on the current tenants of the Titan Data Center.

2.1.1 Potential to Emit for Criteria and Toxic Air Pollutant Emissions

Table 2.1.1: Potential to Emit for Titan Columbia Data Center

Pollutant	**Engine Emission Factors**[1]	**Emission Factor Reference**	**Existing ASK.com Engines**	**Expansion Engines**
Criteria Pollutant	g/kW-hr		tons/yr	tons/yr
NO_x	6.12	§89.112a	6.735	6.00
CO	3.50	§89.112a	0.546	4.58
SO_2	15 ppm/gal	MassBal	0.012	0.008
$PM_{2.5}$	0.200	§89.112a	0.039	0.262
VOC	0.282	CEC-05-049	0.134	0.370
Toxic Air Pollutants				
Primary NO_2	0.62	10% NO_x	0.674	0.60
Diesel Engine Exhaust Particulate (DEEP)	0.200	$PM_{2.5}$	not reported	0.262
Carbon monoxide	3.50	CO	0.546	4.58
Sulfur dioxide	15 ppm	SO_2	0.012	0.008
Carbon based TAPs	lbs/mmBtu			
Acrolein	7.88E-06	AP-42 §3.4	6.5E-05	4.1E-05
Benzene	7.76E-04	"	6.2E-03	4.0E-03
Toluene	2.81E-04	"	2.2E-03	1.5E-03
Xylenes	1.93E-04	"	1.6E-03	1.0E-03
1,3 Butadiene	1.99E-05	"	not reported	1.0E-04
Formaldehyde	7.89E-05	"	6.3E-04	4.1E-04
Acetaldehyde	2.52E-05	"	2.0E-04	1.3E-04

Benzo(a)Pyrene	2.57E-07	"	Not reported	6.7E-07
Benzo(a)anthracene	6.22E-07	"	Not reported	3.2E-06
Chrysene	1.53E-06	"	Not reported	7.9E-06
Benzo(b)fluoranthcene	1.11E-06	"	Not reported	5.7E-06
Benzo(k)fluoranthcene	2.18E-07	"	Not reported	5.6E-07
Dibenz(a,h)anthracene	3.46E-07	"	Not reported	9.0E-07
Ideno(1,2,3-cd)pyrene	4.14E-07	"	Not reported	1.1E-06
PAH (sum)	3.96E-06	"	Not reported	2.0E-05
PAH (w/ TEF)	5.08E-07	"	Not reported	2.6E-06

[1] Emission factors for the new expansion engines only

2.1.2 Maximum Operation

Table 2.1.2: Titan Data Center Expansion 14 Generator Engines Annual Operations: From Table 1-1 in April 11, 2011 NOC Support Document				
No.	**Operation**	**Load**	**Annual Hours**	**kWm-hr/yr**
1	Monthly Testing	50%	16.5[1]	combined 429,591
2	Annual Load Testing	100%	4	
3	Electrical Bypass	59-64%	30	598,415
4	Power Outage	59-64%	8	159,577
5	Total Operations		58.5	1,187,583

[1] Maximum of 1.5 hours during 11 tests per year.

2.2 There are no air emissions reported in the NOC application from the cooling systems, and they are not included in this review document.

2.3 There is a small (> 500 hp) emergency fire pump engine required by uniform fire code at the Titan Data Center. Additional emergency units under 500 hp that may be required under local building regulations can be installed without triggering new source review.

3. APPLICABLE REQUIREMENTS

The proposal by RS Titan-Lotus LLC 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 Titan Data Center is regulated by the requirements specified in:

3.1 Chapter 70.94 Revised Code of Washington (RCW), Washington Clean Air Act,
3.2 Chapter 173-400 Washington Administrative Code (WAC), General Regulations for Air Pollution Sources,
3.3 Chapter 173-460 WAC, Controls for New Sources of Toxic Air Pollutants, and
3.4 40 CFR Part 60 Subpart IIII

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.

4. BEST AVAILABLE CONTROL TECHNOLOGY

Best Available Control Technology (BACT) is defined[1] as "*an emission limitation based on the maximum degree of reduction for each air pollutant subject to regulation under chapter 70.94 RCW emitted from or which results from any new or modified stationary source, which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes and available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of each such pollutant. In no event shall application of the "best available control technology" result in emissions of any pollutants which will exceed the emissions allowed by any applicable standard under 40 CFR Part 60 and Part 61....*"

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, then the next most stringent level of control is determined and similarly evaluated. This process continues until the BACT level under consideration cannot be eliminated by any substantial or unique technical, environmental, or economic objections.[2] The "top-down" approach shifts the burden of proof to the applicant to justify why the proposed source is unable to apply the best technology available. The BACT analysis must be conducted for each pollutant that is subject to new source review.

The proposed diesel engines 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, PM_{10} and $PM_{2.5}$) and sulfur dioxide.

4.1 BACT ANALYSIS FOR NOx

RS Titan-Lotus LLC reviewed EPA's RACT/BACT/LAER Clearinghouse (RBLC) database to look for NOx add-on 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. The RS Titan-Lotus LLC review of the RBLC found that urea -based selective catalytic reduction (SCR) was the most stringent add-on control option demonstrated on diesel engines. The application of the SCR technology for NOx control was therefore considered the top-case control technology and evaluated for technical feasibility and cost-effectiveness.

---

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

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

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 through a literature review include water injection and NOx adsorbers.

4.1.1 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. The use of a lean ultralow sulfur fuel is required to achieve good NOx destruction efficiencies. SCR can reduce NOx emissions by up to 90-95 percent while simultaneously reducing hydrocarbon (HC), CO and PM emissions.

For SCR systems to function effectively, exhaust temperatures must be high enough (about 200 to 500°C) to enable catalyst activation. For this reason, SCR control efficiencies are expected to be relatively low during the first 20 to 30 minutes after engine start up, especially during maintenance, testing and storm avoidance loads. There are also complications of managing and controlling the excess ammonia (ammonia slip) from SCR use.

RS Titan-Lotus LLC has evaluated the cost effectiveness of installing and operating SCR systems on each of the proposed diesel engines. The analysis indicates that the use of SCR systems would cost approximately **$49,516** per ton of NOx removed from the exhaust stream, assuming worst-case emissions. A previous survey by Ecology found that the permitting agencies surveyed have required installation of NOx controls as BACT with expected operational costs ranging from **$143 to $9,473** per ton of NOx removed. Ecology concludes that while SCR is a demonstrated emission control technology for diesel engines, it is not economically feasible for this project. Therefore, Ecology rejects this NOx control option as BACT.

If Titan later proposes to operate each of their engines for longer than 68.5 hours per year, any associated permit revision may involve a reevaluation of the cost effectiveness of SCR. Ecology suggests that Titan explore the use of this technology in order to assure compliance with NO_2 emission limits contained in their NOC approval order and to assure that adverse health impacts do not result from engine operation.

4.1.2 NOx adsorbers

The use of NOx adsorbers (sometimes called lean NOx traps) is a catalytic method being developed and tested by diesel engine manufacturers to reduce NOx emissions, primarily from mobile sources. The NOx adsorber contains a catalyst (e.g., zeolite or platinum) that is used to "trap" NOx (NO and NO_2) molecules found in the exhaust. NOx adsorbers can achieve NOx reductions greater than 90% at typical steady-state exhaust gas temperatures.

However, as of this writing, NOx adsorbers are experimental technology and are, therefore, very expensive. Additionally, a literature search did not reveal any indication that this technology is commercially available for stationary backup generators. Thus, Ecology rejects NOx adsorbers as BACT for the proposed diesel engines.

4.1.3 Combustion Controls and Tier 2 compliance

Diesel engine manufacturers typically use proprietary combustion control methods to achieve the emission reductions needed to meet applicable EPA tier standards. Common controls include fuel injection timing retard and exhaust gas recirculation. Injection timing retard reduces the peak flame temperature and NOx emissions, but may lead to higher fuel consumption. RS Titan-Lotus LLC will install Cummins engines that will use a combination of combustion control methods, including fuel injection timing retard, to comply with EPA Tier-2 emission limits.

In Washington State, proponents of emergency engines who do not wish to file a notice of construction application must comply with the restrictions in WAC 173-400-930. Such emergency engines, as defined at WAC 173-400-930(3)(a) must "[m]eet EPA emission standards applicable to all new nonroad compression-ignition engines, contained in 40 CFR Part 89.112 Table 1 and 40 CFR Part 1039.102 Tables 6 and 7, as applicable for the year that the emergency engine is put in operation." See WAC 173-400-930(2)(a).

4.1.4 Two-Stage Oxidation Catalysts for NOx Reduction

To prevent a modeled NAAQS exceedance of the 1-hour NO_2 national ambient air quality standard (NAAQS), Titan proposes to reduce NOx emissions by installing 2-stage oxidation catalysts ("3-way" catalysts) that are specially designed for NOx, diesel particulate, CO and VOC reduction from diesel engines. The proposed catalysts will be a single-pass system and will be installed without retrofitting closed-loop systems such as Exhaust Gas Recirculation. Each catalyst system will use a stainless steel honeycomb mesh catalyst element coated with three catalysts: cerium washcoat; platinum (Pt) and rhodium (Rh) catalyst coatings.

The proposed "3-way" catalysts will first oxidize CO and VOC while removing oxygen from the gas stream, then the remaining rich-burn environment will react with the Rh catalyst to chemically convert the NO and NO_2 in the exhaust stream to nitrogen. The proposed catalyst system uses a specialized catalyst coating and cell structure to remove oxygen molecules from the diesel exhaust stream, resulting in a low-oxygen environment. The low-oxygen environment enables the use of a Rhodium-based catalyst to safely remove NOx from the exhaust stream. Exhaust temperature must be at least 250°C and not exceed 750°C for the proposed system to be effective.

Although the proposed catalyst systems appear to have been commercially deployed for standby diesel engine applications in Europe, Australia and Canada, Ecology is unaware of specific applications within the United Sates. None-the-less, since a BACT analysis is not exclusive to control technology that is currently available in the United States, the proposed technology, if effective, can be allowed.

RS Titan will use two 35" diameter x 3.5" thick 3-way catalysts within one stainless steel housing. The manufacturer of the proposed catalyst system (Clean Emissions Products, Inc., 1-866-787-2473) will guarantee a NOx reduction of not less than 35% although their website and a company salesman both claim that their 2-stage catalysts are capable of reducing up to 99% of CO, 70% of NOx and 90% of diesel particulate.[3] The proposed oxidation catalysts are also expected to reduce at least 90% of VOC. Actual test data have reported about 43% NOx reduction and about 88% diesel particulate reduction.

4.1.5 ***Other control options***. Other NOx control options, such as water injection, were rejected because there was no indication that they are commercially available and/or effective in new large diesel engines.

4.1.6 **BACT determination for NOx**

Ecology determines that BACT for NOx for each proposed engine is the following:

a. the use of good combustion practices;
b. the use of an engine design that incorporates fuel injection timing retard, turbocharger and a low-temperature aftercooler;
c. the use of EPA Tier 2 certified engines if the engines are installed and operated as emergency engines, as defined at 40 CFR§60.4219; or applicable emission standards found in 40 CFR Part 89.112 Table 1 and 40 CFR Part 1039.102 Tables 6 and 7 if Model Year 2011 or later engines are installed and operated as non-emergency engines;
d. compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII; and
e. installation of a two-stage oxidation catalyst system (i.e., 3-way catalysts) that is guaranteed to remove 35% of nitrogen oxides, and capable of reducing at least 50% each of carbon monoxide, volatile organic compounds and particulate matter from the exhaust stream.

4.2 BACT ANALYSIS FOR PARTICULATE MATTER, CARBON MONOXIDE AND VOLATILE ORGANIC COMPOUNDS

RS Titan-Lotus LLC reviewed the available published literature and the RBLC and identified the following demonstrated technologies for the control of diesel engine exhaust particulate, carbon monoxide and volatile organic compounds from the proposed diesel engines:

4.2.1 ***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

[3] http://www.cleanemissions.com/pdf/TwoStageCatalyst.pdf

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.

RS Titan-Lotus LLC 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 more than **$1,400,000** per ton of engine exhaust particulate removed from the exhaust stream, assuming worst-case emissions (i.e, 8 hours per year of emergency operation). A previous survey by Ecology found that none of the permitting agencies surveyed had required installation of a particulate matter control device (as BACT) that was expected to cost more than $23,200 per ton of particulate removed.

Since the estimated DPF cost effectiveness value for the proposed RS Titan-Lotus LLC project far exceeds the $23,200 per ton upper limit, Ecology concludes that the use of DPFs is not economically feasible for this project. Therefore, Ecology rejects this control option as BACT for particulate matter. However, if Titan later proposes to operate each of their engines for longer than 58.5 hours per year, any associated permit revision may involve a reevaluation of the cost effectiveness of DPFs. Accordingly, Ecology suggests that Titan explore the use of this technology in order to assure compliance with DEEP emission limits contained in their NOC approval order and to assure that adverse health impacts do not result from engine operation.

4.2.2 ***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 (approximately 90% reduction), DOCs have also been demonstrated to reduce up to 30% of diesel engine exhaust particulate emissions, and more than 50% (up to 90%) of hydrocarbon emissions.

RS Titan-Lotus LLC has evaluated the cost effectiveness of installing and operating standard DOCs on each of the proposed diesel engines. Using the total amount of carbon monoxide assuming 8 hours per year of emergency operation, the cost effectiveness of standard DOC use has been calculated at approximately **$8,500** per ton of carbon monoxide removed. If hydrocarbons are individually considered, the cost effectiveness values become **$105,215** per ton of pollutant removed. For particulate control, Ecology estimates the DOC cost effectiveness to be at least **$500,000** per ton of particulate removed. This cost effectiveness estimate assumes a 25% reduction in particulate emissions. Actual reductions will be variable.

As discussed above (see section 4.1.4), DOCs can now be designed to enable a paralled reduction of NOx emissions in addition to CO, VOC and particulate. The resulting 2-stage catalyst is at least 50% more expensive than the standard DOC. Despite their cost, RS Titan proposes to install 2-stage diesel oxidation catalysts ("3-way" catalysts) that are specially designed for NOx, diesel particulate, CO and VOC reduction from diesel engines. Although the primary reason for installing the 2-stage DOCs is to prevent a modeled exceedance of the 1-hour NO_2 NAAQS, significant reductions of CO, VOC and diesel particulate emissions are also expected from the DOCs.

4.2.3 **BACT Determination for Particulate Matter, Carbon Monoxide and Volatile Organic Compounds**

Ecology determines that BACT for Particulate Matter, Carbon Monoxide and Volatile Organic Compounds for each proposed engine is the following:

a. the use of good combustion practices;
b. the use of EPA Tier 2 certified engines if the engines are installed and operated as emergency engines, as defined at 40 CFR§60.4219; or applicable emission standards found in 40 CFR Part 89.112 Table 1 and 40 CFR Part 1039.102 Tables 6 and 7 if Model Year 2011 or later engines are installed and operated as non-emergency engines;
c. compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII; and
d. Compliance with the NOx BACT requirement.

4.3 BACT ANALYSIS FOR SULFUR DIOXIDE

4.3.1 Ecology and RS Titan-Lotus LLC did not find any add-on control options commercially available and feasible for controlling sulfur dioxide emissions from diesel engines. RS Titan-Lotus LLC proposed BACT for sulfur dioxide is the use of ultra-low sulfur diesel fuel (15 ppm by weight of sulfur). Using this control measure, sulfur dioxide emissions would be limited to 0.008 tons per year.

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 BEST AVAILABLE CONTROL TECHNOLOGY FOR TOXICS

Best Available Control Technology for Toxics (tBACT) means BACT, as applied to toxic air pollutants.[4] The procedure for determining tBACT follows the same procedure used above for determining BACT. 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.

For the proposed project, tBACT must be determined for each of the toxic air pollutants listed in Table 1 below. As illustrated by Table 1, Ecology has determined that compliance with BACT, as determined above, satisfies the tBACT requirement.

[4] WAC 173-460-020

Table 1. tBACT Determination

Toxic Air Pollutant	tBACT
Acetaldehyde	Compliance with the VOC BACT requirement
Acrolein	Compliance with the VOC BACT requirement
Benzene	Compliance with the VOC BACT requirement
Benzo(a)pyrene	Compliance with the VOC BACT requirement
1,3-Butadiene	Compliance with the VOC BACT requirement
Carbon monoxide	Compliance with the CO BACT requirement
Diesel engine exhaust particulate	Compliance with the PM BACT requirement
Formaldehyde	Compliance with the VOC BACT requirement
Nitrogen dioxide	Compliance with the NOx BACT requirement
Propylene	Compliance with the VOC BACT requirement
Sulfur dioxide	Compliance with the SO_2 BACT requirement
Toluene	Compliance with the VOC BACT requirement
Total PAHs	Compliance with the VOC BACT requirement
Xylenes	Compliance with the VOC BACT requirement

5. AMBIENT IMPACTS ANALYSIS

ICF conducted air dispersion modeling for Titan Data Center's generators to demonstrate compliance with ambient air quality standards and acceptable source impact levels. The generators were modeled as multiple discharge points. ICF used AERMOD (Version 09292), with EPA's PRIME algorithm for building downwash, to determine worst-case ambient air quality impacts caused by emissions from the proposed generators at the property line and beyond, and at the rooftop of the commonly occupied data center building. The ambient impacts analysis indicates that no ambient air quality standard is expected to be exceeded.

5.1 Ambient Air Quality Compliance Boundary

Multiple information technology tenants will lease space in the three-story Titan Data Center building, and each tenant will use one or more of the backup generators that are the subject of this permit application. Intake air for the entire building is taken from the air handling units on the building rooftop.

Ecology directed ICF to assume that for purposes of AERMOD modeling, the air quality compliance boundary consists of:

- All locations beyond the facility boundary, regardless of whether they are occupied.
- The rooftop of the onsite data center building, which is occupied by multiple tenants. All ventilation air fed to the data center building is taken from the rooftop air handling systems at the rooftop. Therefore, the rooftop represents the source of public air that is used by all tenants inside the building. An AERMOD receptor was placed on the rooftop.

Ecology did not require a demonstration of compliance with ambient air quality standards at outdoor common areas located within the facility boundary because:

- The parking areas and other outdoor areas inside the property boundary will not be exclusively leased to any individual tenant. The entire outdoor common areas will be shared by all tenants.
- Tenants will be free to use any outdoor parking space within the property. There will not be posted signs or other barriers that restrict tenant parking to specific areas or that forbid specific tenants from certain outdoor areas within the property. Therefore, each tenant will jointly utilize the common areas.
- Titan will maintain a physical fence around the entire property. The fence will restrict general public access to the outdoor areas.
- Each of the tenants will undertake their own separate actions in collaboration with Titan to ensure that public access is restricted in the outdoor areas. These individual actions may be in the form of specific provisions in the lease agreement that preclude general public access and require a physical barrier to be maintained around the Titan property.

5.2 AERMOD Dispersion Modeling Methodology

The AERMOD model employed the following data and assumptions[5]:

a) Five years of sequential hourly meteorological data (2004-2008) from Moses Lake were used.

b) Twice-daily upper air data from Spokane were used to define mixing heights.

c) Digital topographical data (in the form of Digital Elevation Model files) for the vicinity were obtained from the Micropath Corporation. 2001 National Land Cover (NLCD2001) land use data.

d) The data center building was included to account for building downwash.

e) The receptor grid for the AERMOD modeling was established using a 10-meter grid spacing along the facility boundary extending to a distance of 300 meters from the north and south sides of the facility boundary, and about 200 meters from the east and west sides of the facility boundary (i.e., within approximately a 350 meter range of all generators).

f) One-hour NO_2 concentrations were modeled using the Plume Volume Molar Ratio Method (PVMRM) module, with default ozone concentrations of 40 parts per billion (ppb), and an equilibrium NO_2/NO_X ambient ratio of 90 percent. For purposes of modeling NO_2 impacts, the primary NO_X emissions were assumed to be 10% NO_2 and 90% nitric oxide (NO) by mass.

g) For this analysis, AERMOD/PVMRM was run using 14 different generator stacks each with its assigned engine size, engine load, stack diameter, stack height, stack temperature, stack velocity, and maximum 1-hour NOx emission rate. The generators were assumed to operate for continuously at their assigned load for 24 hours, 7 days per week, 365 days per year for each of the five years. AERMOD then specified the

[5] See NOC application and second tier petition support documents.

1st-highest 1-hour NO_2 impact location and magnitude. The maximum impact per year and the number of hours for which the ASIL was exceeded during the five-year simulation period were recorded.

h) 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 14 new generators were modeled at their design 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.

i) The ambient NO_2 impacts for the original 16-generator configuration, without the 3-Way Catalysts, were originally modeled for the December 2010 application submittal. For the revised analysis of the 14-generator configuration with 3-Way Catalysts, the previously modeled 16-generator ground level concentrations were manually adjusted by an overall factor of 0.652. That overall adjustment factor was calculated as follows:
   i. Adjustment for reduced kWe generation during a power outage: 0.869
   ii. Adjustment for 25% NOx control = (1- 0.25) = 0.75
   iii. Overall adjustment factor = 0.869 x 0.75 = 0.652.

5.3 Compliance With the 1-Hour NO_2 National Ambient Air Quality Standard (NAAQS)

In 2010, EPA established a new 1-hour NAAQS for NO_2, set at 100 parts per billion (ppb) or approximately 188 $\mu g/m^3$. The new 1-hour standard is intended to protect against short-term exposure to high NO_2 concentrations, particularly near major roadways. The new NO_2 standard establishes a new 1-hour averaging period for the NO_2 NAAQS. To comply with the 1-hour NO_2 NAAQS, the three-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations at the ambient air receptor must be less than 100 ppb. The 1-hour NAAQS is designed to protect against health effects associated with short-term exposures to NO_2, which are generally highest on and near major roads.

During a full unplanned power outage, most of the generators would activate at design load, while other "redundant units" would initially activate but would run at idle to serve as a standby unit. The active generators are designed to run at loads of 47% to 64% during an outage. For this air quality permit it was assumed that only one generator would serve as the "redundant unit". Depending on specific tenant needs, it is likely that they could require a lower electrical demand and could use more than one "redundant unit". In that case the actual emission rates would be lower than the upper-bound rates assumed for this analysis.

Titan assumed the facility would experience 8 hours per year of unplanned power outages, and for estimating worst-case annual emissions, Titan assumed each tenant would conduct their occasional electrical bypass maintenance in the same worst-case year. For purposes of demonstrating compliance with the 24 hour NAAQS and the 24 hour ASILs, Titan further assumed the forecast 8 hours/year of power outages would occur on a single day. However, 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.

The NAAQS limits for 24-hour $PM_{2.5}$ and 1-hour NO_2 are both based on the 3-year average of the 98th percentile highest daily impact. This is equivalent to the eighth-highest operating day during each year. It is unlikely that the Moses Lake area would experience 8 major power failures in any given year. Therefore, for purposes of evaluating 24-hour average $PM_{2.5}$ impacts it was assumed the seventh (and eighth)-highest operating days in any year would consist of the routine monthly engine testing, which consists of each generator running one at a time on the same day for short duration at low load (1.5 hours at 50% load).

To demonstrate compliance with the 1-hour NO_2 NAAQs, a"Monte Carlo" statistical analysis was used to estimate the likelihood of an exceedance of the ambient 1-hour NO_2 NAAQS.

5.4 "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 was recently 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".[6]

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 Titan facility. To do so, 14 different generator operating regimes proposed by Titan 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,

---

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

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 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 selects the days on which the generators operated in each regime, combines the modeled concentrations on those days across all operating regimes and iterates the process 1000 times, so as to obtain a distribution of the possible concentrations at each receptor.
Compliance with the 1-hour NO_2 NAAQS was evaluated based on the median of the distribution of 98th percentile values calculated for each of the five years modeled. The analysis showed that the 1-hour NO_2 NAAQS is not likely to be exceeded if 3-way diesel oxidation catalysts are used to reduce more than 25% of in-stack NOx emissions from each engine.

5.5 Points of Compliance

The multi-tenant Titan Data Center building breathing air intake(s) and all publicly accessible ground-level land outside the Titan Data Center fenceline are designated as the assumed points of maximum public exposure (nearest point of ambient air) to the proposed emissions.

6. SECOND TIER REVIEW FOR DIESEL ENGINE EXHAUST PARTICULATE and NITROGEN DIOXIDE

Proposed emissions of DEEP and NO_2 from the 14 additional engines each exceed their regulatory trigger levels, also called an Acceptable Source Impact Levels (ASILs). A second tier review is required for DEEP and NO_2 in accordance with WAC 173-460-090.

The Titan Data Center is currently the only data center located in Moses Lake, WA. However, due to the April, 2010 enactment of the *Computer Data Centers – Sales and Tax Exemption* law in Washington State, there is anticipated interest in developing new data centers in and around Moses Lake. Large diesel-powered backup engines emit DEEP, which is a high priority toxic air pollutant in the state of Washington. In light of the potential rapid development of other data centers in central WA, and recognizing the potency of DEEP emissions, Ecology may decide to evaluate additional data center development on a community-wide basis. The community-wide evaluation approach considers the cumulative impacts of diesel emissions resulting from new data center projects, and includes consideration of prevailing background emissions from existing permitted data centers and other air pollution sources in the community.

The evaluation of the Titan Data Center was conducted under the second tier review requirements of WAC 173-460-090. The results of Ecology's evaluation of health risks associated with the RS Titan-Lotus LLC project are included in a separate technical support document, dated April 28, 2011. Please refer to that technical support document for a discussion and evaluation of the risks associated with diesel engine exhaust particulate and nitrogen dioxide emitted by RS Titan-Lotus LLC.

7. CONCLUSION

Based on the above analysis, Ecology concludes that operation of the 14 generators will not have an adverse impact on air quality. Ecology finds that RS Titan-Lotus LLC has satisfied all requirements for NOC approval.

******END OF 2011 TITAN DATA CENTER EXPANSION TSD ******