DEPARTMENT OF ECOLOGY State of Washington

Notice of Construction Application

A notice of construction permit is required before installing a new source of air pollution or modifying an existing source of air pollution. This application applies to facilities in Ecology's jurisdiction. Submit this application for review of your project. For general information about completing the application, refer to Ecology Forms ECY 070-410a-g, "Instructions for Ecology's Notice of Construction Application."

Ecology offers up to two hours of free pre-application assistance. We encourage you to schedule a pre-application meeting with the contact person specified for the location of your proposal, below. If you use up your two hours of free pre-application assistance, we will continue to assist you after you submit Part 1 of the application and the application fee. You may schedule a meeting with us at any point in the process.

Upon completion of the application, please enclose a check for the initial fee and mail to:

Department of Ecology
Cashiering Unit
P.O. Box 47611
Olympia, WA 98504-7611

For Fiscal Office Use Only:
001-NSR-216-0299-000404

Check the box for the location of your proposal. For assistance, call the contact listed below:		
	Ecology Permitting Office	**Contact**
☐ **CRO**	**Chelan, Douglas, Kittitas, Klickitat, or Okanogan County** Ecology Central Regional Office – Air Quality Program	Lynnette Haller (509) 457-7126 lynnette.haller@ecy.wa.gov
☒ **ERO**	**Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Stevens, Walla Walla or Whitman County** Ecology Eastern Regional Office – Air Quality Program	Karin Baldwin (509) 329-3452 karin.baldwin@ecy.wa.gov
☐ **NWRO**	**San Juan County** Ecology Northwest Regional Office – Air Quality Program	David Adler (425) 649-7267 david.adler@ecy.wa.gov
☐ **IND**	**For actions taken at** **Kraft and Sulfite Paper Mills and Aluminum Smelters** Ecology Industrial Section – Waste 2 Resources Program Permit manager: ____________________	James DeMay (360) 407-6868 james.demay@ecy.wa.gov
☐ **NWP**	**For actions taken on the** **US Department of Energy Hanford Reservation** Ecology Nuclear Waste Program	Lilyann Murphy (509) 372-7951 lilyann.murphy@ecy.wa.gov

Check the box below for the fee that applies to your application.

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New project or equipment:

☒	**$1,500: Basic project** initial fee covers up to 16 hours of review.
☐	**$10,000: Complex project** initial fee covers up to 106 hours of review.

Change to an existing permit or equipment:

☐	**$200: Administrative or simple change** initial fee covers up to 3 hours of review Ecology may determine your change is complex during completeness review of your application. If your project is complex, you must pay the additional $675 before we will continue working on your application.
☐	**$875: Complex change** initial fee covers up to 10 hours of review
☐	**$350** flat fee: **Replace or alter control technology equipment under WAC 173-400-114** Ecology will contact you if we determine your change belongs in another fee category. You must pay the fee associated with that category before we will continue working on your application.

Read each statement, then check the box next to it to acknowledge that you agree.	
☒	The initial fee you submitted may not cover the cost of processing your application. Ecology will track the number of hours spent on your project. If the number of hours Ecology spends exceeds the hours included in your initial fee, Ecology will bill you $95 per hour for the extra time.
☒	You must include all information requested by this application. Ecology may not process your application if it does not include all the information requested.
☒	Submittal of this application allows Ecology staff to visit and inspect your facility.

DEPARTMENT OF ECOLOGY
State of Washington

Notice of Construction Application

Part 1: General Information

I. Project, Facility, and Company Information

1. Project Name CO6 Expansion	
2. Facility Name Columbia Data Center	
3. Facility Street Address 501 Port Industrial Parkway, Quincy, Washington	
4. Facility Legal Description Grant County Parcel No. 313675001 – Lot 1 MSN Data Center SP 27-28 (TGW 313675000 TCA 0017). Grant County Parcel No. 313675000 – Lot 1 MSN Data Center SP 27-28 (TGW 313675001 TCA 0023)	
5. Company Legal Name (if different from Facility Name) Microsoft Corporation	
6. Company Mailing Address (street, city, state, zip) P.O. Box 187, Quincy, WA 98848	

II. Contact Information and Certification

1. Facility Contact Name (who will be onsite) Michael Wind	
2. Facility Contact Mailing Address (if different than Company Mailing Address) 501 Port Industrial Parkway	
3. Facility Contact Phone Number 206-351-3612	4. Facility Contact E-mail mwind@microsoft.com
5. Billing Contact Name (who should receive billing information) Molly Rehm with CPG	
6. Billing Contact Mailing Address (if different than Company Mailing Address) 20365 Exchange Street, #240, Ashburn, VA 20147	
7. Billing Contact Phone Number 703-726-9726, Ext. 158	8. Billing Contact E-mail molly.rehm@cpgbeyond.com
9. Consultant Name (optional – if 3rd party hired to complete application elements) Mark Brunner	
10. Consultant Organization/Company Landau Associates	
11. Consultant Mailing Address (street, city, state, zip) 130 2nd Ave S, Edmonds, WA 98020	
12. Consultant Phone Number 206-631-8695	13.Consultant E-mail mbrunner@landauinc.com
14. Responsible Official Name and Title (who is responsible for project policy or decision-making) Michael Wind	
16. Responsible Official Phone 206-351-3612	17. Responsible Official E-mail mwind@microsoft.com
18. Responsible Official Certification and Signature I certify that the information on this application is accurate and complete. Signature [signature] Date 12/6/19	

Part 2: Technical Information

DEPARTMENT OF ECOLOGY State of Washington

Notice of Construction Application

The Technical Information may be sent with this application form to the Cashiering Unit, or may be sent directly to the Ecology regional office with jurisdiction along with a copy of this application form.

For all sections, check the box next to each item as you complete it.

III. Project Description

Please attach the following to your application.

- ☒ Written narrative describing your proposed project.
- ☒ Projected construction start and completion dates.
- ☒ Operating schedule and production rates.
- ☒ List of all major process equipment with manufacturer and maximum rated capacity.
- ☒ Process flow diagram with all emission points identified.
- ☒ Plan view site map.

- ☒ Manufacturer specification sheets for major process equipment components.
- ☒ Manufacturer specification sheets for pollution control equipment.
- ☒ Fuel specifications, including type, consumption (per hour & per year) and percent sulfur.

IV. State Environmental Policy Act (SEPA) Compliance

Check the appropriate box below.

☒ SEPA review is complete:
Include a copy of the final SEPA checklist and SEPA determination (e.g., DNS, MDNS, EIS) with your application.

☐ SEPA review has not been conducted:

☒ If review will be conducted by another agency, list the agency. You must provide a copy of the final SEPA checklist and SEPA determination before Ecology will issue your permit.
Agency Reviewing SEPA: ________City of Quincy____________________

☐ If the review will be conducted by Ecology, fill out a SEPA checklist and submit it with your application. You can find a SEPA checklist online at https://ecology.wa.gov/Regulations-Permits/SEPA/Environmental-review/SEPA-document-templates

Notice of Construction Application

V. Emissions Estimations of Criteria Pollutants

Does your project generate criteria air pollutant emissions? ☒ Yes ☐ No

If yes, please provide the following information regarding your criteria emissions in your application.

☒ The names of the criteria air pollutants emitted (i.e., NO_x, SO_2, CO, $PM_{2.5}$, PM_{10}, TSP, VOC, and Pb)

☒ Potential emissions of criteria air pollutants in tons per hour, tons per day, and tons per year (include calculations)

☐ If there will be any fugitive criteria pollutant emissions, clearly identify the pollutant and quantity

VI. Emissions Estimations of Toxic Air Pollutants

Does your project generate toxic air pollutant emissions? ☒ Yes ☐ No

If yes, please provide the following information regarding your toxic air pollutant emissions in your application.

☒ The names of the toxic air pollutants emitted (specified in WAC 173-460-150[1])

☒ Potential emissions of toxic air pollutants in pounds per hour, pounds per day, and pounds per year (include calculations)

☒ If there will be any fugitive toxic air pollutant emissions, clearly identify the pollutant and quantity

VII. Emission Standard Compliance

☒ Provide a list of all applicable new source performance standards, national emission standards for hazardous air pollutants, national emission standards for hazardous air pollutants for source categories, and emission standards adopted under Chapter 70.94 RCW.
Does your project comply with all applicable standards identified? ☒ Yes ☐ No

VIII. Best Available Control Technology

☒ Provide a complete evaluation of Best Available Control Technology (BACT) for your proposal.

[1] http://apps.leg.wa.gov/WAC/default.aspx?cite=173-460-150

DEPARTMENT OF ECOLOGY State of Washington

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IX. Ambient Air Impacts Analyses

Please provide the following:

☒ Ambient air impacts analyses for Criteria Air Pollutants (including fugitive emissions)

☒ Ambient air impacts analyses for Toxic Air Pollutants (including fugitive emissions)

☒ Discharge point data for each point included in air impacts analyses (include only if modeling is required)

- ☒ Exhaust height
- ☒ Exhaust inside dimensions (ex. diameter or length and width)
- ☒ Exhaust gas velocity or volumetric flow rate
- ☒ Exhaust gas exit temperature
- ☒ The volumetric flow rate
- ☒ Description of the discharges (i.e., vertically or horizontally) and whether there are any obstructions (ex., raincap)
- ☒ Identification of the emission unit(s) discharging from the point
- ☒ The distance from the stack to the nearest property line
- ☒ Emission unit building height, width, and length
- ☒ Height of tallest building on-site or in the vicinity and the nearest distance of that building to the exhaust
- ☒ Whether the facility is in an urban or rural location

Does your project cause or contribute to a violation of any ambient air quality standard or acceptable source impact level? ☐ Yes ☒ No

Notice of Construction Application Supporting Information Report
CO6 Expansion
Columbia Data Center
Quincy, Washington

This document was prepared by, or under the direct supervision of, the technical professionals noted below.

Document prepared by: ______________________ Mark Brunner
Primary Author

Document reviewed by: ______________________ Chip Halbert, PE
Quality Reviewer

Date: December 6, 2019
Project No.: 1849001.010
File path: P:\1849\001\R\Revised NOC Report
Project Coordinator: Christopher C. Young

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LIST OF ABBREVIATIONS AND ACRONYMS

AERMAP .... AMS/EPA regulatory model terrain pre-processor
AERMET .... AERMOD meteorological pre-processor
AERMOD .... AMS/EPA regulatory model
AMS .... American Meteorological Society
ASIL .... acceptable source impact level
BACT .... best available control technology
CAT .... Caterpillar
CFR .... Code of Federal Regulations
CO .... carbon monoxide
DEEP .... diesel engine exhaust particulate matter
DOC .... diesel oxidation catalyst
DPF .... diesel particulate filter
Ecology .... Washington State Department of Ecology
EPA .... US Environmental Protection Agency
g/kWm-hr .... grams per mechanical kilowatt-hour
GEP .... good engineering practice
HAP .... hazardous air pollutant
LAI .... Landau Associates, Inc.
MWe .... megawatts electrical
m .... meter
NAAQS .... National Ambient Air Quality Standards
NESHAP .... National Emission Standards for Hazardous Air Pollutants
NO_2 .... nitrogen dioxide
NOC .... Notice of Construction
NO_x .... nitrogen oxides
NSPS .... New Source Performance Standard
NWS .... National Weather Service
PM .... particulate matter
$PM_{2.5}$ .... PM with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10} .... PM with an aerodynamic diameter less than or equal to 10 microns
ppm .... parts per million
RCW .... Revised Code of Washington
RICE .... reciprocating internal combustion engine
SCR .... selective catalytic reduction
SIL .... significant impact level
SO_2 .... sulfur dioxide
SQER .... small-quantity emission rate
TAP .... toxic air pollutant

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

tBACT .... BACT for toxic air pollutants
VOC .... volatile organic compound
WAAQS...Washington Ambient Air Quality Standards
WAC .... Washington Administrative Code

1.0 INTRODUCTION

Landau Associates, Inc. (LAI) prepared this document on behalf of CPG and Microsoft to support the submittal of a Notice of Construction (NOC) application for installation and operation of new emergency generators, under air quality regulations promulgated by the Washington State Department of Ecology (Ecology). The proposed Microsoft CO6 expansion will be located within the existing Columbia Data Center complex at 501 Port Industrial Parkway, in Quincy, Grant County, Washington. Microsoft requests a modification to Approval Order No. 14AQ-E553 (Approval Order) to allow for the proposed expansion and changes to conditions for the existing emission units.

The parcel and legal description information for the property is as follows:

- Grant County Parcel No. 313675001 – Lot 1 MSN Data Center SP 27-28 (TGW 313675000 TCA 0017)
- Grant County Parcel No. 313675000 – Lot 1 MSN Data Center SP 27-28 (TGW 313675001 TCA 0023)

The project will include the construction of a computer server building and the installation of five emergency generators. Proposed changes to the Approval Order are outlined in Sections 2.1.1 and 2.3.

Based on the results of this evaluation, the recommended Best Available Control Technology for criteria pollutants (BACT) and toxic air pollutants (tBACT) is emission limitations consistent with the US Environmental Protection Agency's (EPA's) Tier 2 emission standards, which are achieved with combustion controls and the use of ultra-low sulfur diesel fuel. The basis for this recommendation is that the cost of EPA Tier 4-compliant emission controls is disproportionate to the benefit (i.e., emission reduction) achieved. Section 5.0 outlines the BACT and tBACT evaluation completed and the proposed limits.

Air dispersion modeling was conducted for criteria air pollutants and toxic air pollutants (TAPs). The results of modeling demonstrate that ambient criteria pollutant concentrations that result from operations at Columbia Data Center, and other local and regional background sources, are below the National Ambient Air Quality Standards (NAAQS). Additionally, the results of modeling demonstrate that ambient TAP concentrations that result from operations at CO6 are below Washington acceptable source impact levels (ASILs). Section 6.0 presents the results of the air dispersion modeling.

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2.0 PROJECT DESCRIPTION

(Section III of NOC application form)

2.1 Facility Description

Microsoft's existing Columbia Data Center (CO1, CO2, CO3, CO4, and CO5) includes server buildings and additional ancillary buildings. Note, the CO4 and CO5 buildings do not have any emission units associated with them. The proposed expansion (CO6) would include one new building on the site, which is located at 501 Port Industrial Parkway, south of D Street NW and west of 2nd Avenue NW. Vicinity and site maps are provided on Figures 1, 2, and 3. The site is accessible on the west side of the facility from Port Industrial Parkway.

A site map for the proposed project is provided on Figure 2.

2.1.1 Diesel-Powered Emergency Generators

This section describes emissions from the exhaust stacks of the diesel-fired engines that are included with each emergency generator. The emergency generator includes a diesel-powered engine that drives an alternator section to produce electricity. The alternator section does not emit any air pollutants, so the overall emissions from a diesel generator are produced only from the diesel engine. State and federal air quality regulations apply only to the emissions from the diesel engines. The terms "generator" and "engine" are used interchangeably in this report.

Each generator will be operated only as an emergency generator, with generator usage and runtime hours limited to those for "emergency generators" by the federal New Source Performance Standard (NSPS) Subpart IIII. NSPS Subpart IIII requires that emergency engines satisfy EPA Tier 2 emission standards for emergency engines as defined by the federal regulations (40 CFR Part 89). Microsoft will use Tier 2-certified generators. Also, all emergency generators will use ultra-low sulfur diesel fuel (15 parts per million [ppm] sulfur content).

Each of the emergency generators will be housed within enclosures at the locations shown on Figure 2. Specifications and manufacturer-provided emissions data for the proposed Caterpillar 2.5-megawatt electrical (MWe) diesel generators are provided in Appendix A. The equipment evaluated for this NOC application consists of five (5) Caterpillar Model 3516C generators. If model numbers change in future years during the planned phased construction, specification sheets for the updated generator or engine models will be provided to Ecology. The five generators will have a combined capacity of 12.5 MWe. The engines will have a displacement of 78 liters. Microsoft will not install any other diesel engines for use as fire pumps or for building safety generators.

Microsoft requests that the following changes be made to the Approval Order to reflect actual as-built conditions at the facility:

- In Table 1.1 of the Approval Order, remove the generators with Unit IDs 36 and 37. Microsoft no longer plans to install the two additional generators that were previously permitted at CO3.
- In Table 1.2 of the Approval Order, remove the fire pump with Unit ID “CO3.1, 3.2, and 3.3.” Microsoft no longer plans to install a third fire pump at the facility.
- Remove Table 1.3 of the Approval Order. The pre-treatment generator is owned and operated by the City of Quincy.

2.2 Generator Runtime Scenarios

The emission estimates and ambient impact modeling presented in this NOC application are based on emergency generator runtimes as described below.

2.2.1 Proposed New Generators

On an annual basis, Microsoft requests that compliance with per-generator runtime limits for the project be demonstrated by summing total actual operating hours for all generators in service for the project and comparing that to the total number of permitted hours for all generators in service for the project. To demonstrate that these requests will result in facility operations and air pollutant emissions that are below regulatory thresholds, this evaluation proposes the following annual runtime limits for the CO6 engines:

- An **annual runtime limit** of 80 hours per year, per generator.
- A **“theoretical maximum year”** addresses the worst-case consideration that the generators may run the maximum number of hours they are permitted in the same year that they are commissioned and stack-tested. In this theoretical maximum year scenario, the generators could each run up to 94 hours per year. This unlikely but possible event is considered the ultra-worst case scenario for project-related emissions from the emergency generators and was used for demonstration of compliance with the annually averaged NAAQS and Washington State TAP standards with an annual averaging period.

Generator operating scenarios for CO6 are as follows:

- **Non-emergency quarterly operation**: Routine operation and maintenance on the emergency generators will be conducted on a quarterly basis. This runtime activity will be conducted on one emergency generator at a time for 1 hour per generator at less than or equal to 100 percent load (full-variable load).
- **Non-emergency triennial operation**: Every 3 years, triennial electrical gear maintenance will be conducted. This runtime activity will be conducted on one emergency generator at a time for approximately 4 hours per generator under full-variable load.
- **Unplanned power outage**: During a power outage at the site, all installed generators will activate in order to supplement power to the server system. All five generators will operate concurrently under full-variable load.
- **Generator startup and commissioning**: After a new generator is installed it will require commissioning, which includes up to 10 hours of operation under a range of loads. First, each

generator is run for 2 hours one at a time. Then, a site integration test is completed, which involves operating all five generators concurrently for 8 hours under full-variable load.

- **Stack testing**: It is anticipated that Ecology will require exhaust stack emission testing of one generator, once every 5 years in order to demonstrate continued compliance with air quality standards. It is assumed that each stack test can take up to 6 hours. The worst-case scenario would be if the stack test failed, requiring a second, follow-up test in the same year, in which case two additional generators would need to be tested for up to 6 hours each. The worst-case runtime that could occur in a single year from stack testing would be operation of three 2.5-MWe generators, one at a time, for 6 hours each (i.e., a maximum of 18 hours of combined generator runtime in 1 year for CO6). This 18-hour combined maximum runtime was evenly distributed across all five generators and incorporated into the theoretical maximum year as specified above and accounts for 4 out of the 94 hours per generator.

2.2.2 Change to Existing Generators

As part of this project, Microsoft requests a reduction in the number of permitted operating hours for the existing emergency generators at the Columbia Data Center. Microsoft proposes a new annual operating limit of 100 hours per year for each existing emergency generator at CO1, CO2, and CO3. Current limits for CO1/CO2 and CO3 are 121 hours per year and 104 hours per year, respectively. Additionally, Microsoft requests that the operating load restriction contained in Approval Order condition 3.5 be removed so that maintenance testing can occur at any load.

2.3 Proposed Permit Conditions

The evaluation documented in this NOC application demonstrates that the above-described modifications will result in facility operations and air pollutant impacts that are in compliance with all federal and state laws and regulations. In summary, Microsoft requests the following Approval Order conditions to allow for minimum operational needs:

1. The following runtime limits:
    a. 80 hours per year, per generator for the proposed 2.5-MWe generators at CO6. Compliance with the operating hour limits in this condition is averaged over all CO6 generators in service.
    b. 100 hours per year, per generator for the existing 2.5-MWe generators at CO1, CO2, and CO3. Compliance with the operating hour limits in this condition is averaged over all CO1, CO2, and CO3 generators in service.
2. Operation of more than one generator for more than 15 hours per generator in any 24-hour period shall not occur more than three times in any three calendar year period.
3. The operation of more than one generator, operating concurrently at any one time, shall not occur on more than 21 calendar days in any three calendar year period.
4. There is no limit on the number of days that operation of one generator at a time can occur, but operation under this scenario is limited to daytime hours only (7:00 a.m. to 7:00 p.m.).

The evaluation in this NOC application has been completed to allow for Approval Order conditions that do not assign specific fuel or runtime limits to each individual runtime activity (e.g., unplanned power outages).

2.4 Compliance with State and Federal Regulations

The CO6 data center expansion will comply with the following applicable air regulations, in accordance with the federal and state Clean Air Acts. These requirements are 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 Code of Federal Regulations (CFR) Part 60 Subpart A (General Provisions)
- 40 CFR Part 60 Subpart IIII (Stationary Compression Ignition Internal Combustion Engines)
- 40 CFR Part 63 Subpart ZZZZ (National Emission Standards for Hazardous Air Pollutants [NESHAP] for Reciprocating Internal Combustion Engines [RICEs]).

Specifically, the project includes sources of air contaminants and will follow applicable air contaminant regulations as listed in:

- RCW 70.94.152
- WAC 173-400-113
- WAC 173-460-040.

The project is located in an attainment area for all Clean Air Act criteria pollutants. Facilities that produce more than 100 tons per year of any criteria pollutant are considered major sources under the federal regulation 40 CFR Part 70 and the state regulation WAC 173-410 et seq. Potential-to-emit estimates provided in Section 3.0 demonstrate that the facility will emit:

- Less than 100 tons per year of any criteria pollutant (nitrogen oxides [NO_x], particulate matter [PM], carbon monoxide [CO], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], and volatile organic compounds [VOCs])
- Less than 10 tons per year of any EPA hazardous air pollutant (HAP)
- Less than 25 tons per year of total HAPs.

As a result, a Prevention of Significant Deterioration New Source Review pre-construction permit and a Title V Air Operating Permit are not required.

All of the generators will be operated in a manner that satisfies the definition of “emergency engines” according to the federal regulations NSPS Subpart IIII and NESHAP Subpart ZZZZ. Therefore, NSPS Subpart IIII requires that each generator shall be manufactured and certified to meet EPA Tier 2 emission limits. The applicable sections of NESHAP Subpart ZZZZ indicate that compliance with the NESHAP for emergency engines requires each generator to meet the EPA Tier 2 emission standards, and each generator must be operated and maintained in accordance with the requirements of NSPS Subpart IIII.

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3.0 AIR POLLUTANT EMISSION ESTIMATES

(Section VIII of NOC application form)

Air pollutant emission rates were calculated for the generators per the requirements of WAC 173-400-103 and WAC 173-460-050. Emission rates were calculated for criteria pollutants and TAPs based on peak hourly (worst-case maximum) and long-term (annual maximum) operating scenarios. For comparison of emission rate standards of short-term durations, such as 1-hour, 8-hour, or 24-hour averaging periods, the peak hourly rate was multiplied by the corresponding number of operating hours (i.e., maximum duration of a particular runtime scenario).

All generators will be Caterpillar Tier 2-certified. Manufacturer-reported not-to-exceed generator emission factors for CO, NO_x, and PM were used to estimate emission rates. Additionally, the manufacturer-provided hydrocarbon emission rate was assumed to represent the emission rate for total VOC emissions.

3.1 Derivation of Emission Factors for Generators, Project-Only Emission Rates, and Fuel Usage

During all operations, the CO6 generators will activate at less than or equal to 100 percent load (full-variable load). Microsoft is requesting the flexibility to operate the emergency generators at any load, which will be set based on electrical demand. Considering that not all pollutant emission rates are maximum under the same operating load and because Microsoft is requesting the flexibility to operate at any load, the pollutant-specific maximum emission rate, under any load less than or equal to 100 percent, was assumed for calculating the worst-case emission rates. These vendor-reported worst-case emission rates are provided in Table 1 and were used in all compliance demonstrations.

Emissions of diesel engine exhaust particulate matter (DEEP) are conservatively assumed to be equal to the manufacturers' not-to-exceed emissions value for PM emission rates. The emission rates for PM with aerodynamic diameters of less than or equal to 10 microns (PM_{10}) and less than or equal to 2.5 microns ($PM_{2.5}$) include an estimate for "front-half" (filterable PM) and "back-half" (condensable PM) emissions for all modeling scenarios that demonstrate compliance with the NAAQS. The filterable PM estimate is equal to the manufacturers' not-to-exceed emission factor for PM. Condensable PM is assumed to be equal to the manufacturer's not-to-exceed value for total hydrocarbons, which is considered equivalent to an estimate for analysis by EPA Method 202.

All remaining pollutant emission rates, except for SO_2, were calculated using emission factors from the EPA's AP-42, Volume I, Chapter 3.4, which provides emission factors for HAPs from large internal combustion diesel engines (EPA 1995). These factors are based on fuel consumption. However, as listed in the generator specification sheets (provided in Appendix A), fuel consumption is highest at 100 percent load. Therefore, the maximum fuel consumption for full-variable load operations of all five generators would be 70,120 gallons of diesel fuel per year. Table 2 summarizes the maximum fuel-based project-only emission estimates and fuel consumption rates.

The emission rate for SO_2 was calculated using a mass-balance approach based on the maximum sulfur content in the fuel (i.e., 15 ppm) and the maximum expected fuel usage.

3.2 Generator Startup Emissions

In order to account for slightly higher emissions during the first minute of each engine startup, the estimated emission rates of pollutants associated with startup (PM, CO, total VOCs, and volatile TAPs) were scaled up using a “black-puff” emission factor. These “black-puff” factors are based on short-term concentration trends for VOC and CO emissions observed immediately after startup of a large diesel emergency generator. These observations were documented by the California Energy Commission’s report Air Quality Implications of Backup Generators in California (Lents et al. 2005). LAI’s derivation of startup emission factors is provided in Table 3. Additional details are provided in Appendix B.

The resultant project-only and facility-wide potentials-to-emit are provided in Tables 4 and 5.

4.0 EMISSION STANDARD COMPLIANCE

(Section VII of NOC application form)

The emergency diesel generators are subject to the emission control requirements under NSPS Subpart IIII, "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." The runtime limits requested for the generators satisfy the definition of "emergency generator" as specified by NSPS Subpart IIII. Based on that definition of "emergency generators," NSPS Subpart IIII indicates that the new generators are subject to EPA Tier 2 emission limits for emergency engines as specified by 40 CFR Part 89.

Microsoft will conduct all notifications, generator maintenance, recordkeeping, and reporting as required by NSPS Subpart IIII.

The generators will also be subject to the NESHAP requirements under Subpart ZZZZ, "National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines (RICEs)." NESHAP Section 63.6590(c)(1) specifies requirements for emergency RICEs that are also subject to NSPS Subpart IIII. The Microsoft facility will be an "area source" of federal HAPs; accordingly, NESHAP Section 63.6590(c)(1) indicates that the emergency generators will not be required to comply with any portions of Subpart ZZZZ as long as the generators comply with EPA Tier 2 emission standards and Microsoft operates the generators in compliance with NSPS Subpart IIII.

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5.0 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

(Section VIII of NOC application form)

This section describes the process of evaluating BACT for the emergency generators.

5.1 General Approach for Best Available Control Technology Assessment

BACT is an emission limitation based on the maximum degree of reduction that can be feasibly achieved for each air pollutant emitted from any new or modified stationary source. Ecology determines BACT using a "top-down" approach as described in the EPA's draft New Source Review Workshop Manual: Prevention of Significant Deterioration and Non-Attainment Area Permitting (EPA 1990). The following five steps are involved in the top-down process:

1. The first step in the top-down analysis is to identify all available control technologies that can be practicably applied for each emission unit.
2. The second step is to determine the technical feasibility of potential control options and to eliminate options that are demonstrated to be technically infeasible.
3. The third step is to rank all remaining options based on control effectiveness, with the most effective control alternative at the top.
4. The fourth step is to evaluate the remaining control alternatives. If the top-ranked control alternative is considered unacceptable based on disproportionate economic, environmental, and/or energy impacts, it is discarded. Justifications for discarding top-ranked control options must be approved by Ecology.
5. The fifth and final step is to choose the top-ranked alternative from the list of control options remaining after applying Steps 1 through 4. This option becomes the BACT, including the resulting emission rate.

Control options for potential reductions in criteria pollutant and, as practical, TAP emissions were identified for each source. In Washington State, the term BACT refers to the control technology applied to achieve reductions in criteria pollutant emission rates. The term "tBACT" refers to BACT applied to achieve reductions in TAP emission rates. Technologies were identified by considering Ecology's previous environmental permit determinations for diesel generators in Washington State. Available controls that are judged to be technically feasible are further evaluated taking into account energy, environmental, and economic impacts and other costs.

The following sections summarize the findings and recommended BACT determination. Detailed cost estimates and assumptions that support this BACT assessment are provided in Appendix C. Additionally, electronic calculation spreadsheets in Excel® format are provided in Appendix E.

5.2 Steps 1, 2, and 3: Identify Feasible Control Technologies for Diesel Generators

Based on Ecology's prior determinations in permitting diesel generators at computer data centers, the following technologies were considered to be commercially available and technically feasible for use at CO6:

- **Tier 4 integrated control package**. This control option consists of an integrated diesel particulate filter (DPF), diesel oxidation catalyst (DOC), and urea-based selective catalytic reduction (SCR). This system is highly efficient for control of NO_x (90 percent), PM_{10}/$PM_{2.5}$/DEEP (85 percent of "front-half"), CO (80 percent), VOCs and gaseous TAPs (70 percent), and meets Tier 4 emission standards as defined by the federal regulations (40 CFR Part 89). Note, when engine or emission control system manufacturers are producing Tier 4-compliant engines, they will typically weld the DOC to the DPF and call it a "catalyzed DPF." While the Tier 4 integrated control package is technically feasible, it does have some operational constraints for emergency generators. For example, SCRs typically do not provide NO_x removal when the engine exhaust temperature is below the target temperature of 575°F.
- **Urea-based SCR**. This control option is highly efficient for control of NO_x (90 percent) and NO_2. While the SCR is technically feasible, it does have some operational constraints for emergency generators as described above.
- **Catalyzed DPF (passive)**. This control option is highly efficient for control of PM_{10}/$PM_{2.5}$/DEEP (85 percent of "front-half"), CO (80 percent), VOCs and gaseous TAPs (70 percent). The amount of condensable ("back-half") particulates removed by catalyzed DPFs (if any) is not well understood.
- **Catalyzed DPF (active)**. This control option is highly efficient for control of PM_{10}/$PM_{2.5}$/DEEP (85 percent of "front-half"), CO (80 percent), VOCs and gaseous TAPs (70 percent). The amount of condensable ("back-half") particulates removed by catalyzed DPFs (if any) is not well understood.
- **DOC**. This control option is highly efficient for removal of CO (80 percent), VOCs, and gaseous TAPs (70 percent). It is marginally effective for removal of PM_{10}/$PM_{2.5}$/DEEP (15 to 25 percent depending on the load). This analysis conservatively assumed 25 percent removal of PM_{10}/$PM_{2.5}$/DEEP ("front-half") for the DOC system.
- **Tier 2-certified**. Tier 2-certified engines rely on combustion controls and the use of ultra-low sulfur diesel fuel (15 ppm sulfur content) to comply with EPA Tier 2 emission standards.

In previous permit applications for data centers, three-way catalysts have also been considered to be technologically feasible for use on diesel generators. However, recent compliance stack tests required at another data center in Grant County, Washington indicated that three-way catalysts were ineffective for removal of NO_x, and that the device actually increased the emission rate for NO_2. Those test results support the conclusion that commercially available three-way catalysts are not technically feasible for emergency generator use; therefore, they were dropped from consideration for this analysis.

5.3 Step 4: Evaluate Technically Feasible Technologies for Diesel Generators

All of the technologies listed above are assumed to be commercially available, reasonably reliable, and safe for use on backup diesel generators. One potential concern with the use of DOCs by themselves is their tendency to increase the emission rate for NO_2. Regardless of that concern, use of DOCs by themselves has not been eliminated from consideration based solely on that tendency since they have been demonstrated to provide effective control for CO and VOCs.

5.3.1 Methodology for Cost-Effectiveness Analyses for Diesel Generators

Detailed calculation spreadsheets for the BACT cost-effectiveness analyses are provided in Appendix C. For the individual pollutants, cost effectiveness was calculated by dividing the total life-cycle annual cost (dollars per year) by the tons of pollutant removed by the control device. The derived cost effectiveness was then compared to the following cost-effectiveness criteria values, which were developed based on Ecology's methodology for previous BACT evaluations for diesel generators in Grant County or were calculated by LAI using the Hanford[1] methodology as recommended by Ecology:

- Criteria air pollutants: Range between $5,000 and $12,000 per ton of removed pollutants (Ecology 2016; Appendix C).
- Toxic air pollutants: Range between $730 and $59,360 per ton of TAP removed based on the Hanford methodology (Haass et al. 2010; Appendix C).

The cost-effectiveness analysis for this NOC application was conducted using generally accepted assumptions that provide a reasonable but conservatively low estimate of the capital and operating costs. The capital cost, operating cost, life-cycle annualized cost, and cost effectiveness (dollars per ton of destroyed pollutant) were calculated using the methodology specified in the EPA Air Pollution Control Cost Manual (EPA 2002).

Cost estimates and pollutant destruction and removal efficiencies were obtained from either Johnson Matthey or Rypos for each evaluated emission control option. Indirect cost factors to derive a conservatively low total installation cost were obtained from the EPA Air Pollution Control Cost Manual (EPA 2002). The annual capital recovery costs were calculated assuming a 30-year system lifetime and a 5.5 percent annual discount rate. Conservatively low estimates of annual operation and maintenance costs for each control option were derived by assuming that there would be no operating cost for electricity or equipment maintenance. To provide a conservatively low estimate of the annual operating cost, the operational unit costs for each emission control option were set to zero.

[1] The Hanford method for evaluating the cost effectiveness of control technologies is documented in a report titled, Evaluation of Best Available Control Technology for Toxics (tBACT), Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations (Haass et al. 2010).

5.4 Best Available Control Technology Cost Effectiveness

This section describes the evaluation conducted to determine the cost effectiveness of controlling criteria pollutant emissions using the technologies identified in Section 5.2. As discussed below, the costs of controlling criteria pollutant emissions using the Tier 4 integrated control package, catalyzed DPF (passive or active), SCR, and DOC are disproportionate to the benefit received.

5.4.1 Cost Effectiveness Analysis for Tier 4 Integrated Control Package

The cost effectiveness (as dollars per ton of pollutant removed) of installing the Tier 4 integrated control package for control of NO_x ($75,030), PM_{10}/$PM_{2.5}$ ($8.5 million), CO ($643,612), VOCs ($4.9 million), and combined criteria air pollutants ($65,766) is provided in Table 6. As shown in Table 6, the forecast cost effectiveness for control of individual and combined pollutants exceeds Ecology's thresholds for cost effectiveness; therefore, subject to Ecology's review and concurrence, the Tier 4 integrated control package is cost-prohibitive for the purpose of reducing criteria air pollutant emissions.

5.4.2 Cost Effectiveness Analysis for SCR

The cost effectiveness of installing an SCR for control of NO_x is $71,722 per ton (Table 6). As shown in Table 6, the forecast cost effectiveness for control of NO_x exceeds Ecology's cost-effectiveness threshold of $12,000 per ton of NO_x; therefore, subject to Ecology's review and concurrence, an SCR is cost-prohibitive for the purpose of controlling NO_x emissions.

5.4.3 Cost Effectiveness Analysis for Catalyzed DPF (Passive)

The cost effectiveness of installing a passive/catalyzed DPF for control of PM_{10}/$PM_{2.5}$ ($610,459 per ton), CO ($49,023 per ton), VOCs ($370,224 per ton), and combined pollutants ($40,424 per ton) is provided in Table 6. As shown in Table 6, the forecast cost effectiveness for control of individual and combined pollutants exceeds Ecology's thresholds for cost effectiveness; therefore, subject to Ecology's review and concurrence, the passive/catalyzed DPF is cost-prohibitive for the purpose of controlling criteria air pollutant emissions.

Ecology requested that Microsoft's BACT assessment consider any potential added generator runtime and fuel use that is needed for regenerating a passive catalyzed DPF. According to Pacific Power, a passive catalyzed DPFs should be regenerated by running the generator at least twice per year for 30 minutes, with an exhaust temperature of at least 617 F. Microsoft's current quarterly generator maintenance runs (up to 1 hour at 50 percent load), which are proposed even without a DPF installed, would be sufficient to regenerate any passive catalyzed DPF. Therefore, additional runtime or fuel use is not necessary for this emission control option.

5.4.4 Cost Effectiveness Analysis for Catalyzed DPF (Active)

The cost effectiveness of installing an active/catalyzed DPF for control of $PM_{10}/PM_{2.5}$ ($1.6 million per ton), CO ($127,243 per ton), VOCs ($960,943 per ton), and combined pollutants ($104,923 per ton) is provided in Table 6. As shown in Table 6, the forecast cost effectiveness for control of individual and combined pollutants exceeds Ecology's thresholds for cost effectiveness; therefore, subject to Ecology's review and concurrence, the active/catalyzed DPF is cost-prohibitive for the purpose of controlling criteria air pollutant emissions.

5.4.5 Cost Effectiveness Analysis for DOC

The cost effectiveness of installing a DOC for control of $PM_{10}/PM_{2.5}$ ($447,911 per ton), CO ($9,992 per ton), VOCs ($75,457 per ton), and combined pollutants ($8,653 per ton) is provided in Table 6. As shown in Table 6, the forecast cost effectiveness for control of individual and combined pollutants exceeds Ecology's thresholds for cost effectiveness. Therefore, subject to Ecology's review and concurrence, the DOC is cost-prohibitive for the purpose of reducing individual criteria air pollutant emissions.

5.5 Toxics Best Available Control Technology Cost Effectiveness

This section describes the evaluation conducted to determine the cost effectiveness of controlling TAP emissions using the technologies identified in Section 5.2. As discussed below, the costs of controlling TAP emissions using the Tier 4 integrated control package, catalyzed DPF, SCR, and DOC are disproportionate to the benefit received. Subject to Ecology's review and concurrence, the analysis presented below supports the conclusion that Tier 4 integrated controls are cost-prohibitive for designation as BACT on the basis of control efficiencies for TAPs.

TAPs emitted by Tier 2 emergency generators at rates exceeding the *de minimis* thresholds consist of: NO_2, CO, and acrolein.

The air pollutant emission control options described in Section 5.2 would be effective at various ranges of efficiencies for control of TAPs. A cost-effectiveness summary for each TAP control option is provided in Appendix C. Table 7 summarizes the calculated TAP cost effectiveness for each control option in comparison to the presumed acceptable thresholds derived using the Hanford methodology. The cost-effectiveness calculations are provided in Excel format in Appendix E.

A cost-effectiveness evaluation was completed for CO as a criteria pollutant (see Section 5.4 and Table 6). CO is also evaluated as a TAP in this section. The derived cost threshold for removal of CO, based on the Hanford method, is $731 per ton. As shown in Table 7, the forecast cost effectiveness to control CO using a Tier 4 integrated control package ($643,612 per ton), catalyzed DPF ($49,023 per ton), active DPF ($127,243), and DOC ($9,992 per ton) exceeds Ecology's thresholds for cost effectiveness. Therefore, subject to Ecology's review and concurrence, the control options identified are cost-prohibitive for the purpose of controlling CO emissions.

NO_2 is a minor component of NO_x; the in-stack ratio of NO_2 to NO_x is assumed to be 10 percent. Therefore, control technologies evaluated for NO_x are applicable to NO_2 and costs are proportionately applicable. The derived cost threshold for removal of NO_2, based on the Hanford method, is $18,472 per ton. As shown in Table 7, the forecast cost effectiveness to control NO_2 using a Tier 4 integrated control package ($750,299 per ton) and SCR ($674,186 per ton) exceeds Ecology's thresholds for cost effectiveness. Therefore, subject to Ecology's review and concurrence, the control options identified are cost-prohibitive for the purpose of controlling NO_2 emissions.

Emissions of acrolein are treatable using the same control options applicable to control VOCs. The derived cost thresholds for removal of acrolein, based on the Hanford method, is $59,359 per ton of removed acrolein. As shown in Table 7, the forecast cost to control acrolein using a Tier 4 integrated control package ($23 billion per ton), catalyzed DPF ($1.8 billion per ton), active DPF ($4.6 billion), and DOC ($361 million per ton) exceeds Ecology's thresholds for cost effectiveness; therefore, the control options identified are cost-prohibitive for the purpose of controlling acrolein emissions.

Table 7 also provides the combined cost effectiveness for controlling all TAPs for each emission control option. As shown in Table 7, the combined cost effectiveness for TAPs exceeds Ecology's threshold for cost effectiveness for each control option.

5.6 Step 5: Recommended Best Available Control Technology for Diesel Generators

Although all of the add-on control technology options associated with Tier 4 diesel engine controls (Tier 4 integrated control package, SCR, catalyzed DPF options, or DOC) are technically feasible, each of them failed the BACT and tBACT cost-effectiveness evaluations. Therefore, none of the add-on controls are BACT or tBACT because the costs of emission control are disproportionate to the benefit received. Instead, emission limitations consistent with the EPA's Tier 2 emission standards—achieved with combustion controls and the use of ultra-low sulfur diesel fuel—are the recommended BACT and tBACT determination. The proposed BACT recommendation is based on compliance with the EPA's Tier 2 emission standards for a non-road diesel engine: 0.20 grams per mechanical kilowatt-hour (g/kWm-hr) for PM, 3.5 g/kWm-hr for CO, and 6.4 g/kWm-hr for combined NO_x plus VOCs.

6.0 AMBIENT AIR QUALITY IMPACT ANALYSIS

(Section IX of NOC application form)

This section discusses the air dispersion modeling results and provides a comparison of the results to the NAAQS and Washington Ambient Air Quality Standards (WAAQS) for criteria pollutants and the Washington State small-quantity emission rates (SQERs) and ASILs for TAPs. Air dispersion modeling input values are provided in Appendix D. Copies of the electronic modeling files and inputs are provided in Appendix E.

As discussed in the following sections, the modeled ambient impacts expected from project emissions are either 1) less than the Significant Impact Levels (SILs) or 2) less than the NAAQS and WAAQS, even after summing with modeled local background impacts and regional background concentrations. Additionally, all predicted project-related ambient TAP impacts are less than the ASILs.

6.1 First-Tier Screening of Toxic Air Pollutant Impacts

A first-tier TAP assessment compares the forecast emission rates to the SQERs and compares the maximum ambient impacts to ASILs. Table 8 shows the estimated project emission rates for each TAP expected to be released in the Microsoft emergency generator exhaust, and compares those emission rates to the corresponding SQER. Each SQER is an emission rate threshold, below which Ecology does not require an air quality impact assessment for the corresponding TAP. As shown in Table 8, estimated project-only emissions of NO_2 and acrolein are greater than their respective SQERs, so an ambient impact analysis was completed for those TAPs.

Ecology requires facilities to conduct a first-tier screening analysis for each TAP whose emissions exceed its SQER by modeling the 1^{st}-highest 1-hour, 1^{st}-highest 24-hour, and annual ambient impacts (depending on the TAP of interest), then comparing the modeled values to the ASILs (WAC 173-460-080).

6.2 Air Dispersion Modeling – Model and Assumptions

Air dispersion modeling was conducted in general accordance with the EPA's Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule (EPA 2005). The AERMOD[2] modeling system was used in accordance with the EPA's Revision to the Guideline on Air Quality Models (EPA 2005) to estimate ambient pollutant concentrations beyond the site property boundary.

AERMOD was used to calculate maximum ambient impact concentrations of criteria pollutants and TAPs that would be emitted from the project. To do this, AERMOD requires input from several models in order to process meteorological parameters, downwash parameters, and terrain heights. The

[2] American Meteorological Society (AMS)/US Environmental Protection Agency (EPA) Regulatory Model.

following sections describe these input models, as provided in guidance documents by the EPA, Electric Power Research Institute, and Lakes Environmental.

Ambient air impacts were modeled for all criteria pollutants and TAPs for which compliance is not demonstrated via emissions threshold screening.

AERMOD Version 19191 was used for all CO6 project ambient air dispersion modeling. AERMOD incorporates the data from the pre-processors described below with emission estimates and physical emission point characteristics to model ambient impacts. The model was used to estimate ambient concentrations based on various averaging times (e.g., 1 hour, 24 hours, annual, etc.) to demonstrate compliance with air quality standards for a network of receptors.

The AERMOD model was used to estimate the short-term impacts (i.e., 24-hour average or less) of PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, and acrolein emissions and long-term impacts (i.e., annual average) of PM_{10}, $PM_{2.5}$, and NO_2 emissions.

Each AERMOD setup was arranged to simulate the generator configuration that corresponds to the modeled operating scenario. The modeling setup for short-term project impacts at full-variable load included load-specific stack parameters (i.e., flow rate and exhaust exit temperature), which correspond to the characteristic worst-case emission load of each pollutant. For example, the modeling setup for 1-hour average NO_x uses a flow rate and exhaust exit temperature that corresponds to the 100 percent operating load, which is the operating load that produces the worst-case NO_x emission rate. The stack parameters setup for long-term impacts conservatively used the vendor-reported load-specific exhaust flow rate and temperature that would result in the worst-case dispersion conditions (i.e., the load condition with the lowest reported exhaust temperature and velocity). For example, since the annual average NO_x model uses a continuous year-long emission rate, the exhaust flow and temperature were conservatively set at the vendor-reported lowest values in lieu of calculating weighted-average stack parameters.

6.2.1 Stack Heights and Building Downwash Input Parameter Modeling

CO6 generator stack heights and diameters were modeled as follows:

- Stack height = 38 feet
- Stack diameter = 24 inches
- Stacks will discharge vertically with no obstructions.

Building downwash occurs when the aerodynamic turbulence induced by nearby buildings causes a pollutant emitted from an elevated source to be mixed rapidly toward the ground (downwash), resulting in higher ground-level pollutant concentrations. The software program Building Profile Input Program-Plume Rise Model Enhancements was used to determine if exhaust from emission units would be affected by nearby building structures. In general, these determinations are made if a stack's height is less than the height defined by the EPA's Good Engineering Practice (GEP) stack height.

GEP stack height is defined as the height of the nearby structure(s) measured from the ground-level elevation at the base of the stack plus 1.5 times the lesser dimension, height, or projected width of the nearby structure(s). Stack height for any emission source must be less than 65 meters or GEP, whichever is greater. The proposed generator's exhaust stacks will be lower than 65 meters. Building height for the proposed new building is 25.5 feet. The generator stacks are approximately 50 feet from the new building.

6.2.2 Receptor Grid Spacing and Terrain Height Input Modeling

To model complex terrain, AERMOD requires information about the surrounding terrain. This information includes a height scale and a base elevation for each receptor. The AMS/EPA Regulatory Model Terrain Pre-processor (AERMAP) was used to obtain a height scale and the base elevation for a receptor, and to develop receptor grids with terrain effects.

A receptor grid was extended from beyond the facility boundary consisting of Cartesian flagpole receptor grids placed at a height of 1.5 meters (m) above ground to approximate the human breathing zone. The grid spacing varied with distance from the facility, as listed below:

- 12.5-m spacing from the property boundary to 150 m from the nearest emission source
- 25-m spacing from 150 m to 400 m
- 50-m spacing from 400 m to 900 m
- 100-m spacing from 900 m to 2,000 m
- 300-m spacing between 2,000 m and 4,500 m
- 600-m spacing beyond 4,500 m.

The project generator stack located closest to the property line is approximately 120 meters from the western property boundary.

AERMAP requires the use of topographic data to estimate surface elevations above mean sea level. Digital topographic data (in the form of National Elevation Data files) for the analysis region were obtained from the Web GIS website (http://www.webgis.com) and processed for use in AERMOD. The National Elevation Data used for this project have a resolution of approximately 10 m (1 arc-second).

AERMAP produces a Receptor Output File (*.rou) containing the calculated terrain elevations and scale height for each receptor. AERMAP also produces a Source Output File (*.sou). This file contains the calculated base elevations for all sources.

6.2.3 Meteorological Input Parameter Modeling

The AERMOD Meteorological Pre-Processor (AERMET; Version 19191) is the meteorological pre-processor model that estimates boundary-layer parameters for use in AERMOD. AERMET processes three types of meteorological input data in three stages, and from this process it generates two input files for the AERMOD model. The two AERMOD input files produced by AERMET are: the Surface File with hourly boundary-layer parameter estimates; and the Profile File with multi-level observations of wind speed, wind direction, temperature, and standard deviations of fluctuating wind components. The three types of meteorological data used by AERMET for this project are described below.

- National Weather Service (NWS) hourly surface observations from Grant County International Airport in Moses Lake, Washington located approximately 24 miles from the Columbia site. Five years (January 1, 2012 through December 31, 2016) of hourly surface data were processed in AERMET.
- NWS twice-daily upper air soundings from Spokane, Washington. Five years (January 1, 2012 through December 31, 2016) of upper air data were processed in AERMET.
- The surface characteristic data required for AERMET are Albedo, Bowen ratio, and surface roughness. Albedo is a measure of the solar radiation reflected back from earth into space. The Bowen ratio is an evaporation-related measurement and is defined as the ratio of sensible heat to latent heat. The surface roughness length is the theoretical height above ground where the wind speed becomes zero. Surface characteristic data were based on land-use data surrounding the surface observation site.

AERSURFACE was used to determine the Albedo, Bowen ratio, and surface roughness within 12 equal sectors of a circle centered on the surface station tower. The default study radius of 1 km for surface roughness and 10 km for Bowen ratio and albedo was used. Looking at each sector individually, AERSURFACE determines the percentage of land-use type within each sector. Land cover data from the US Geological Survey National Land Cover Data 1992 archives were used as an input to AERSURFACE (USGS 1992). Default seasonal categories are used in AERSURFACE to represent the four seasonal categories as follows: 1) midsummer with lush vegetation; 2) autumn with unharvested cropland; 3) winter with continuous snow; and 4) transitional spring with partial green coverage or short annuals.

The AERSURFACE designation for an airport location (with the assumed surface roughness calculated based on 95 percent transportation and 5 percent commercial and industrial) is appropriate for this site. Annual precipitation for Moses Lake for each modeled year was obtained from the Western Regional Climate Center database. The annual precipitation was within the top 30th percentile of the past 30 years of annual precipitation totals for 2012, 2015, and 2016. Therefore, in accordance with EPA guidance, surface moisture conditions are considered wet when compared to historical norms and Bowen ratio values for wet surface moisture was used for those 3 years. The annual precipitation was between the top and bottom 30th percentile of the past 30 years of annual precipitation totals for 2013 and 2014 so Bowen ratio values for average surface moisture is used for those 2 years.

6.2.4 Demonstration of Compliance with Standards that are Based on an Annual Averaging Period

Annual emission rates were established based on the annual runtime limit of 80 hours of operation per generator with a total of 8 startup events per generator.

To demonstrate compliance for the "theoretical maximum year" during which Microsoft would operate the emergency generators for the entire annual allotment, plus operation for commissioning and stack testing in the same year, it was assumed each generator would operate a total of 94 hours in a 12-month period. The total theoretical maximum year emission rate is divided by the number of hours in a year (8,760 hours) to establish the pounds per hour emission rate input into AERMOD. This unlikely but possible scenario was considered for the following AERMOD compliance demonstrations:

- $PM_{2.5}$ annual average NAAQS
- NO_2 annual average NAAQS.

The ambient NO_2 annual average (and 1-hour average) concentrations were modeled using the Plume Volume Molar Ratio Method option, which was approved by the EPA for use in this model (McAlpine 2017). This AERMOD option calculates ambient NO_2 concentrations surrounding the site by applying a default NO_2/NO_x equilibrium ratio of 0.90 and a NO_2/NO_x in-stack ratio of 0.1. The estimated ambient ozone concentration was assumed to be 51.8 parts per billion (IDEQ; accessed August 16, 2019).

The results of the criteria pollutant modeling are provided in Table 9. Emission rate estimates and stack parameters for these scenarios are provided in Appendix D. The modeled annual average ambient impacts for NO_2, PM_{10}, and $PM_{2.5}$ are less than the NAAQS.

6.2.5 Demonstration of Compliance with Standards that are Based on a 1-Hour Averaging Period (Worst-Case 1-Hour)

To determine the worst-case ambient impacts for CO and SO_2, each with a 1-hour averaging period, the modeling setup assumed the worst-case scenario of all generators facility-wide operating concurrently. The model assumed five generators operating under full-variable load for 24 hours per day, 365 days per year, for 5 years. These assumptions are to address the conservative consideration that a power outage could occur at any time of day or night on any day of the year. To account for a worst-case scenario, the hour of activation for the power outage scenario was assumed (i.e., startup emissions of all 5 engines are accounted for in this single-hour scenario). These modeling assumptions are used in the setups for:

- CO 2nd-highest, 1-hour average NAAQS
- SO_2 1st-highest, 1-hour average NAAQS
- Any applicable TAP with a 1-hour averaging period (i.e., NO_2 ASIL).

The results of this scenario are provided in Table 9. The results of the TAP modeling are discussed in Section 6.3. The modeled 1-hour average ambient impacts for CO and SO_2 are less than the NAAQS.

6.2.6 Demonstration of Compliance with Standards that are Based on 3-Hour, 8-Hour, or 24-Hour Averaging Periods (Worst-Case 1-Hour)

To estimate worst-case ambient impacts for pollutants regulated on other short-term averages (i.e., 3-hour, 8-hour, or 24-hour), the modeling setup assumed a worst-case scenario of all generators facility-wide operating concurrently. The air dispersion models were set up for all five generators to operate 24 hours per day, 365 days per year, for 5 years. A single startup for each engine was assumed to occur once during each simulation. This modeling setup included:

- CO 2^{nd}-highest, 8-hour average NAAQS
- SO_2 1^{st}-highest, 3-hour average NAAQS
- Any applicable TAP with a 24-hour averaging period (i.e., acrolein).

The results of this scenario are provided in Table 9. The results of the TAP modeling are discussed in Section 6.3. The modeled 8-hour ambient impacts for CO and 3-hour ambient impacts for SO_2 are less than the NAAQS.

6.2.7 Demonstration of Compliance with the NO_2 1-hour Average NAAQS

The NO_2 1-hour average NAAQS is a probabilistic standard based on the 98^{th} percentile (averaged over 3 years) of the 1-hour daily maximum concentrations. Ecology allows compliance to be demonstrated with this standard by modeling the 8^{th}-highest daily impact. This demonstration conservatively compares the 1^{st}-highest 1-hour average NO_2 concentration for the modeled 8^{th}-highest emitting day.

As shown in Table 10, the 8^{th}-highest emitting day is expected to be the scenario for quarterly maintenance operations. The hourly emission rate input to AERMOD assumed operation in this scenario will be restricted to 12 hours per day during daylight hours (7:00 a.m. to 7:00 p.m.).

The results of this scenario are provided in Table 9. The modeled 1-hour average ambient impact for NO_2 is less than the NAAQS.

6.2.8 Demonstration of Compliance with the $PM_{2.5}$ 24-hour Average NAAQS

The $PM_{2.5}$ 24-hour average NAAQS is also a probabilistic standard based on the 98^{th} percentile (averaged over 3 years) of the 24-hour average concentration. Ecology allows compliance to be demonstrated with this standard by modeling the 8^{th}-highest daily impact. Therefore, this demonstration compares the 1^{st}-highest 24-hour average $PM_{2.5}$ concentration for the modeled 8^{th}-highest emitting day.

As shown in Table 10, the 8th-highest emitting day is expected to be the scenario for quarterly maintenance operations. The hourly emission rate input to AERMOD assumed operation in this scenario will be restricted to 12 hours per day during daylight hours (7:00 a.m. to 7:00 p.m.).

The results of this scenario are provided in Table 9. The modeled project emissions plus local background 24-hour average ambient impact for $PM_{2.5}$ is less than the NAAQS. Modeled cumulative concentration results are below the NAAQS where the project-related concentration is significant.

6.2.9 Demonstration of Compliance with the PM_{10} 24-hour Average NAAQS

The PM_{10} 24-hour average NAAQS is not to be exceeded more than once per year on average over 3 years; therefore, compliance with this standard was modeled based on the 2nd-highest emitting day, which is a scenario that assumes all generators are operating concurrently facility-wide. Note, because Microsoft is requesting a 15-hour operational limit on the 2nd through 7th days of concurrent generator operation in a calendar year, this modeling scenario assumed a 15-hour utility outage and the 1st-highest concentration in AERMOD was compared to the PM_{10} 24-hour average NAAQS. The 15-hour emissions total for this event was divided by 24 hours to develop the hourly emission rate input into AERMOD.[3]

The results of this scenario are provided in Table 9. The modeled project emissions plus local background 24-hour average ambient impact for PM_{10} is less than the NAAQS. Modeled cumulative concentration results are below the NAAQS where the project-related concentration is significant.

6.2.10 Assumed Background Impacts

An evaluation of background impacts was conducted when the modeled concentration at a receptor from only project sources have the potential to be above the SIL. Background impacts were added to project-related impacts only at receptors where the project-related concentration exceeded the SIL.

This evaluation included regional background values contributed by existing regional emission sources in the project vicinity (e.g., permitted sources, highway vehicles, area sources) and local background values contributed by the other nearby data centers and the Lamb Weston facility. Project coordinate-specific regional background values were obtained from the Idaho DEQ website (IDEQ; accessed August 16, 2019).

Local background values for $PM_{2.5}$, PM_{10}, and NO_2 consisted of the ambient impacts caused by emissions from the industrial emission sources at the neighboring NTT DATA Data Center, Microsoft

[3] Note: The emission rates presented in Table 4 are the maximum potential emissions on an hourly basis considering one startup occurs in that hour. The PM_{10} NAAQS is based on a 24-hour average and may be exceeded once per year over 3 years. The facility proposes to limit the number of hours on the second day all generators run in a power outage scenario to 15 hours. The modeled emission rate considers one startup event for the 15-hour period and emissions for the worst-case load (25%) for the remainder of the 15 hours of operation, then averaged over the 24-hour modeled period (by dividing by 24). The resulting modeled emission rate is 0.872 lb/hr (1.10E-01 g/s) as shown in Table D-2.

MWH Data Center, the CyrusOne Data Center, the Lamb Weston industrial facility, and existing sources at the Columbia Data Center. Emissions from each of these facilities were assumed to be equal to their respective permit limits. The modeling assumptions for local background sources were as follows:

- **Compliance with PM_{10} 24-hour and NO_2 annual average NAAQS**. This evaluation assumes that the permitted sources at the NTT DATA Data Center (emergency generators), Microsoft Columbia Data Center (emergency generators and cooling towers), MWH Data Center (emergency generators and cooling towers), CyrusOne Data Center (emergency generators) and the boilers at Lamb Weston would operate at their maximum emission rates.
- **Compliance with $PM_{2.5}$ 24-hour average NAAQS**. This evaluation assumes that the permitted cooling towers at the Microsoft Columbia Data Center and MWH Data Center and the boilers at Lamb Weston would operate at their respective maximum emission rates.
- **Compliance with NO_2 1-hour average NAAQS**. This evaluation assumes that the Lamb Weston industrial facility would operate at its maximum emission rates.

6.3 Toxic Air Pollutant Ambient Impacts Compared to Acceptable Source Impact Levels

The first-tier ambient concentration screening analysis is summarized in Table 11. This screening analysis was conducted on all TAPs with expected emission rates that exceed the SQER (as presented in Table 8). The project-only emission rates listed in Table 11 represent full-buildout operations. As shown in Table 11, the maximum modeled ambient concentrations for NO_2 and acrolein are less than their respective ASILs.

7.0 REFERENCES

Ecology. 2016. Memorandum: BACT and tBACT Cost-Effectiveness Thresholds. From Robert Koster, Washington State Department of Ecology, to File, Washington State Department of Ecology. August 2.

EPA. 1990. Draft: New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting. Office of Air Quality Planning and Standards, US Environmental Protection Agency. October. http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100XFU4.txt.

EPA. 1995. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources. AP-42. 5th ed. Office of Air Quality Planning and Standards, US Environmental Protection Agency. January. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors.

EPA. 2002. EPA Air Pollution Control Cost Manual. EPA/452/B-02-00. US Environmental Protection Agency. January. http://www.epa.gov/ttn/catc/dir1/c_allchs.pdf

EPA. 2005. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions: Final Rule. US Environmental Protection Agency. 40 CFR Part 51. November 9.

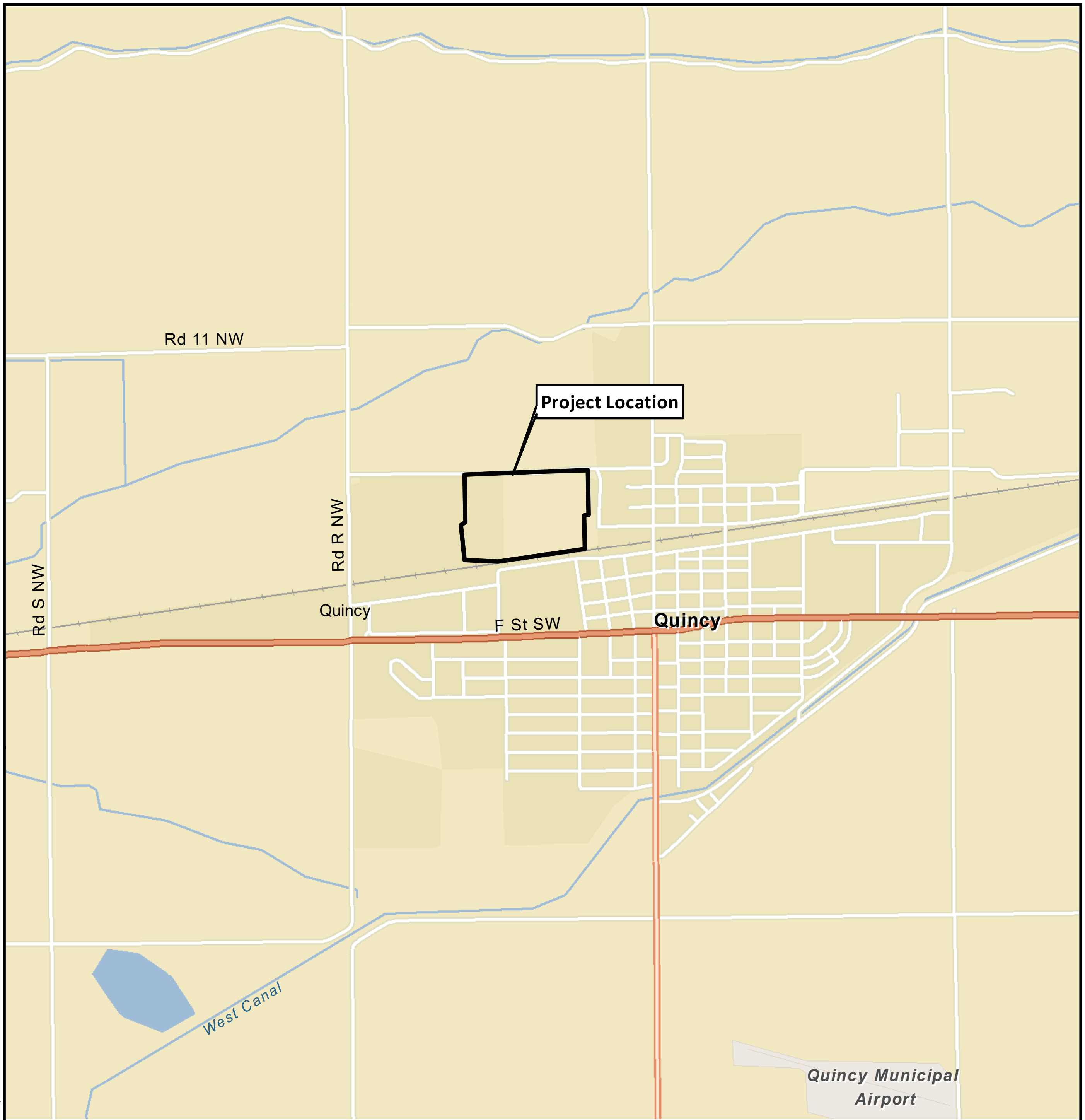
Haass, C.C., J.L. Kovach, S.E. Kelly, and D.A. Turner. 2010. Evaluation of Best Available Control Technology for Toxics (tBACT), Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations. RPP-ENV-46679, Rev. 0 US Department of Energy. June 3.

IDEQ. Background Concentrations 2014-2017. Idaho Department of Environmental Quality. https://idahodeq.maps.arcgis.com/apps/MapSeries/index.html?appid=0c8a006e11fe4ec5939804b873098dfe.

Lents, J.M., L. Arth, M. Boretz, M. Chitjian, K. Cocker, N. Davis, K Johnson, Y Long, J.W. Miller, U. Mondragon, R.M. Nikkila, M. Omary, D. Pacocha, Y. Quin, S. Shah, and G. Tonnesen. 2005. Air Quality Implications of Backup Generators in California - Volume One: Generation Scenarios, Emissions and Atmospheric Modeling, and Health Risk Analysis. Publication No. CEC-500-2005-048. California Energy Commission, PIER Energy-Related Environmental Research. March.

McAlpine, J. 2017. "Re: Microsoft MWH Data Center in Quincy, WA, Air Dispersion Modeling Protocol Review Process." From Jay McAlpine, Office of Air and Waste, US Environmental Protection Agency, to Tesfamichael Ghidey, Washington State Department of Ecology. December 12.

USGS. 1992. National Land Cover Data 1992. US Geological Survey. https://www.mrlc.gov/nlcd1992.php.



Data Source: Esri 2012.

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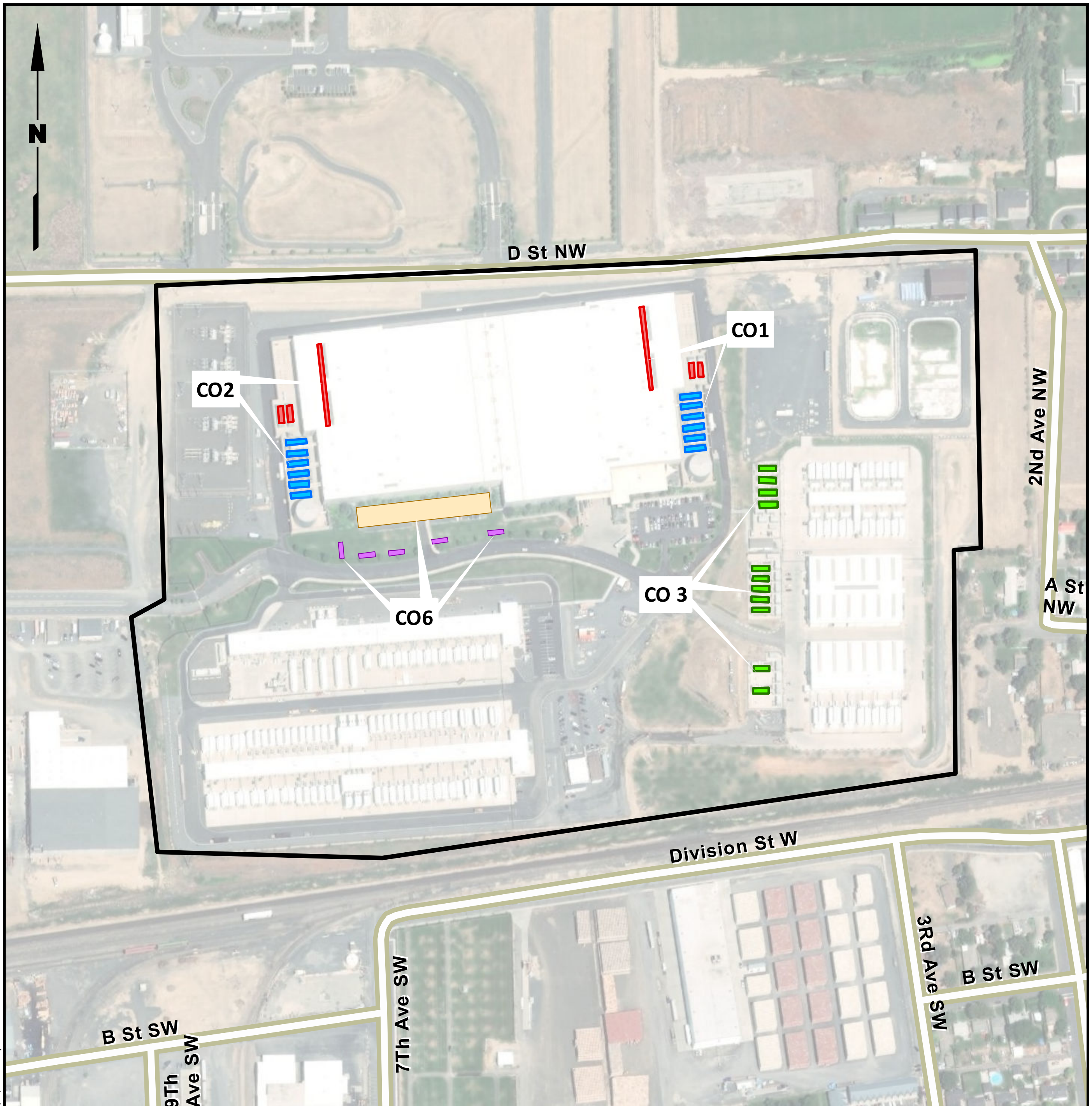
CO6 Expansion Columbia Data Center Quincy, Washington	**Vicinity Map**	Figure 1



Legend

- CO6 Proposed Building
- CO6 Proposed Generator
- CO3 Generator
- Generators
- Cooling Tower
- Facility Boundary

0 400 800

Scale in Feet

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Source:s Esri World Imagery

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CO6 Expansion Columbia Data Center Quincy, Washington	Site Map	Figure 2

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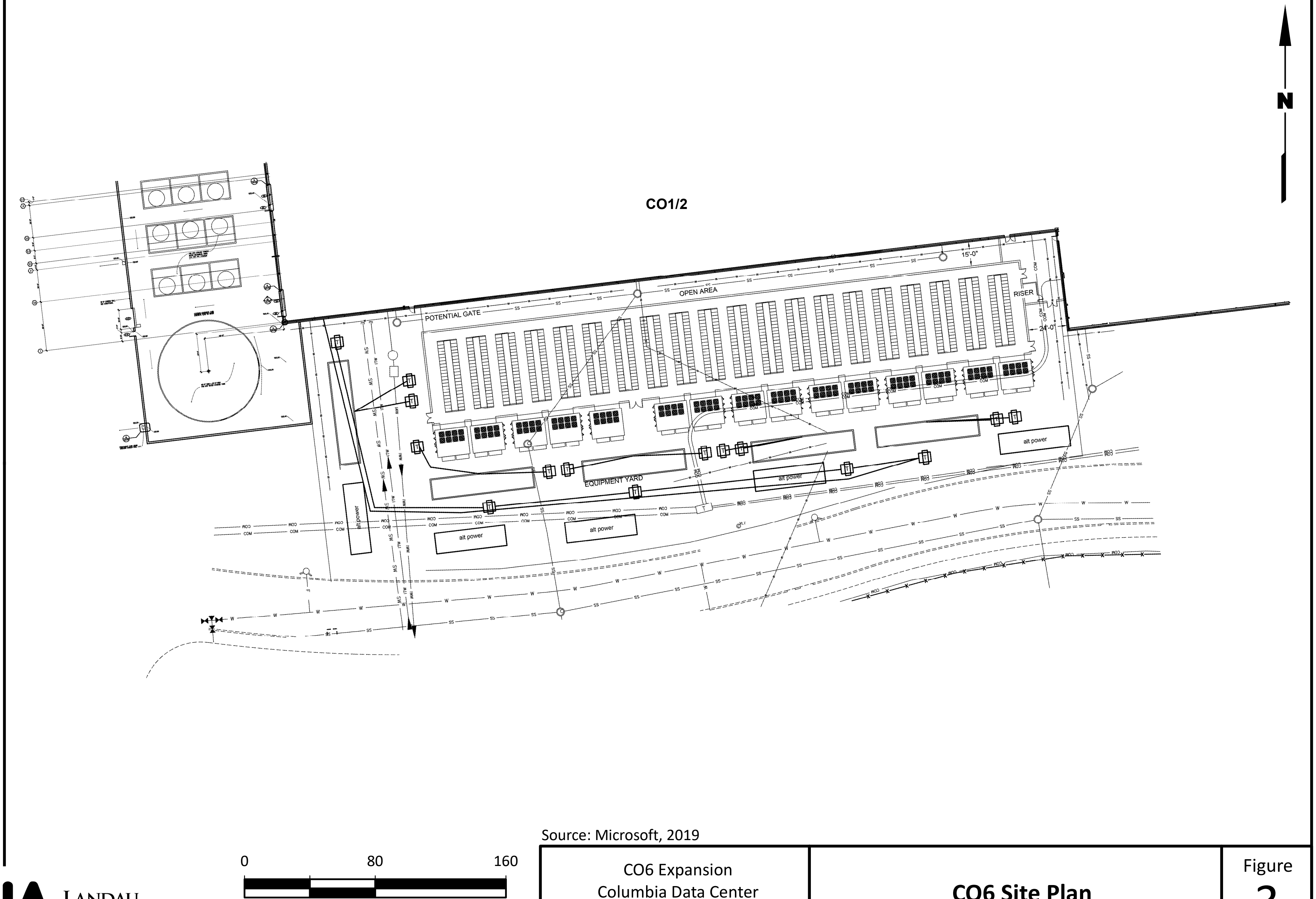

Source: Microsoft, 2019

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CO6 Expansion
Columbia Data Center
Quincy, Washington

CO6 Site Plan

Figure
3

Abbreviations and Acronyms
CO6 Expansion – Columbia Data Center
Quincy, Washington

Abbreviations and Acronyms:

°F	degrees Fahrenheit
$\mu g/m^3$	micrograms per cubic meter
ASIL	acceptable source impact level
avg	averaging
BH	"Back-half" condensable emissions
Btu	British thermal unit
CAS	Chemical Abstract Service number
cfm	cubic feet per minute
CO	carbon monoxide
DEEP	diesel engine exhaust particulate matter
DOC	diesel oxidation catalyst
DPF	diesel particulate filter
E	Easting
FH	"Front-half" filterable emissions
ft	feet
gph	gallons per hour
gpm	gallons per minute
HC	hydrocarbons
HQ	hazard quotient
hr	hour
in	inches
KW	kilowatts
Kwe	kilowatts electrical
L	liter
lbs	pounds
lbs/dy	pounds per day
lbs/hr	pounds per hour
m	meters
mg	milligrams
MMBtu	million British thermal units
MW	megawatts
MWe	megawatts electrical
N	Northing
NA	not applicable
NAAQS	National Ambient Air Quality Standards
No.	number
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NTE	not to exceed
PAH	polycyclic aromatic hydrocarbon
PM	particulate matter
PM_{10}	particulate matter with aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$	particulate matter with aerodynamic diameter less than or equal to 2.5 microns
ppm	parts per million
PTE	potential-to-emit
SCR	selective catalytic reduction
Sec	section
SO_2	sulfur dioxide
SQER	small-quantity emission rate
TAPs	toxic air pollutants
TPY	tons per year
ULSD	ultra-low sulfur diesel
UTM	universal transverse mercator coordinate system zone
VOCs	volatile organic compounds

Table 1
Vendor-Reported Air Pollutant Emission Rates
CO6 Expansion – Columbia Data Center
Quincy, Washington

Pollutant	Worst-Case 2.5-MW Generator Full-variable (≤ 100%) Load Emission Parameters[a]		
	Worst-case Emissions (lb/hr)	Load-specific Exhaust Temp. (°F)	Load-specific Exhaust Flow (cfm)
NO_X	53.70	851	18,808
CO	6.95	851	18,808
HC	1.06	759	15,367
DEEP[b]	0.50	655	7,490
PM (FH+BH)[c]	1.39	655	7,490
Min Flow/Temp	--	501	5,003
Max Flow/Temp	--	851	18,808
Fuel usage per genset (gph)	--	175	

Notes:

[a] "Full-variable load" is the pollutant-specific worst-case emission rate at any load ≤100 percent load.

[b] DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

[c] PM (particulate matter) attributable to front-half and back-half emissions is assumed equal to the sum of vendor NTE values for PM and hydrocarbons.

Table 2
Fuel-Based Emissions Summary
CO6 Expansion – Columbia Data Center
Quincy, Washington

Parameter	Value	Units
Generator Size	2,500	kW
No. of Generators	5	--
Fuel Usage (per genset)	175	gph
Hourly Heat Input	24.02	MMBtu /hr
Fuel Type	ULSD	--
Fuel Sulfur Content	15	ppm weight
Fuel Density	7.1	lbs /gallon
Fuel Heat Content	137,000	Btu /gallon

Annual Hours of Operation	
Average	80
Max with Commissioning and Stack	94

Duration	Units	Peak Hourly	Peak Daily	Annual Average	Max Year (With Commissioning and Stack Testing)
Fuel Usage (per period)	Gallons	877	21,036	70,120	82,040
Heat Input (per period)	MMBtu	120	2,882	9,606	11,240

Pollutant	CAS Number	Emission factor		Peak Emission Rate[a]		Annual Emission Rate[b] (TPY)	
				Hourly (lb/hr per genset)	Daily, all generators (lb/dy)	Average	Max Year (With Commissioning and Stack Testing)
SO_2	7446-09-5	0.0015% Sulfur (wt)	c	0.037	4.5	-	-
Benzene	71-43-2	7.8E-04 lb/MMBtu	d	0.020	2.2	0.0037	0.0044
Toluene	108-88-3	2.8E-04 lb/MMBtu	d	0.0071	0.78	0.0014	0.0016
Xylenes	95-47-6	1.9E-04 lb/MMBtu	d	0.0049	0.54	9.3E-04	0.0011
1,3-Butadiene	106-99-0	3.9E-05 lb/MMBtu	d	9.9E-04	0.11	1.9E-04	2.2E-04
Formaldehyde	50-00-0	7.9E-05 lb/MMBtu	d	0.0020	0.22	3.8E-04	4.5E-04
Acetaldehyde	75-07-0	2.5E-05 lb/MMBtu	d	6.4E-04	0.070	1.2E-04	1.4E-04
Acrolein	107-02-8	7.9E-06 lb/MMBtu	d	2.0E-04	0.022	3.8E-05	4.5E-05
Benzo(a)pyrene	50-32-8	2.6E-07 lb/MMBtu	d	6.5E-06	7.2E-04	1.2E-06	1.5E-06
Benz(a)anthracene	56-55-3	6.2E-07 lb/MMBtu	d	1.6E-05	0.0017	3.0E-06	3.5E-06
Chrysene	218-01-9	1.5E-06 lb/MMBtu	d	3.9E-05	0.0043	7.4E-06	8.6E-06
Benzo(b)fluoranthene	205-99-2	1.1E-06 lb/MMBtu	d	2.8E-05	0.0031	5.4E-06	6.3E-06
Benzo(k)fluoranthene	207-08-9	2.2E-07 lb/MMBtu	d	5.5E-06	6.1E-04	1.1E-06	1.2E-06
Dibenz(a,h)anthracene	53-70-3	3.5E-07 lb/MMBtu	d	8.8E-06	0.0010	1.7E-06	2.0E-06
Indeno(1,2,3-cd)pyrene	193-39-5	4.1E-07 lb/MMBtu	d	1.0E-05	0.0012	2.0E-06	2.3E-06
Naphthalene	91-20-3	1.3E-04 lb/MMBtu	d	0.0033	0.36	6.3E-04	7.3E-04
Propylene	115-07-1	2.8E-03 lb/MMBtu	d	0.071	7.8	0.013	0.016

Notes:

[a] Emission rate accounts for one startup event per hour.

[b] No change to the annual fuel use limits are proposed. Therefore, there is no increase in annual fuel-based emissions as a result of the project. Annual emission rates are presented for informational purposes to show maximum potential emissions from the proposed new generators alone.

[c] SO_2 emissions are based on a mass balance of the use of ultra-low sulfur diesel fuel, assuming fuel sulfur content of 15 ppm

[d] Source: AP-42 Sec 23.4 (EPA 1995).

Table 3
Startup Emissions Summary
CO6 Expansion – Columbia Data Center
Quincy, Washington

"Black-Puff" Emissions Test Data (see Appendix B)

Pollutant	Spike Duration (seconds)	Measured Concentration (ppm)		Cold-Start Emission Factor
		Cold-Start Emission Spike	Steady-State (Warm) Emissions	
PM+HC	14	900	30	4.3
NO_X	8.0	40	38	0.94
CO	20	750	30	9.0

Pollutant	Worst-case Emission Rate (lbs/hr)	
	2.5 MW	
	Cold-start[a]	Warm
HC	4.52	1.06
NO_X[c]	53.7	53.7
CO	63	7.0
DEEP[b]	2.13	0.50
PM (FH+BH)	5.9	1.39

Startup emission rate applied to one hour (full-variable Load (≤100% Load) emissions)

Pollutant	2.5 MW - Single Hour Emissions (lb/hr)		
	Startup (1 min)	Warm (59 min)	Total (1 hr)
HC	0.075	1.04	1.12
NO_X	0.90	52.8	53.7
CO	1.04	6.83	7.88
DEEP[b]	0.0356	0.492	0.527
PM (FH+BH)	0.099	1.37	1.47

Notes:

[a] Startup emission factor applies to the first 60 seconds of emissions after engine startup.

[b] DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

[c] Although the startup emission factor derived for NO_x is less than 1 (i.e., decreased emissions), this evaluation will conservatively assume a factor of 1.0.

Table 4
Proposed Sources Potential-to-Emit Emissions Summary
CO6 Expansion – Columbia Data Center
Quincy, Washington

Parameter	Units	Annual	Max Year (with Commissioning and Stack Testing)
Annual Hours of Operation (per unit)	Hours	80	94
Number of Cold Startup Events	Events	8	15
Duration Each Cold Startup Event	Hours	0.017	0.017
Total Duration Cold Conditions	Hours	0.13	0.25

Pollutant	PTE Proposed Sources[a]		
	Hourly (lbs/hr)	Annual (TPY)	Max Year (with Commissioning and Stack Testing) (TPY)
Criteria Pollutants			
NO_X	269	10.7	12.6
CO	39.4	1.41	1.66
SO_2	0.186	0.0015	0.0017
$PM_{10}/PM_{2.5}$ (gensets only)	7.3	0.28	0.33
VOCs	5.59	0.21	0.25
Toxic Air Pollutants			
Primary NO_2[b]	26.9	1.07	1.26
DEEP	2.64	0.101	0.118
CO	39.4	1.41	1.66
SO_2	0.19	0.0015	0.0017
Carbon-based TAPs			
Acrolein	9.98E-04	3.8E-05	4.5E-05
Benzene	9.83E-02	3.75E-03	4.38E-03
Propylene	3.53E-01	1.35E-02	1.58E-02
Toluene	3.56E-02	1.36E-03	1.59E-03
Xylenes	2.44E-02	9.32E-04	1.09E-03
Formaldehyde	9.99E-03	3.81E-04	4.46E-04
Acetaldehyde	3.19E-03	1.22E-04	1.42E-04
1,3-Butadiene	4.95E-03	1.89E-04	2.21E-04
Polycyclic Aromatic Hydrocarbons			
Naphthalene	1.65E-02	6.28E-04	7.35E-04
Benz(a)anthracene	7.88E-05	3.00E-06	3.51E-06
Chrysene	1.94E-04	7.39E-06	8.65E-06
Benzo(b)fluoranthene	1.41E-04	5.36E-06	6.27E-06
Benzo(k)fluoranthene	2.76E-05	1.05E-06	1.23E-06
Benzo(a)pyrene	3.25E-05	1.24E-06	1.45E-06
Indeno(1,2,3-cd)pyrene	5.24E-05	2.00E-06	2.34E-06
Dibenz(a,h)anthracene	4.38E-05	1.67E-06	1.96E-06

Notes:

[a] Startup emissions are accounted for in the project emissions.

[b] NO_2 is assumed to be 10% of the NO_x.

Table 5
Facility Potential-to-Emit Emissions Summary
CO6 Expansion – Columbia Data Center
Quincy, Washington

Pollutant	Existing PTE Rates	Existing PTE Limited to 100 hours/year	Existing PTE Change	Existing Facility Reduction + Proposed PTE Rates[a]	
	Annual Average (TPY)	Annual Average (TPY)	Annual Average (TPY)	Annual Average (TPY)	Max Year (with Commissioning) (TPY)
Criteria Pollutants					
NO_X	44.0	26.4	-17.6	-6.91	-5.1
CO	10.1	4.3	-5.8	-4.4	-4.2
SO_2	No change to annual fuel use limits.				
$PM_{10}/PM_{2.5}$ (generators only)	1.03	2.6	1.56	1.84	1.89
VOCs	2.00	2.1	0.088	0.30	0.34
Toxic Air Pollutants					
Primary NO_2[b]	4.4	2.6	-1.76	-0.69	-0.51
DEEP[c]	1.03	0.50	-0.53	-0.43	-0.41
CO	10.1	4.3	-5.8	-4.4	-4.2
SO_2	No change to annual fuel use limits.				
Carbon-based TAPs	No change to annual fuel use limits.				
PAHs	No change to annual fuel use limits.				

Notes:

[a] Startup emissions are accounted for in the project emissions.

[b] NO_2 is assumed to be 10% of the NO_x.

[c] DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

Table 6
Summary of Cost Effectiveness for Removal of Criteria Pollutants
CO6 Expansion – Columbia Data Center
Quincy, Washington

	$PM_{10}/PM_{2.5}$	CO	Total VOCs	NO_x	Actual Cost for Combined Criteria Pollutants
Acceptable Unit Cost (dollars per ton)	$12,000	$5,000	$12,000	$12,000	
Control Option	**Actual Cost to Control (dollars per ton)**				
Tier 4 Integrated Control Package[a]	$8,486,024	$643,612	$4,860,593	$75,030	$65,766
SCR[b]	--	--	--	$71,722	$71,722
Catalyzed DPF[c]	$610,459	$49,023	$370,224	--	$40,424
Active DPF[c]	$1,584,488	$127,243	$960,943	--	$104,923
DOC[d]	$447,911	$9,992	$75,457	--	$8,653
	not acceptable	not acceptable	not acceptable	not acceptable	not acceptable

Notes:

[a] The expected control efficiency for a Tier 4 integrated control package to reduce emission is 90% for NO_x, 85% for PM (front half), 80% for CO, and 80% for VOCs.

[b] The expected control efficiency for an SCR is 90% for NO_x.

[c] The expected control efficiency for a catalyzed DPF is 90% for PM (front half), 80% for CO, and 70% for VOCs.

[d] The expected control efficiency for a DOC is 80% for CO, 70% for VOCs, and 25% for filterable $PM_{10}/PM_{2.5}$.

Table 7
Summary of Cost Effectiveness for Removal of Toxic Air Pollutants
CO6 Expansion – Columbia Data Center
Quincy, Washington

Toxic Air Pollutant	ASIL ($\mu g/m^3$)	Hanford Method Cost Factor	Hanford Method Ceiling Cost (dollar per ton)	Emission Control Option - Actual Cost to Control (dollars per ton)				
				Tier 4 Integrated Control Package[a]	SCR[b]	Catalyzed DPF[c]	Active DPF[d]	DOC[e]
CO	23,000	0.1	$731	$643,612	--	$49,023	$127,243	$9,992
NO_2 (10% of NO_x)	470	1.8	$18,472	$750,299	$674,186	--	--	--
Acrolein	0.06	5.7	$59,359	$23,269,153,380	--	$1,772,377,500	$4,600,328,613	$361,234,117
Non-Carcinogenic VOCs	NA	NA	NA	$23,269,153,380	--	$1,772,377,500	$4,600,328,613	$361,234,117
Combined TAPs Cost-effectiveness				$346,431	$674,186	$45,378	$117,781	$9,773
Presumed Acceptable Annual Cost for Combined TAP Control (based on the Hanford Method)				$8,924	$18,472	$6,071	$6,071	$2,300

Notes:

[a] The expected control efficiency of a Tier 4 integrated control package to reduce emission of VOCs and gaseous TAPs is 70%.

[b] There is no expected control of VOCs and gaseous TAPs using SCR.

[c] The expected control efficiency to reduce emission of VOCs and gaseous TAPs using the catalyzed DPF is 70%.

[d] The expected control efficiency to reduce emission of VOCs and gaseous TAPs using the active DPF is 70%.

[e] The expected control efficiency to reduce emission of VOCs and gaseous TAPs using the DOC is 70%.

-- = Ineffective control technology

Table 8
Project Emissions Compared to Small-Quantity Emission Rates
CO6 Expansion – Columbia Data Center
Quincy, Washington

Pollutant	CAS Number	Averaging Period	Emissions Reduction[a]	Proposed Generators Emissions Increase	Project-Related Emissions Change	*De Minimis*	SQER	Required Action
			(pounds per averaging period)					
Diesel Engine Generator Emissions								
NO_2	10102-44-0	1-hr	-5	26.9	22.0	0.457	1.03	Model
DEEP	--	year	-1057	236	-821	0.0320	0.639	
SO_2	7446-09-5	1-hr	-0.0738	0.186	0.113	0.457	1.45	
CO	630-08-0	1-hr	-3.9	39.4	35.5	1.14	50.4	Report
Benzene	71-43-2	year	0	0	0	0.331	6.62	
Toluene	108-88-3	24-hr	-0.321	0.783	0.462	32.9	657	
Xylenes	95-47-6	24-hr	-0.221	0.538	0.317	1.45	29.0	
1,3-Butadiene	106-99-0	year	0	0	0	0.0564	1.13	
Formaldehyde	50-00-0	year	0	0	0	1.60	32.0	
Acetaldehyde	75-07-0	year	0	0	0	3.55	71.0	
Acrolein	107-02-8	24-hr	-0.00901	0.0220	0.0130	0.000394	0.00789	Model
Benzo(a)pyrene	50-32-8	year	0	0	0	0.00872	0.174	
Benzo(a)anthracene	56-55-3	year	0	0	0	0.0872	1.74	
Chrysene	218-01-9	year	0	0	0	0.872	17.4	
Benzo(b)fluoranthene	205-99-2	year	0	0	0	0.0872	1.74	
Benzo(k)fluoranthene	207-08-9	year	0	0	0	0.0872	1.74	
Dibenz(a,h)anthracene	53-70-3	year	0	0	0	0.00799	0.160	
Indeno(1,2,3-cd)pyrene	193-39-5	year	0	0	0	0.0872	1.74	
Naphthalene	91-20-3	year	0	0	0	0.282	5.64	
Propylene	115-07-1	24-hr	-3.19	7.78	4.59	19.7	394	

Notes:

Highlighted cells indicate pollutants that require ambient air dispersion model analysis

[a] The 24-hr and 1-hr emissions are reduced as a result of the permit modification due to two permitted engines that were not installed. Annual emissions reduction of DEEP is due to reducing annual operating hours to 100 hours per year. No changes are proposed to the annual fuel use limits; therefore, no annual emissions changes for other TAPs emitted by generators.

Table 9
Estimated Project and Background Impacts Compared to National Ambient Air Quality Standards
CO6 Expansion – Columbia Data Center
Quincy, Washington

Criteria Pollutant	National and Washington Ambient Standards (µg/m³)	Significant Impact Level (µg/m³)	Modeled Operating Scenario	AERMOD Filename	Modeled Project[a]		Modeled Project + Local Background	Regional Background[b]	Estimated Cumulative Concentration[c]
					(µg/m³)				
CO									
8-hour average	10,000	500	Unplanned power outage	CO.ST	357	d	--	--	--
1-hour average	40,000	2,000	Unplanned power outage		675	d	--	--	--
SO_2									
3-hour average	1,310	25	Unplanned power outage	SO2.ST.PRJ	2.7	d	--	--	--
1-hour average	200	7.8	Unplanned power outage		3.2	d	--	--	--
PM_{10}									
24-hour average	150	5	Unplanned power outage of 15 hours	PM10.24HR.PO15	29	d, e	69	78	147
$PM_{2.5}$									
Annual average	12	0.2	Theoretical Max. Year	PM25.ANN.SIL	0.088		--	--	--
24-hour average	35	1.2	Non-emergency quarterly operations (Ranked Day 8)	PM25.24HR.QRT	4.3	d, f	8.4	19	27
NO_2									
Annual average	100	1	Theoretical Max. Year	NO2.ANN	3.2	e	10	6.6	17
1-hour average	188	7.5	Non-emergency triennial or quarterly operations (Ranked Day 8)	NO2.1HR.MT	139	d, f, g	141	37	179

Notes:

[a] Maximum design value concentration of proposed new sources alone.

[b] Regional background level obtained from Idaho Department of Environmental Quality for model and monitoring data from July 2014 through June 2017 (IDEQ; accessed August 16, 2019).

[c] Cumulative concentrations are calculated for pollutant's where project related contributions are above the Significant Impact Level.

[d] Reported values represent the 1[st]-highest modeled impacts.

[e] It was assumed that local data centers were concurrently operating in facility-wide power outage mode. The Lamb Weston facility was modeled as continuously operating at PTE rates. All cooling towers were modeled as continuously operating at PTE rates.

[f] For quarterly and triennial operations one engine is running at a time and operations may occur any time during daytime hours (7 a.m. to 7 p.m.). Local background modeling for this scenario assumed nearby data centers were not operating any generators. The Lamb Weston facility was modeled as continuously operating at PTE rates. All cooling towers were modeled as continuously operating at PTE rates.

[g] For cumulative NO_2 1-hour average modeling, there are receptors located within a nearby sources' own property boundary. Due to this, we subtract the contribution of that source to receptors on its property and report only cumulative totals of all other sources in the model at those receptors. The project + local background concentration is 141 µg/m³ using the maximum 3-year average.

Table 10
Summary of Ranked Generator Runtime Scenarios
CO6 Expansion – Columbia Data Center
Quincy, Washington

Ranked Generator Runtime Scenarios - $PM_{2.5}$ and PM_{10}

Ranked Day	Activity	Activity Duration (hours/generator)	Max. No. Generators to Operate Concurrently	Max. Daily Operating Hours	Max. Annual Operating Days	Max. Daily Project $PM_{2.5}$ and PM_{10} Emissions (lbs/day)
1	Emergency operations	24	5	24	1	167
2-7	Emergency operations	15	5	15	6	105
8-11	Non-emergency quarterly operations	1	1	12	4	35
12-13	Non-emergency triennial operations	4	1	12	2	34

Ranked Generator Runtime Scenarios - NO_x

Ranked Day	Activity	Max. No. Generators to Operate Concurrently	Max. Annual Operating Days	Max. Hourly Project NO_X Emissions (lbs/hour)
1-7	Emergency operations	5	7	269
8-11	Non-emergency quarterly operations	1	4	54
12-13	Non-emergency triennial operations	1	2	54

Note:

Operating conditions and assumed number of days for each modeling scenario may be subject to change.

Table 11
Estimated Project Impacts Compared to Acceptable Source Impact Levels
CO6 Expansion – Columbia Data Center
Quincy, Washington

Pollutant	CAS Number	Averaging Period	Project-Only Emission Rate (lbs/avg. period)	Project Concentration[a] (µg/m^3)	ASIL (µg/m^3)
Acrolein	107-02-8	24-hr	0.01295	0.0042	0.06
NO_2	10102-44-0	1-hr	22.0	455	470

Note:

[a] Maximum concentration of proposed new sources (concentrations do not reflect any credit for uninstalled engines).

APPENDIX A

Vendor Specification Sheets

Cat® 3516C

Diesel Generator Sets

Image shown may not reflect actual configuration

Bore – mm (in)	170 (6.69)
Stroke – mm (in)	215 (8.46)
Displacement – L (in³)	78 (4764.73)
Compression Ratio	14.7:1
Aspiration	TA
Fuel System	EUI
Governor Type	ADEM™ A3

Standby 60 Hz ekW (kVA)	Mission Critical 60 Hz ekW (kVA)	Prime 60 Hz ekW (kVA)	Continuous 60 Hz ekW (kVA)	Emissions Performance
2500 (3125)	2500 (3125)	2250 (2812)	2050 (2562)	U.S. EPA Stationary Emergency Use Only (Tier 2)

Standard Features

Cat® Diesel Engine
- Meets U.S. EPA Stationary Emergency Use Only (Tier 2) emission standards
- Reliable performance proven in thousands of applications worldwide

Generator Set Package
- Accepts 100% block load in one step and meets other NFPA 110 loading requirements
- Conforms to ISO 8528-5 G3 load acceptance requirements
- Reliability verified through torsional vibration, fuel consumption, oil consumption, transient performance, and endurance testing

Alternators
- Superior motor starting capability minimizes need for oversizing generator
- Designed to match performance and output characteristics of Cat diesel engines

Cooling System
- Cooling systems available to operate in ambient temperatures up to 50°C (122°F)
- Tested to ensure proper generator set cooling

EMCP 4 Control Panels
- User-friendly interface and navigation
- Scalable system to meet a wide range of installation requirements
- Expansion modules and site specific programming for specific customer requirements

Warranty
- 24 months/1000-hour warranty for standby and mission critical ratings
- 12 months/unlimited hour warranty for prime and continuous ratings
- Extended service protection is available to provide extended coverage options

Worldwide Product Support
- Cat dealers have over 1,800 dealer branch stores operating in 200 countries
- Your local Cat dealer provides extensive post-sale support, including maintenance and repair agreements

Financing
- Caterpillar offers an array of financial products to help you succeed through financial service excellence
- Options include loans, finance lease, operating lease, working capital, and revolving line of credit
- Contact your local Cat dealer for availability in your region

Optional Equipment

Engine

Air Cleaner
- ❑ Single element
- ❑ Dual element

Muffler
- ❑ Industrial grade (15 dB)

Starting
- ❑ Standard batteries
- ❑ Oversized batteries
- ❑ Standard electric starter(s)
- ❑ Heavy duty electric starter(s)
- ❑ Air starter(s)
- ❑ Jacket water heater

Alternator

Output voltage
- ❑ 380V ❑ 6300V
- ❑ 440V ❑ 6600V
- ❑ 480V ❑ 6900V
- ❑ 600V ❑ 12470V
- ❑ 2400V ❑ 13200V
- ❑ 4160V ❑ 13800V

Temperature Rise (over 40°C ambient)
- ❑ 150°C
- ❑ 125°C/130°C
- ❑ 105°C
- ❑ 80°C

Winding type
- ❑ Random wound
- ❑ Form wound

Excitation
- ❑ Internal excitation (IE)
- ❑ Permanent magnet (PM)

Attachments
- ❑ Anti-condensation heater
- ❑ Stator and bearing temperature monitoring and protection

Power Termination

Type
- ❑ Bus bar
- ❑ Circuit breaker
- ❑ 1600A ❑ 2000A
- ❑ 2500A ❑ 3000A
- ❑ 3200A ❑ 4000A
- ❑ 5000A
- ❑ IEC ❑ UL
- ❑ 3-pole ❑ 4-pole
- ❑ Manually operated
- ❑ Electrically operated

Trip Unit
- ❑ LSI ❑ LSI-G
- ❑ LSIG-P

Control System

Controller
- ❑ EMCP 4.2B
- ❑ EMCP 4.3
- ❑ EMCP 4.4

Attachments
- ❑ Local annunciator module
- ❑ Remote annunciator module
- ❑ Expansion I/O module
- ❑ Remote monitoring software

Charging
- ❑ Battery charger – 10A
- ❑ Battery charger – 20A
- ❑ Battery charger – 35A

Vibration Isolators
- ❑ Rubber
- ❑ Spring
- ❑ Seismic rated

Cat Connect

Connectivity
- ❑ Ethernet
- ❑ Cellular
- ❑ Satellite

Extended Service Options

Terms
- ❑ 2 year (prime)
- ❑ 3 year
- ❑ 5 year
- ❑ 10 year

Coverage
- ❑ Silver
- ❑ Gold
- ❑ Platinum
- ❑ Platinum Plus

Ancillary Equipment
- ❑ Automatic transfer switch (ATS)
- ❑ Uninterruptible power supply (UPS)
- ❑ Paralleling switchgear
- ❑ Paralleling controls

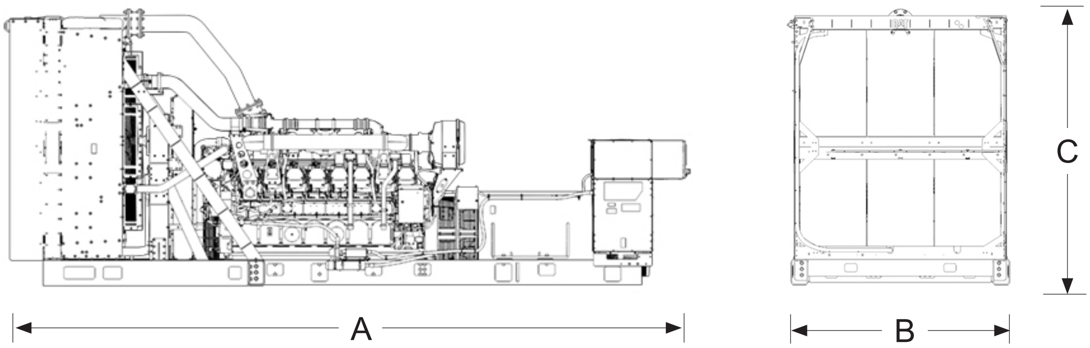
Certifications
- ❑ UL2200
- ❑ CSA
- ❑ IBC seismic certification
- ❑ OSHPD pre-approval

Note: *Some options may not be available on all models. Certifications may not be available with all model configurations. Consult factory for availability.*

Package Performance

Performance	Standby		Mission Critical		Prime		Continuous	
Frequency	60 Hz		60 Hz		60 Hz		60 Hz	
Gen set power rating with fan	2500 ekW		2500 ekW		2250 ekW		2050 ekW	
Gen set power rating with fan @ 0.8 power factor	3125 kVA		3125 kVA		2812 kVA		2562 kVA	
Emissions	EPA ESE (TIER 2)		EPA ESE (TIER 2)		EPA ESE (TIER 2)		EPA ESE (TIER 2)	
Performance number	EM1894-01		EM1895-02		DM8447-04		DM8268-03	
Fuel Consumption								
100% load with fan – L/hr (gal/hr)	656.8	(175.3)	656.8	(175.3)	593.0	(156.6)	549.3	(145.1)
75% load with fan – L/hr (gal/hr)	510.8	(134.9)	510.8	(134.9)	467.8	(123.6)	435.6	(115.1)
50% load with fan – L/hr (gal/hr)	372.4	(98.4)	372.4	(98.4)	341.9	(90.3)	316.8	(83.7)
25% load with fan – L/hr (gal/hr)	219.3	(57.9)	219.3	(57.9)	203.0	(53.6)	188.9	(49.9)
Cooling System								
Radiator air flow restriction (system) – kPa (in. water)	0.12	(0.48)	0.12	(0.48)	0.12	(0.48)	0.12	(0.48)
Radiator air flow – m^3/min (cfm)	2800.0	(98881)	2800.0	(98881)	2800.0	(98881)	2800.0	(98881)
Engine coolant capacity – L (gal)	233.0	(61.6)	233.0	(61.6)	233.0	(61.6)	233.0	(61.6)
Radiator coolant capacity – L (gal)	268.8	(71.0)	268.8	(71.0)	268.8	(71.0)	268.8	(71.0)
Total coolant capacity – L (gal)	501.8	(132.6)	501.8	(132.6)	501.8	(132.6)	501.8	(132.6)
Inlet Air								
Combustion air inlet flow rate – m^3/min (cfm)	242.2	(7212.2)	242.2	(7212.2)	193.1	(6819.8)	183.8	(6491.7)
Exhaust System								
Exhaust stack gas temperature – °C (°F)	490.7	(915.2)	490.7	(915.2)	471.3	(880.4)	463.6	(866.5)
Exhaust gas flow rate – m^3/min (cfm)	554.5	(19578.8)	554.5	(19578.8)	507.9	(17935.1)	476.5	(16826.7)
Exhaust system backpressure (maximum allowable) – kPa (in. water)	6.7	(27.0)	6.7	(27.0)	6.7	(27.0)	6.7	(27.0)
Heat Rejection								
Heat rejection to jacket water – kW (Btu/min)	826	(46992)	826	(46992)	777	(44160)	739	(42021)
Heat rejection to exhaust (total) – kW (Btu/min)	2502	(142265)	2502	(142265)	2243	(127532)	2092	(118949)
Heat rejection to aftercooler – kW (Btu/min)	786	(44723)	786	(44723)	690	(39224)	619	(35176)
Heat rejection to atmosphere from engine – kW (Btu/min)	161	(9146)	161	(9146)	150	(8542)	145	(8229)
Heat rejection from alternator – kW (Btu/min)	121	(6853)	121	(6853)	99	(5607)	94	(5368)
Emissions (Nominal)								
NOx mg/Nm^3 (g/hp-h)	2349.1	(5.32)	2349.1	(5.32)	2206.7	(4.95)	2038.1	(4.62)
CO mg/Nm^3 (g/hp-h)	195.4	(0.42)	195.4	(0.42)	141.2	(0.30)	124.8	(0.27)
HC mg/Nm^3 (g/hp-h)	42.1	(0.10)	42.1	(0.10)	44.4	(0.11)	49.2	(0.12)
PM mg/Nm^3 (g/hp-h)	14.1	(0.04)	14.1	(0.04)	10.9	(0.03)	11.0	(0.03)
Emissions (Potential Site Variation)								
NOx mg/Nm^3 (g/hp-h)	2818.9	(6.38)	2818.9	(6.38)	2648.0	(5.94)	2445.8	(5.55)
CO mg/Nm^3 (g/hp-h)	351.8	(0.76)	351.8	(0.76)	254.2	(0.55)	224.6	(0.49)
HC mg/Nm^3 (g/hp-h)	55.9	(0.14)	55.9	(0.14)	59.1	(0.15)	65.5	(0.16)
PM mg/Nm^3 (g/hp-h)	19.7	(0.05)	19.7	(0.05)	15.2	(0.04)	15.3	(0.04)

Weights and Dimensions



Dim "A" mm (in)	Dim "B" mm (in)	Dim "C" mm (in)	Dry Weight kg (lb)
7495 (295.1)	2569 (101.2)	3009 (118.5)	17 590 (38,780)

Note: *For reference only. Do not use for installation design. Contact your local Cat dealer for precise weights and dimensions.*

Ratings Definitions

Standby
Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year.

Mission Critical
Output available with varying load for the duration of the interruption of the normal source power. Average power output is 85% of the mission critical power rating. Typical peak demand up to 100% of rated power for up to 5% of the operating time. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year.

Prime
Output available with varying load for an unlimited time. Average power output is 70% of the prime power rating. Typical peak demand is 100% of prime rated ekW with 10% overload capability for emergency use for a maximum of 1 hour in 12. Overload operation cannot exceed 25 hours per year.

Continuous
Output available with non-varying load for an unlimited time. Average power output is 70-100% of the continuous power rating. Typical peak demand is 100% of continuous rated kW for 100% of the operating hours.

Applicable Codes and Standards
AS1359, CSA C22.2 No100-04, UL142, UL489, UL869, UL2200, NFPA37, NFPA70, NFPA99, NFPA110, IBC, IEC60034-1, ISO3046, ISO8528, NEMA MG1-22, NEMA MG1-33, 2014/35/EU, 2006/42/EC, 2014/30/EU.

Note: Codes may not be available in all model configurations. Please consult your local Cat dealer for availability.

Data Center Applications
Tier III/Tier IV compliant per Uptime Institute requirements. ANSI/TIA-942 compliant for Rated-1 through Rated-4 data centers.

Fuel Rates
Fuel rates are based on fuel oil of 35º API [16°C (60ºF)] gravity having an LHV of 42,780 kJ/kg (18,390 Btu/lb) when used at 29ºC (85ºF) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.)

PERFORMANCE DATA[EM1895]

Performance Number: EM1895 **Change Level: 03**

SALES MODEL:	3516C
BRAND:	CAT
ENGINE POWER (BHP):	3,634
GEN POWER WITH FAN (EKW):	2,500.0
COMPRESSION RATIO:	14.7
RATING LEVEL:	MISSION CRITICAL STANDBY
PUMP QUANTITY:	1
FUEL TYPE:	DIESEL
MANIFOLD TYPE:	DRY
GOVERNOR TYPE:	ADEM3
ELECTRONICS TYPE:	ADEM3
CAMSHAFT TYPE:	STANDARD
IGNITION TYPE:	CI
INJECTOR TYPE:	EUI
FUEL INJECTOR:	3920221
UNIT INJECTOR TIMING (IN):	64.34
REF EXH STACK DIAMETER (IN):	12
MAX OPERATING ALTITUDE (FT):	2,953
COMBUSTION:	DI
ENGINE SPEED (RPM):	1,800
HERTZ:	60
FAN POWER (HP):	130.1
ASPIRATION:	TA
AFTERCOOLER TYPE:	ATAAC
AFTERCOOLER CIRCUIT TYPE:	JW+OC, ATAAC
INLET MANIFOLD AIR TEMP (F):	122
JACKET WATER TEMP (F):	210.2
TURBO CONFIGURATION:	PARALLEL
TURBO QUANTITY:	4
TURBOCHARGER MODEL:	GTA5523N-51T-1.40
CERTIFICATION YEAR:	2006
CRANKCASE BLOWBY RATE (FT3/HR):	3,619.4
FUEL RATE (RATED RPM) NO LOAD (GAL/HR):	16.2
PISTON SPD @ RATED ENG SPD (FT/MIN):	2,539.4

INDUSTRY	SUBINDUSTRY	APPLICATION
OIL AND GAS	LAND PRODUCTION	PACKAGED GENSET
ELECTRIC POWER	STANDARD	PACKAGED GENSET

General Performance Data

THIS STANDBY RATING IS FOR A STANDBY ONLY ENGINE ARRANGEMENT. RERATING THE ENGINE TO A PRIME OR CONTINUOUS RATING IS NOT PERMITTED.

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
2,500.0	100	3,633	336	0.337	175.0	78.7	121.9	1,257.5	73.7	850.7
2,250.0	90	3,283	303	0.336	157.4	73.1	117.9	1,187.0	67.7	805.1
2,000.0	80	2,935	271	0.337	141.1	66.8	113.9	1,130.0	60.6	771.3
1,875.0	75	2,760	255	0.339	133.8	63.5	112.3	1,106.1	57.1	759.0
1,750.0	70	2,586	239	0.342	126.2	60.0	109.9	1,084.8	53.7	748.2
1,500.0	60	2,237	207	0.348	111.3	52.3	105.5	1,044.3	46.2	730.5
1,250.0	50	1,889	174	0.358	96.5	44.3	101.5	1,006.8	39.1	717.5
1,000.0	40	1,547	143	0.366	80.7	34.0	95.7	965.0	30.7	702.1
750.0	30	1,203	111	0.378	64.9	24.0	91.0	909.0	22.9	675.7
625.0	25	1,029	95	0.388	57.1	19.5	90.1	870.4	19.6	654.6
500.0	20	854	79	0.400	48.8	14.9	88.7	812.8	16.1	619.1
250.0	10	497	46	0.454	32.2	7.4	84.4	639.9	11.1	500.7

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
2,500.0	100	3,633	85	461.5	7,287.6	18,807.6	32,267.8	33,492.3	7,056.8	6,459.6
2,250.0	90	3,283	79	433.3	7,010.4	17,355.6	30,953.6	32,055.8	6,747.1	6,203.5
2,000.0	80	2,935	73	406.1	6,677.5	15,977.0	29,330.8	30,320.5	6,381.7	5,888.1
1,875.0	75	2,760	69	392.8	6,521.0	15,366.6	28,518.9	29,454.2	6,199.4	5,732.7
1,750.0	70	2,586	66	379.8	6,305.6	14,697.2	27,541.4	28,424.8	5,982.7	5,533.7
1,500.0	60	2,237	58	349.2	5,845.1	13,330.2	25,384.7	26,164.1	5,507.0	5,109.3
1,250.0	50	1,889	49	316.2	5,360.5	11,961.2	23,064.3	23,735.1	4,995.9	4,651.4
1,000.0	40	1,547	38	274.9	4,652.6	10,183.4	19,911.6	20,477.1	4,309.7	4,018.2
750.0	30	1,203	28	230.7	3,911.5	8,341.7	16,706.6	17,160.9	3,612.2	3,375.1
625.0	25	1,029	23	208.3	3,596.5	7,490.0	15,294.6	15,694.5	3,304.9	3,093.1
500.0	20	854	18	184.2	3,261.8	6,551.0	13,823.8	14,165.6	2,985.9	2,801.6
250.0	10	497	10	140.3	2,772.6	5,002.5	11,496.9	11,723.3	2,561.1	2,425.3

Heat Rejection Data

PERFORMANCE DATA[EM1895]

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHUAST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
2,500.0	100	3,633	46,119	9,196	141,970	70,970	20,037	49,407	154,077	376,192	400,739

Sound Data

SOUND PRESSURE DATA FOR THIS RATING CAN BE FOUND IN PERFORMANCE NUMBER - DM8779.

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	2,500.0	1,875.0	1,250.0	625.0	250.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	3,633	2,760	1,889	1,029	497
TOTAL NOX (AS NO2)		G/HR	24,359	14,666	7,549	3,839	3,385
TOTAL CO		G/HR	3,155	1,707	1,218	2,036	2,477
TOTAL HC		G/HR	400	482	483	405	413
PART MATTER		G/HR	156.4	114.7	129.5	225.4	118.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,915.5	2,261.4	1,598.4	1,357.3	2,093.9
TOTAL CO	(CORR 5% O2)	MG/NM3	372.5	258.7	253.4	710.3	1,516.7
TOTAL HC	(CORR 5% O2)	MG/NM3	41.0	63.3	86.9	122.3	220.3
PART MATTER	(CORR 5% O2)	MG/NM3	15.5	14.9	23.4	69.9	65.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,420	1,101	779	661	1,020
TOTAL CO	(CORR 5% O2)	PPM	298	207	203	568	1,213
TOTAL HC	(CORR 5% O2)	PPM	77	118	162	228	411
TOTAL NOX (AS NO2)		G/HP-HR	6.77	5.36	4.02	3.74	6.83
TOTAL CO		G/HP-HR	0.88	0.62	0.65	1.99	5.00
TOTAL HC		G/HP-HR	0.11	0.18	0.26	0.40	0.83
PART MATTER		G/HP-HR	0.04	0.04	0.07	0.22	0.24
TOTAL NOX (AS NO2)		LB/HR	53.70	32.33	16.64	8.46	7.46
TOTAL CO		LB/HR	6.95	3.76	2.69	4.49	5.46
TOTAL HC		LB/HR	0.88	1.06	1.06	0.89	0.91
PART MATTER		LB/HR	0.34	0.25	0.29	0.50	0.26

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	2,500.0	1,875.0	1,250.0	625.0	250.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	3,633	2,760	1,889	1,029	497
TOTAL NOX (AS NO2)		G/HR	20,299	12,222	6,291	3,199	2,821
TOTAL CO		G/HR	1,753	948	677	1,131	1,376
TOTAL HC		G/HR	301	362	363	305	311
TOTAL CO2		KG/HR	1,793	1,368	987	581	328
PART MATTER		G/HR	111.7	81.9	92.5	161.0	85.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,429.5	1,884.5	1,332.0	1,131.1	1,744.9
TOTAL CO	(CORR 5% O2)	MG/NM3	206.9	143.7	140.8	394.6	842.6
TOTAL HC	(CORR 5% O2)	MG/NM3	30.8	47.6	65.3	92.0	165.6
PART MATTER	(CORR 5% O2)	MG/NM3	11.0	10.6	16.7	49.9	47.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,183	918	649	551	850
TOTAL CO	(CORR 5% O2)	PPM	166	115	113	316	674
TOTAL HC	(CORR 5% O2)	PPM	58	89	122	172	309
TOTAL NOX (AS NO2)		G/HP-HR	5.64	4.46	3.35	3.12	5.70
TOTAL CO		G/HP-HR	0.49	0.35	0.36	1.10	2.78
TOTAL HC		G/HP-HR	0.08	0.13	0.19	0.30	0.63
PART MATTER		G/HP-HR	0.03	0.03	0.05	0.16	0.17
TOTAL NOX (AS NO2)		LB/HR	44.75	26.94	13.87	7.05	6.22
TOTAL CO		LB/HR	3.86	2.09	1.49	2.49	3.03
TOTAL HC		LB/HR	0.66	0.80	0.80	0.67	0.68
TOTAL CO2		LB/HR	3,952	3,017	2,175	1,281	723
PART MATTER		LB/HR	0.25	0.18	0.20	0.35	0.19
OXYGEN IN EXH		%	8.4	10.0	11.1	12.1	14.0
DRY SMOKE OPACITY		%	1.3	1.1	1.6	3.5	2.7
BOSCH SMOKE NUMBER			0.46	0.40	0.55	1.21	1.01

PERFORMANCE DATA[EM1895]

Regulatory Information

EPA EMERGENCY STATIONARY		2011 - ----		
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 6.4 PM: 0.20

Altitude Derate Data

A BLANK IN THE ALTITUDE DERATE TABLE SIGNIFIES THAT NO RATING IS AVAILABLE AT THAT SPECIFIED ALTITUDE AND AMBIENT TEMPERATURE.

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	30	40	50	60	70	80	90	100	110	120	130	140	NORMAL
ALTITUDE (FT)													
0	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,561	3,489	3,343	3,198	3,634
1,000	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,561	3,452	3,307	3,162	3,634
2,000	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,561	3,489	3,380	3,234	3,053	3,634
3,000	3,628	3,628	3,628	3,628	3,628	3,603	3,537	3,474	3,413	3,234	3,053	2,871	3,628
4,000	3,504	3,504	3,504	3,504	3,504	3,472	3,408	3,347	3,234	3,089	2,907	2,689	3,504
5,000	3,384	3,384	3,384	3,384	3,384	3,344	3,284	3,225	3,089	2,907	2,689	2,471	3,384
6,000	3,269	3,269	3,269	3,269	3,269	3,221	3,162	3,089	2,907	2,726	2,471	2,217	3,269
7,000	3,159	3,159	3,159	3,159	3,159	3,101	3,045	2,944	2,726	2,471	2,217	1,962	3,159
8,000	3,052	3,052	3,052	3,052	3,042	2,985	2,871	2,726	2,507	2,253	1,999	1,708	3,052
9,000	2,950	2,950	2,950	2,950	2,927	2,835	2,689	2,507	2,253	1,999	1,708	1,454	2,950
10,000	2,851	2,851	2,851	2,851	2,762	2,616	2,435	2,289	2,035	1,708	1,490	1,272	2,851
11,000	2,756	2,756	2,756	2,689	2,544	2,362	2,217	2,035	1,744	1,490	1,308	1,163	2,756
12,000	2,665	2,665	2,616	2,471	2,289	2,144	1,962	1,744	1,526	1,308	1,163	1,018	2,665
13,000	2,577	2,544	2,398	2,217	2,071	1,853	1,672	1,526	1,308	1,163	1,054	945	2,544
14,000	2,471	2,326	2,144	1,962	1,744	1,635	1,454	1,345	1,163	1,054	945		2,362
15,000	2,253	2,071	1,890	1,708	1,563	1,417	1,272	1,199	1,054	945			2,180

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
4577176	LL1858	5084280	GS336	-	SBK02483	
4581567	LL6760	5157721	PG243	-	LYM00001	

Supplementary Data

Type	Classification	Performance Number
SOUND	SOUND PRESSURE	DM8779

Performance Parameter Reference

Parameters Reference:DM9600-10
PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE

APPENDIX B

Startup Emissions Estimation Method

APPENDIX B

Diesel Generator "Cold-Start Spike" Adjustment Factors

Short-term concentration trends for emissions of volatile organic compounds (VOCs), carbon monoxide (CO), and oxides of nitrogen (NO_x) immediately following a cold startup of a large diesel backup generator were measured by the California Energy Commission (CEC) in its document entitled Air Quality Implications of Backup Generators in California (Lents et al. 2005)[1]. CEC used continuous monitors to measure the trends shown in the attached figure (Figure B-1), which are discussed below.

As shown on Figure B-1, during the first 14 seconds after a cold start, the VOC concentration spiked to a maximum value of 900 parts per million (ppm) before dropping back to the steady-state exhaust concentration of 30 ppm. The measured (triangular) area under the 14-second concentration-vs-time curve represents emissions during a "VOC spike," which is 6,300 ppm-seconds.

Unlike VOC emissions, the NO_x exhaust concentration did not "spike" during cold-start. It took 8 seconds for the exhaust concentration of NO_x to rise from the initial value of zero to its steady-state concentration of 38 ppm. The measured area under the concentration-vs-time curve represents the "NO_x deficit" emissions of 160 ppm-seconds.

The CEC was unable to measure the time trend of diesel engine exhaust particulate matter (DEEP) concentrations during the first several seconds after a cold start. Therefore, for the purpose of estimating the DEEP trend, it was assumed that DEEP would exhibit the same concentration-vs-time trend as VOC emissions.

The numerical value of the Cold-start Spike Adjustment Factor was derived by dividing the area under the "cold-start spike" by the area under the steady-state concentration profile for the 1-minute averaging period.

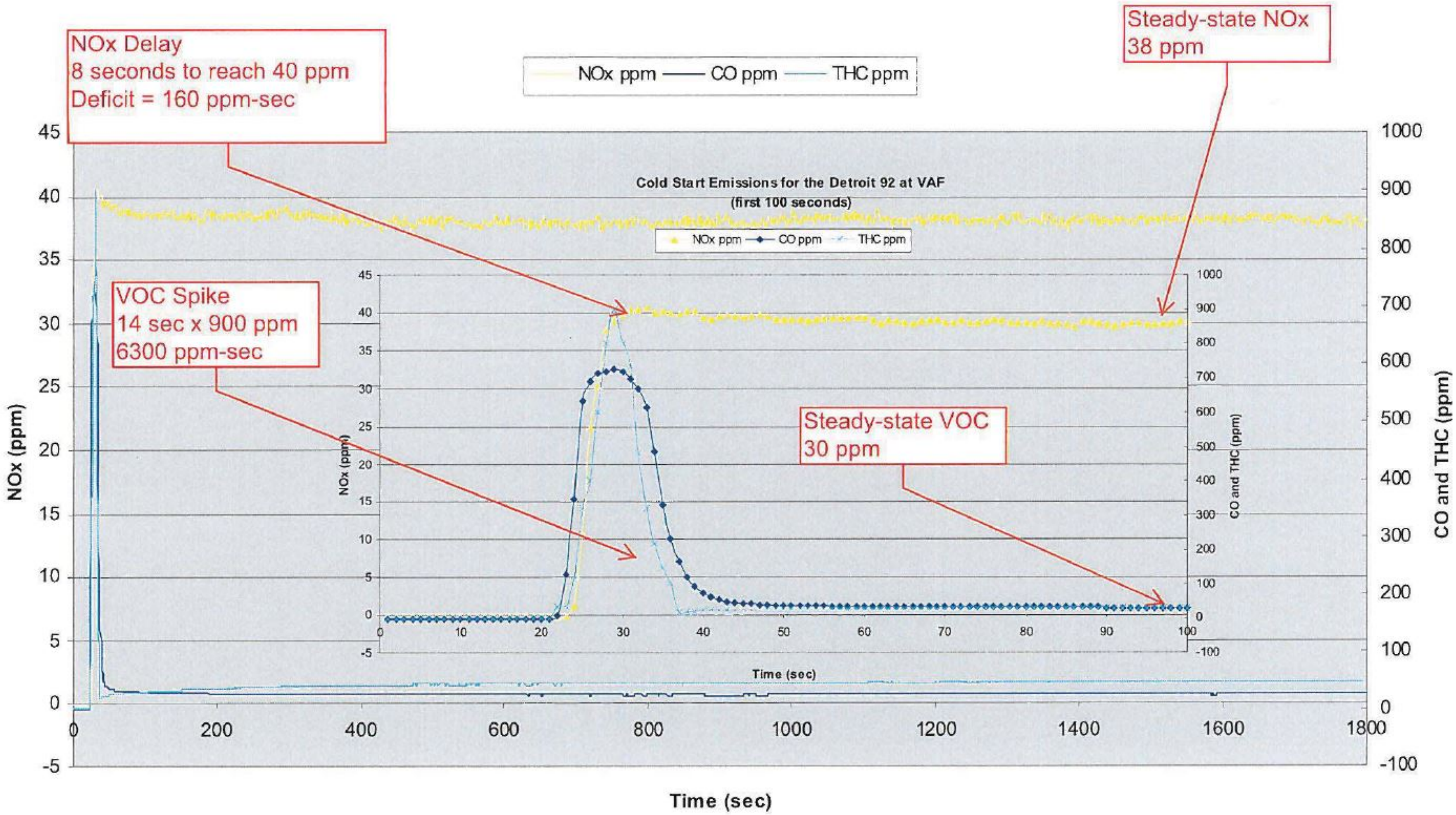
Example: Cold-Start Spike Factor for VOCs, first 1-minute after cold-start at low load.

The "VOC spike" was observed 14 seconds after cold-start and reached a concentration of 6,300 ppm-seconds. The **triangular** area under the curve is $\frac{14\,\text{seconds} \times 900\,ppm}{2} = 6{,}300\ ppm\text{-}seconds$.

The steady-state VOC concentration is 30 *ppm*. For the 1-minute (60-seconds) steady-state period the area under the curve is $(60\ seconds - 14\ seconds) \times 30\ ppm\ = 1{,}380\ ppm\text{-}seconds$.

Therefore, the startup emission factor (to be applied to the warm-emission rate estimate for the first 1-minute after startup) was estimated by $\frac{6{,}300\ ppm{-}seconds\ +\ 1{,}380\ ppm{-}seconds}{30\ ppm \times 60\ seconds}$.

[1] Lents, J.M., L. Arth, M. Boretz, M. Chitjian, K. Cocker, N. Davis, K Johnson, Y Long, J.W. Miller, U. Mondragon, R.M. Nikkila, M. Omary, D. Pacocha, Y. Quin, S. Shah, and G. Tonnesen. 2005. Air Quality Implications of Backup Generators in California - Volume One: Generation Scenarios, Emissions and Atmospheric Modeling, and Health Risk Analysis. Publication No. CEC-500-2005-048. California Energy Commission, PIER Energy-Related Environmental Research. March.



Source: Lents et al. 2005.

CO6 Expansion Columbia Data Center Quincy, Washington	**Cold-Start Emission Trends**	Figure B-1

APPENDIX C

Best Available Control Technology Cost Summary Tables

Table C-1 (Integrated)
Tier 4 Integrated Control Package Capital Cost
CO6 Expansion – Columbia Data Center
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,500-KWe emission control package	Cost estimate by Johnson Matthey		5	$207,430	$1,037,150
2,500-KWe miscellaneous parts	Assumed no cost			$0	$0
Combined systems cost					$1,037,150
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax		WA state tax	6.5%	--	$67,415
Shipping (2,500-KWe)		Johnson Matthey	5	$ 4,500	$22,500
Subtotal Purchased Equipment Cost (PEC)					$1,127,065
Direct Installation Costs					
Enclosure structural supports (2,500-KWe)	Cost estimate by Johnson Matthey		5	$3,500	$17,500
Onsite Installation (2,500-KWe)	Cost estimate by Johnson Matthey		5	$22,000	$110,000
Electrical	Included above		0	$0	$0.00
Piping	Included above		0	$0	$0.00
Insulation	Assumed no cost		0	$0	$0.00
Painting	Assumed no cost		0	$0	$0.00
Subtotal Direct Installation Costs (DIC)					$127,500
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0.00
Total Direct Costs, (DC = PEC + DIC + SP)					$1,254,565
Indirect Costs (Installation)					
Engineering		Johnson Matthey	5	$5,000	$25,000
Construction and field expenses		Johnson Matthey	5	$3,000	$15,000
Contractor Fees	From DIS data center		6.8%	--	$76,302
Startup		Johnson Matthey	5	$3,000	$15,000
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$11,271
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$112,706
Subtotal Indirect Costs (IC)					$255,279
Total Capital Investment (TCI = DC+IC)					**$1,509,844**

Table C-2
Tier 4 Integrated Control Package Cost Effectiveness
CO6 Expansion – Columbia Data Center
Quincy, Washington

Item	Quantity	Units	Unit Cost	Units	Subtotal
Annualized Capital Recovery					
Total Capital Cost					$1,509,844
Capital Recovery Factor:	30	years	5.5%	discount	0.069
Subtotal Annualized 30-year Capital Recovery Cost					$103,885
Direct Annual Cost					
Increased Fuel Consumption	Insignificant				$0
Reagent Consumption (estimated by Pacific Power Group)	140,240	gallons/year	$4.00	per gallon	$560,960
Catalyst Replacement (EPA Manual)	Insignificant				$0
Annual operation/labor/maintenance costs: Upper-bound estimate would assume CARB's value of $1.50/hp/year and would result in $472,710/year. Lower-bound estimate would assume zero annual O&M. Mid-range value would account for fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. <u>For this screening-level analysis, we assumed the lower-bound annual O&M cost of zero.</u>					$0
Subtotal Direct Annual Cost					$560,960
Indirect Annual Costs					
Annual Admin charges (EPA Manual)	2.0%	of Total Capital Investment			$30,197
Annual Property tax (EPA Manual)	1.0%	of Total Capital Investment			$15,098
Annual Insurance (EPA Manual)	1.0%	of Total Capital Investment			$15,098
Subtotal Indirect Annual Costs					$60,394
Total Annual Cost (Capital Recovery + Direct Annual Costs + Indirect Annual Costs)					**$725,239**
Uncontrolled Emissions (Combined Pollutants)					12.5
Annual Tons Removed (Combined Pollutants)					11.0
Cost Effectiveness ($ per tons combined pollutant destroyed)					**$65,766**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$472,710	per year per generator
2,500	KW-hr
470	annual generator hours
$1.50	per HP_M per year

MULTI-CRITERIA POLLUTANT COST EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
NO_x	$12,000	10	$115,992 per year
CO	$5,000	1.1	$5,634 per year
VOCs	$12,000	0.15	$1,790 per year
PM	$12,000	0.09	$1,026 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$124,442 per year
Actual Annual Control Cost			$725,239 per year
		Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

CRITERIA POLLUTANT CONTROL EFFICIENCIES[a]

Pollutant	PM (FH)	CO	VOCs	NO_x
Tier 2 Uncontrolled Emissions (TPY)	0.10	1.4	0.21	11
Controlled Emissions (TPY)	0.015	0.3	0.06	1.1
TPY Removed	0.09	1.1	0.15	9.7
Combined Uncontrolled Emissions (TPY)	12			
Combined TPY Removed	11			
Expected Removal Efficiency	85%	80%	70%	90%
Annualized Cost ($/year)	$725,239			
Individual Pollutant $/Ton Removed	$8,486,024	$643,612	$4,860,593	$75,030

MULTI-TOXIC AIR POLLUTANT COST EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	ASIL (μg/m³)	"Hanford Method" Cost Factor	Ecology Guidance "Ceiling Cost" ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
CO	23,000	0.070	$731	1.1	$824 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	1.0	$17,855 per year
Acrolein	0.06	5.7	$59,359	3.1E-05	$2 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	0.0	$0 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$18,681 per year
Actual Annual Control Cost					$725,239 per year
				Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
CO	1.41	0.3	1.1	80%	$643,612
NO_2 (10% of NOx)	1.07	0.11	1.0	90%	$750,299
Acrolein	4.45E-05	1.3E-05	3.12E-05	70%	$23,269,153,380
Non-Carcinogenic VOCs	4.45E-05	1.34E-05	3.12E-05	70%	$23,269,153,380
Annualized Cost ($/yr)					$725,239
Combined Uncontrolled Emissions (TPY)					2.5
Combined TPY Removed					2.1
Combined TAPs $/Ton Removed					$346,431

Notes:

FH ("front-half" filterable emissions)
BH ("back-half" condensable emissions)
PM (particulate matter) attributable to front-half and back-half emissions is assumed equal to the sum of vendor NTE values for PM and hydrocarbons.
DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.
[a] The expected Tier 4 control efficiency to reduce emission is 90% for NO_x, 85% for PM (front half), 80% for CO, and 80% for VOCs.

Table C-3 (SCR)
Selective Catalytic Reduction Capital Cost
CO6 Expansion – Columbia Data Center
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,500-KWe emission control package	Cost estimate by Johnson Matthey		5	$140,851	$704,255
2,500-KWe miscellaneous parts	Assumed no cost			$0	$0
Combined systems cost					$704,255
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$45,777
Shipping (2,500-KWe)		Johnson Matthey	5	$3,500	$17,500
Subtotal Purchased Equipment Cost (PEC)					$767,532
Direct Installation Costs					
Enclosure structural supports (2,500-KWe)	Cost estimate by Johnson Matthey		5	$2,500	$12,500
Onsite Installation (2,500-KWe)	Cost estimate by Johnson Matthey		5	$12,000	$60,000
Electrical	Included above		0	$0	$0
Piping	Included above		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$72,500
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$840,032
Indirect Costs (Installation)					
Engineering		Johnson Matthey	5	$3,000	$15,000
Construction and field expenses		Johnson Matthey	5	$3,000	$15,000
Contractor Fees	From DIS data center		6.8%	--	$51,962
Startup		Johnson Matthey	5	$3,000	$15,000
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$7,675
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$76,753
Subtotal Indirect Costs (IC)					$181,390
Total Capital Investment (TCI = DC+IC)					**$1,021,422**

Table C-4
Selective Catalytic Reduction Cost Effectiveness
CO6 Expansion – Columbia Data Center
Quincy, Washington

Item	Quantity	Units	Unit Cost	Units	Subtotal
Annualized Capital Recovery					
Total Capital Cost					$1,021,422
Capital Recovery Factor:	30	years	5.5%	discount	0.069
Subtotal Annualized 30-year Capital Recovery Cost					$70,279
Direct Annual Cost					
Increased Fuel Consumption	Insignificant				$0
Reagent Consumption (estimated by Pacific Power Group)	140,240	gallons/year	$4.00	per gallon	$560,960
Catalyst Replacement (EPA Manual)	Insignificant				$0
Annual operation/labor/maintenance costs: Upper-bound estimate would assume CARB's value of $1.50/hp/year and would result in $472,710/year. Lower-bound estimate would assume zero annual O&M. Mid-range value would account for fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. For this screening-level analysis, we assumed the lower-bound annual O&M cost of zero.					$0
Subtotal Direct Annual Cost					$560,960
Indirect Annual Costs					
Annual Admin charges (EPA Manual)	2.0%	of Total Capital Investment			$20,428
Annual Property tax (EPA Manual)	0.0%	of Total Capital Investment			$0
Annual Insurance (EPA Manual)	0.0%	of Total Capital Investment			$0
Subtotal Indirect Annual Costs					$20,428
Total Annual Cost (Capital Recovery + Direct Annual Costs + Indirect Annual Costs)					**$651,668**
Uncontrolled Emissions (Combined Pollutants)					12.5
Annual Tons Removed (Combined Pollutants)					9.1
Cost Effectiveness ($ per tons combined pollutant destroyed)					**$71,722**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$472,710	per year per generator
2,500	KW-hr
470	annual generator hours
$1.50	per HP_M per year

MULTI-CRITERIA POLLUTANT COST EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
NO_x	$12,000	9.09	$109,032 per year
CO	$5,000	0	$0 per year
VOCs	$12,000	0	$0 per year
PM	$12,000	0	$0 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$109,032 per year
Actual Annual Control Cost			$651,668 per year
		Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

CRITERIA POLLUTANT CONTROL EFFICIENCIES[a]

Pollutant	PM (FH)	CO	VOCs	NO_x
Tier 2 Uncontrolled Emissions (TPY)	0.10	1.4	0.21	11
Controlled Emissions (TPY)	0.10	1.4	0.21	1.7
TPY Removed	0	0	0	9
Combined Uncontrolled Emissions (TPY)	12.5			
Combined TPY Removed	9.1			
Expected Removal Efficiency	0%	0%	0%	90%
Annualized Cost ($/year)	$651,668			
Individual Pollutant $/Ton Removed	--	--	--	$71,722

MULTI-TOXIC AIR POLLUTANT COST-EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	ASIL (µg/m^3)	"Hanford Method" Cost Factor	Ecology Guidance "Ceiling Cost" ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
CO	23,000	0.070	$731	0.0	$0 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	0.97	$17,855 per year
Acrolein	0.060	5.7	$59,359	0.0	$0 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	0.0	$0 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$17,855 per year
Actual Annual Control Cost					$651,668 per year
				Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton
CO	1.41	1.4	0.0	0%	--
NO_2 (10% of NO_x)	1.07	0.11	0.97	90%	$674,186
Acrolein	4.45E-05	4.5E-05	0.0	0%	--
Non-Carcinogenic VOCs	4.45E-05	0.0	0.0	0%	--
Annualized Cost ($/yr)					$651,668
Combined Uncontrolled Emissions (TPY)					2.5
Combined TPY Removed					1.0
Combined TAPs $/Ton Removed					$674,186

Notes:

FH ("front-half" filterable emissions)
BH ("back-half" condensable emissions)
PM (particulate matter) attributable to front-half and back-half emissions is assumed equal to the sum of vendor NTE values for PM and hydrocarbons.
DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

[a] The expected control efficiency using the SCR control option is 90% for NO_x, only.

Table C-5 (Cat DPF)
Catalyzed Diesel Particulate Filter Capital Cost
CO6 Expansion – Columbia Data Center
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,500-KWe emission control package	Cost estimate by Cummins		5	$66,579	$332,895
2,500-KWe miscellaneous parts	Assumed no cost			$0	$0
Combined systems cost					$332,895
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$21,638
Shipping (2,500-KWe)		Johnson Matthey	5	$3,000	$15,000
Subtotal Purchased Equipment Cost (PEC)					$369,533
Direct Installation Costs					
Enclosure structural supports (2,500-KWe)	Cost estimate by Johnson Matthey		5	$1,000	$5,000
Onsite Installation (2,500-KWe)	Cost estimate by Johnson Matthey		5	$10,000	$50,000
Electrical	Included above		0	$0	$0
Piping	Included above		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$55,000
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$424,533
Indirect Costs (Installation)					
Engineering		Johnson Matthey	5	$2,000	$10,000
Construction and field expenses		Johnson Matthey	5	$0	$0
Contractor Fees	From DIS data center		6.8%	--	$25,017
Startup		Johnson Matthey	5	$1,500	$7,500
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$3,695
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$36,953
Subtotal Indirect Costs (IC)					$83,166
Total Capital Investment (TCI = DC+IC)					**$507,699**

Table C-6
Catalyzed Diesel Particulate Filter Cost Effectiveness
CO6 Expansion – Columbia Data Center
Quincy, Washington

Item	Quantity	Units	Unit Cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				**$507,699**
Capital Recovery Factor: years:	30	discount:	5.5%	0.069
Subtotal Annualized 30-year Capital Recovery Cost				$34,932
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$10,154
Annual Property tax	1% of TCI (EPA Manual)		0.01	$5,077
Annual Insurance	1% of TCI (EPA Manual)		0.01	$5,077
Annual operation/labor/maintenance costs: Upper-bound estimate would assume CARB's value of $1.00/hp/year and would result in $315,140/year. Lower-bound estimate would assume zero annual O&M. Mid-range value would account for fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.				$0
Subtotal Direct Annual Costs				$20,308
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$55,240**
Uncontrolled Emissions (Combined Pollutants)				12.5
Annual Tons Removed (Combined Pollutants)				1.4
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$40,424**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$315,140	per year per generator
2,500	KW-hr
470	annual generator hours
$1.00	per HP_M per year

MULTI-CRITERIA POLLUTANT COST EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
NO_x	$12,000	0	$0 per year
CO	$5,000	1	$5,634 per year
VOCs	$12,000	0	$1,790 per year
PM	$12,000	0.1	$1,086 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$8,511 per year
Actual Annual Control Cost			$55,240 per year
		Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

CRITERIA POLLUTANT CONTROL EFFICIENCIES[a]

Pollutant	PM (FH)	CO	VOCs	NO_x
Tier 2 Uncontrolled Emissions (TPY)	0.10	1.4	0.21	11
Controlled Emissions (TPY)	0.010	0.3	0.06	11
TPY Removed	0.09	1.1	0.15	0
Combined Uncontrolled Emissions (TPY)	12			
Combined TPY Removed	1.4			
Expected Removal Efficiency	90%	80%	70%	0%
Annualized Cost ($/year)	$55,240			
Individual Pollutant $/Ton Removed	$610,459	$49,023	$370,224	--

MULTI-TOXIC AIR POLLUTANT COST-EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	ASIL (µg/m^3)	"Hanford Method" Cost Factor	Ecology Guidance "Ceiling Cost" ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
DEEP	0.00333	6.9	$72,544	0.09	$6,564 per year
CO	23,000	0.070	$731	1.1	$824 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	0.0	$0.0 per year
Acrolein	0.06	5.7	$59,359	3.1E-05	$1.9 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	0.0	$0 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	0.0	$0 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$7,390 per year
Actual Annual Control Cost					$55,240 per year
				Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
DEEP	0.10	0.01	0.09	90%	$610,459
CO	1.41	0.3	1.1	80%	$49,023
NO_2 (10% of NO_x)	1.07	1.1	0.0	0%	--
Acrolein	4.45E-05	1.3E-05	3.1E-05	70%	$1,772,377,500
Carcinogenic VOCs	0.0	0.0	0.0	70%	--
Non-Carcinogenic VOCs	4.45E-05	0.0	0.0	70%	$1,772,377,500
Annualized Cost ($/yr)					$55,240
Combined Uncontrolled Emissions (TPY)					2.6
Combined TPY Removed					1.2
Combined TAPs $/Ton Removed					$45,378

Notes:

FH ("front-half" filterable emissions)

BH ("back-half" condensable emissions)

PM (particulate matter) attributable to front-half and back-half emissions is assumed equal to the sum of vendor NTE values for PM and hydrocarbons.

DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

[a] The expected control efficiency using the catalyzed DPF is 85% for PM (front half), 80% for CO, and 70% for VOCs. There is no expected control of NO_x emissions using the catalyzed DPF option.

Table C-7 (Active DPF)
Active Diesel Particulate Filter Capital Cost
CO6 Expansion – Columbia Data Center
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,500-KWe emission control package	Cost estimate by Vendor		5	$182,000	$910,000
2,500-KWe miscellaneous parts	Assumed no cost			$2,000	$10,000
Dealer markup (DPFs not sold directly)			10%	$18,200	$91,000
Combined systems cost					$1,011,000
Instrumentation	Included above		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$65,715
Shipping (2,500-KWe)		Johnson Matthey	5	$2,500	$12,500
Subtotal Purchased Equipment Cost (PEC)					$1,089,215
Direct Installation Costs					
Enclosure structural supports (2,500-KWe)	Assumed no cost		0	$0	$0
Onsite Installation (2,500-KWe)	Cost estimate by Vendor		5	$0	$0
Electrical/Piping/Painting	Cost estimate by Vendor		5	$5,000	$25,000
Insulation	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$25,000
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$1,114,215
Indirect Costs (Installation)					
Engineering	No additional cost	Vendor	0	$0	$0
Construction and field expenses	No additional cost	Vendor	0	$0	$0
Contractor Fees	From DIS data center		6.8%	--	$73,740
Startup (onsite commissioning)		Vendor	5	$2,000	$10,000
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$10,892
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$108,922
Subtotal Indirect Costs (IC)					$203,554
Total Capital Investment (TCI = DC+IC)					**$1,317,769**

Table C-8
Active Diesel Particulate Filter Cost Effectiveness
CO6 Expansion – Columbia Data Center
Quincy, Washington

Item	Quantity	Units	Unit Cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				**$1,317,769**
Capital Recovery Factor: years:	30	discount:	5.5%	0.069
Subtotal Annualized 30-year Capital Recovery Cost				$90,670
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$26,355
Annual Property tax	1% of TCI (EPA Manual)		0.01	$13,178
Annual Insurance	1% of TCI (EPA Manual)		0.01	$13,178
Annual operation/labor/maintenance costs: Upper-bound estimate would assume CARB's value of $1.00/hp/year and would result in $315,140/year. Lower-bound estimate would assume zero annual O&M. Mid-range value would account for fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.				$0
Subtotal Direct Annual Costs				$52,711
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$143,380**
Uncontrolled Emissions (Combined Pollutants)				12.5
Annual Tons Removed (Combined Pollutants)				1.4
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$104,923**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$315,140	per year per generator
2,500	KW-hr
470	annual generator hours
$1.00	per HP_M per year
$18.00	per hour for additional fuel use
$1,692.00	per generator per year additional fuel

MULTI-CRITERIA POLLUTANT COST EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
NO_x	$12,000	0	$0 per year
CO	$5,000	1	$5,634 per year
VOCs	$12,000	0	$1,790 per year
PM	$12,000	0.1	$1,086 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$8,511 per year
Actual Annual Control Cost			$143,380 per year
		Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

CRITERIA POLLUTANT CONTROL EFFICIENCIES[a]

Pollutant	PM (FH)	CO	VOCs	NO_x
Tier 2 Uncontrolled Emissions (TPY)	0.10	1.4	0.21	11
Controlled Emissions (TPY)	0.010	0.3	0.06	11
TPY Removed	0.09	1.1	0.15	0
Combined Uncontrolled Emissions (TPY)	12			
Combined TPY Removed	1.4			
Expected Removal Efficiency	90%	80%	70%	0%
Annualized Cost ($/year)	$143,380			
Individual Pollutant $/Ton Removed	$1,584,488	$127,243	$960,943	--

MULTI-TOXIC AIR POLLUTANT COST-EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	ASIL (µg/m^3)	"Hanford Method" Cost Factor	Ecology Guidance "Ceiling Cost" ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
DEEP	0.00333	6.9	$72,544	0.09	$6,564 per year
CO	23,000	0.070	$731	1.1	$824 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	0.0	$0.0 per year
Acrolein	0.06	5.7	$59,359	3.1E-05	$1.9 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	0.0	$0 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	0.0	$0 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$7,390 per year
Actual Annual Control Cost					$143,380 per year
				Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
DEEP	0.10	0.01	0.09	90%	$1,584,488
CO	1.41	0.3	1.1	80%	$127,243
NO_2 (10% of NO_x)	1.07	1.1	0.0	0%	--
Acrolein	4.45E-05	1.3E-05	3.1E-05	70%	$4,600,328,613
Carcinogenic VOCs	0.0	0.0	0.0	70%	--
Non-Carcinogenic VOCs	4.45E-05	0.0	0.0	70%	$4,600,328,613
Annualized Cost ($/yr)					$143,380
Combined Uncontrolled Emissions (TPY)					2.6
Combined TPY Removed					1.2
Combined TAPs $/Ton Removed					$117,781

Notes:

FH ("front-half" filterable emissions)

BH ("back-half" condensable emissions)

PM (particulate matter) attributable to front-half and back-half emissions is assumed equal to the sum of vendor NTE values for PM and hydrocarbons.

DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

[a] The expected control efficiency using the catalyzed DPF is 85% for PM (front half), 80% for CO, and 70% for VOCs. There is no expected control of NO_x emissions using the catalyzed DPF option.

Table C-9 (DOC)
Diesel Oxidation Catalyst Capital Cost
CO6 Expansion – Columbia Data Center
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,500-KWe emission control package	Cost estimate by Cummins		5	$11,486	$57,430
2,500-KWe miscellaneous parts	Assumed no cost			$0	$0
Combined systems ost					$57,430
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$3,733
Shipping (2,500-KWe)		Johnson Matthey	5	$500	$2,500
Subtotal Purchased Equipment Cost (PEC)					$63,663
Direct Installation Costs					
Enclosure structural supports (2,500-KWe)	Cost estimate by Johnson Matthey		5	$0	$0
Onsite Installation (2,500-KWe)	Cost estimate by Johnson Matthey		5	$3,000	$15,000
Electrical	Included above		0	$0	$0
Piping	Included above		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$15,000
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$78,663
Indirect Costs (Installation)					
Engineering		Johnson Matthey	5	$1,200	$6,000
Construction and field expenses		Johnson Matthey	5	$0	$0
Contractor Fees	From DIS data center		6.8%	--	$4,310
Startup		Johnson Matthey	5	$1,500	$7,500
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$637
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$6,366
Subtotal Indirect Costs (IC)					$24,813
Total Capital Investment (TCI = DC+IC)					**$103,476**

Table C-10
Diesel Oxidation Catalyst Cost Effectiveness
CO6 Expansion – Columbia Data Center
Quincy, Washington

Item	Quantity	Units	Unit Cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				**$103,476**
Capital Recovery Factor - years:	30	discount:	5.5%	0.069
Subtotal Annualized 30-year Capital Recovery Cost				$7,119.70
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$2,070
Annual Property tax	1% of TCI (EPA Manual)		0.01	$1,035
Annual Insurance	1% of TCI (EPA Manual)		0.01	$1,035
Catalyst Replacement	Assume cost of zero.		$0	$0
Annual operation/labor/maintenance costs: Upper-bound estimate would assume CARB's value of $0.20/hp/year and would result in $63,028/year. Lower-bound estimate would assume zero annual O&M. Mid-range value would account for fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. For this screening-level analysis, we assumed the lower-bound annual O&M cost of zero.				$0
Subtotal Direct Annual Costs				$4,139
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$11,259**
Uncontrolled Emissions (Combined Pollutants)				12.5
Annual Tons Removed (Combined Pollutants)				1.3
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$8,653**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$63,028	per year per generator
2,500	KW-hr
470	annual generator hours
$0.20	per HP_M per year

MULTI-CRITERIA POLLUTANT COST EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
NO_x	$12,000	0	$0 per year
CO	$5,000	1.1	$5,634 per year
VOCs	$12,000	0.15	$1,790 per year
PM	$12,000	0.03	$302 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$7,726 per year
Actual Annual Control Cost			$11,259 per year
		Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

CRITERIA POLLUTANT CONTROL EFFICIENCIES[a]

Pollutant	PM (FH)	CO	VOCs	NO_x
Tier 2 Uncontrolled Emissions (TPY)	0.10	1.4	0.21	11
Controlled Emissions (TPY)	0.08	0.28	0.06	11
TPY Removed	0.03	1.1	0.15	0
Combined Uncontrolled Emissions (TPY)	12			
Combined TPY Removed	1.3			
Expected Removal Efficiency	25%	80%	70%	0%
Annualized Cost ($/year)	$11,259			
Individual Pollutant $/Ton Removed	$447,911	$9,992	$75,457	--

MULTI-TOXIC AIR POLLUTANT COST-EFFECTIVENESS (Reasonable vs. Actual Cost to Control)[a]

Pollutant	ASIL (μg/m^3)	"Hanford Method" Cost Factor	Ecology Guidance "Ceiling Cost" ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
DEEP	0.00333	6.9	$72,544	0.03	$1,823 per year
CO	23,000	0.1	$731	1.1	$824 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	0.0	$0 per year
Acrolein	0.06	5.7	$59,359	3.1E-05	$1.9 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	0.0	$0 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	3.12E-05	$0.16 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$2,649 per year
Actual Annual Control Cost					$11,259 per year
				Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
DEEP	0.10	0.08	0.03	25%	$447,911
CO	1.41	0.3	1.1	80%	$9,992
NO_2 (10% of NOx)	1.07	1.1	0.0	0%	--
Acrolein	4.45E-05	1.3E-05	3.1E-05	70%	$361,234,117
Carcinogenic VOCs	0.0	0.0	0.0	70%	--
Non-Carcinogenic VOCs	4.45E-05	0.0	0.0	70%	$361,234,117
Annualized Cost ($/yr)					$11,259
Combined Uncontrolled Emissions (TPY)					2.6
Combined TPY Removed					1.2
Combined TAPs $/Ton Removed					$9,773

Notes:

FH ("front-half" filterable emissions)

BH ("back-half" condensable emissions)

PM (particulate matter) attributable to front-half and back-half emissions is assumed equal to the sum of vendor NTE values for PM and hydrocarbons.

DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors

DEEP (diesel engine exhaust particulate matter) is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

[a] The expected control efficiency using the DOC is 80% for CO, and 70% for VOCs. DOCs are marginally effective for removal of PM (15% - 25%) depending on the load). There is no expected control of NO_x emissions using the DOC control option.

APPENDIX D

Summary of AERMOD Inputs

Table D-1
Modeling Stack Parameters and Emission Rates
CO6 Expansion – Columbia Data Center
Quincy, Washington

Stack Dimensions

Parameter	2.5-MWe Genset
Stack height (ft)	38
Stack diameter (in)	24

Theoretical Maximum Year with Commissioning

Operating Condition	Assumptions for Cold-start Emissions Calculations	
	2.5-MWe Genset	
	Startup	Warm
Hours at each runtime mode	0.25	93.35
Maximum Generators Concurrently Operating	5	
Parameter	**2.5-MWe Genset**	
Input Emissions per Point Source (lb/hr)[a,b]		
NO_x (annual NAAQS)	0.57	
$PM_{2.5}$ (annual NAAQS)	0.015	
Input Exhaust Parameters		
Worst-case Exhaust Temp. (°F)	501	
Worst-case Exhaust Flow (cfm)	5,003	

Maximum Short-Term Emissions

Operating Condition	Assumptions for Cold-start Emissions Calculations	
	2.5-MWe Genset	
	Startup	Warm
Number of events	1	1
Duration of each event (hours)	0.017	0.983
Hours at each runtime mode	0.017	0.983
Maximum Generators Concurrently Operating	5	
Parameter	**2.5-MWe Genset**	
Input Emissions per Point Source (lb/hr)[a]		
CO (1 & 8-hour NAAQS)	8	
SO_2 (1 & 3-hour NAAQS)	0.037	
NO_2 (1-hour ASIL)	54	
Input Exhaust Parameters		
Load-Specific Exhaust Temp. (°F)	851	
Load-Specific Exhaust Flow (cfm)	18,808	

24-Hour Power Outage Scenario

Operating Condition	Assumptions for Cold-start Emissions Calculations	
	2.5-MWe Genset	
	Startup	Warm
Number of events	1	1
Duration of each event (hours)	0.017	23.983
Hours at each runtime mode	0.017	23.983
Parameter	**2.5-MWe Genset**	
Acrolein (ASIL)		
Emissions per Point Source (lb/hr)[a]	1.830E-04	
Load-Specific Exhaust Temp. (°F)	851	
Load-Specific Exhaust Flow (cfm)	18,808	

Table D-1
Modeling Stack Parameters and Emission Rates
CO6 Expansion – Columbia Data Center
Quincy, Washington

Notes:

[a] All generators were modeled under full-variable load conditions (≤100% Load). Startup emissions were included for applicable pollutants.

[b] For modeling local background impacts, neighboring data centers were assumed to emit at the permitted potential-to-emit rates. Cooling towers and the Lamb Weston facility were assumed to operate continuously and emit at permited rates.

Table D-2
Modeling Stack Parameters and Emission Rates for PM_{10} and $PM_{2.5}$
CO6 Expansion – Columbia Data Center
Quincy, Washington

PM_{10} 24-hour NAAQS Setup: Power Outage, 15 Hours on 2nd day

Operating Condition	Assumptions for Cold-start Emissions Calculations	
	2.5-MWe Genset	
	Startup	Warm
Number of events per day	1	1
Duration of each event (hours)	0.017	14.98
Hours at each runtime mode	0.017	14.98
Maximum Generators Concurrently Operating	5	
Parameter	**2.5-MWe Genset**	
Emissions per Point Source (lb/hr)[a]	0.872	
Load-Specific Exhaust Temp. (°F)	655	
Load-Specific Exhaust Flow (cfm)	7,490	

$PM_{2.5}$ 24-hour Setup: Non-emergency routine quarterly operations

Operating Condition	Assumptions for Startup Emissions Calculations	
	2.5-MWe Genset	
	Startup	Warm
Hours of operation per day	12	
Number of events per day	12	12
Duration of each event (hours)	0.017	0.98
Hours at each runtime mode (per day)	0.200	11.80
Maximum Generators Concurrently Operating	1	
Parameter	**2.5-MWe Genset**	
AERMOD Input Emissions per Point Source (lb/hr)		
$PM_{2.5}$ (24-hour NAAQS)[a, b]	1.4657	
AERMOD Input Exhaust Parameters		
Load-Specific Exhaust Temp. (°F)	655	
Load-Specific Exhaust Flow (cfm)	7,490	

NO_2 1-Hour NAAQS Setup: Non-Emergency Triennial and Quarterly Operations

Parameter	2.5-MWe Genset
Emissions per Point Source (lb/hr)[b]	53.70
Load-Specific Exhaust Temp. (°F)	851
Load-Specific Exhaust Flow (cfm)	18,808

Notes:

[a] All generators were modeled under full-variable load conditions (≤100% Load). Startup emissions were included for all applicable pollutants.

[b] Quarterly maintenance operations are expected to occur on a single engine for 60 minutes per engine. In the event that complications arise during testing, this duration may be greater. Likewise, multiple sequential tests may occur within the same day for up to 12 hr/dy.

APPENDIX E

Electronic Files Archive

(on DVD)

Notice of Construction Application Supporting Information Report CO6 Expansion – Columbia Data Center Quincy, Washington

December 6, 2019

Prepared for

CPG and Microsoft Corporation

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