DEPARTMENT OF ECOLOGY
State of Washington

Notice of Construction Application

This application applies statewide for facilities under the Department of Ecology's jurisdiction. Submit this form for review of your project to construct a new or modified source of air emissions. Please refer to Ecology Forms ECY 070-410a-g, "Instructions for NOC Application," for general information about completing the 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

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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	Greg Flibbert (509) 329-3452 gregory.flibbert@ecy.wa.gov
☐ **NWRO**	**San Juan County** Ecology Northwest Regional Office – Air Quality Program	David Adler (425) 649-7082 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: ____________	Garin Schrieve (360) 407-6916 garin.schrieve@ecy.wa.gov
☐ **NWP**	**For actions taken on the US Department of Energy Hanford Reservation** Ecology Nuclear Waste Program	Philip Gent (509) 372-7983 philip.gent@ecy.wa.gov

If you need this document in a format for the visually impaired, call the Air Quality Program at 360-407-6800. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

DEPARTMENT OF ECOLOGY State of Washington

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

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.

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DEPARTMENT OF ECOLOGY State of Washington

Notice of Construction Application
Part 1: General Information

I. Project, Facility, and Company Information

1. Project Name Project Riker	
2. Facility Name Riker Data Center	
3. Facility Street Address 2101 M Street NE, Quincy, WA 98848	RECEIVED
4. Facility Legal Description FU 339 BLOCK 73 LS TAX# 11853 4 20 24	AUG 19 2016
5. Company Legal Name (if different from Facility Name) Vantage Data Centers	Department of Ecology Eastern Washington Office
6. Company Mailing Address (street, city, state, zip) 2101 M Street NE, Quincy, WA 98848	

II. Contact Information and Certification

1. Facility Contact Name (who will be onsite) Mark Johnson	
2. Facility Contact Mailing Address (if different than Company Mailing Address) 2101 M Street NE, Quincy, WA 98848	
3. Facility Contact Phone Number 509-797-8008	4. Facility Contact E-mail mjohnson@vantagedatacenters.com
5. Billing Contact Name (who should receive billing information) Eunice Castillo	
6. Billing Contact Mailing Address (if different than Company Mailing Address) 2805 Bowers Ave, #220, Santa Clara, CA 95051	
7. Billing Contact Phone Number 408-215-7785	8. Billing Contact E-mail accountspayable@vantagedatacenters.com
9. Consultant Name (optional – if 3rd party hired to complete application elements) Chip Halbert	
10. Consultant Organization/Company Landau Associates	
11. Consultant Mailing Address (street, city, state, zip) 601 Union Street, Suite 1606, Seattle, WA 98101	
12. Consultant Phone Number 206-631-8690	13.Consultant E-mail chalbert@landauinc.com
14. Responsible Official Name and Title (who is responsible for project policy or decision-making) Mark Johnson	
16. Responsible Official Phone 509-797-8008	17. Responsible Official E-mail mjohnson@vantagedatacenters.com
18. Responsible Official Certification and Signature I certify, based on information and belief formed after reasonable inquiry, the statements and information in this application are true, accurate and complete. Signature *Mark Johnson* Date *8-12-16*	

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Part 2: Technical Information

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

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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:

____

☐ 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 www.ecy.wa.gov/programs/sea/sepa/docs/echecklist.doc

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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.

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)

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

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☒ 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 Riker Data Center Quincy, Washington

August 10, 2016

Prepared for

Vantage Data Centers
2805 Bowers Avenue, Suite 200
Santa Clara, California

Landau Associates

130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

THIS REPORT HAS BEEN PREPARED TO PROVIDE SUPPORTING DOCUMENTATION FOR WASHINGTON STATE DEPARTMENT OF ECOLOGY FORM NO. ECY 070-410, *NOTICE OF CONSTRUCTION APPLICATION: NEW PROJECT OR MODIFICATION OF EXISTING STATIONARY SOURCE*. EACH SECTION OF THIS REPORT PROVIDES A CROSS-REFERENCE TO THE SECTION OF FORM NO. ECY 070-410 FOR WHICH SUPPORTING DOCUMENTATION IS BEING PROVIDED.

Notice of Construction Application Supporting Information Report
Riker Data Center
Quincy, Washington

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

Document prepared by: ______________________ Mark W. Brunner
Project Manager

Document reviewed by: ______________________ Chip Halbert
Principal Quality Reviewer

Date:	August 10, 2016
Project No.:	1499001.010
File path:	P:\1499\001\R\2016 NOC Report
Project Coordinator:	Christopher C. Young

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APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

$\mu g/m^3$	microgram per cubic meter
AERMAP	AMS/EPA regulatory model terrain pre-processor
AERMET	AERMOD meteorological pre-processor
AERMOD	AMS/EPA regulatory model
AMS	American Meteorological Society
Approval Order	Approval Order No. 12AQ-E450
ASIL	acceptable source impact level
BACT	best available control technology
BPIP	building profile input program
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
ISC	Industrial Source Complex
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
NSR	New Source Review
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
PRIME	Plume Rise Model Enhancements
PVMRM	Plume Volume Molar Reaction Model
RCW	Revised Code of Washington
RICE	reciprocating internal combustion engine

LIST OF ABBREVIATIONS AND ACRONYMS (continued)

SCR .... selective catalytic reduction
SIT .... site integration test
SO_2 .... sulfur dioxide
SQER .... small-quantity emission rate
TAP .... toxic air pollutant
tBACT .... BACT for toxic air pollutants
USGS .... US Geological Survey
VDC .... Vantage Data Centers
VOC .... volatile organic compound
WAAQS .... Washington Ambient Air Quality Standards
WAC .... Washington Administrative Code

1.0 EXECUTIVE SUMMARY

Vantage Data Centers (VDC) currently operates Riker Data Center in Quincy, Washington. In 2013, VDC obtained Approval Order No. 12AQ-E450 (Approval Order) from the Washington State Department of Ecology (Ecology) to install and operate up to 17 3.0-megawatt electrical (MWe) emergency generators. Five of the 17 emergency generators have been installed as originally proposed with US Environmental Protection Agency (EPA) Tier 4-compliant emission controls. This document has been prepared by Landau Associates, Inc. (LAI) on behalf of VDC to support a Notice of Construction (NOC) application.

Two performance tests have been completed at the Riker Data Center and measured emission rates of total particulate matter (PM), nitrogen dioxide (NO_2), and ammonia exceeded Approval Order limits in one or both tests. The EPA Tier 4 emission control vendor was unable to make system adjustments that would allow for a passing performance test.

VDC is requesting a modification to the Approval Order that will allow the 17 emergency generators to operate in compliance with EPA Tier 2 emission standards (i.e., without Tier 4-compliant emission controls). VDC is also requesting modifications to the operating limitations in the Approval Order to accommodate the minimum operational needs for the facility.

The list of equipment that was evaluated for this NOC application consists of 17 MTU Model 20V4000 diesel engines used to power emergency electrical generators, Model MTU 3000. The 17 3.0-MWe generators will have a combined capacity of 51 MWe. The generators will be installed in up to four phases. Phase 1 will consist of seven 3.0-MWe generators, five of which have already been installed. Phases 2, 3, and 4 will consist of a total of 10 additional 3.0-MWe generators, which will be installed at the facility as independent tenant companies contract for space at the Riker Data Center. The generator identification numbers and building locations are summarized as follows:

Engine and Generator Serial Numbers

Project Phase	DC BLDG	Unit ID	Capacity (MWe)	Engine SN	Generator SN	Build Date
1	DC1	DC1-1P	3.0	34487-1-1	28420-01	9/1/2013
1	DC1	DC1-2P	3.0	34487-1-2	28420-02	9/1/2013
1	DC1	DC1-3P	3.0	34487-1-3	28420-03	9/1/2013
1	DC1	DC1-4P	3.0	34487-1-4	34571-01	9/1/2014
1	DC1	DC1-5P	3.0	34487-1-5	34707-01	9/1/2014
1	DC1	DC1-6P	3.0			
1	DC1	DC1-7P	3.0			
2	DC2	DC2-1P	3.0			
2	DC2	DC2-2P	3.0			
2	DC2	DC2-3P	3.0			
2	DC2	DC2-4P	3.0			
3	DC3	DC3-1P	3.0			
3	DC3	DC3-2P	3.0			

Project Phase	DC BLDG	Unit ID	Capacity (MWe)	Engine SN	Generator SN	Build Date
3	DC3	DC3-3P	3.0			
3	DC3	DC3-4P	3.0			
4	ETC	ETC-1P	3.0			
4	ETC	ETC-2P	3.0			

Consistent with the recent approach to permitting data centers in Quincy—in which the worst-case emissions are evaluated to allow permitting on a cumulative hours basis rather than on a scenario- and load-specific basis—VDC is requesting the following Approval Order conditions:

- Annual runtime limit of 765 cumulative generator hours facility-wide.
- Limit on facility-wide concurrent operation of between 8 and 17 generators to no more than 3 separate days per calendar year.
- Limit on operation of up to 7 generators operating concurrently in any single building for up to 4 hours per day, for up to 6 days per calendar year per building. Note, operation associated with the preceding scenario (i.e., concurrent operation of between 8 and 17 generators) would not count against this limitation.
- Limit on one-at-a-time generator operation for no more than 6 hours per day, during daytime hours only (7:00 a.m. to 7:00 p.m.). Additionally, one-at-a-time generator operation will be scheduled and coordinated with other nearby data centers.

Additionally, VDC is requesting that:

- The Approval Order conditions not assign specific fuel or runtime limits to each individual runtime activity (e.g., unplanned power outages).
- Any reference to “reserve engine” be removed from the Approval Order, as the evaluation contained herein treats all generators as primary, consistent with the facility’s operational needs.
- Compliance with per-generator runtime and fuel limits be demonstrated by summing total actual operating hours and fuel used for all generators in service and comparing that to the total number of permitted hours or fuel usage for all generators in service.
- Compliance with the annual generator runtime and fuel usage limitations be based on a 3-year averaging period using monthly rolling totals.

Air pollutant emission rate estimates were calculated based on vendor-provided not-to-exceed emission factors or emission factors from EPA AP-42 Volume I, Chapter 3.4 (EPA 1995). VDC is requesting flexibility to operate the generators at any load; therefore, the emission rate used for this evaluation was based on emission factors for the highest emitting load for each pollutant. In order to account for slightly higher emissions during the first minute of each engine cold startup, the estimated emission rates of pollutants associated with cold-startup were scaled-up using a “black-puff” emission factor.

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

EPA's Tier 2 emission standards, which is 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. Furthermore, the use of Tier 4 emission controls originally installed on the five operational emergency generators not only failed to meet Tier 4 standards, but actually increased some emission rates above those normally achieved by Tier 2-compliant emergency generators. Subject to Ecology's review and approval, the evaluations presented in this NOC application support the proposal of the following emission rates as BACT for the emergency generators in use, and yet to be installed, at the Riker Data Center:

Best Available Control Technology Proposal

Pollutant(s)	BACT and tBACT Proposal
Particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOC), and nitrogen oxides (NO_x)	a. Use of EPA Tier 2-certified engines when installed and operated as emergency engines, as defined by 40 CFR 60.4219. b. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart III.
Sulfur dioxide (SO_2)	Use of ultra-low sulfur diesel fuel containing no more than 15 parts per million (ppm) by weight of sulfur.
Toxic air pollutants, including acetaldehyde, CO, acrolein, benzene, benzo(a)pyrene, 1,3-butadiene, diesel engine exhaust particulate matter (DEEP), formaldehyde, propylene, toluene, total polycyclic aromatic hydrocarbons, xylenes, nitrogen dioxide (NO_2) and SO_2.	Compliance with the proposed BACT requirements for PM, CO, VOC, NO_x, and SO_2.

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 Riker 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 Riker Data Center are below Washington acceptable source impact levels (ASILs), with the exception of NO_2 and diesel engine exhaust particulate matter (DEEP). Because modeled NO_2 and DEEP concentrations exceed ASILs, a second-tier health impact assessment will be prepared and submitted to Ecology under separate cover.

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2.0 INTRODUCTION

This document has been prepared for VDC to support the submittal of a NOC application for revised buildout plans for installation and operation of the currently permitted emergency generators at its Riker Data Center in Quincy, Washington, under air quality regulations promulgated by Ecology.

The currently permitted 17 3.0-MWe generators were originally planned to be furnished with EPA Tier 4-compliant emission control equipment. VDC has completed construction of Building 1 and has installed 5 of the 7 permitted generators at Building 1.

VDC currently operates under Approval Order No. 12AQ-E450 (Approval Order). ELM Energy, the third-party supplier of the EPA Tier 4-compliant emission control system, provided “not-to-exceed” air pollutant emission rates based on the use of a catalyzed diesel particulate filter (DPF) and a selective catalytic reduction (SCR) catalyst with urea injection for combined control of PM and oxides of nitrogen (NO_x) and destruction of CO and unburned hydrocarbons. Those not-to-exceed emission rates were used as the basis for the development of emission limits in the Approval Order.

VDC completed a generator emissions performance test in August 2014. The results of that test indicated that measured emission rates of PM, NO_2 (during the 11 percent load test), and ammonia exceeded the permit limits. Following the failed performance test, ELM Energy conducted troubleshooting, repairs, and system optimization. A second performance test was conducted in April 2015, the results of which indicated that measured emission rates of total PM and ammonia exceeded the permit limits. Following the second failed performance test, VDC completed an exhaustive inquiry into determining the reason for the failed tests, which involved consultation with industry experts, laboratory testing on the PM residue collected during the performance test, and testing to confirm the fuel and urea used during testing was within specifications. The results of consultations and testing were inconclusive and there was no clear explanation for the higher than anticipated emission rates. In the course of its efforts to optimize the performance of the engines and control equipment, ELM Energy has been unable to remedy the equipment performance issues to achieve its original performance claims that supported the selection and installation of that equipment.

For comparison, the emission rates measured during performance testing, current Approval Order emission limits, and manufacturer-provided not-to-exceed emission rates for emergency generators that comply with EPA Tier 2 emission standards (i.e., the same emergency generators, just without any add-on emission controls) are summarized in Table 1. As shown in Table 1, the highest measured total PM emission rate during performance testing is more than 10 times higher than the permit limit and more than twice as high as the engine manufacturer’s not-to-exceed value for total PM emissions for the same generator with no add-on emission controls (i.e., without a catalyzed DPF and SCR). In other words, the control equipment intended to achieve Tier 4-compliant performance not only failed to achieve that objective, it actually increased PM emissions beyond rates that would have been achieved solely by installing and operating Tier 2-compliant engines. The reason for this increased total PM and ammonia emissions is unclear, but could be the result of chemical interactions associated with urea injection in the exhaust, which has been documented in the literature for other combustion sources. Regardless, ELM Energy was unable to make system adjustments that would allow for a passing performance test.

VDC was the first data center operator in the region to embark on a plan to install Tier 4-compliant emission controls on its emergency generators. In a community known for its clean-air activism, VDC took pride in its voluntary early adoption of Tier 4-compliant emission controls that are normally not installed on emergency engines with low annual runtimes. However, after recent events, VDC has been unable to establish an economically (or technically) viable path forward to retain the emission controls and is, therefore, compelled to request an amendment to the Approval Order that will allow VDC to remove the Tier 4 add-on controls and operate the emergency generators in compliance with EPA Tier 2 emission standards.

Ecology has consistently concluded that emergency generators that meet EPA Tier 2 emission standards are considered BACT and tBACT. LAI has conducted a BACT assessment based on current conditions and concludes that EPA Tier 2 emission standards continue to meet the definition of BACT and tBACT for emergency engines. Therefore, subject to Ecology's review and approval, VDC proposes to remove the catalyzed DPF and SCR. This NOC application documents our understanding of the regulatory basis for removing the emission controls and constitutes a request to amend the Approval Order conditions accordingly. Additionally, VDC would like to request changes to the Approval Order conditions to better accommodate current operational needs and to streamline recordkeeping requirements.

3.0 PROJECT DESCRIPTION

(Section III of NOC application form)

3.1 Facility Description

VDC is currently permitted to construct and operate the Riker Data Center located in Quincy, Washington. The Riker Data Center is located at the intersection of Road O NW and M Street NE, which is immediately north of the existing Sabey Data Center and east of the Intuit Data Center. A vicinity map is provided on Figure 1. The site is accessible by M Street NE to the south of the site.

The development plan for the Riker Data Center will be completed in phases. The Approval Order covers full buildout for all phases combined, which includes 17 3.0-MWe generators. A site map for the existing and proposed development is provided on Figure 2. Full buildout will consist of four main data center buildings, three smaller structures to house the generators, and a future substation. The configuration of permitted emergency generators at the Riker Data Center are as follows:

- Building 1 will house up to seven 3.0-MWe emergency generators to supplement power to the server system during an unplanned power outage. Five of the seven emergency generators have been installed.
- Future Buildings 2 and 3 will both house four 3.0-MWe generators each.
- A future Enterprise Technology Center building will house two 3.0-MWe generators.

Future phases of development could begin in 2018. The Riker Data Center may house different tenants throughout the facility; therefore this ambient air impact evaluation assesses exposure to air pollutants within the facility's fence line.

3.1.1 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 as defined by the federal regulations (40 CFR Part 89). All emergency generators at the facility will satisfy EPA Tier 2 standards, as required, and will use ultra-low sulfur diesel fuel (15 ppm sulfur content).

Each of the emergency generators will be housed within buildings at the facility with stack locations shown on Figure 2. Each generator will have its own exhaust stack extending approximately 14 to 19 feet above the roof of each generator building, with a resulting stack height of 43 feet above ground for the five generators already installed and 48 feet above ground for the remaining 12 generators. Specifications and manufacturer-provided emissions data for the existing and proposed MTU 3.0-MWe diesel generators are provided in Appendix A. VDC will not install any other diesel engines for use as fire pumps or for building safety generators.

3.1.2 Evaporative Cooling Units

There will not be any wet mechanical-draft cooling towers used for the project.

3.2 Generator Runtime Scenarios

The emission estimates and ambient impact modeling presented in this NOC application are based on emissions at "full-variable load," which corresponds to the characteristic worst-case emission load of each pollutant. Emission estimates are discussed in more detail in Section 4.0.

On an annual basis, VDC requests that compliance with per-generator runtime limits be demonstrated by summing total actual operating hours for all generators in service and comparing that to the total number of permitted hours for all generators in service. Additionally, VDC is requesting that compliance with the annual fuel usage and operating hour limitations be averaged over a 3-year period using monthly rolling totals. For example, total fuel and operating hours will be summed for the 3-year period and an annual average for that period will be calculated and compared to the annual fuel and hour limits. To demonstrate that these requests will result in facility operations and air pollutant emissions that are below regulatory thresholds, this evaluation considers two annual operating scenarios:

- An **annual runtime limit** of 765 cumulative generator hours is requested based on VDC operational needs.
- A **"theoretical maximum year"** addresses the worst-case consideration that, for fuel usage and hour limitations to be averaged over a 3-year period, there is potential for emitting the 3-year maximum entirely within a single 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 the Riker Data Center are as follows:

- **Facility-wide concurrent generator operation:** This generator operating scenario would be initiated if utility power was not available (e.g., unplanned power outage, etc.). For this scenario, 17 3.0-MW emergency generators would activate for the purpose of supplying power to the facility's server systems. To meet the operational needs for this scenario, VDC requests a limit on facility-wide concurrent generator operation that would allow concurrent operation of eight or more generators on at least 3 separate days per calendar year.

- **Building-wide concurrent generator operation:** This generator operating scenario would be initiated in circumstances when it is necessary to concurrently operate multiple generators in a single building for maintenance or testing purposes (i.e., electrical bypass events, site integration testing during commissioning). This scenario would include only concurrent operation of generators in a single building; therefore, it would require no more than seven generators operating concurrently. Note, operation associated with the preceding scenario (i.e., concurrent operation of between 8 and 17 generators) would not count against this limitation. To meet operational needs for this scenario, VDC requests a limit on operation of up to seven generators operating concurrently in any single building for up to 4 hours per day, for up to 6 days per calendar year per building.
- **One-at-a-time generator operation:** This generator operating scenario would be initiated in circumstances when generator operation is necessary, but concurrent operation of multiple generators is not necessary (i.e., monthly maintenance, annual load bank testing, commissioning, performance testing). To meet the operational needs for this scenario, VDC requests a limit on one-at-a-time generator operation for no more than 6 hours per day, during daytime hours (7:00 a.m. to 7:00 p.m.). Additionally, one-at-a-time generator operation would be scheduled and coordinated with other nearby data centers.
- **Generator Startup and Commissioning:** After a new generator is installed, that generator will require commissioning, which includes up to 30 hours of individual operation under a range of loads followed by a 10-hour site integration test (SIT), which requires operation of all the generators that service a single computer server building. If there are multiple phases of generator installations in a single building, it may be necessary to complete a second 10-hour SIT on the generators that were installed in the first phase for that building. For example, for the existing Building 1, five generators have already been installed and a SIT has been completed. However, once the remaining two generators are installed at that building, a SIT must be completed for all seven generators in that building. No additional runtime or fuel usage is requested for this activity (i.e., the proposed operational limits outlined above will accommodate this activity).
- **Performance Testing:** It is anticipated that Ecology will require performance testing of a single generator once every 5 years in order to demonstrate continued compliance with air quality standards. A performance test may take about 6 hours and involve several engine startup and shutdown events. The worst-case annual scenario would be if the performance test failed, requiring a second, follow-up test in the same year. The worst-case runtime that could occur in a single year from performance testing would be the operation of two generators for 6 hours each. No additional runtime or fuel usage is requested for this activity (i.e., the proposed operational limits outlined above will accommodate this activity).

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

- Annual runtime limit of 765 cumulative generator hours facility-wide.
- Limit on facility-wide concurrent operation of between 8 and 17 generators to no more than 3 separate days per calendar year.

- Limit on operation of up to seven generators operating concurrently in any single building for up to 4 hours per day, for up to 6 days per calendar year per building. Note, operation associated with the preceding scenario (i.e., concurrent operation of between 8 and 17 generators) would not count against this limitation.
- Limit on one-at-a-time generator operation for no more than 6 hours per day, during daytime hours only (7:00 a.m. to 7:00 p.m.). Additionally, one-at-a-time generator operation will be scheduled and coordinated with other nearby data centers.

The evaluation in this NOC application and the evaluation that will be presented in the second-tier health impact assessment 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). Note, we request that any reference to "reserve engine" be removed from the Approval Order, as this evaluation treats all generators as primary, consistent with the facility's operational needs.

3.3 Compliance with State and Federal Regulations

The Riker Data Center 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. Since the maximum potential-to-emit for all criteria pollutants will be less than 250 tons per year, the permittee is applying for an approval order to meet minor New Source Review (NSR) requirements. 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., and those that produce less than 100 tons per year are considered minor sources. Potential-to-emit estimates provided in Section 4.0 demonstrate that the facility will emit:

- Less than 100 tons per year of any criteria pollutant (PM, carbon monoxide [CO], 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, neither a Prevention of Significant Deterioration NSR pre-construction permit nor a Title V operating permit is 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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4.0 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).

The emergency generators will be guaranteed by the manufacturer to meet EPA Tier 2 emission standards for non-road diesel engines. The emergency generator manufacturer is MTU. MTU's reported not to exceed generator emission factors for CO, nitrogen oxides (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.

4.1 Derivation of Emission Factors, Facility-wide Emission Rates, and Fuel Usage

During all operations, the generators will activate at less than or equal to 100 percent load (full-variable load). VDC 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 VDC is requesting 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 worst-case emission rates are provided in Table 2 and were used in all compliance demonstrations.

Emissions of DEEP are conservatively assumed to be equal to the manufacturers' not-to-exceed emissions value for total PM emission rates. The emission rates for PM with an aerodynamic diameter of less than or equal to 10 microns (PM_{10}) and diameter of 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 manufacturer's 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 (as recommended by the manufacturer), 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 17 generators would be 158,472 gallons of diesel fuel per year, averaged over 3 years. Table 3 summarizes the maximum fuel-based facility-wide 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.

4.2 Cold-Start Emissions

In order to account for slightly higher emissions during the first minute of each engine cold startup, the estimated emission rates of pollutants associated with cold-startup (PM, CO, NO_x, 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, CO, and NO_x emissions observed immediately after cold-start of a large diesel backup generator. These observations were documented by the California Energy Commission's report Air Quality Implications of Backup Generators in California (Lents et al. 2005). Our derivation of cold-start emission factors are provided in Table 4. Additional details are provided in Appendix B.

This analysis conservatively assumed that 22 cold-starts would be required per engine, per year. All compliance demonstrations assume at least one cold-start per engine for every day the engine is operated.

The resultant facility-wide potential-to-emit is provided in Table 5.

5.0 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 as specified by 40 CFR Part 89.

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

The new 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 Riker facility will be an "area source" of federal HAPs; accordingly, NESHAP Section 63.6590(c)(1) indicates that the new 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 VDC operates the generators in compliance with NSPS Subpart IIII.

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6.0 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

(Section VIII of NOC application form)

6.1 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 in Appendix E were previously provided.

6.2 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 VDC's Quincy campus:

- **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 (88 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 480 degrees Fahrenheit. For VDC's engines, it can take up to 60 minutes to reach the target temperature when operating at 20 percent load or less. At operating loads of less than 40 percent, it can take up to 20 minutes to reach the target temperature.
- **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**. This control option is highly efficient for control of PM_{10}/$PM_{2.5}$/DEEP (90 percent of "front-half"), CO (80 percent), VOCs and gaseous TAPs (70 percent). Note, catalyzed DPFs do not remove condensable ("back-half") particulates. Additionally, operation at low loads and exhaust temperatures does not allow for necessary routine regeneration of the DPF; therefore, additional operation at high loads/temperatures can be required.
- **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; they were, therefore, dropped from consideration for this analysis.

6.3 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.

6.3.1 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 $79,000 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, and a reasonable but conservatively high estimate of the pollutant removal efficiencies.

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 Pacific Power Group for each evaluated emission control option (Elder 2016). 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 25-year system lifetime and a 4 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

[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; on DVD in Appendix C).

the annual operating cost, the operational unit costs for each emission control option were set to zero.

6.4 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 6.2. As discussed below, the costs of controlling criteria pollutant emissions using the Tier 4 integrated control package, catalyzed DPF, SCR, and DOC are disproportionate to the benefit received.

6.4.1 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 ($37,080), PM_{10}/$PM_{2.5}$ ($2.9 million), CO ($223,676), VOCs ($1.5 million), and combined criteria air pollutants ($30,811) 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.

6.4.2 Cost Effectiveness Analysis for SCR

The cost effectiveness of installing an SCR for control of NO_x is $25,070 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.

6.4.3 Cost Effectiveness Analysis for Catalyzed DPF

The cost effectiveness of installing a catalyzed DPF for control of PM_{10}/$PM_{2.5}$ ($1.2 million per ton), CO ($95,913 per ton), VOCs ($642,025 per ton), and combined pollutants ($78,031 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 catalyzed DPF is cost-prohibitive for the purpose of controlling criteria air pollutant emissions.

6.4.4 Cost Effectiveness Analysis for DOC

The cost effectiveness of installing a DOC for control of PM_{10}/$PM_{2.5}$ ($1.3 million per ton), CO ($28,446 per ton), VOCs ($190,409 per ton), and combined pollutants ($24,280 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.

6.5 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 6.2. 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 the emergency generators at rates exceeding the *de minimis* thresholds consist of: DEEP, benzene, 1,3-butadiene, naphthalene, CO, SO_2, NO_2, benzo(a)pyrene, dibenz(a,h)anthracene, formaldehyde, xylenes, propylene, and acrolein.

The air pollutant emission control options described in Section 6.2 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 Appendix E cost-effectiveness calculations were previously provided in Excel format.

Emission control technologies and the cost-effectiveness evaluation for control of PM_{10}/$PM_{2.5}$ is the same for control of DEEP, because catalyzed DPFs remove only filterable ("front-half") particulates. The derived cost threshold (i.e., the Hanford "ceiling cost"—or the cost threshold above which controls are considered cost-prohibitive) for removal of DEEP, based on the Hanford method, is $72,544 per ton. As shown in Table 7, the forecast cost effectiveness to control DEEP using a Tier 4 integrated control package ($2.9 million per ton), catalyzed DPF ($1.2 million per ton), or a DOC ($1.3 million 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 DEEP emissions.

A cost-effectiveness evaluation was completed for CO as a criteria pollutant (see Section 6.4 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 ($223,676 per ton), catalyzed DPF ($95,913 per ton), and DOC ($28,446 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 (Section 6.4) 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 ($370,795 per ton) and SCR ($250,703 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, benzene, 1,3-butadiene, benzo(a)pyrene, dibenz(a,h)anthracene, formaldehyde, naphthalene, propylene, and xylenes are treatable using the same control options applicable to control VOCs. The derived cost thresholds for removal of these VOCs, based on the Hanford method, are:

- $59,359 per ton of removed acrolein
- $61,882 per ton of removed benzene
- $69,951 per ton of removed 1,3-butadiene
- $78,464 per ton of removed benzo(a)pyrene
- $78,863 per ton of removed dibenz(a,h)anthracene
- $54,691 per ton of removed formaldehyde
- $62,612 per ton of removed naphthalene
- $10,020 per ton of removed propylene
- $21,913 per ton of removed xylenes.

As shown in Table 7, the forecast costs to control these individual VOCs each exceed Ecology's thresholds for cost effectiveness for all applicable control options; therefore, subject to Ecology's review and concurrence, the control options identified are cost-prohibitive for the purpose of controlling individual VOC 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.

6.6 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, 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.

7.0 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 modeling files in Appendix E were previously provided in Excel format.

As discussed in the following sections, the modeled ambient impacts expected from project emissions are less than the NAAQS and WAAQS, even after summing with modeled local background impacts and regional background concentrations. With the exception of two TAPs (DEEP and NO_2), all predicted ambient TAP impacts are less than the ASILs. Therefore a second-tier health impact assessment will be conducted for DEEP and NO_2.

7.1 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 facility-wide emission rates for each TAP expected to be released in the VDC 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 facility-wide emissions of DEEP, benzene, CO, NO_2, 1,3-butadiene, acrolein, and naphthalene are greater than their respective SQER, 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).

7.2 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, introduced by the American Meteorological Society (AMS)/EPA Regulatory Model Improvement Committee, was used in accordance with the EPA's Revision to the Guideline on Air Quality Models (EPA 2005) to estimate

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

ambient pollutant concentrations beyond the project property boundary and at selected onsite receptor locations where facility tenants could be exposed.

AERMOD was used to calculate maximum ambient impact concentrations of criteria pollutants and TAPs that would be emitted from the facility. To do this, AERMOD requires input from several models in order to process meteorological parameters, downwash parameters, and terrain heights. The 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. The Industrial Source Complex (ISC)-AERMOD View Version 9.1 interface provided by Lakes Environmental was used for all air dispersion modeling.

The AERMOD interface provided by Lakes Environmental was used for all Riker Data Center ambient air dispersion modeling. This version of the Lakes Environmental software incorporates the most recent version of AERMOD (version 15181). 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, 8 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 DEEP, PM_{10}, $PM_{2.5}$, NO_2, SO_2, benzene, naphthalene, and 1,3-butadiene emissions.

Each AERMOD setup was arranged to simulate the generator configuration that corresponds to the modeled operating scenario. The modeling setup for short-term 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, since the worst-case emission rate for CO is at 100 percent load, then the input stack parameters for all CO modeling was set up for the corresponding flow rate and temperature reported for 100 percent load conditions. 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).

7.2.1 Stack Heights and Building Downwash Input Parameter Modeling

Generator stack heights and diameters were modeled as follows:

- Stack height for existing five generators in Building 1 = 43 feet
- Stack height for all future 12 generators = 48 feet
- Stack diameter = 26 inches

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 (BPIP)-Plume Rise Model Enhancements (PRIME) 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). VDC's generator exhaust stacks will be lower than GEP height.

7.2.2 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.

Considering that each onsite building will house tenants (independent of other tenants within the facility) where employees may spend their working hours, the onsite structures were evaluated as if they were neighboring (offsite) commercial properties, subject to exposure from project-related ambient impacts. For this reason, modeling receptors were placed on the rooftop of each onsite building and in the ground-level parking lot.

AERMAP requires the use of topographic data to estimate surface elevations above mean sea level. Digital topographic data (in the form of Shuttle Radar Topography Mission files) for the analysis region were obtained from the Web GIS website (http://www.webgis.com) and processed for use in AERMOD. The Shuttle Radar Topography Mission data used for this project have a resolution of approximately 30 m (1 arc-second).

AERMAP produces a Receptor Output File (*.rou) containing the calculated terrain elevations and scale height for each receptor. The *.rou file was used as an input runstream file (AERMOD Input File) for the Receptor Pathway in the Terrain Options page of the Control Pathway. AERMAP also produces a Source Output File (*.sou). This file contains the calculated base elevations for all sources.

7.2.3 Meteorological Input Parameter Modeling

The AERMOD Meteorological Pre-Processor (AERMET; Version 15181) 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 VDC site. Five years (January 1, 2001 through December 31, 2005) of hourly surface data processed in AERMET.
- NWS twice-daily upper air soundings from Spokane, Washington. Five years (January 1, 2001 through December 31, 2005) of upper air data processed in AERMET.
- The site-specific 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. The VDC site does not have an instrumentation tower to record these site-specific parameters for use in AERMET; therefore, site-specific data were approximated based on surface data from the meteorological tower at Grant County International Airport. AERSURFACE was used to approximate the Albedo, Bowen ratio, and surface roughness within 12 equal sectors of a circle that has a 1-kilometer radius and is centered on the surface station tower. Looking at each sector individually, AERSURFACE determines the percentage of land-use type within each sector. Land cover data from the US Geological Survey (USGS) 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) late autumn after frost and harvest, or winter with no continuous snow; and 4) transitional spring with partial green coverage or short annuals.

7.2.4 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 45 hours of operation per generator with a total of 22 cold-start events per generator.

To demonstrate compliance for the "theoretical maximum year" during which VDC would operate the emergency generators 3 times the annual limit (i.e., 135 hours per generator in a 12-month period), emission rates for input to AERMOD were calculated by multiplying the annual average runtime of 45 hours per engine, or annual fuel usage, by 3. 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
- PM_{10} annual average NAAQS
- NO_2 annual average NAAQS
- SO_2 annual average WAAQS
- TAPs with an annual averaging period (e.g., DEEP ASIL).

The ambient NO_2 annual average concentrations were modeled using the Plume Volume Molar Ratio Method (PVMRM) option. 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 49 parts per billion (WSU; accessed August 2016).

The results of the criteria pollutant modeling are provided in Table 9. The results of the TAP modeling are discussed in Section 7.3. 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.

7.2.5 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 17 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., cold-start emissions of all 17 engines are accounted for in this single-hour scenario). These modeling assumptions are used in the setups for:

- CO 1st-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 and SO_2 ASIL).

The results of this scenario are provided in Table 9. The results of the TAP modeling are discussed in Section 7.3. The modeled 1-hour average ambient impacts for CO and SO_2 are less than the NAAQS.

7.2.6 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 17 generators to operate 24 hours per day, 365 days per year, for 5 years. A single cold-start event for each engine was assumed to occur once during each simulation. This modeling setup included:

- CO 1st-highest, 8-hour average NAAQS
- SO_2 1st-highest, 3-hour average NAAQS
- SO_2 1st-highest, 24-hour average WAAQS
- Any applicable TAP with a 24-hour averaging period (e.g., acrolein).

The results of this scenario are provided in Table 9. The results of the TAP modeling are discussed in Section 7.3. The modeled 8-hour ambient impacts for CO and 3 and 24-hour ambient impacts for SO_2 were less than the NAAQS.

7.2.7 Demonstration of Compliance with the NO_2 1-hour Average and $PM_{2.5}$ 24-hour Average NAAQS

The $PM_{2.5}$ 24-hour and NO_2 1-hour average NAAQS are based on the 3-year rolling average of the 98th percentile of the daily maximum ambient impacts. Emergency generator engine operations will be intermittent and on any given day, the operating scenarios and arrangement of activated engines will vary, as will the meteorological conditions that affect the dispersion of pollutants. Due to the variability and unpredictability of weather patterns and variable timing for most of the operating scenarios, a screening-level approach to demonstrate compliance with these standards has been developed by Ecology using a stochastic Monte Carlo script that is run in the statistical software "R." The script was developed by Ecology specifically to evaluate compliance[3] with intermittent emission sources, such as emergency generators at data centers (Dhammapala 2016), and has been similarly used to demonstrate compliance with the NO_2 1-hour average NAAQS for emergency generators at other data centers located in Grant County, Washington. The script post-processes files from AERMOD runs that have been generated for each representative engine runtime scenario. The programming script then randomizes results from all the generator runtime scenarios, wind directions, and wind speeds to estimate the probability that the NO_2 1-hour or $PM_{2.5}$ 24-hour average NAAQS will be violated at any given receptor location.

[3] Compliance with the 1-hour NO_2, SO_2, and 24-hour $PM_{2.5}$ NAAQS.

Each project-specific engine runtime scenario has been characterized and ranked, based on potential facility emissions (see Table 10). The 1st- through 3rd-highest emitting days are expected to occur when all 17 generators activate concurrently at full-variable load. The 4th-through 27th-highest ranked emitting days are expected on days when up to seven generators in a single building activate for up to 4 hours at full-variable load. The 28th-through 92nd-highest ranked emitting days are expected when generators are operated one at a time for up to 6 hours at full-variable load.

The resultant 1st-highest impact of each scenario was modeled in AERMOD and processed by Ecology's Monte Carlo script in "R." This script was used to establish the 98th-percentile impact value at every receptor location within the modeling domain by performing 1,000 iterative runs on 5 years of meteorological data.

7.2.7.1 NO_2 1-Hour Average Modeling and Statistical Analysis

The assumptions for the Monte Carlo analysis were developed based on the generator runtime scenarios ranked in Table 10. The AERMOD runs used for this analysis were developed with the following assumptions:

- Modeling to estimate the ambient impacts associated with up to 17 generators operating concurrently (e.g., during a facility-wide power outage) assumes each daily event lasts for 24 hours and all 17 generators are operating under full-variable load. This scenario also assumes one cold-start event for each engine per day. To ensure ambient NO_2 impacts associated with this scenario were developed based on worst-case meteorological conditions, the AERMOD model simulated continuous operation for 365 days per year, for 5 years.
- Modeling to estimate the ambient impacts associated with up to seven generators operating concurrently in a single building (e.g., during an electrical bypass event) assumes each daily event lasts for 4 hours during daylight hours and all seven generators are operating under full-variable load. This scenario also assumes one cold-start event for each engine per day. To ensure ambient NO_2 impacts associated with this scenario were developed based on worst-case meteorological conditions, the AERMOD model assumed this scenario occurs 365 days per year, for 5 years.
- the AERMOD model assumed this scenario occurs 365 days per year, for 5 years
- Modeling to estimate the ambient impacts associated with one-at-a-time generator operation (e.g., during monthly maintenance or annual load bank testing) assumes each daily event lasts for 6 hours during daylight hours and generators are operating under full-variable load. To ensure ambient NO_2 impacts associated with this scenario were developed based on worst-case meteorological conditions, AERMOD assumed this scenario occurs 365 days per year, for 5 years.
- The ambient NO_2 concentrations were modeled using the PVMRM option within AERMOD. The NO_2/NO_x equilibrium ratio, NO_2/NO_x in-stack ratio, and ambient ozone concentration were set equal to the values used for modeling NO_2 annual average impacts, as described in Section 7.2.4.

Additional details on the emission estimates and stack parameter inputs into AERMOD for each scenario are provided in Appendix D.

Based on the assumptions outlined above and the stochastic Monte Carlo analysis, the maximum predicted 3-year rolling average of the 98th-percentile of the maximum daily 1-hour average concentration of NO_2 was 133 micrograms per cubic meter (µg/m^3) at an onsite building rooftop receptor (see Figure 3).

This evaluation assumed a “regional background” concentration of 16 µg/m^3, which was obtained from the Washington State University NW Airquest website (WSU; accessed August 2016) and accounts for local highway and railroad emission impacts. Additionally, “local background” impacts were modeled at the maximally impacted receptor using the approach outlined in Section 7.2.9.

As shown in Table 9, the maximum cumulative NO_2 concentration (i.e., project + local and regional background) is estimated at 149 µg/m^3, which is less than the NO_2 1-hour average NAAQS of 188 µg/m^3. Electronic copies of the AERMOD and Monte Carlo simulation output files in Appendix E were previously provided.

7.2.7.2 $PM_{2.5}$ 24-Hour Average Modeling and Statistical Analysis

The assumptions for the Monte Carlo software processing were developed based on the generator runtime scenarios outlined in Table 10. The AERMOD runs used for this analysis were developed with the following assumptions:

- The AERMOD runs setup for the ambient impacts associated with up to 17 generators operating concurrently (e.g., during a facility-wide power outage) assumes each daily event lasts for 24 hours and all 17 generators are operating under full-variable load. This scenario also assumes one cold-start event for each engine per day. To ensure ambient $PM_{2.5}$ impacts associated with this scenario were developed based on worst-case meteorological conditions, the AERMOD model assumed this scenario occurs 365 days per year, for 5 years.
- Modeling to estimate the ambient impacts associated with up to seven generators operating concurrently in a single building (e.g., during an electrical bypass event) assumes each daily event lasts for 4 hours during daylight hours and all seven generators are operating under full-variable load. This scenario also assumes one cold-start event for each engine per day. To ensure ambient $PM_{2.5}$ impacts associated with this scenario were developed based on worst-case meteorological conditions, the AERMOD model assumed this scenario occurs 365 days per year, for 5 years.
- Modeling to estimate the ambient impacts associated with one-at-a-time generator operation (e.g., during monthly maintenance or annual load bank testing) assumes each daily event lasts for 6 hours during daylight hours and generators are operating under full-variable load. To ensure ambient $PM_{2.5}$ impacts associated with this scenario were developed based on worst-case meteorological conditions, the AERMOD model assumed this scenario occurs 365 days per year, for 5 years.

Additional details on the emission estimates and stack parameter inputs into AERMOD for each scenario are provided in Appendix D.

Based on the assumptions outlined above and the stochastic Monte Carlo analysis, the maximum predicted 3-year rolling average of the 98th-percentile of the maximum daily average concentration of $PM_{2.5}$ was 9.9 μg/m^3 at an onsite building rooftop receptor (see Figure 3).

This evaluation assumed a regional background concentration of 21 μg/m^3, which was obtained from the Washington State University NW Airquest website (WSU; accessed August 2016) and accounts for local highway and railroad emission impacts. Additionally, local background impacts were modeled at the maximally impacted receptor using the approach outlined in Section 7.2.9.

As shown in Table 9, the maximum cumulative $PM_{2.5}$ concentration (i.e., project + local and regional background) is estimated at 34 μg/m^3, which is less than the $PM_{2.5}$ 24-hour average NAAQS of 35 μg/m^3. The Appendix E electronic copies of the AERMOD and Monte Carlo simulation output files were previously provided.

7.2.7.3 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. With a meteorological data set of 5 years, compliance is demonstrated with this standard by comparing the 4th-highest daily average value in AERMOD to the PM_{10} 24-hour average NAAQS. However, because all 17 generators will be permitted to operate concurrently for a maximum of only 3 days per year, the 4th-highest daily average value would occur on a day when only up to seven generators could operate concurrently in a single building for up to 4 hours per day (see Table 10). Therefore, the model setup assumes that seven generators operate concurrently for 4 hours per day and the 1st-highest daily average value in AERMOD is compared to the PM_{10} 24-hour average NAAQS. A single cold-start event for each engine was assumed to occur once during each simulation. The 4-hour emissions total for this event was divided by 24 hours to develop the hourly emission rate input into AERMOD.

The results of this scenario are provided in Table 9. The modeled 24-hour average ambient impact for PM_{10} is less than the NAAQS.

7.2.8 Assumed Background Impacts

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 data centers and in the vicinity of the Celite facility. Project coordinate-specific regional background values were obtained from the Washington State University NW Airquest website (WSU; accessed August 2016).

Local background values for $PM_{2.5}$, PM_{10}, and NO_2 consisted of the ambient impacts, at the project's maximum impact location, caused by emissions from the nearby emergency generators and industrial emission sources at the neighboring Yahoo! Data Center, Sabey Data Center, Intuit Data Center, and the Celite facility. Emissions from each of these facilities were assumed to be equal to their respective permit limits. The locations of the maximum project-related impacts were determined, and AERMOD was used to model the local background ambient impacts at that location caused by simultaneous activity of the local background sources. The modeling assumptions for local background sources were as follows:

- **Compliance with PM_{10} and $PM_{2.5}$ 24-hour average NAAQS**. This evaluation assumes that the existing cooling towers at the Yahoo! Data Center and Intuit Data Center and the industrial sources at the Celite facility would operate at their respective permitted limits. Additionally, this evaluation assumes that the Yahoo! Data Center, Sabey Data Center, and Intuit Data Center would be conducting monthly maintenance testing on emergency generators.
- **Compliance with NO_2 1-hour average NAAQS**. This evaluation assumes that the Celite facility would operate at its permitted limit. Additionally, this evaluation assumes that the Yahoo! Data Center, Sabey Data Center, and Intuit Data Center would be conducting monthly maintenance testing on emergency generators.

7.3 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 facility-wide emission rates listed in Table 11 represent full-buildout operations. As shown in Table 11, the maximum modeled ambient concentrations for benzene, 1,3-butadiene, naphthalene, CO, and acrolein are less than their respective ASILs.

7.3.1 Annual Average DEEP Impacts

The DEEP modeling analysis was conducted by assuming all generators at the facility would operate for the theoretical maximum annual runtime hours, under full-variable load conditions. Modeling assumptions are discussed in Section 7.2. Further details on the modeling input parameters are provided in Appendix D. The maximum modeled annual average ambient DEEP concentration was 0.24 $\mu g/m^3$ (Table 11), which exceeds the ASIL of 0.00333 $\mu g/m^3$. This location of the modeled maximum ambient impact is shown on Figure 3.

Since the maximum modeled ambient DEEP concentration (attributable to project-related sources) was modeled to be greater than the ASIL, a second-tier health impact assessment will be conducted for DEEP (to be provided to Ecology under separate cover).

7.3.2 1-Hour NO_2 Impacts During Facility-wide Concurrent Generator Operation

The ambient 1-hour average NO_2 concentrations were modeled using the PVMRM option within AERMOD. The NO_2/NO_x equilibrium ratio, NO_2/NO_x in-stack ratio, and ambient ozone concentration were set equal to the values used for modeling NO_2 annual average impacts, as described in Section 7.2.4. The AERMOD model for this scenario was set up to assume that VDC would operate 17 generators for 24 hours per day, 365 days per year, for 5 years. The maximum modeled 1st-highest 1-hour average ambient NO_2 concentration was 1,410 µg/m^3 (Table 11). The location of the modeled maximum ambient impact is shown on Figure 3.

Since the maximum modeled ambient NO_2 concentration (attributable to project-related sources) was modeled to be greater than the ASIL, a second-tier health impact assessment will be conducted for NO_2 (to be provided to Ecology under separate cover).

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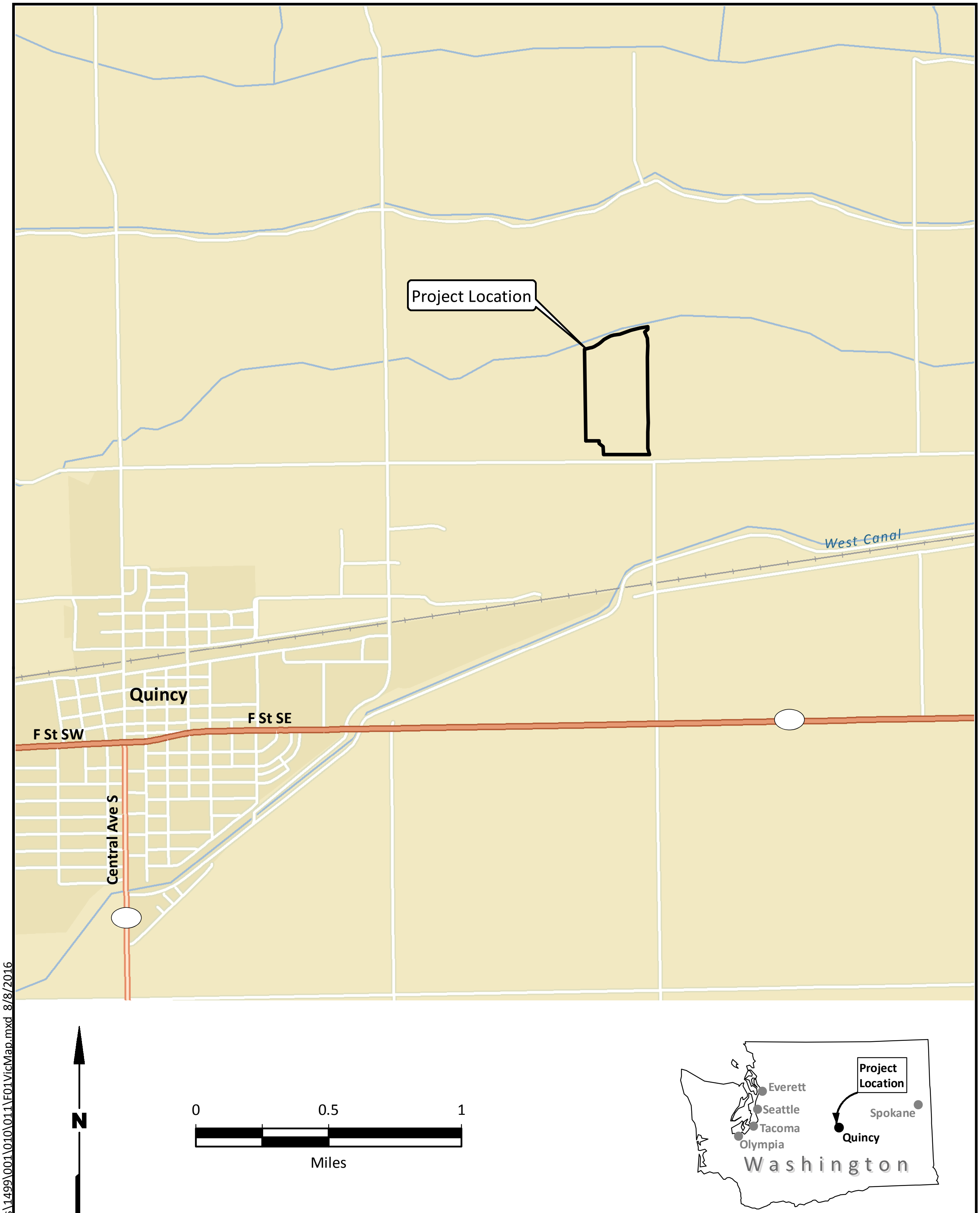

Data Source: Esri 2012.

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Riker Data Center Vantage Data Centers Quincy, Washington	**Vicinity Map**	Figure 1

Source: ICF 2012

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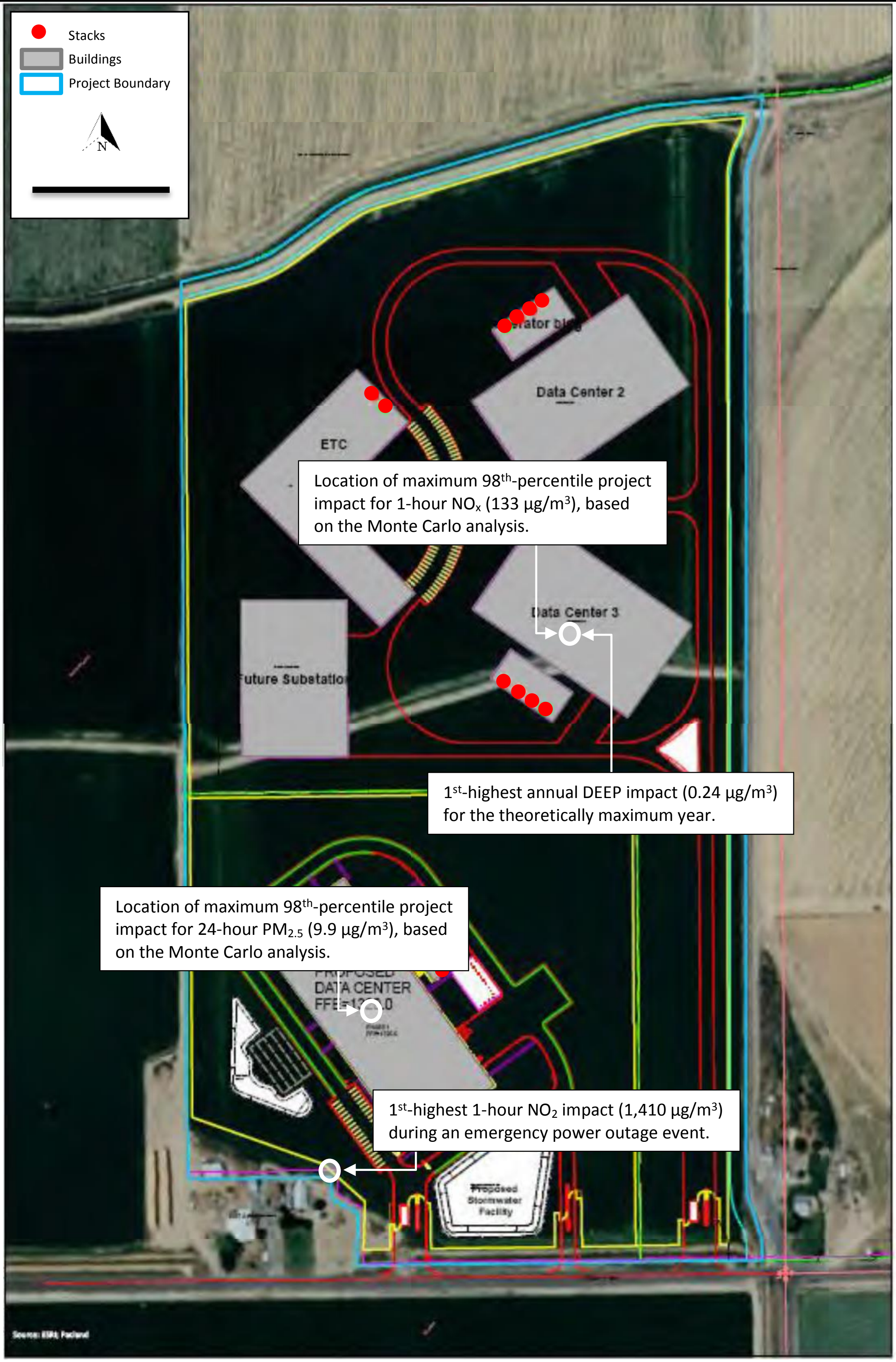
Riker Data Center Vantage Data Centers Quincy, Washington	**Site Map**	Figure 2



Source: ICF 2012

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Riker Data Center Vantage Data Centers Quincy, Washington	**Project Impacts**	Figure 3

Table 1
Vendor-Reported Air Pollutant Emission Rates
Riker Data Center
Vantage Data Centers – Quincy, Washington

Pollutant	Actual Tier 4 Measured Value (lbs/hr)[a]	Current Tier 4 Permit Limit (lbs/hr)	Certified Tier 2 Vendor NTE (lbs/hr)
	100% load	100% load	100% load
Nitrogen oxides (NO_x)	8.9	10	61
Nitrogen dioxide (NO_2)	0.22	1.5	6.1
Carbon monoxide	0.14	1.4	10.8
VOCs	0.032	0.22	1.5
Total PM	5.4	0.48	2.0
Ammonia	2.9	0.64	NA

Notes:
NA = Not applicable
NTE = Not to exceed
lbs/hr = Pounds per hour
PM = Particulate matter
VOCs = Volatile organic compounds

[a] Maximum measured value of compliance tests completed August 13-14, 2014 and April 7-9, 2015.

Table 2
Vendor-Reported Air Pollutant Emission Rates
Riker Data Center
Vantage Data Centers – Quincy, Washington

Pollutant	Load-Specific NTE Emission Rate (lbs/hr)					Full-variable Load Emission Rate (lbs/hr)[a]
	10%	25%	50%	75%	100%	≤ 100% load
Nitrogen oxides (NO_x)	6.9	9.4	22	37	61	61
Carbon monoxide	5.1	6.5	6.1	7.5	11	11
Hydrocarbons	1.9	1.3	1.7	1.7	1.5	1.9
DEEP[b]	0.79	0.79	0.73	0.46	0.46	0.79
PM (FH+BH)[c]	2.7	2.1	2.4	2.1	2.0	2.7
Exhaust Temp. (°F)	491	662	727	808	923	491
Exhaust Flow (cfm)	5,810	9,692	15,431	20,644	24,944	5,810

Notes:
BH = "Back-half" condensable emissions
cfm = cubic feet per minute
FH = "Front-half" filterable emissions
NTE = Not to exceed
lbs/hr = Pounds per hour

[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 3
Fuel-Based Emissions Estimation Summary
Riker Data Center
Vantage Data Centers – Quincy, Washington

Parameter	Units	Value
Generator Size	MW	3.0 MW
No. of Generators	--	17
Annual Runtime (per genset)	hours	45
Fuel Usage (per genset)	gph	207
Fuel Type	--	Ultra-low Sulfur Diesel
Fuel Density	lbs/gallon	7.1
Fuel Heat Content	Btu/gallon	137,000
Fuel Sulfur Content	ppm weight	15

Duration	--	Per Hour	Per Day	Per Year	Per Year (Theoretical)
Fuel Usage (per period)	Gallons	3,519	84,456	158,472	475,417
Heat Input (per period)	MMBtu	482	11,570	21,711	65,132

					Facility-wide Emission Rate			
		Emission Factor			Hourly	Daily	Yearly (average)	Theoretical Maximum Year
Pollutant	CAS Number	Factor	Units	Source[b]	(lbs/hr)[a]	(lbs/day)	(TPY)	
Nitrogen dioxide (NO_2)	10102-44-0	10% of primary NO_x			-	-	2.4	7.1
Sulfur dioxide (SO_2)	7446-09-5	0.0015% $_W$ Sulfur			0.75	18	0.017	0.051
Benzene	71-43-2	7.76E-04	lbs/MMBtu	AP-42 Sec 3.4	0.39	9.0	0.0086	0.026
Toluene	108-88-3	2.81E-04	lbs/MMBtu	AP-42 Sec 3.4	0.14	3.3	3.1E-03	0.0094
Xylenes	95-47-6	1.93E-04	lbs/MMBtu	AP-42 Sec 3.4	0.10	2.2	2.2E-03	6.5E-03
1,3-Butadiene	106-99-0	3.91E-05	lbs/MMBtu	AP-42 Sec 3.4	2.0E-02	0.45	4.4E-04	1.3E-03
Formaldehyde	50-00-0	7.89E-05	lbs/MMBtu	AP-42 Sec 3.4	4.0E-02	0.91	8.8E-04	2.6E-03
Acetaldehyde	75-07-0	2.52E-05	lbs/MMBtu	AP-42 Sec 3.4	1.3E-02	0.29	2.8E-04	8.4E-04
Acrolein	107-02-8	7.88E-06	lbs/MMBtu	AP-42 Sec 3.4	4.0E-03	0.091	8.8E-05	2.6E-04
Benzo(a)pyrene	50-32-8	2.57E-07	lbs/MMBtu	AP-42 Sec 3.4	1.3E-04	3.0E-03	2.9E-06	8.6E-06
Benzo(a)anthracene	56-55-3	6.22E-07	lbs/MMBtu	AP-42 Sec 3.4	3.2E-04	7.2E-03	6.9E-06	2.1E-05
Chrysene	218-01-9	1.53E-06	lbs/MMBtu	AP-42 Sec 3.4	7.8E-04	1.8E-02	1.7E-05	5.1E-05
Benzo(b)fluoranthene	205-99-2	1.11E-06	lbs/MMBtu	AP-42 Sec 3.4	5.6E-04	1.3E-02	1.2E-05	3.7E-05
Benzo(k)fluoranthene	207-08-9	2.18E-07	lbs/MMBtu	AP-42 Sec 3.4	1.1E-04	2.5E-03	2.4E-06	7.3E-06
Dibenz(a,h)anthracene	53-70-3	3.46E-07	lbs/MMBtu	AP-42 Sec 3.4	1.8E-04	4.0E-03	3.9E-06	1.2E-05
Ideno(1,2,3-cd)pyrene	193-39-5	4.14E-07	lbs/MMBtu	AP-42 Sec 3.4	2.1E-04	4.8E-03	4.6E-06	1.4E-05
Naphthalene	91-20-3	1.30E-04	lbs/MMBtu	AP-42 Sec 3.4	6.6E-02	1.5	1.4E-03	4.3E-03
Propylene	115-07-1	2.79E-03	lbs/MMBtu	AP-42 Sec 3.4	1.4	32	0.031	0.093

Notes:

Btu = British thermal unit
gph = Gallons per hour
lbs = Pounds

lbs/hr = Pounds per hour
MMBtu = Million metric British thermal units
MW = Megawatts

ppm = Parts per million
TPY = Tons per year
Sec = Section

[a] Fuel-based emission rates also account for cold-start emissions.
[b] EPA 1995.

Table 4
Cold-Start Emissions Summary
Riker Data Center
Vantage Data Centers – Quincy, Washington

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

Pollutant	Spike Duration (seconds)	Measured Concentration (ppm) Cold-Start Emission Spike	Measured Concentration (ppm) Steady-State (Warm) Emissions	Cold-Start Emission Factor
PM+HC	14	900	30	4.3
Nitrogen oxides (NO_x)	8	40	38	0.9
Carbon monoxide	20	750	30	9.0

Full-variable Load (≤100% Load) Emissions

Pollutant	Worst-case Emission Rate (lbs/hr) Warm	Worst-case Emission Rate (lbs/hr) Cold-start[a]
HC	1.9	8.1
Nitrogen oxides (NO_x)	61	58
Carbon monoxide	11	97
DEEP[b]	0.79	3.4
PM (FH+BH)	2.7	12

Notes:
BH = "Back-half" condensable emissions
FH = "Front-half" filterable emissions
HC = Hydrocarbons
lbs/hr = Pounds per hour
NA = Not applicable
NTE = Not to exceed
PM = Particulate matter
ppm = Parts per million

[a] Cold-start 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.

Table 5
Project Emissions Compared to Acceptable Source Impact Levels
Riker Data Center
Vantage Data Centers – Quincy, Washington

Pollutant[a]	Facility-wide Emission Rates Peak Hourly (lbs/hr)	Yearly (average) TPY	Theoretical Maximum Year (TPY)
Criteria Pollutants			
Nitrogen oxides (NO_x)	1,044	24	71
Carbon monoxide (CO)	207	4.4	13
Sulfur dioxide (SO_2)[b]	0.75	0.02	0.05
$PM_{2.5}$ / PM_{10} (FH+BH)[c]	48	1.1	3.2
VOCs	34	0.75	2.2
Toxic Air Pollutants (TAPs)			
Primary NO_2[d]	104	2.4	7.1
DEEP[e]	14	0.31	0.93
CO	207	4.4	13
SO_2[b]	0.75	0.017	0.051
Carbon-based TAPs			
Acrolein	4.0E-03	8.8E-05	2.6E-04
Benzene	0.39	0.0086	0.026
Propylene	1.42	0.031	0.093
Toluene	0.14	3.1E-03	0.0094
Xylenes	0.10	2.2E-03	6.5E-03
Formaldehyde	0.040	8.8E-04	2.6E-03
Acetaldehyde	0.013	2.8E-04	8.4E-04
1,3-Butadiene	0.020	4.4E-04	1.3E-03
Polycyclic Aromatic Hydrocarbons			
Naphthalene	0.066	1.4E-03	4.3E-03
Benz(a)anthracene	3.2E-04	6.9E-06	2.1E-05
Chrysene	7.8E-04	1.7E-05	5.1E-05
Benzo(b)fluoranthene	5.6E-04	1.2E-05	3.7E-05
Benzo(k)fluoranthene	1.1E-04	2.4E-06	7.3E-06
Benzo(a)pyrene	1.3E-04	2.9E-06	8.6E-06
Indeno(1,2,3-cd)pyrene	2.1E-04	4.6E-06	1.4E-05
Dibenz(a,h)anthracene	1.8E-04	3.9E-06	1.2E-05

Notes:
BH = "Back-half" condensable emissions
CO = Carbon monoxide
DEEP = Diesel engine exhaust particulate matter
FH = "Front-half" filterable emissions
lbs/hr = Pounds per hour
NO_2 = Nitrogen dioxide
NO_x = Nitrogen oxide
NTE = Not to exceed
PM = Particulate matter
TAPs = Toxic air pollutants
SO_2 = Sulfur dioxide
TPY = Tons per year
VOCs = Volatile organic compounds

[a] Cold-start emissions are accounted for in the project emissions.
[b] SO_2 emissions are based on emission factor for sulfur oxides from AP-42 Section 3.4 (EPA 1995) with an assumed fuel
[c] FH+BH (Front-half and back-half emissions) are assumed equal to the sum of vendor NTE values for PM and hydrocarbons.
[d] NO_2 is assumed to be 10% of the NO_x.
[e] Value assumed to be equal the front-half NTE particulate emissions, as reported by the vendors.

Table 6
Summary of Cost Effectiveness for Removal of Criteria Pollutants
Riker Data Center
Vantage Data Centers – Quincy, Washington

	$PM_{10}/PM_{2.5}$	CO	Total VOCs	NO_x	Actual Cost for Combined Criteria
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]	$2,867,631	$223,676	$1,497,247	$37,080	$30,811
SCR[b]	--	--	--	$25,070	$25,070
Catalyzed DPF[c]	$1,202,326	$95,913	$642,025	--	$78,031
DOC[d]	$1,283,691	$28,446	$190,409	--	$24,280

Notes:
-- = Ineffective control technology
CO = Carbon monoxide
DEEP = Diesel engine exhaust particulate matter is assumed equal to front-half NTE particulate emissions, as reported by the vendor
DOC = Diesel oxidation catalyst
DPF = Diesel particulate filter
$PM_{2.5}/PM_{10}$ = Particulate matter attributable to front-half and back-half emissions is assumed equal to the sum of vendor NTE values for PM and hydrocarbons.
SCR = Selective catalytic reduction

[a] The expected control efficiency for a Tier 4 integrated control package to reduce emission is 90% for NO_x, 88% for PM (front half), 80% for CO, and 70% 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 15% - 25% for filterable $PM_{10}/PM_{2.5}$ (depending on the load).

Table 7
Summary of Cost Effectiveness for Removal of Toxic Air Pollutants
Riker Data Center
Vantage Data Centers – Quincy, Washington

Toxic Air Pollutant	ASIL (µg/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]	DOC[d]
DEEP	0.00333	6.9	$72,544	$2,867,631	--	$1,202,326	$1,283,691
CO	23,000	0.1	$731	$223,676	--	$95,913	$28,446
NO_2 (10% of NO_x)	470	1.8	$18,472	$370,795	$250,703	--	--
Benzene	0.0345	5.9	$61,882	$129,706,577	--	$55,618,685	$16,495,158
1,3-Butadiene	0.00588	6.7	$69,951	$2,574,227,712	--	$1,103,838,860	$327,371,935
Acrolein	0.06	5.7	$59,359	$12,773,134,965	--	$5,477,169,976	$1,624,396,279
Naphthalene	0.0294	6.0	$62,612	$774,248,489	--	$332,000,765	$98,463,405
Formaldehyde	0.167	5.2	$54,691	$1,275,694,595	--	$547,022,806	$162,233,747
Benzo(a)pyrene	0.000909	7.5	$78,464	$391,643,204,364	--	$167,938,129,998	$49,806,391,730
Dibenz(a,h)anthracene	0.000833	7.5	$78,863	$290,902,611,334	--	$124,740,171,704	$36,994,921,025
Xylenes	221	2.1	$21,913	$521,514,526	--	$223,627,458	$66,322,501
SO_2	660	1.6	$16,924	--	--	--	--
Propylene	3,000	1.0	$10,020	$36,076,094	--	$15,469,570	$4,587,901
Carcinogenic VOCs	NA	NA	NA	$97,863,488	--	$41,964,244	$12,445,581
Non-Carcinogenic VOCs	NA	NA	NA	$30,762,835	--	$13,191,223	$3,912,198
Combined TAPs Cost-effectiveness				$132,340	$250,703	$88,099	$27,588
Presumed Acceptable Annual Cost for Combined TAP Control (based on the Hanford Method)				$10,535	$18,472	$6,237	$2,532

Notes:
-- = Ineffective control technology
ASIL = Acceptable source impact level
CO = Carbon monoxide
DEEP = Diesel engine exhaust particulate matter is assumed equal to front-half "not to exceed" vendor particulate emissions
DOC = Diesel oxidation catalyst
DPF = Diesel particulate filter
NA = Not applicable
SCR = Selective catalytic reduction
SO_2 = Sulfur dioxide
TAP = Toxic air pollutant
µg/m^3 = Micrograms per cubic meter

[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 DOC is 70%.

Table 8
Project Emissions Compared to Small-Quantity Emission Rates
Riker Data Center
Vantage Data Centers – Quincy, Washington

Pollutant	CAS Number	Averaging Period	Facility-wide Emission Rate	De Minimis	SQER	Required Action
			(pounds per averaging period)			
NO_2	10102-44-0	1-hr	61	0.457	1.03	Model
DEEP	--	year	1,867	0.032	0.639	Model
SO_2	7446-09-5	1-hr	0.75	0.457	1.45	Report
Carbon monoxide (CO)	630-08-0	1-hr	207	1.1	50.4	Model
Benzene	71-43-2	year	52	0.331	6.62	Model
Toluene	108-88-3	24-hr	3.3	32.9	657	
Xylenes	95-47-6	24-hr	2.2	1.45	29	Report
1,3-Butadiene	106-99-0	year	2.6	0.0564	1.13	Model
Formaldehyde	50-00-0	year	5.3	1.6	32	Report
Acetaldehyde	75-07-0	year	1.7	3.6	71	
Acrolein	107-02-8	24-hr	0.091	0.00039	0.00789	Model
Benzo(a)pyrene	50-32-8	year	0.017	0.00872	0.174	Report
Benzo(a)anthracene	56-55-3	year	0.042	0.0872	1.74	
Chrysene	218-01-9	year	0.10	0.872	17.4	
Benzo(b)fluoranthene	205-99-2	year	0.074	0.0872	1.74	
Benzo(k)fluoranthene	207-08-9	year	0.015	0.0872	1.74	
Dibenz(a,h)anthracene	53-70-3	year	0.023	0.00799	0.16	Report
Ideno(1,2,3-cd)pyrene	193-39-5	year	0.028	0.0872	1.74	
Naphthalene	91-20-3	year	8.7	0.282	5.64	Model
Propylene	115-07-1	24-hr	32	19.7	394	Report

Notes:
Highlighted cells indicate pollutants that require ambient air dispersion model analysis
DEEP = Diesel engine exhaust particulate matter
CAS = Chemical abstract service number
hr = Hour
NO_2 = Nitrogen dioxide
SO_2 = Sulfur dioxide
SQER = Small-quantity emission rate

Table 9
Project and Background Emissions Compared to National Ambient Air Quality Standards
Riker Data Center
Vantage Data Centers – Quincy, Washington

Criteria Pollutant/ Hazardous Air Pollutant	National Standards Primary ($\mu g/m^3$)	National Standards Secondary ($\mu g/m^3$)	Washington State Standards ($\mu g/m^3$)	Modeled Operating Scenario	Modeled Max. Project-Related Impact ($\mu g/m^3$)	Max. Project + Local Background ($\mu g/m^3$)[a]	Regional Background ($\mu g/m^3$)[b]	Predicted Cumulative Ambient Impact ($\mu g/m^3$)
Carbon Monoxide (CO)								
8-hour average	10,000	--	10,000	Power Outage	1,073 [c]	--	3,308	4,381
1-hour average	40,000	--	40,000	Power Outage	1,999 [d]	--	5,776	7,775
Sulfur Dioxide (SO_2)								
Annual arithmetic mean	--	--	52	Theoretical Max. Year	0.013	--	0.26	0.27
24-hour average	--	--	260	Power Outage	6.5	--	1.0	7.5
3-hour average	--	1,310	1,310	Power Outage	12.2	--	2.1	14.3
1-hour average	200	--	200	Power Outage	16.2	--	2.6	18.8
Particulate Matter (PM_{10})								
Annual average	--	--	50	Theoretical Max. Year	0.81	1.3	--	1.3
24-hour average	150[e]	150	150	Electrical bypass [f]	77.3 [c]	77.4	62	139
Particulate Matter ($PM_{2.5}$)								
Annual average	15	15	12	Theoretical Max. Year	0.81	1.3	6.5	8
24-hour average	35	35	35	Monte Carlo	9.9	12	21	33
Nitrogen Oxides (NO_x)								
Annual average	100	100	100	Theoretical Max. Year	16	18	2.8	21
1-hour average	188	--	--	Monte Carlo	133	134	16	149

Notes:

$PM_{2.5}$ = Particulate matter with aerodynamic diameter less than or equal to 2.5 microns.

PM_{10} = Particulate matter with aerodynamic diameter less than or equal to 10 microns.

$\mu g/m^3$ = Micrograms per cubic meter

[a] Modeled impact, including local background sources, at the project related maximum impact location.

[b] Regional background level obtained from Ecology's Air Monitoring Network website (WSU website 2015).

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

[d] Reported values represent the 2nd highest modeled impacts.

[e] Not to be exceeded more than once per year, over a 3-year period. The modeled compliance for this NAAQS is based on the highest 6th highest concentration over 5 years (40 CFR Part 51 Part III Section 10.0).

[f] Modeled operating scenario is the 4th- highest emitting day.

Table 10
Summary of Ranked Generator Runtime Scenarios
Riker Data Center
Vantage Data Centers – Quincy, Washington

Ranked Day	Assumed Duration (hours per day)	Maximum Generators Concurrently Operating	Operating Load	Max. Hourly Facility-wide NO_2 Emissions (lbs/hr)	Max. Daily Facility-wide $PM_{2.5}$ Emissions (lbs/day)
1-3	24	17	≤100%	1,044	1,103
4-27	4	≤ 7	≤100%	123 - 430	3.6 - 26
28+	6	1	≤100%	61	8.5

Notes:
lbs/hr = Pounds per hour
lbs/day = Pounds per day

Table 11
Project Emissions Compared to Acceptable Source Impact Levels
Riker Data Center
Vantage Data Centers – Quincy, Washington

Pollutant	CAS Number	Averaging Period	Facility-wide Emission Rate (lbs/avg. period)	AERMOD Filename	Modeled Max. Project-Impact ($\mu g/m^3$)	ASIL ($\mu g/m^3$)
NO_2	10102-44-0	1-hr	61	NO2_080616	1,410	470
DEEP	--	year	1,867	ncDEEP_080516c[a]	0.24	0.00333
CO	630-08-0	1-hr	207	co_080516a	2,002	23,000
Benzene	71-43-2	year	52	[b]	0.020	0.0345
1,3-Butadiene	106-99-0	year	2.6	[b]	1.0E-03	0.00588
Acrolein	107-02-8	24-hr	0.091	acrolein_080816a	0.032	0.06
Naphthalene	91-20-3	year	8.7	[b]	3.4E-03	0.0294

Notes:
avg = Averaging
CAS = Chemical abstract service number
CO = Carbon monoxide
DEEP = Diesel engine exhaust particulate matter
hr = hour
NO_2 = Nitrogen dioxide
$\mu g/m^3$ = micrograms per cubic meter

[a] This reported AERMOD run represents the highest annual impact (2003) from individual meteorological year test runs (2001-2005).
[b] Maximum impact was estimated based on dispersion factors from the ncDEEP_080516c model and theoretical maximum year emission rates.

APPENDIX A

Vendor Specification Sheets

DIESEL ENGINE-GENERATOR SET
3000-XC6DT2

3000 kWe / 60 Hz / Standby
480 - 13.8kV

(Reference 2800-XC6DT2 for Prime Rating Technical Data)

SYSTEM RATINGS

Standby

Voltage (L-L)	480V	600V	4160V	12470V	13200V	13800V
Phase	3	3	3	3	3	3
PF	0.8	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60	60
kW	3000	3000	3000	3000	3000	3000
kVA	3750	3750	3750	3750	3750	3750
AMPS	4511	3609	520	174	164	157
skVA@30% Voltage Dip	6400	6800	5250	C/F	C/F	C/F
Generator Model*	1030FDL1005	1030FDS1015	1020FDM1204	1030FDH1429	1030FDH1429	1030FDH1429
Temp Rise	130 °C/27 °C	125 °C/40 °C	130 °C/27 °C	130 °C/27 °C	130 °C/27 °C	130 °C/27 °C
Connection	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE

* The Generator Model Number identified in the table is for standard C Series Configuration. Consult the factory for alternate configuration.

CERTIFICATIONS AND STANDARDS

// **Emissions –** EPA Tier 2 Certified

// **Engine-generator set is designed and manufactured in facilities certified to standards ISO 9001:2008 and ISO 14001:2004**

// **UL 2200 / CSA – Optional**
– UL 2200 Listed
– CSA Certified

// **Performance Assurance Certification (PAC)**
- Engine-Generator Set Tested to ISO 8528-5 for Transient Response
- Verified product design, quality and performance integrity
- All engine systems are prototype and factory tested

// **Power Rating**
- Accepts Rated Load in One Step Per NFPA 110
- Permissible average power output during 24 hours of operation is approved up to 85%.

STANDARD FEATURES*

- // MTU Onsite Energy is a single source supplier
- // Global Product Support
- // 2 Year Standard Warranty
- // 20V 4000 Diesel Engine
  - 95.4 Liter Displacement
  - Common Rail Fuel Injection
  - 4-Cycle
- // Complete Range of Accessories
- // Generator
  - Brushless, Rotating Field Generator
  - PMG (Permanent Magnet Generator) supply to regulator
  - 300% Short Circuit Capability
  - 2/3 Pitch Windings
  - Standard for 570 frame and larger
  - Optional for 430 frame and smaller
- // Digital Control Panel(s)
  - UL Recognized, CSA Certified, NFPA 110
  - Complete System Metering
  - LCD Display
- // Cooling System
  - Integral Set-Mounted
  - Engine Driven Fan

STANDARD EQUIPMENT*

// Engine

Air Cleaners
Oil Pump
Oil Drain Extension & S/O Valve
Full Flow Oil Filter
Closed Crankcase Ventilation
Jacket Water Pump
Inter Cooler Water Pump
Thermostats
Blower Fan & Fan Drive
Radiator - Unit Mounted
Electric Starting Motor - 24V
Governor – Electronic Isochronous
Base - Structural Steel
SAE Flywheel & Bell Housing
Charging Alternator - 24V
Battery Box & Cables
Flexible Fuel Connectors
Flexible Exhaust Connection
EPA Certified Engine

// Generator

NEMA MG1, IEEE and ANSI standards compliance for temperature rise and motor starting
Sustained short circuit current of up to 300% of the rated current for up to 10 seconds
Self- entilated and Drip-Proof
Superior oltage Waveform
Digital, Solid State, Volts-per-Hertz Regulator
No Load to Full Load Regulation
Brushless Alternator with Brushless Pilot Exciter
4 Pole, Rotating Field
130 °C Maximum Standby Temperature Rise
2 Bearing, Sealed
Flexible Coupling
Full Amortisseur Windings
125% Rotor Balancing
3-Phase Voltage Sensing
±0.25% Voltage Regulation
100% of Rated Load - One Step
3% Maximum Harmonic Content

// Digital Control Panel(s)

Digital Metering
Engine Parameters
Generator Protection Functions
Engine Protection
CAN Bus ECU Communications
Windows-Based Software
Multilingual Capability
Remote Communications to RDP-110 Remote Annunciator
16 Programmable Contact Inputs
Up to 11 Contact Outputs
UL Recognized, CSA Certified, CE Approved
Event Recording
IP 54 Front Panel Rating with Integrated Gasket
NFPA 110 Compatible

* Represents standard product only. Consult Factory/MTU Onsite Energy Distributor for additional configurations.

APPLICATION DATA

// Engine

Manufacturer	MTU
Model	20V 4000 G83L 6 ECT
Type	4-Cycle
Arrangement	20V
Displacement: L (in^3)	95.4 (5,822)
Bore: cm (in)	17 (6.69)
Stroke: cm (in)	21 (8.27)
Compression Ratio	16.5:1
Rated RPM	1,800
Engine Governor	Electronic Isochronous (ADEC)
Maximum Power: kWm (bhp)	3,490 (4,678)
Speed Regulation	±0.25%
Air Cleaner	Dry

// Liquid Capacity (Lubrication)

Total Oil System: L (gal)	390 (103)
Engine Jacket Water Capacity: L (gal)	205 (54.2)
After Cooler Water Capacity: L (gal)	55 (14.5)
System Coolant Capacity: L (gal)	814 (215)

// Electrical

Electric Volts DC	24
Cold Cranking Amps Under -17.8 °C (0 °F)	3,000

// Fuel System

Fuel Supply Connection Size	1” NPT
Fuel Return Connection Size	1” NPT
Maximum Fuel Lift: m (ft)	1 (3)
Recommended Fuel	Diesel #2
Total Fuel Flow: L/hr (gal/hr)	1,620 (428)

// Fuel Consumption

	STANDBY
At 100% of Power Rating: L/hr (gal/hr)	784 (207)
At 75% of Power Rating: L/hr (gal/hr)	594 (157)
At 50% of Power Rating: L/hr (gal/hr)	413 (109)

// Cooling - Radiator System

	STANDBY
Ambient Capacity of Radiator: °C (°F)	47 (117)
Maximum Allowable Static Pressure on Rad. Exhaust: kPa (in. H_2O)	0.12 (0.5)
Water Pump Capacity: L/min (gpm)	1,567 (414)
After Cooler Pump Capacity: L/min (gpm)	567 (150)
Heat Rejection to Coolant: kW (BTUM)	1,300 (73,929)
Heat Rejection to After Cooler: kW (BTUM)	970 (55,162)
Heat Radiated to Ambient: kW (BTUM)	230 (13,080)

// Air Requirements

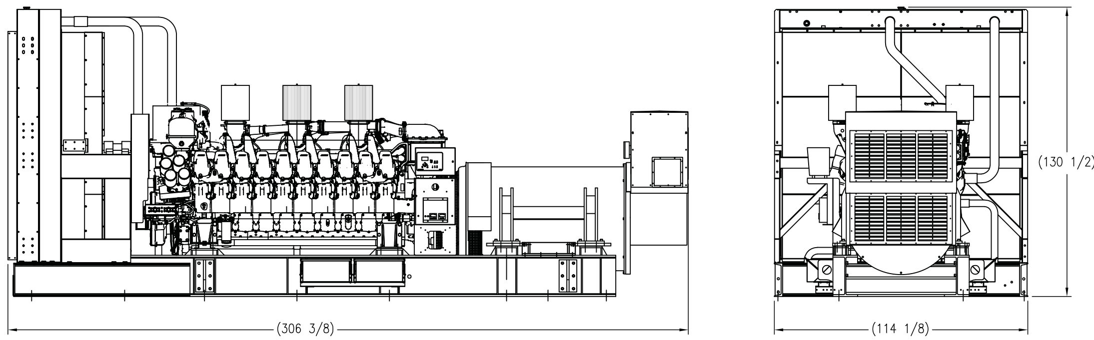
	STANDBY
Aspirating: *m^3/min (SCFM)	264 (9,323)
Air Flow Required for Rad. Cooled Unit: *m^3/min (SCFM)	3,833 (135,367)
Remote Cooled Applications; Air Flow Required for Dissipation of Radiated Gen-set Heat for a Max of 25 °F Rise: *m^3/min (SCFM)	840 (29,500)

* Air density = 1.184 kg/m (0.0739 lbm/ft^3)

// Exhaust System

	STANDBY
Gas Temp. (Stack): °C (°F)	525 (977)
Gas Volume at Stack Temp: m^3/min (CFM)	702 (24,791)
Maximum Allowable Back Pressure: kPa (in. H_2O)	8.5 (34.1)

WEIGHTS AND DIMENSIONS



Drawing above for illustration purposes only, based on standard open power 480 volt engine-generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (L x W x H)	Weight (less tank)
OPU	7,780 x 2,900 x 3,310 mm (306.38 x 114.13 x 130.5 in)	27,466 kg (60,553 lb)

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific engine-generator set.

SOUND DATA

Unit Type	Standby Full Load
Level 0: Open Power Unit (dBA)	107

Sound data is provided at 7 m (23 ft). Engine-generator set tested in accordance with ISO 8528-10 and with infinite exhaust.

EMISSIONS DATA

NO_x + NMHC	CO	PM
4.21	0.52	0.06

All units are in g/hp-hr and are EPA D2 cycle values.
Emission levels of the engine may vary as a function of ambient temperature, barometric pressure, humidity, fuel type and quality, installation parameters, measuring instrumentation, etc. The data provided are laboratory results from one engine representing this rating. The data was obtained under controlled environmental conditions with calibrated instrumentation traceable to the United States National Bureau of Standards and in compliance with US EPA regulations found within 40 CFR Part 89. The weighted cycle value from each engine is guaranteed to be below the US EPA Standards at the US EPA defined conditions.

RATING DEFINITIONS AND CONDITIONS

// Standby ratings apply to installations served by a reliable utility source. The standby rating is applicable to varying loads for the duration of a power outage. No overload capability for this rating. Ratings are in accordance with ISO 8528-1, ISO 3046-1, BS 5514, AS 2789, and DIN 6271.

// Deration Factor:
Altitude: Consult your local MTU Onsite Energy Power Generation Distributor for altitude derations.
Temperature: Consult your local MTU Onsite Energy Power Generation Distributor for temperature derations.

Materials and specifications subject to change without notice.
C/F = Consult Factory/MTU Onsite Energy Distributor

Inhaltsverzeichnis
Contents

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G83L (6ETC)				
Application group	3D, 3H				
Emission Stage/Optimisation	EPA Tier 2				
Test cycle	D2				
Data Set	EPA Tier 2				
Fuel sulphur content [ppm]	5				

							Benennung/Title **Emissionsdatenblatt** **Emission Data Sheet**
				MTU Friedrichshafen GmbH			
b	Überarbeitung „Not-to-exceed"-Werte	23.04.15	Lenhof		Datum/Date	Name/Name	Zeichnungs-Nr./Drawing No.
a	Hinzufügen „Not to exceed" Werte	21.01.14	Lenhof	Bearbeiter/Drawn by	09.05.2012	Lenhof	**EDS 4000 0527**
-	Freigabe	06.06.12	Zwisler	Geprüft/Checked	04.06.2012	Rehm	
Buchstabe/ Revision	Änderung Modifikation	Datum Date	Name Name	Org.-Einheit/Dept.	TKF	Veser	

Vers.2.0

Revision *Change index*					

Motordaten

engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G83L (6ETC)				
Application group	3D, 3H				
Emission Stage/Optimisation	EPA Tier 2				
Test cycle	D2				
fuel sulphur content [ppm]	5				
mg/mN³ values base on residual oxygen value of [%]	measured				

Motor Rohemissionen*

*Engine raw emissions**

Cycle point	[-]	n1	n2	n3	n4	n5	n6	n7	n8
Power (P/PN)	[-]	1	0,75	0,50	0,25	0,10			
Power	[kW]	3490	2618	1745	872	349			
Speed (n/nN)	[-]	1	1	1	1	1			
Speed	[rpm]	1800	1800	1800	1800	1800			
Exhaust temperature after turbine	[°C]	495	431	386	350	255			
Exhaust massflow	[kg/h]	19529	17631	14079	9354	6616			
Exhaust back pressure	[mbar]	64	43	25	10	4			
NOx	[g/kWh]	6,7	5,4	4,6	4,1	7,5			
	[mg/mN³]	1869	1238	881	581	595			
CO	[g/kWh]	0,8	0,7	0,9	1,9	3,7			
	[mg/mN³]	197	148	155	239	259			
HC	[g/kWh]	0,14	0,19	0,29	0,45	1,66			
	[mg/mN³]	34	39	49	57	117			
O2	[%]	9,1	11,0	12,4	13,7	15,8			
Particulate measured	[g/kWh]	0,04	0,06	0,14	0,30	0,74			
	[mg/mN³]	11	11	24	37	52			
Particulate calculated	[g/kWh]	-	-	-	-	-			
	[mg/mN³]	-	-	-	-	-			
Dust (only TA-Luft)	[mg/mN³]	-	-	-	-	-			
FSN	[-]	0,3	0,4	0,7	1,0	0,3			
NO/NO2**	[-]	-	-	-	-	-			
CO2	[g/kWh]	647,9	659,8	684,6	776,3	973,6			
	[mg/mN³]	162461	135829	116579	98698	69093			
SO2	[g/kWh]	0,002	0,002	0,002	0,002	0,003			
	[mg/mN³]	0,5	0,4	0,4	0,3	0,2			

* Emission data measurement procedures are consistent with the respective emission evaluation process. Noncertified engines are measured to sales data (TVU/TEN) standard conditions.
These boundary conditions might not be representative for detailed dimensioning of exhaust gas aftertreatment, in this case it is recommended to contact the responsible department for more information.
Measurements are subject to variation. The nominal emission data shown is subject to instrumentation, measurement, facility, and engine-to-engine variations.
All data applies to an engine in new condition. Over extended operating time deterioration may occur which might have an impact on emission.
Exhaust temperature depends on engine ambient conditions.

** No standard test. To be measured on demand.

				MTU Friedrichshafen GmbH			Benennung/Title **Emissionsdatenblatt Emission Data Sheet**
b	Überarbeitung „Not-to-exceed"-Werte	23.04.15	Lenhof		Datum/Date	Name/Name	Zeichnungs-Nr./Drawing No.
a	Hinzufügen „Not to exceed" Werte	21.01.14	Lenhof	Bearbeiter/Drawn by	09.05.2012	Lenhof	
-	Freigabe	06.06.12	Zwisler	Geprüft/Checked	04.06.2012	Rehm	**EDS 4000 0527**
Buchstabe/ Revision	Änderung Modifikation	Datum Date	Name Name	Org.-Einheit/Dept.	TKF	Veser	

Vers.2.0

Revision *Change index*	a	b				

Motordaten
engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G83L (6ETC)				
Application group	3D, 3H				
Emission Stage/Optimisation	EPA Tier 2				
Test cycle	D2				
fuel sulphur content [ppm]	5				
mg/mN³ values base on residual oxygen value of [%]	measured				

Not to exceed Werte*
*not to exceed values**

Cycle point	[-]	n1	n2	n3	n4	n5	n6	n7	n8
Power (P/PN)	[-]	1	0,75	0,50	0,25				
Power	[kW]	3490	2618	1745	872				
Speed (n/nN)	[-]	1	1	1	1				
Speed	[rpm]	1800	1800	1800	1800				
Exhaust back pressure	[mbar]	64	43	25	10				
NOx	[g/kWh]	8,7	7,0	6,0	6,2				
	[mg/mN³]	2430	1609	1145	871				
CO	[g/kWh]	1,3	1,2	1,7	3,8				
	[mg/mN³]	335	251	294	477				
HC	[g/kWh]	0,23	0,32	0,55	0,90				
	[mg/mN³]	58	67	94	115				
O2	[%]	9,1	11,0	12,4	13,7				
Particulate measured	[g/kWh]	0,07	0,09	0,21	0,44				
	[mg/mN³]	16	18	35	56				

* Calculated values are not proven by tests and therefore the accuracy cannot be guaranteed.
Emissions data measurement procedures are consistent with those described in the applicable rules and standards.
The NOx, CO, HC and PM emission data tabulated here were taken from a single new engine under the test conditions shown above and are valid for the following conditions:
- Ambient air pressure 1 bar
- Air intake temperature approx. 25°C
- Rel. Humidity 30%-60%
- New Engine
- New standard- air filter
- Exhaust gas back pressure according the given value in this EDS
- Fuel according to EN 590 or US EPA 40CFR89
- Coolant and Lubricants according MTU Fuels and Lubricants Specification

The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations. Emissions data is based on single operating points and thus cannot be used to compare to EPA regulations which use values based on a weighted cycle. Emissions data may vary depending on the type of exhaust gas aftertreatment that may be installed on the engine, therefore it is suggested that the engine manufacturer be contacted directly for further information.
Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures, and instrumentation. Over time deterioration may occur which may have an impact on emission levels. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may results in elevated emission levels.
MTU Friedrichshafen GmbH has made efforts to ensure that the information in this data sheet is accurate, but reserves the right to amend specifications and information without notice and without obligation or liability. No liability for any errors, facts or opinions is accepted. Customers must satisfy themselves as to the suitability of this product for their application. No responsibility for any loss as a result of any person placing reliance on any material contained in this data sheet will be accepted.

GASEOUS EMISSIONS DATA MEASUREMENTS ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII FOR MEASURING HC, CO, PM, AND NOX.

Locality	Agency	Regulation	Tier/Stage	Max. Limit G/(kW -HR)	T2	T3
U.S. (INCL CALIF)	EPA	Stationary	Emergency Stationary Tier 2 (>560kW) Tier 3 (<560kW)	NOx+ NMHC:	6,4	4,0
				CO:	3,5	3,5
				PM:	0,20	0,20

** No standard test. To be measured on demand.

Buchstabe/ Revision	Änderung Modifikation	Datum Date	Name Name	MTU Friedrichshafen GmbH			Benennung/Title: Emissionsdatenblatt Emission Data Sheet
b	Überarbeitung „Not-to-exceed“-Werte	23.04.15	Lenhof		Datum/Date	Name/Name	Zeichnungs-Nr./Drawing No.
a	Hinzufügen „Not to exceed“ Werte	21.01.14	Lenhof	Bearbeiter/Drawn by	09.05.2012	Lenhof	**EDS 4000 0527**
-	Freigabe	06.06.12	Zwisler	Geprüft/Checked	04.06.2012	Rehm	
				Org.-Einheit/Dept.	TKF	Veser	

Vers.2.0

APPENDIX B

Cold-Start Emissions Estimation Method

APPENDIX B

Diesel Generator "Cold-Start Spike" Adjustment Factors

Short-term concentration trends for emissions of volatile organic compounds (VOC), 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.

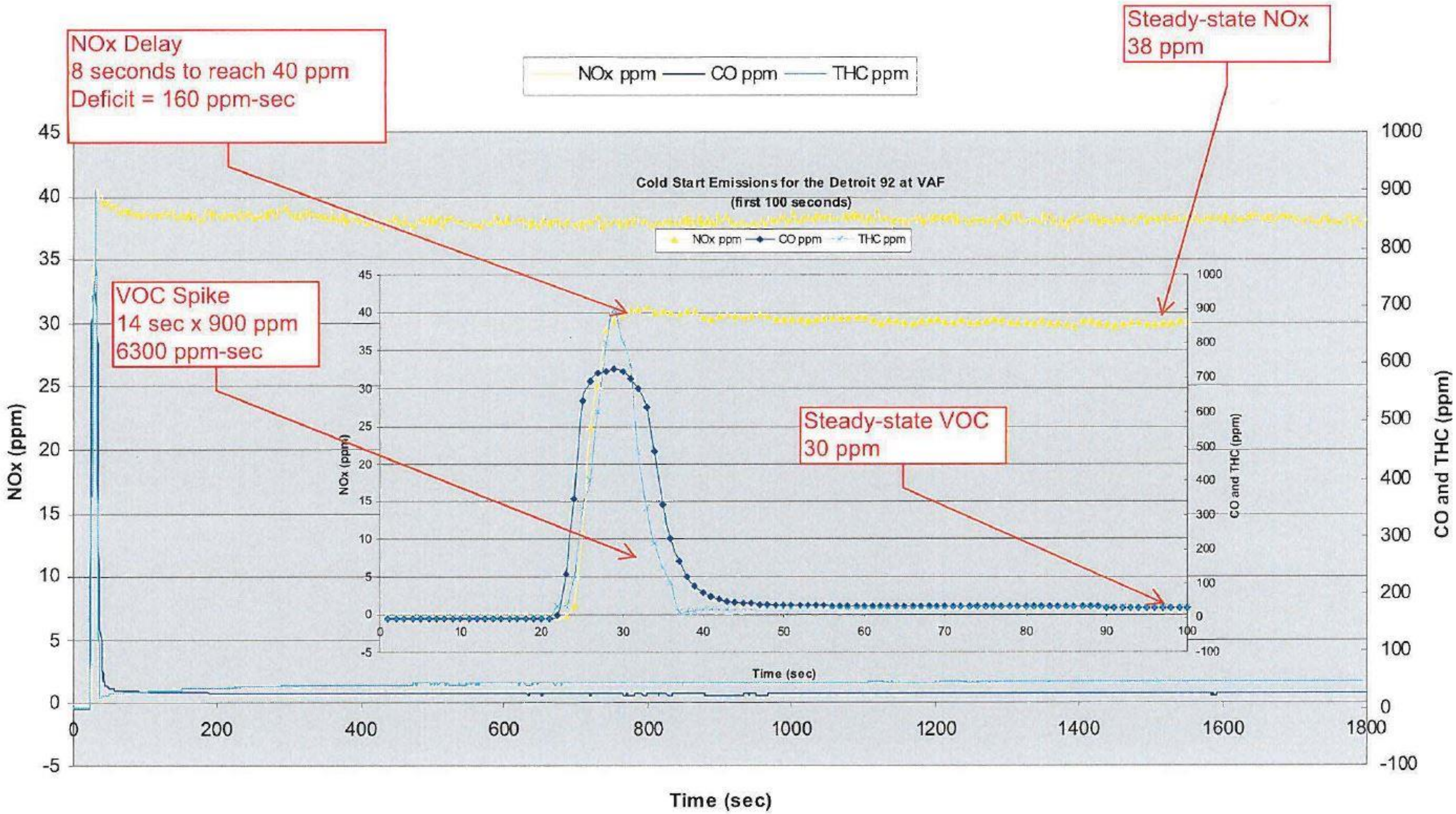
Example: Cold-Start Spike Factor for VOCs, first 1-minute after cold-start at low load.

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 cold-start emission factor (to be applied to the warm-emission rate estimate for the first 1-minute after cold-start) 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.

Riker Data Center Vantage Data Centers Quincy, Washington	**Cold-Start Emission Trends**	Figure B-1

LANDAU ASSOCIATES

APPENDIX C

Best Available Control Technology Cost Summary Tables

Table C-1
Tier 4 Integrated Control Package Capital Cost
Riker Data Center
Vantage Data Centers – Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
3.0-MWe emission control package	Cost estimate by Pacific Power Group		17	$306,000	$5,202,000
3.0-MWe miscellaneous parts	Assumed no cost			$0	$0
Combined systems FOB cost					$5,202,000
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$338,130
Shipping	0.05A	EPA Cost Manual	5.0%	--	$260,100
Subtotal Purchased Equipment Cost (PEC)					$5,800,230
Direct Installation Costs					
Enclosure structural supports	Assumed no cost		0	$0	$0
Onsite Installation	Cost estimate by EKI Solutions Group		17	$16,000	$272,000.00
Electrical	Assumed no cost		0	$0	$0.00
Piping	Assumed no cost		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)					$272,000
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0.00
Total Direct Costs, (DC = PEC + DIC + SP)					$6,072,230
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$145,006
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$145,006
Contractor Fees	From DIS data center		6.8%	--	$412,020
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$116,005
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$58,002
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$174,007
Subtotal Indirect Costs (IC)					$1,050,045
Total Capital Investment (TCI = DC+IC)					**$7,122,275**

Table C-2
Tier 4 Integrated Control Package Cost Effectiveness
Riker Data Center
Vantage Data Centers – Quincy, Washington

Item	Quantity	Units	Unit Cost	Units	Subtotal
Annualized Capital Recovery					
Total Capital Cost					$7,122,275
Capital Recovery Factor:	25	years	4%	discount	0.064
Subtotal Annualized 25-year Capital Recovery Cost					$455,911
Direct Annual Cost					
Increased Fuel Consumption	Insignificant				$0
Reagent Consumption (estimated by Pacific Power Group)	11,093	gallons/year	$4.00	per gallon	$44,372
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 $345,000/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					$44,372
Indirect Annual Costs					
Annual Admin charges (EPA Manual)	2.0%	of Total Capital Investment			$142,445
Annual Property tax (EPA Manual)	1.0%	of Total Capital Investment			$71,223
Annual Insurance (EPA Manual)	1.0%	of Total Capital Investment			$71,223
Subtotal Indirect Annual Costs					$284,891
Total Annual Cost (Capital Recovery + Direct Annual Costs + Indirect Annual Costs)					**$785,174**
Uncontrolled Emissions (Combined Pollutants)					29
Annual Tons Removed (Combined Pollutants)					25
Cost Effectiveness ($ per tons combined pollutant destroyed)					**$30,811**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$271,758	per year per generator
3,000	KW-hr
766	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	21	$254,105 per year
CO	$5,000	3.5	$17,552 per year
VOCs	$12,000	0.5	$6,293 per year
PM	$12,000	0.3	$3,286 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$281,235 per year
Actual Annual Control Cost			$785,174 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)	0.31	4.4	0.75	24
Controlled Emissions (TPY)	0.037	0.88	0.22	2.4
TPY Removed	0	4	1	21
Combined Uncontrolled Emissions (TPY)	29			
Combined TPY Removed	25			
Expected Removal Efficiency	88%	80%	70%	90%
Annualized Cost ($/year)	$785,174			
Individual Pollutant $/Ton Removed	$2,867,631	$223,676	$1,497,247	$37,080

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	0.27	$19,863 per year
CO	23,000	0.1	$731	3.5	$2,567 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	2.1	$39,116 per year
Benzene	0.0345	5.9	$61,882	6.1E-03	$375 per year
1,3-Butadiene	0.00588	6.7	$69,951	3.1E-04	$21 per year
Acrolein	0.06	5.7	$59,359	6.1E-05	$4 per year
Naphthalene	0.0294	6.0	$62,612	1.0E-03	$63 per year
Formaldehyde	0.167	5.2	$54,691	6.2E-04	$34 per year
Benzo(a)pyrene	0.000909	7.5	$78,464	2.0E-06	$0 per year
Dibenz(a,h)anthracene	0.000833	7.5	$78,863	2.7E-06	$0 per year
Xylenes	221	2.1	$21,913	1.5E-03	$33 per year
SO_2	660	1.6	$16,924	0.00	$0 per year
Propylene	3,000	1.0	$10,020	0.02	$218 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	8.0E-03	$80 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	0.03	$128 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$62,501 per year
Actual Annual Control Cost					$785,174 per year
				Is The Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions (TPY)	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
DEEP	0.31	0.04	0.27	88%	$2,867,631
CO	4.4	0.9	3.5	80%	$223,676
NO_2 (10% of NOx)	2.4	0.24	2.1	90%	$370,795
Benzene	8.6E-03	2.6E-03	0.0061	70%	$129,706,577
1,3-Butadiene	4.4E-04	1.3E-04	0.00031	70%	$2,574,227,712
Acrolein	8.8E-05	2.6E-05	0.000061	70%	$12,773,134,965
Naphthalene	1.4E-03	4.3E-04	0.0010	70%	$774,248,489
Formaldehyde	8.8E-04	2.6E-04	0.00062	70%	$1,275,694,595
Benzo(a)pyrene	2.9E-06	8.6E-07	0.0000020	70%	$391,643,204,364
Dibenz(a,h)anthracene	3.9E-06	1.2E-06	0.0000027	70%	$290,902,611,334
Xylenes	2.2E-03	6.5E-04	0.0015	70%	$521,514,526
SO_2	1.7E-02	1.7E-02	0.000	0%	--
Propylene	3.1E-02	9.3E-03	0.022	70%	$36,076,094
Carcinogenic VOCs	1.1E-02	3.4E-03	0.0080	70%	$97,863,488
Non-Carcinogenic VOCs	0.04	0.01	0.026	70%	$30,762,835
Annualized Cost ($/yr)					$785,174
Combined Uncontrolled Emissions (TPY)					7.1
Combined TPY Removed					5.9
Combined TAPs $/Ton Removed					$132,340

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

[a] The expected Tier 4 control efficiency to reduce emission is 90% for NO_x, 88% for PM (front half), 80% for CO, and 70% for VOCs.

Table C-3
Selective Catalytic Reduction Capital Cost
Riker Data Center
Vantage Data Centers – Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
3.0-MWe emission control package	Cost estimate by Pacific Power Group		17	$198,000	$3,366,000
3.0-MWe miscellaneous parts	Assumed no cost			$0	$0
Combined systems FOB cost					$3,366,000
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$218,790
Shipping	0.05A	EPA Cost Manual	5.0%	--	$168,300
Subtotal Purchased Equipment Cost (PEC)					$3,753,090
Direct Installation Costs					
Enclosure structural supports	Assumed no cost		0	$0	$0
Onsite Installation	Cost estimate by EKI Solutions Group		17	$14,000	$238,000.00
Electrical	Assumed no cost		0	$0	$0
Piping	Assumed no cost		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$238,000
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$3,991,090
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$93,827
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$93,827
Contractor Fees	From DIS data center		6.8%	--	$273,428
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$75,062
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$37,531
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$112,593
Subtotal Indirect Costs (IC)					$686,268
Total Capital Investment (TCI = DC+IC)					**$4,677,358**

Table C-4
Selective Catalytic Reduction Cost Effectiveness
Riker Data Center
Vantage Data Centers – Quincy, Washington

Item	Quantity	Units	Unit Cost	Units	Subtotal
Annualized Capital Recovery					
Total Capital Cost					$4,677,358
Capital Recovery Factor:	25	years	4%	discount	0.064
Subtotal Annualized 25-year Capital Recovery Cost					$299,407
Direct Annual Cost					
Increased Fuel Consumption	Insignificant				$0
Reagent Consumption (estimated by Pacific Power Group)	11,093	gallons/year	$4.00	per gallon	$44,372
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 $345,000/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					$44,372
Indirect Annual Costs					
Annual Admin charges (EPA Manual)	2.0%	of Total Capital Investment			$93,547
Annual Property tax (EPA Manual)	1.0%	of Total Capital Investment			$46,774
Annual Insurance (EPA Manual)	1.0%	of Total Capital Investment			$46,774
Subtotal Indirect Annual Costs					$187,094
Total Annual Cost (Capital Recovery + Direct Annual Costs + Indirect Annual Costs)					**$530,873**
Uncontrolled Emissions (Combined Pollutants)					29
Annual Tons Removed (Combined Pollutants)					21
Cost Effectiveness ($ per tons combined pollutant destroyed)					**$25,070**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$271,758	per year per generator
3,000	KW-hr
766	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	21	$254,105 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			$254,105 per year
Actual Annual Control Cost			$530,873 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)	0.31	4.4	0.75	24
Controlled Emissions (TPY)	0.31	4.4	0.75	2.4
TPY Removed	0	0	0	21
Combined Uncontrolled Emissions (TPY)	29			
Combined TPY Removed	21			
Expected Removal Efficiency	0%	0%	0%	90%
Annualized Cost ($/year)	$530,873			
Individual Pollutant $/Ton Removed	--	--	--	$25,070

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)
DEEP	0.00333	6.9	$72,544	0.0	$0 per year
CO	23,000	0.1	$731	0.0	$0 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	2.1	$39,116 per year
Benzene	0.0345	5.9	$61,882	0.0	$0 per year
1,3-Butadiene	0.00588	6.7	$69,951	0.0	$0 per year
Acrolein	0.06	5.7	$59,359	0.0	$0 per year
Naphthalene	0.0294	6.0	$62,612	0.0	$0 per year
Formaldehyde	0.167	5.2	$54,691	0.0	$0 per year
Benzo(a)pyrene	0.000909	7.5	$78,464	0.0	$0 per year
Dibenz(a,h)anthracene	0.000833	7.5	$78,863	0.0	$0 per year
Xylenes	221	2.1	$21,913	0.0	$0 per year
SO_2	660	1.6	$16,924	0.0	$0 per year
Propylene	3,000	1.0	$10,020	0.0	$0 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					$39,116 per year
Actual Annual Control Cost					$530,873 per year
				Is The Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions (TPY)	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
DEEP	0.31	0.31	0.0	0%	--
CO	4.4	4.4	0.0	0%	--
NO_2 (10% of NO_x)	2.4	0.24	2.1	90%	$250,703
Benzene	8.6E-03	8.6E-03	0.0	0%	--
1,3-Butadiene	4.4E-04	4.4E-04	0.0	0%	--
Acrolein	8.8E-05	8.8E-05	0.0	0%	--
Naphthalene	1.4E-03	1.4E-03	0.0	0%	--
Formaldehyde	8.8E-04	8.8E-04	0.0	0%	--
Benzo(a)pyrene	2.9E-06	2.9E-06	0.0	0%	--
Dibenz(a,h)anthracene	3.9E-06	3.9E-06	0.0	0%	--
Xylenes	2.2E-03	2.2E-03	0.0	0%	--
SO_2	1.7E-02	1.7E-02	0.0	0%	--
Propylene	3.1E-02	3.1E-02	0.0	0%	--
Carcinogenic VOCs	1.1E-02	1.1E-02	0.0	0%	--
Non-Carcinogenic VOCs	0.04	0.04	0.0	0%	--
Annualized Cost ($/yr)					$530,873
Combined Uncontrolled Emissions (TPY)					7.1
Combined TPY Removed					2.1
Combined TAPs $/Ton Removed					$250,703

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

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

Table C-5
Diesel Particulate Filter Capital Cost
Riker Data Center
Vantage Data Centers – Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
3.0-MWe emission control package	Cost estimate by Pacific Power Group		17	$135,000	$2,295,000
3.0-MWe miscellaneous parts	Assumed no cost			$0	$0
Combined systems FOB cost					$2,295,000
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$149,175
Shipping	0.05A	EPA Cost Manual	5.0%	--	$114,750
Subtotal Purchased Equipment Cost (PEC)					$2,558,925
Direct Installation Costs					
Enclosure structural supports	Assumed no cost		0	$0	$0
On-site Installation	Cost estimate by EKI Solutions Group		17	$12,000	$204,000.00
Electrical	Assumed no cost		0	$0	$0
Piping	Assumed no cost		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$204,000
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$2,762,925
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$63,973
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$63,973
Contractor Fees	From DIS data center		6.8%	--	$192,583
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$51,179
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$25,589
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$76,768
Subtotal Indirect Costs (IC)					$474,065
Total Capital Investment (TCI = DC+IC)					**$3,236,990**

Table C-6
Diesel Particulate Filter Cost Effectiveness
Riker Data Center
Vantage Data Centers – Quincy, Washington

Item	Quantity	Units	Unit Cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				**$3,236,990**
Capital Recovery Factor, 25 yrs, 4% discount rate				0.064
Subtotal Annualized 25-year Capital Recovery Cost				$207,206
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$64,740
Annual Property tax	1% of TCI (EPA Manual)		0.01	$32,370
Annual Insurance	1% of TCI (EPA Manual)		0.01	$32,370
Annual operation/labor/maintenance costs: Upper-bound estimate would assume CARB's value of $1.00/hp/year and would result in $230,000/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				$129,480
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$336,686**
Uncontrolled Emissions (Combined Pollutants)				29
Annual Tons Removed (Combined Pollutants)				4.3
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$78,031**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$181,172	per year per generator
3,000	KW-hr
766	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	4	$17,552 per year
VOCs	$12,000	1	$6,293 per year
PM	$12,000	0.3	$3,360 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$27,205 per year
Actual Annual Control Cost			$336,686 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)	0.31	4.4	0.75	24
Controlled Emissions (TPY)	0.0	0.9	0.22	24
TPY Removed	0.28	3.5	0.52	0
Combined Uncontrolled Emissions (TPY)	29			
Combined TPY Removed	4.3			
Expected Removal Efficiency	90%	80%	70%	0%
Annualized Cost ($/year)	$336,686			
Individual Pollutant $/Ton Removed	$1,202,326	$95,913	$642,025	--

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	0.28	$20,314 per year
CO	23,000	0.1	$731	3.5	$2,567 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	0.0	$0 per year
Benzene	0.0345	5.9	$61,882	6.1E-03	$375 per year
1,3-Butadiene	0.00588	6.7	$69,951	3.1E-04	$21 per year
Acrolein	0.06	5.7	$59,359	6.1E-05	$4 per year
Naphthalene	0.0294	6.0	$62,612	1.0E-03	$63 per year
Formaldehyde	0.167	5.2	$54,691	6.2E-04	$34 per year
Benzo(a)pyrene	0.000909	7.5	$78,464	2.0E-06	$0 per year
Dibenz(a,h)anthracene	0.000833	7.5	$78,863	2.7E-06	$0 per year
Xylenes	221	2.1	$21,913	1.5E-03	$33 per year
SO_2	660	1.6	$16,924	0.0	$0 per year
Propylene	3,000	1.0	$10,020	2.2E-02	$218 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	8.0E-03	$80 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	0.03	$128 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$23,837 per year
Actual Annual Control Cost					$336,686 per year
				Is The Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions (TPY)	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
DEEP	0.31	0.03	0.28	90%	$1,202,326
CO	4.4	0.9	3.5	80%	$95,913
NO_2 (10% of NO_x)	2.4	2.4	0.0	0%	--
Benzene	8.6E-03	2.6E-03	6.1E-03	70%	$55,618,685
1,3-Butadiene	4.4E-04	1.3E-04	3.1E-04	70%	$1,103,838,860
Acrolein	8.8E-05	2.6E-05	6.1E-05	70%	$5,477,169,976
Naphthalene	1.4E-03	4.3E-04	1.0E-03	70%	$332,000,765
Formaldehyde	8.8E-04	2.6E-04	6.2E-04	70%	$547,022,806
Benzo(a)pyrene	2.9E-06	8.6E-07	2.0E-06	70%	$167,938,129,998
Dibenz(a,h)anthracene	3.9E-06	1.2E-06	2.7E-06	70%	$124,740,171,704
Xylenes	2.2E-03	6.5E-04	1.5E-03	70%	$223,627,458
SO_2	1.7E-02	1.7E-02	0.0E+00	0%	--
Propylene	3.1E-02	9.3E-03	2.2E-02	70%	$15,469,570
Carcinogenic VOCs	1.1E-02	3.4E-03	8.0E-03	70%	$41,964,244
Non-Carcinogenic VOCs	0.04	0.01	0.03	70%	$13,191,223
Annualized Cost ($/yr)					$336,686
Combined Uncontrolled Emissions (TPY)					7.1
Combined TPY Removed					3.8
Combined TAPs $/Ton Removed					$88,099

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.
[a] The expected control efficiency using the catalyzed DPF is 90% for PM (front half), 80% for CO, and 70% for VOCs. There is no expected control of NO emissions using the catalyzed DPF option.

Table C-7
Diesel Oxidation Catalyst Capital Cost
Riker Data Center
Vantage Data Centers – Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
3.0-MWe emission control package	Cost estimate by Pacific Power Group		17	$33,000	$561,000
3.0-MWe miscellaneous parts	Assumed no cost			$0	$0
Combined systems FOB cost					$561,000
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$36,465
Shipping	0.05A	EPA Cost Manual	5.0%	--	$28,050
Subtotal Purchased Equipment Cost (PEC)					$625,515
Direct Installation Costs					
Enclosure structural supports	Assumed no cost		0	$0	$0
On-site Installation	Cost estimate by EKI Solutions Group		17	$12,000	$204,000.00
Electrical	Assumed no cost		0	$0	$0
Piping	Assumed no cost		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$204,000
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$829,515
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$15,638
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$15,638
Contractor Fees	From DIS data center		6.8%	--	$61,691
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$12,510
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$6,255
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$18,765
Subtotal Indirect Costs (IC)					$130,498
Total Capital Investment (TCI = DC+IC)					**$960,013**

Table C-8
Diesel Oxidation Catalyst Cost Effectiveness
Riker Data Center
Vantage Data Centers – Quincy, Washington

Item	Quantity	Units	Unit Cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				**$960,013**
Capital Recovery Factor, 25 yrs, 4% discount rate				0.064
Subtotal Annualized 25-year Capital Recovery Cost				$61,452
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$19,200
Annual Property tax	1% of TCI (EPA Manual)		0.01	$9,600
Annual Insurance	1% of TCI (EPA Manual)		0.01	$9,600
Annual operation/labor/maintenance costs. Upper-bound estimate would assume CARB's value of $0.20/hp/year and would result in $46,000/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 Costs				$38,401
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$99,853**
Uncontrolled Emissions (Combined Pollutants)				29
Annual Tons Removed (Combined Pollutants)				4.1
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$24,280**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$36,234	per year per generator
3,000	KW-hr
766	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 ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
NO_x	$12,000	0	$0 per year
CO	$5,000	3.5	$17,552 per year
VOCs	$12,000	0.52	$6,293 per year
PM	$12,000	0.08	$933 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$24,778 per year
Actual Annual Control Cost			$99,853 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)	0.31	4.4	0.75	24
Controlled Emissions (TPY)	0.23	0.88	0.22	24
TPY Removed	0.08	3.5	0.52	0
Combined Uncontrolled Emissions (TPY)	29			
Combined TPY Removed	4.1			
Expected Removal Efficiency	25%	80%	70%	0%
Annualized Cost ($/year)	$99,853			
Individual Pollutant $/Ton Removed	$1,283,691	$28,446	$190,409	--

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)
DEEP	0.00333	6.9	$72,544	0.08	$5,643 per year
CO	23,000	0.1	$731	3.5	$2,567 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	0.0	$0 per year
Benzene	0.0345	5.9	$61,882	6.1E-03	$375 per year
1,3-Butadiene	0.00588	6.7	$69,951	3.1E-04	$21 per year
Acrolein	0.06	5.7	$59,359	6.1E-05	$3.6 per year
Naphthalene	0.0294	6.0	$62,612	1.0E-03	$63 per year
Formaldehyde	0.167	5.2	$54,691	6.2E-04	$34 per year
Benzo(a)pyrene	0.000909	7.5	$78,464	2.0E-06	$0 per year
Dibenz(a,h)anthracene	0.000833	7.5	$78,863	2.7E-06	$0 per year
Xylenes	221	2.1	$21,913	1.5E-03	$33 per year
SO_2	660	1.6	$16,924	0.0E+00	$0 per year
Propylene	3,000	1.0	$10,020	2.2E-02	$218 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	8.0E-03	$80 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	0.03	$128 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$9,166 per year
Actual Annual Control Cost					$99,853 per year
				Is The Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions (TPY)	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
DEEP	0.31	0.23	0.08	25%	$1,283,691
CO	4.4	0.9	3.5	80%	$28,446
NO_2 (10% of NOx)	2.4	2.4	0.0	0%	--
Benzene	8.6E-03	2.6E-03	6.1E-03	70%	$16,495,158
1,3-Butadiene	4.4E-04	1.3E-04	3.1E-04	70%	$327,371,935
Acrolein	8.8E-05	2.6E-05	6.1E-05	70%	$1,624,396,279
Naphthalene	1.4E-03	4.3E-04	1.0E-03	70%	$98,463,405
Formaldehyde	8.8E-04	2.6E-04	6.2E-04	70%	$162,233,747
Benzo(a)pyrene	2.9E-06	8.6E-07	2.0E-06	70%	$49,806,391,730
Dibenz(a,h)anthracene	3.9E-06	1.2E-06	2.7E-06	70%	$36,994,921,025
Xylenes	2.2E-03	6.5E-04	1.5E-03	70%	$66,322,501
SO_2	1.7E-02	1.7E-02	0.0E+00	0%	--
Propylene	3.1E-02	9.3E-03	2.2E-02	70%	$4,587,901
Carcinogenic VOCs	1.1E-02	3.4E-03	8.0E-03	70%	$12,445,581
Non-Carcinogenic VOCs	0.04	0.01	0.03	70%	$3,912,198
Annualized Cost ($/yr)					$99,853
Combined Uncontrolled Emissions (TPY)					7.1
Combined TPY Removed					3.6
Combined TAPs $/Ton Removed					$27,588

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.

[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.

Memo to File
August 2nd, 2016
Robert Koster, P.E.
Subject: BACT and t-BACT Cost Effectiveness Thresholds

As of this date, the following cost-effectiveness thresholds are the economic criteria used to determine BACT and t-BACT in ERO. These criteria are used on a case by case basis and are expected to increase for pollutants with ambient standard attainment issues or for other case-specific concerns:

Criteria Pollutants

1. NOx, PM10 and PM2.5, VOC, and SOx: 10,000-12,000 $ per ton. Most on the 10,000 $/ton side of the range.
2. CO: 5,000 $ per ton.

Toxics: There is less history for the establishment of cost thresholds for t-BACT determinations. The "Hanford Methodology", Option 2, produces cost values that are useful, and significantly higher than those we use for criteria pollutants as they are expected to be. The method accounts for the individual substance toxicity and uses a weighted average approach for multiple pollutants controlled by a single device. The method is in use for evaluations at the Hanford Nuclear Reservation. The principal analytical tool is the following equation:

1. Cost Factor $=\log_{10}(27,000/ASIL)$

The cost factor determined using this equation is then multiplied by previous 'plateau' and 'ceiling' cost to develop a plateau and ceiling for toxics. Per the Hanford document the ceiling value to multiply by the cost factor is $10,500, the plateau is 5,700. For lead, also a criteria pollutant, the ceiling calculated this way is 57,597 $/ton. The plateau is 31,264 $/ton.

For future use of this methodology, consideration should be given to a method of increasing the plateau and ceiling costs.

Mark Brunner

From: Elder, Rick <RELDER@PacificPowerGroup.com>
Sent: Wednesday, July 20, 2016 12:22 PM
To: Mark Brunner
Cc: Lukkasson, Randy
Subject: FW: Vantage gen cost info
Attachments: BACT Cost Info Request.docx

Mark please see the following.

1. (1) Tier 2 genset 3250ekw with unit mounted radiator, medium voltage alternator (12.47-13.8KV), standard options for data center (batteries/battery charger/block heaters), loose exhaust silencer/flex, OPU (open power unit) no fuel tank or enclosure, no MLCB (circuit breaker) no NGR, delivered to site Quincy, allowance for startup and commissioning and project management. Note off loading/installation is by others.
    a. Budgeted cost of the equipment…………$985,000.00
2. (1) DOC (diesel oxidation catalyst) DOC/silencer including exhaust flexes, back pressure monitor, delivery to site. No installation, startup or commissioning. Note in general an exhaust silencer will not be required as a DOC will reduce sound emission (dependent on site requirements and components specification)
    a. Budgeted cost of the equipment…………$33,000.00
    b. Warranty/life cycle costs, Depending on OEM warranty is 2 years/8000 hours. It is not expected that in this application that there will be any catalyst block replacement or any other maintenance/repairs (there are no other wear or replacement parts).
    c. Expected reduction of emission constituents (note these are targeted/estimated amounts, actual can vary due to operating conditions, installation and equipment).
        i.

Load Point	CO* reduction (%)	HC* reduction (%)	PM** reduction (est.)	NOX reduction (%)
100%	80	70	15-25%	NA
75%	80	70	15-25%	NA
50%	80	70	15-25%	NA
25%	80	70	15-25%	NA
10%	80	70	15-25%	NA

    d. ** PM reduction is estimated as reduction levels are affected by the % of soluble verses non-soluble PM. This varies per engine and per % of load and OEMs are not required to publish and or capture this test data.
    e. * CO and HC reduction % can be tuned. Standard DOC targets are for CO > 80 % and HC > 70 of raw engine emissions. And at different load levels there can be reduction variables of up to 5-10% but the aggregate reduction levels will be equal to or more then stated %.
3. (1) DPF (diesel particulate filter) system (targeted @ 90% reduction of PM) catalyst reactor including delivery, lagging/insulation, flex, back pressure monitor etc. No installation.
    a. Budgeted cost of the equipment………..$ 135,000.00
    b. Depending on OEM standard life of catalyst is expected to be >15,000 hours (there are no other wear or replacement parts).
    c. Expected reduction of emission constituents (note these are targeted/estimated amounts, actual can vary due to operating conditions, installation and equipment).

i.

Load Point	PM* reduction	CO Reduction (%)	HC Reduction (%)	NOX reduction
100%	90	80	70	NA
75%	90	80	70	NA
50%	90	80	70	NA
25%	90	80	70	NA
10%	90	80	70	NA

4. (1) SCR system NOX reduction targeted at 90% reduction, including the following equipment (dosing cabinet/controls/reactor/mixing tube/exhaust flexes (2), lagging/insulation), air compressor, day tank for the urea. All equipment delivered to site, install by others.
    a. Budgeted cost of the equipment…………$198,000.00
    b. Warranty depending on OEM, 60 months and 4200 operating hours. Standard life of catalyst is expected to be >20,000 operating hours. Note other wear items can be the injection lance (generally programed at 7000 operating hours), filters etc.
    c. Expected reduction of emission constituents (note these are targeted/estimated amounts, actual can vary due to operating conditions, installation and equipment).
        i.

Load Point	NOX Reduction(%)	CO ** Reduction (%)	HC ** Reduction (%)	PM ** Reduction (%)
100%	90	NA	NA	NA
75%	90	NA	NA	NA
50%	90	NA	NA	NA
25%	90	NA	NA	NA
10%	0 *	NA	NA	NA

    d. * It is expected that exhaust temperatures @ 10% load will be below the threshold required for UREA injection, so NOX reduction will be 0.
    e. ** CO, HC, PM are not targeted or removed in any measureable quantities with SCR application.
5. (1) SCR/DPF and potential DOC system (DOC inclusion dependent on supplier) to meet Tier 4F requirements, see above combined scope of supply for DPF and SCR.
    a. Budgeted cost of the equipment…………..$306,000.00
    b. Life cycle/maintenance costs see comments above.
    c. Expected reduction of emission constituents (note these are targeted/estimated amounts, actual can vary due to operating conditions, installation and equipment).
        i.

Load Point	NOX *	PM Reduction %	CO Reduction (%)	HC Reduction (%)
100%	90	88	80	70
75%	90.	88	80	70
50%	90	88	80	70
25%	90	88	80	70

10%	0			
*		88	80	70

d. * It is predicted that exhaust temperature will be too low @ 10% load for urea injection to occur.

6. Fuel consumption:
   a. Operation with DOC should be the equal to or the same as a Tier 2 engine/genset.
   b. Operation with DPF-SCR-and SCR/DPF
      i. Fuel consumption should be expected to increase due to the following factors.
         1. DPFs, Minimum exhaust/catalyst temp that the catalyst blocks will regenerate. If minimum temperatures to regenerate are not reached catalyst blocks can be plugged. This can cause exhaust back pressure to exceed OEM limits and engine shutdown will occur. If this event occurs engine will have to be put under additional load with a load bank consuming more fuel. The worst case scenario is that system will have to be shut down, catalyst blocks removed and cleaned.
         2. SCRs if load is below minimum temperature required for urea injection, additional load will have to be applied with accompanying rise in fuel consumption.
7. Urea consumption:
   a. This is generally factored at a 7% of fuel burn and budget figure per gallon is $4.

Mark as needed we can discuss this afternoon (3-5PM), or tomorrow before 10AM,

Hopefully this assists. Thanks Rick

From: Mark Brunner [mailto:mbrunner@landauinc.com]
Sent: Tuesday, July 12, 2016 9:55 AM
To: Lukkasson, Randy <RLUKKASSON@PacificPowerGroup.com>
Cc: 'Mark Johnson' <mjohnson@vantagedatacenters.com>
Subject: Vantage gen cost info

Randy,

Thanks for your help getting this cost information. I've attached a table of the cost estimate and "not-to-exceed" emission rate information that we need for our analysis. Our cost analysis must consider the additional incremental cost to control emissions for multiple different scenarios (i.e., Tier 2 generator + DOC, Tier 2 generator + SCR, Tier 2 generator + DPF, and fully integrated Tier 4 generator). For example, to calculate the incremental cost of the Tier 2 generator + DOC option, we must subtract the cost of a Tier 2 generator from the cost of a Tier 2 generator with a DOC.

I recognize that some of the information in the attached table may be challenging to estimate or something that you typically wouldn't quote a client on. If you would be able to provide your best estimate on some of this information, that would be very helpful.

Let me know if you'd like to have a call to discuss.

Thanks,

Mark Brunner
Associate
Landau Associates

Cell: (206) 550-5808
601 Union Street, Suite 1606, Seattle, WA 98101
www.landauinc.com

Note: The Hanford Method Report is not included in the PDF version; this attachment is provided on DVD in the paper copy

APPENDIX D

Summary of AERMOD Inputs

Table D-1
AERMOD Parameter Estimation
Riker Data Center
Vantage Data Centers – Quincy, Washington

AERMOD INPUT (Theoretical max. year)[a]
Event: Theoretical Max Year

Regulatory Demonstration	AERMOD INPUT (lb/hr) per Genset
NO_x (annual NAAQS)	0.9480 [b]
SO_2 (annual NAAQS)	6.786E-04
DEEP (ASIL / non-cancer risk HQ)	0.0125
$PM_{10}/PM_{2.5}$ (annual NAAQS)	0.0427 [b]
Benzene (ASIL)	3.5E-04
1,3-Butadiene (ASIL)	1.8E-05
Naphthalene (ASIL)	5.8E-05
Worst-case Exhaust Temp. (°F)	491
Worst-case Exhaust Flow (cfm)	5,810

AERMOD INPUT (Worst-case 1-hour) Power Outage Scenario

Operating Condition	Cold-start	Warm
Number of events	1	1
Duration of each event (hours)	0.02	0.98
Hours at each runtime mode	0.02	0.98
CO (1 & 8-hour NAAQS)	12.20	
Load-Specific Exhaust Temp. (°F)	923	
Load-Specific Exhaust Flow (cfm)	24,944	
SO_2 (1, 3, & 24-hour NAAQS)	0.0440	
Load-Specific Exhaust Temp. (°F)	491	
Load-Specific Exhaust Flow (cfm)	5,810	

AERMOD INPUT (Worst-case 24-hour) Power Outage Scenario

Operating Condition	Cold-start	Warm
Number of events	1	1
Duration of each event (hours)	0.02	23.98
Hours at each runtime mode	0.02	23.98
Acrolein (ASIL)	0.000224	
Load-Specific Exhaust Temp. (°F)	491	
Load-Specific Exhaust Flow (cfm)	5,810	

Notes:
[a] All operations are assumed to run at full-variable load (≤100% Load).
[b] For modeling local background impacts, neighboring data centers were assumed to emit at the full potential to emit. Cooling toweres and the Celite facility were assumed to be operating at permited limits.

Table D-2
AERMOD Parameter Estimation for NO_2 Monte Carlo
Riker Data Center
Vantage Data Centers – Quincy, Washington

NO_2 1-hour NAAQS Demonstration	
AERMOD Filename	mc_NOx_080416a
AERMOD Filename (local background)	NOx_080516c

AERMOD Setup: Emergency Power Outage

Source Group	POWER	
Operating Condition	**Cold-start**	**Warm**
Hours per Day	1	
Number of events	1	1
Duration of each event (hours)	0.02	0.98
Hours at each runtime mode	0.02	0.98
NO_x (lb/hr)	61.43 [a]	
Engines Concurrently Running	17	
Load-Specific Exhaust Temp. (°F)	923	
Load-Specific Exhaust Flow (cfm)	24,944	
Background Emissions: Power outage	All local data centers in power outage mode. Assumed Celite facility was emitting at permit limit.	
Background Emissions: Electrical bypass	Assumed Celite facility was emitting at permit limit. Due to the difficulty of predicting neighboring data center operations, it was conservatively assumed that each local data center was in monthly maintenance operating mode.	
Background Emissions: Monthly maint. / Load bank testing	Local data centers coordinate routine operations to prevent concurrent diesel engine activities. Assumed Celite facility was emitting at permit limit.	

[a] With the exception of emergency power outage events, generator operations were assumed to occur between daylight hours only (7 a.m. to 7 p.m.).

Table D-3
AERMOD Parameter Estimation for $PM_{2.5}$ Monte Carlo
Riker Data Center
Vantage Data Centers –
Quincy, Washington

$PM_{2.5}$ 24-hour NAAQS Demonstration
AERMOD Filename mc_pm25_080916a
AERMOD Filename (local background) pm25_080916c

AERMOD Setup: Emergency Power Outage

Source Group	POWER	
Operating Condition	**Cold-start**	**Warm**
Hours per Day	24	
Number of events	1	1
Duration of each event (hours)	0.02	23.98
Hours at each runtime mode	0.02	23.98
$PM_{2.5}$ (lb/hr)	2.70	
Engines Concurrently Running	17	
Load-Specific Exhaust Temp. (°F)	491	
Load-Specific Exhaust Flow (cfm)	5,810	
Background Emissions	All local data centers in power outage mode. Assumed Celite facility and cooling towers were emitting at permit limit.	

AERMOD Setup: Electrical bypass

Source Group	EB1 - EB4	
Operating Condition	**Cold-start**	**Warm**
Hours per Day	4	
Number of events	1	1
Duration of each event (hours)	0.02	3.98
Hours at each runtime mode	0.02	3.98
$PM_{2.5}$ (lb/hr)	0.9116 [a]	
Engines Concurrently Running	≤ 7	
Load-Specific Exhaust Temp. (°F)	491	
Load-Specific Exhaust Flow (cfm)	5,810	
Background Emissions	Assumed Celite facility was emitting at permit limit. Due to the difficulty of predicting neighboring data center operations, it was conservatively assumed that each local data center was in monthly maintenance operating mode.	

AERMOD Setup: Monthly maintenance / Load bank testing

Source Group	MO1 - MO4	
Operating Condition	**Cold-start**	**Warm**
Hours per Day	6	
Number of events	1	1
Duration of each event (hours)	0.02	0.98
Hours at each runtime mode	0.02	0.98
$PM_{2.5}$ (lb/hr)	1.42 [b]	
Engines Concurrently Running	1	
Load-Specific Exhaust Temp. (°F)	491	
Load-Specific Exhaust Flow (cfm)	5,810	
Background Emissions	Local data centers coordinate routine operations to prevent concurrent diesel engine activities. Assumed Celite facility and cooling towers were emitting at permit limit.	

[a] Model setup was also used in AERMOD run pm10_080916a for demonstrating compliance with 24-hour PM_{10} NAAQS (as the model of 4th-highest day).
[b] Assumes generator operations will occur between daylight hours only (7 a.m. to 7 p.m.)

Table D-4
Summary of Monte Carlo Analysis
Riker Data Center
Vantage Data Centers – Quincy, Washington

UTM= 11	(m East)	(m North)	Max. Project Impact (μg/m^3)	Max. Local Background	Threshold Limit
Monte Carlo Predicted: NO_2 Impact	287,189	5,237,079	133	0.42	172
Monte Carlo Predicted: $PM_{2.5}$ Impact	287,195	5,237,226	9.9	2.6	14

Runtime Scenario	Engine Condition	Assumed Operating Days per Year (Monte Carlo Input)	NO_2 1-hour Impact (μg/m^3) 1st-highest Max. Impact Project only	NO_2 1-hour Impact (μg/m^3) Modeled Local Background Impact at (287189.3 m E, 5237078.93 m N)	$PM_{2.5}$ 24-hour Impact (μg/m^3) 1st-highest Max. Impact Project only	$PM_{2.5}$ 24-hour Impact (μg/m^3) Modeled Local Background Impact at (287195.01 m E, 5237226.36 m N)
Power outage	Facility-wide power outage including local data centers[a]	3	1,394	99	387	0.2
Electrical bypass	Electrical bypass occuring at building 1[b]	6	933	0.42	77	2.6
	Electrical bypass occuring at the ETC building[b]	6[d,e]	219	0.003	12	1.5
	Electrical bypass occuring at data center 3[b]	6[d]	439	0.08	23	1.6
	Electrical bypass occuring at data center 2[b]	6[d]	353	1.8E-04	24	0.6
Monthly Maintenance OR Load testing	Monthly maintenance occuring at building 1[c]	12[d]	155	1.4E-04	17	2.4
	Monthly maintenance testing at the ETC building[c]	12[d,e]	124	3.0E-05	10	1.5
	Monthly maintenance testing at data center 3[c]	12[d,e]	107	3.3E-04	9.1	1.2
	Monthly maintenance testing at data center 2[c]	12[d,e]	110	0.0E+00	11	1.1
Corresponding AERMOD Run			mc_NOx_080416a	NOx_080516c	mc_pm25_080916a	pm25_080916c

Notes:
Highlighted cells indicated a maximum project related impact that exceeds the threshold limit
Highlighted cells indicated the conservative maximum local background impact used for comparison to the NAAQS.
E = East
m = Meters
N = North
NO_2 = Nitrogen dioxide
$PM_{2.5}$ = Particulate matter with aerodynamic diameter less than or equal to 2.5 microns
UTM = Universal transverse mercator coordinate system zone
μg/m^3 = micrograms per cubic meter

[a] Local background sources are assumed to be in power outage operating mode. Cooling towers and the Celite facility are assumed to be operating at permited limit
[b] Local background sources are conservatively assumed to be in monthly maintenance operating mode. Cooling towers and the Celite facility are assumed to be operating at permited limit
[c] Monthly maintenance operations and load testing was assumed to occur between daylight hours (7 a.m. to 7 p.m.), with coordination between local data centers to prevent concurrent testing, and for no more than 6 hours per day.
[d] AERMOD results indicate that the modeling scenarios is not applicable to the NO_2 Monte Carlo analysis because the maximum expected impact would not contribute to an exceedace of (188 - 16) 172μg/m^3.
[e] AERMOD results indicate that the modeling scenarios is not applicable to the $PM_{2.5}$ Monte Carlo analysis because the maximum expected impact would not contribute to an exceedace of (35 - 21) 14μg/m^3.

APPENDIX E

Electronic Files Archive