Revised Notice of Construction Application Supporting Information Report H5 Data Center Campus Expansion Quincy, Washington

July 15, 2021

Prepared for

H5 Data Centers
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Quincy, Washington

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Supporting Information Report
H5 Data Center Campus Expansion
Quincy, Washington

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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
ASIL	acceptable source impact level
BACT	best available control technology
cDPF	catalyzed diesel particulate filter
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
H5	H5 Data Centers
HAP	hazardous air pollutant
HC	hydrocarbon
IDEQ	Idaho Department of Environmental Quality
km	kilometer
LAI	Landau Associates, Inc.
m	meter
MTU	MTU Onsite Energy
MWe	megawatts electrical
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO_2	nitrogen dioxide
NOC	Notice of Construction
NO_X	nitrogen oxides
NSPS	New Source Performance Standard
NWS	National Weather Service
PM	particulate matter
$PM_{2.5}$	PM with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10}	PM with an aerodynamic diameter less than or equal to 10 microns
ppm	parts per million
PVMRM	Plume Volume Molar Reaction Model

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

RCW	Revised Code of Washington
RICE	reciprocating internal combustion engine
SCR	selective catalytic reduction
SIL	significant impact level
SO_2	sulfur dioxide
SQER	small-quantity emission rate
TAP	toxic air pollutant
tBACT	BACT for toxic air pollutants
TDS	total dissolved solids
VOC	volatile organic compound
WAAQS	Washington Ambient Air Quality Standards
WAC	Washington Administrative Code

1.0 EXECUTIVE SUMMARY

H5 Data Centers (H5) is proposing to expand the existing H5 Data Center in Quincy, Washington (Figure 1). This document has been prepared to support the submittal of a Notice of Construction (NOC) application for emergency generators, under air quality regulations promulgated by the Washington State Department of Ecology (Ecology). The H5 Data Center is located at 1711 M Street NE in Quincy, Washington.

H5 currently operates six (6) MTU Onsite Energy (MTU) 2.25-megawatt electrical (MWe) diesel-fired emergency generator sets and four (4) evaporative cooling towers. These were previously permitted by Ecology under Approval Order No. 18AQ-E044. H5 proposes to install an additional twelve (12) 2.25-MWe generators, each powered by either an MTU Model 16V4000DS2250 engine or powered by a Kohler KD Model 2250 engine, increasing the total number of generators to 18. H5 also proposes to add eight (8) cooling towers, increasing the total number of cooling towers to 12. The additional 12 generators will provide emergency backup power to additional server equipment to be located in the existing H5 Data Center.

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

The equipment that was evaluated for this NOC application consists of the following:

- Twelve (12) Tier 2-certified diesel-fired emergency generator sets. The 2.25-MWe generators will have a combined capacity of 27 MWe.
- Eight (8) evaporative cooling towers.

Consistent with the recent approach to permitting data centers in Washington—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—H5 is requesting the following Approval Order conditions for the H5 Data Center emergency generators:

1. A runtime limit of 18 hours per year per generator for the proposed 2.25-MWe generators.
2. Operation of more than 6 generator-hours (combined) in any 24-hour period shall not occur more than 15 times in any 3 calendar-year period.
3. The Approval Order conditions will not assign specific fuel or runtime limits to each individual runtime activity (e.g., unplanned power outages).
4. A separate allowance of 28 hours to complete startup and commissioning on each generator.

Air pollutant emission rate estimates were calculated based on vendor-provided "not-to-exceed" or "potential site variation" emission estimates for nitrogen oxides (NO_X), carbon monoxide (CO), hydrocarbons (HC), and filterable particulate matter (PM); sulfur mass-balance for sulfur dioxide (SO_2) assuming 100 percent conversion of sulfur in the fuel to SO_2; and emission factors from the US Environmental Protection Agency's (EPA's) AP-42 Volume I, Chapter 3.4 (EPA 1995) for toxic air pollutants (TAPs). H5 is requesting flexibility to operate the generators at any load; therefore, the emission rates used for this evaluation were based on emission factors for the worst-case load for each pollutant, taking into account emission rates, stack exhaust temperature, and velocity at each operating load. In order to account for slightly higher emissions during the first minute of each engine startup, the estimated emission rates of pollutants associated with startup were scaled up using a "black-puff" scaling factor.

Based on the results of this evaluation, the recommended best available control technology (BACT) for criteria pollutants and toxic air pollutants (tBACT) is emission limitations consistent with the EPA's Tier 2 emission standards, which will be 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. Subject to Ecology's review and approval, the evaluations presented in this NOC application support the proposal of the following emission limitations as BACT for the emergency generators to be installed at the H5 Data Center:

Best Available Control Technology Proposal

Pollutant(s)	BACT and tBACT Proposal
Particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOCs), and nitrogen oxides (NO_X)	Use of EPA Tier 2-certified engines when installed and operated as emergency engines, as defined by 40 Code of Federal Regulations (CFR) 60.4219. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
Toxic air pollutants (TAPs), including primary nitrogen dioxide (NO_2), diesel engine exhaust particulate matter (DEEP), CO, 1,3-butadiene, acrolein, benzene, dibenz(a,h)anthracene, formaldehyde, naphthalene, arsenic, and vanadium	Compliance with the proposed BACT requirements for PM, CO, VOCs, NO_X, and SO_2. The proposed BACT for the cooling towers is the use of high-efficiency drift eliminators that reduce the drift droplet rate to at most 0.0005 percent of the recirculation water flow rate.

Air dispersion modeling was conducted for criteria air pollutants and TAPs. The results of modeling demonstrate that ambient criteria pollutant concentrations that result from operations at the H5 Data Center, and other local and regional background sources, are below the National Ambient Air Quality Standards (NAAQS). Additionally, the modeling results demonstrate that ambient TAP concentrations from operations at the H5 Data Center are below Washington acceptable source impact levels (ASILs), with the exception of NO_2 and DEEP. Because modeled NO_2 and DEEP concentrations exceed ASILs, a second-tier health impact assessment has been prepared and is being submitted to Ecology under separate cover.

2.0 INTRODUCTION

Landau Associates, Inc. (LAI) prepared this document on behalf of H5 to support the submittal of a NOC application for installation and operation of new emergency generators, under air quality regulations promulgated by Ecology. The H5 Data Center is located at 1711 M Street NE in Quincy, Washington, on Grant County Parcel No. 040411025. The legal description of the property is as follows: FU 128 BLOCK 73 4 20 24.

This NOC permit application proposes installation of an additional 12 2.25-MWe generators, increasing the total number of generators to 18 and an additional 8 evaporative cooling towers, increasing the total number of cooling towers to 12.

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3.0 PROJECT DESCRIPTION

(Section III of NOC application form)

3.1 Facility Description

H5's existing Quincy campus includes one server building. The data center is located north of M Street NE and east of Road P NW, as shown on Figure 1. The site is accessible from M Street NE.

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

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. Each 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, which requires that emergency engines satisfy EPA Tier 2 emission standards for emergency engines as defined by the federal regulations (40 CFR Part 89). H5 will use Tier 2-certified generators. All H5 emergency generators will use ultra-low sulfur diesel fuel (15 parts per million [ppm] sulfur content).

Each of the emergency generators will be located on the east side of the building shown on Figure 2. Specifications and manufacturer-provided emissions data for the proposed MTU 2.25-MWe diesel generators are provided in Appendix A. The equipment evaluated for this NOC application consists of 12 diesel-fired emergency generator sets, powered by MTU Model 16V4000DS2250 engines or powered by Kohler Model KD 2250 engines. The worst-case generator between the two will be used for modeling and is discussed further in Section 7.1.1. If model numbers change in future years during the planned phased construction, specification sheets for the updated generator or engine models will be provided to Ecology. The generators have the following specifications:

- 12 2.25-MWe generators with a combined capacity of 27 MWe.
- All generators will be Tier 2-certified.

H5 will not install any other diesel engines for use as fire pumps or for building safety generators.

3.2 Generator Runtime Scenarios

The emission estimates 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, H5 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. To demonstrate compliance with regulatory thresholds, the calculations incorporate the following annual hours of operation for H5 Data Center engines:

- An **annual runtime assumption** of 26 hours per year, per generator (inclusive of hours assumed during a utility outage).
- A “**theoretical maximum year**” addresses a hypothetical worst-case year in which all new generators are commissioned. This is considered the 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 H5 Data Center are as follows:

- **Monthly Maintenance Testing**: Routine operation and maintenance on the new emergency generators will be conducted on a monthly basis. The specific runtime per generator may vary, but generally it will be completed in 1 hour per month or less per generator at full-variable load.
- **Annual Testing**: Testing will be conducted annually on each new emergency generator for about 4 hours or less per generator and would substitute for one monthly maintenance test. The annual testing will be conducted under full-variable load.
- **Additional Testing:** Additional testing may be required throughout the year. Testing will be conducted under full-variable load for up to 3 hours per generator, per year.
- **Unplanned Power Outage**: During a power outage at the site, all 12 new generators will activate in order to supplement power to the server system and will operate at full-variable load.
- **Generator Startup and Commissioning**: After a new generator is installed, it will require commissioning. Commissioning occurs only once in the lifetime of each generator and consists of approximately 24 hours per generator. Commissioning activities that involve all 12 generators operating simultaneously are limited to 4 hours in a year.
- **Stack Testing**: It is anticipated that Ecology will require exhaust stack emission testing of one of the 12 new generators every 5 years, to demonstrate continued compliance with air quality standards. Such a stack test can take up to 6 hours.

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, H5 requests the following Approval Order conditions to allow for minimum operational needs:

1. A runtime limit of 18 hours per year per generator for the proposed 2.25-MWe generators.
2. Operation of more than 6 generator-hours (combined) in any 24-hour period shall not occur more than 15 times in any 3 calendar-year period.
3. The Approval Order conditions will not assign specific fuel or runtime limits to each individual runtime activity (e.g., unplanned power outages).
4. A separate allowance of 28 hours to complete startup and commissioning on each generator.

The evaluation in this NOC application and the evaluation that will be presented in the second-tier health impact assessment have 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).

3.3 Compliance with State and Federal Regulations

The H5 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; updated December 30, 2019)
- 40 CFR Part 60 Subpart A (General Provisions)
- 40 CFR Part 60 Subpart IIII (Stationary Compression Ignition Internal Combustion Engines)
- 40 CFR Part 63 Subpart ZZZZ (National Emission Standards for Hazardous Air Pollutants [NESHAP] for Reciprocating Internal Combustion Engines [RICEs]).

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

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

The project is located in an attainment area for all Clean Air Act criteria pollutants. Facilities that produce more than 100 tons per year of any criteria pollutant, 10 tons per year of individual hazardous air pollutant (HAP), or 25 tons per year of combined HAPs are considered major sources under the federal regulation 40 CFR Part 70 and the state regulation WAC 173-410 et seq. Potential-to-emit estimates provided in Section 4.0 demonstrate that the facility will emit:

- Less than 100 tons per year of any criteria pollutant (PM, CO, NO_2, SO_2, and VOCs)
- Less than 10 tons per year of any individual HAP
- Less than 25 tons per year of combined HAPs.

As a result, a Title V operating permit is not required. Likewise, a Prevention of Significant Deterioration New Source Review pre-construction permit is not required because all emissions will be below the major source threshold of 250 tons per year.

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 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.

4.0 AIR POLLUTANT EMISSION ESTIMATES

(Sections V and VI 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.

All generators will be Tier 2-certified. The emergency generator manufacturer will be either MTU or Kohler. Manufacturer-reported not-to-exceed generator emission factors for CO, NO_X, and PM were used to estimate emission rates. Additionally, the manufacturer-provided HC emission rate was assumed to represent the emission rate for total VOC emissions.

4.1 Generator Emission Calculation Method

During all operations, the generators will activate at less than or equal to 100 percent load (full-variable load). Operating scenarios used to calculate emission estimates are provided in Table 1. H5 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, the pollutant-specific maximum emission rate under any load less than or equal to 100 percent was assumed for calculating the worst-case potential emission rates. These vendor-reported 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 PM emission rates. The emission rates for PM with aerodynamic diameters of less than or equal to 10 microns (PM_{10}) and less than or equal to 2.5 microns ($PM_{2.5}$) include an estimate for "front-half" (filterable PM) and "back-half" (condensable PM) emissions. The filterable PM estimate is equal to the manufacturers' not-to-exceed emission factor for PM. An estimate of condensable PM is assumed to be equal to the manufacturers' not-to-exceed emission factor for HC.

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 maximum fuel consumption. 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 12 generators would be 108,281 gallons of diesel fuel per year. Table 3 summarizes the maximum fuel-based project-only emission estimates and fuel consumption rates.

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

4.1.1 Startup Emissions

To account for slightly higher emissions during the first minute of each engine startup, the estimated emission rates of pollutants associated with startup (PM, CO, total VOCs, and volatile TAPs) were scaled up using a “black-puff” emission factor. These “black-puff” factors are based on short-term concentration trends for VOC and CO emissions observed immediately after startup of a large diesel backup generator. These observations were documented in the California Energy Commission’s report “Air Quality Implications of Backup Generators in California” (Lents et al. 2005). LAI’s derivation of startup emission factors is provided in Table 4. Additional details are provided in Appendix B.

4.2 Cooling Tower Emissions

The cooling towers will be operated using drift eliminators certified to reduce the drift droplet rate to at most 0.0005 percent of the recirculation water flow rate. It was assumed that the non-volatile chemical concentrations in the drift droplets will be identical to the non-volatile aqueous concentrations in the recirculation water, and the drift droplets will quickly evaporate to form solid drift particles containing those non-volatile compounds.

The size distribution of the liquid droplets for mechanical draft evaporative fluid coolers with a drift performance of 0.0005 percent was based on data from SPX/Marley, a major manufacturer of evaporative fluid coolers. The size distribution of the evaporated solid particles was calculated based on the liquid droplet size distribution and the assumption that the total dissolved solids (TDS) concentration inside the liquid droplets will be the same as the TDS concentration within the cooler recirculation water.

The water supply will be a combination of water from the City of Quincy’s domestic water supply and well water from an onsite well. Samples of both water sources were analyzed for potential TAPs (Cascade Analytical 2020). Because the specific mixture of well water and domestic water may vary depending on water availability, the worst-case concentration of chemicals from either water source was used to evaluate the worst-case emissions from the cooling towers. Reporting limits were conservatively used for analytes not detected in samples. Cooling tower emission rates are provided in Table 5.

The resultant project-only and facility-wide potentials-to-emit are provided in Table 6. Table 7 shows the estimated project emission rates for each TAP expected to be released in the H5 emergency generator and cooling tower exhaust, and compares those emission rates to the corresponding small-quantity emission rate (SQER; discussed further in Section 7.1.7).

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 for emergency engines as specified by 40 CFR Part 89.

H5 will conduct all notifications, generator maintenance, recordkeeping, and reporting as required by NSPS Subpart IIII.

The generators will also be subject to the NESHAP requirements under Subpart ZZZZ, “National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines (RICEs).” NESHAP Section 63.6590(c)(1) specifies requirements for emergency RICEs that are also subject to NSPS Subpart IIII. The H5 facility will be an “area source” of federal HAPs; accordingly, NESHAP Section 63.6590(c)(1) indicates that the emergency generators will not be required to comply with any portions of Subpart ZZZZ as long as the generators comply with EPA Tier 2 emission standards and H5 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)

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

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. BACT is the emission rate that results from the control.

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.

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 the H5 Data Center:

- **Tier 4 integrated control package**. This control option consists of an integrated diesel particulate filter (DPF), diesel oxidation catalyst (DOC), and urea-based selective catalytic reduction (SCR). This system is highly efficient for control of NO_X (90 percent), PM_{10}/$PM_{2.5}$/DEEP (85 percent of "front-half"), CO (80 percent), VOCs and gaseous TAPs (70 percent), and meets Tier 4 emission standards as defined by the federal regulations (40 CFR Part 89). Note, when engine or emission control system manufacturers are producing Tier 4-compliant engines, they will typically weld the DOC to the DPF and call it a "catalyzed DPF." While the Tier 4 integrated control package is technically feasible, it does have some operational constraints for emergency generators. For example, SCRs typically do not provide NO_X removal when the engine exhaust temperature is below the target temperature of 575°F, which may occur at low loads.
- **Urea-based SCR**. This control option is highly efficient for control of NO_X (90 percent) and NO_2. While the SCR is technically feasible, it does have some operational constraints for emergency generators as described above.
- **Catalyzed DPF (passive)**. This control option is highly efficient for control of PM_{10}/$PM_{2.5}$/DEEP (85 percent of "front-half"), CO (80 percent), and VOCs and gaseous TAPs (70 percent). The amount of condensable ("back-half") particulates removed by cDPFs (if any) is not well understood. Note, "active" cDPFs have also been reviewed on previous projects; however, the cost to control a ton of pollutants was found to be about double that of a passive cDPF even when taking into account the marginally fewer number of operating hours required to maintain it. Therefore, this option is not reviewed further in this BACT analysis.
- **Diesel oxidation catalyst**. This control option is highly efficient for removal of CO (80 percent), and 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 in Washington State, three-way catalysts have also been considered to be technologically feasible for use on diesel generators. However, recent compliance stack tests required at a 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 demonstrated to be achieved in practice for emergency generator use; therefore, they were 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.

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.[1] 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 or were calculated by LAI using the Hanford[2] 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 E).

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 2019).

Cost estimates and pollutant destruction and removal efficiencies were obtained from MIRATECH® for each evaluated emission control option (Eisele 2020). Indirect cost factors to derive a conservatively low total installation cost were obtained from the EPA Air Pollution Control Cost Manual (EPA 2019). The annual capital recovery costs were calculated assuming a 30-year system lifetime and a 5.5 percent annual discount rate. Conservatively low estimates of annual operation and maintenance costs for each control option were derived by assuming that there would be no operating cost for electricity or equipment maintenance. To provide a conservatively low estimate of the annual operating cost, the operational unit costs for each emission control option were set to zero.

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[1] BACT analysis was conducted based on a runtime limit of 38 hours per year. That limit was revised during HIA analysis to reduce DEEP cancer risk. Because higher runtime limits are more conservative for BACT analysis (more pollutants removed), the BACT analysis was not revised to reflect the lower runtime.

[2] 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 E).

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, cDPF, 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 ($69,000), PM_{10}/$PM_{2.5}$ ($2,022,000), CO ($288,000), VOCs ($1,442,000), and combined criteria air pollutants ($52,000) is provided in Table 8. As shown in Table 8, 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 controlling 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 $40,000 per ton (Table 8). As shown in Table 8, 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 (Passive)

The cost effectiveness of installing a passive cDPF for control of PM_{10}/$PM_{2.5}$ ($485,000 per ton), CO ($69,000 per ton), VOCs ($346,000 per ton), and combined pollutants ($51,000 per ton) is provided in Table 8. As shown in Table 8, the forecast cost effectiveness for control of individual and combined pollutants exceeds Ecology's thresholds for cost effectiveness; therefore, subject to Ecology's review and concurrence, the passive cDPF 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}/$PM_{2.5}$ ($632,000 per ton), CO ($26,000 per ton), VOCs ($133,000 per ton), and combined pollutants ($21,000 per ton) is provided in Table 8. As shown in Table 8, 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 controlling 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 for TAPs.

TAPs emitted by Tier 2 emergency generators at rates exceeding the *de minimis* thresholds consist of: NO_2, DEEP, CO, 1,3-butadiene, acrolein, benzene, dibenz(a,h)anthracene, formaldehyde, and naphthalene.

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 9 summarizes the calculated TAP cost effectiveness for each control option in comparison to the presumed acceptable thresholds derived using the Hanford methodology.

Emission control technologies and the cost-effectiveness evaluation for control of PM_{10}/$PM_{2.5}$ are the same for control of DEEP, because cDPFs 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 9, the forecast cost effectiveness to control DEEP using a Tier 4 integrated control package ($2,022,000 per ton), passive cDPF ($485,000 per ton), or a DOC ($632,000 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 9). 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 9, the forecast cost effectiveness to control CO using a Tier 4 integrated control package ($288,000 per ton), passive cDPF ($69,000 per ton), and DOC ($26,000 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 at the point of release; 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 9, the forecast cost effectiveness to control NO_2 using a Tier 4 integrated control package ($644,000 per ton) and SCR ($374,000 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 1,3-butadiene, acrolein, benzene, dibenz(a,h)anthracene, formaldehyde, and naphthalene 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:

- $69,951 per ton of removed 1,3-butadiene
- $59,359 per ton of removed acrolein
- $61,882 per ton of removed benzene
- $78,863 per ton of removed dibenz(a,h)anthracene.
- $54,691 per ton of removed formaldehyde
- $62,612 per ton of removed naphthalene.

As shown in Table 9, 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 9 also provides the combined cost effectiveness for controlling all TAPs for each emission control option. As shown in Table 9, 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, cDPF, or DOC) are technically feasible, each of them failed the BACT and tBACT cost-effectiveness evaluations. Therefore, none of the add-on controls are BACT or tBACT because the costs of emission control are disproportionate to the benefit received. Instead, emission limitations consistent with the EPA's Tier 2 emission standards—achieved with combustion controls and the use of ultra-low sulfur diesel fuel—are the recommended BACT and tBACT determination. The proposed BACT recommendation is based on compliance with the EPA's Tier 2 emission standards for a non-road diesel engine: 0.20 grams per mechanical kilowatt-hour (g/kWm-hr) for PM, 3.5 g/kWm-hr for CO, and 6.4 g/kWm-hr for combined NO_X plus VOCs.

6.7 Step 6: Recommended Best Available Control Technology for Cooler Drift

Evaporative fluid coolers or cooling towers are used to cool non-contact process water to a temperature that is useful for the process. The direct contact between the cooling water and air results in entrainment of some of the liquid water into the air. The resulting drift droplets contain total dissolved solids (TDS), which form solid particles after the drift droplets evaporate downwind of the towers or evaporative fluid coolers.

Evaporative fluid coolers or cooling towers will be equipped with high-efficiency drift eliminators certified to reduce the drift droplet rate to at most 0.0005 percent of the recirculation water flow rate within each cooling unit. EVAPCO and Baltimore Air Coil have stated that this reduction is the greatest reduction in drift emissions the manufacturer is able to certify (Kline 2017; Shank 2017). Therefore, the high-efficient drift eliminators (0.0005 percent) are proposed as BACT.

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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 acceptable source impact levels (ASILs) for TAPs. Air dispersion modeling input values and selected isopleths are provided in Appendix D. Copies of the electronic modeling files and inputs are provided in Appendix E.

As discussed in the following sections, the modeled ambient impacts expected from project emissions are either less than the significant impact levels (SILs) or less than the NAAQS and WAAQS, even after summing with modeled local 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 Model Methodology 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[3] modeling system was used in accordance with the EPA's Revision to the Guideline on Air Quality Models (EPA 2005) to estimate ambient pollutant concentrations beyond the site property boundary.

Ambient air impacts were modeled for all criteria pollutants and TAPs for which compliance was not demonstrated via emissions threshold screening. The Industrial Source Complex-AERMOD View Version 9.9 interface provided by Lakes Environmental was used to support the air dispersion modeling. This version of the Lakes Environmental software incorporated the most recent version of AERMOD (Version v19191) at the time the modeling was completed. AERMOD requires input from several pre-processors, described below, for meteorological parameters, downwash parameters, and terrain heights. AERMOD incorporates the data from the pre-processors with emission estimates and physical exhaust release point characteristics to predict ambient concentrations as a result of the proposed project. The model calculates concentrations based on various averaging times (e.g., 1 hour, 24 hours, annual, etc.) for a network of receptors and results are compared to air quality standards.

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, and SO_2 emissions and long-term impacts (i.e., annual average) of DEEP, PM_{10}, $PM_{2.5}$, and NO_2 emissions.

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

7.1.1 Stack Parameters

H5 uses rain caps on generator exhaust stacks to prevent precipitation from entering the generator stacks. At or below 10 percent load, the exhaust velocity is not great enough to entirely open the rain caps. This obstructs the flow of the exhaust, reducing the vertical velocity and increasing the plume width. According to a review conducted by Ecology, the exhaust exit velocity is reduced by 30 percent for a vertical stack with a rain cap that has an angle of 45 degrees (multiply the actual exhaust velocity by an adjustment factor of 0.7). A conservatively low exhaust exit velocity adjustment factor of 0.42 was used to calculate the adjusted velocity at 10 percent generator operating load. The stack diameter was also adjusted to simulate the widening of the plume and to maintain the actual flow rate of the release. The effective stack diameter was calculated by dividing the actual flow by the adjusted exhaust velocity.

The stack exhaust velocity and exit temperature for long-term impacts was conservatively based on the worst-case vendor-reported exhaust velocity and lowest vendor-reported temperature.

The actual stack dimensions are 43 feet in height and 24 inches in inside diameter. Additionally, a model was run to demonstrate that with a smaller stack diameter of 20 inches, the maximum modeled concentrations are slightly lower. The adjusted stack velocities and diameters at 10 percent load were modeled as follows:

- Effective diameter = 36.96 inches
- Adjusted velocity = 600.86 feet per minute.

Because stack exhaust temperature and velocity impact dispersion of pollutants, a screening model was run to determine the operating load that results in the worst-case concentration for each pollutant and averaging period modeled. In the screening model, the exhaust temperature and exit velocity for each load case was modeled using a 1 pound per hour emission rate to generate a dispersion factor for each load and averaging period. The load-specific concentration for each pollutant was calculated by multiplying the dispersion factor by the emission rate for that load case. The results of the screening analysis are presented in Table 10.

An additional safety factor was applied reducing the modeled exhaust flow and temperature by 5 percent to account for variations in onsite environmental conditions.

7.1.2 Building Downwash

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

GEP stack height is defined as the height of the nearby structure(s) measured from the ground-level elevation at the base of the stack plus 1.5 times the lesser dimension, height, or projected width of the nearby structure(s). H5 Data Center's generator exhaust stacks will be lower than GEP height. The data center building height is 31 feet. The generator stacks are located on the east side of the building roof.

7.1.3 Receptor Grid

To model complex terrain, AERMOD requires information about the surrounding terrain. The AMS/EPA Regulatory Model Terrain Pre-processor (AERMAP, version 18081) was used to obtain the hill height scale and the base elevation for each receptor.

A receptor flagpole height of 1.5 meters (m) above ground was defined to approximate the human breathing zone. The receptor grid spacing increases with distance from the facility, as listed below:

- 12.5-m spacing from the property boundary to 150 m
- 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 from 2,000 m to 4,500 m
- 600-m spacing from 4,500 m to 10,000 m.

All generator stacks are located approximately the same distance from the eastern fence line, at 152 meters; the nearest fence boundary is 85 meters from the generator stack on the north side.

AERMAP requires the use of topographic data to estimate surface elevations above mean sea level. Digital topographic data (in the form of National Elevation Data files) for the analysis region were obtained from the Lakes Web GIS website (Lakes Environmental; accessed June 1, 2020) and processed for use in AERMOD. The National Elevation Data used for this project have a resolution of approximately 10 m (⅓ arc-second).

AERMAP produces a Receptor Output File (*.rou) containing the calculated terrain elevations and hill height scale for each receptor. The *.rou file was used as an input runstream file (AERMOD Include File). AERMAP also produces a Source Output File (*.sou). This file contains the calculated base elevations for all sources.

7.1.4 Meteorology

The AERMOD Meteorological Pre-Processor (AERMET; Version 19191) is the meteorological pre-processor model that estimates boundary-layer parameters for use in AERMOD. AERMET processes formatted meteorological data from observation stations and generates two input files for the AERMOD model: 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 meteorological observation data processed 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 20 miles from the H5 site. Five years (January 1, 2012 through December 31, 2016) of hourly surface data were processed in AERMET. AERMINUTE was run to reduce the instance of "calms." A potential concern related to the use of meteorological data for dispersion modeling is the high incidence of "calms," or periods of time with low wind speeds. NWS and Federal Aviation Administration data coding defines a wind speed of less than 3 knots as "calm" and assigns a value of 0 knots. This results in an overestimation of the amount of calm conditions. Similarly, if wind speed is up to 6 knots, but wind direction varies more than 60 degrees during a 2-minute averaging period, wind direction is reported as "missing." AERMINUTE reprocesses Automated Surface Observing System 1-minute wind data at a lower threshold and calculates hourly average wind speed and directions to supplement the standard hourly data processed in AERMET.
- NWS twice-daily upper air soundings from Spokane, Washington. Five years (January 1, 2012 through December 31, 2016) of upper air data were processed in AERMET.
- Surface characteristics of albedo, Bowen ratio, and surface roughness are used by AERMET in stage 3 of the processing. 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.

  AERSURFACE version 20060 was used to determine the albedo, Bowen ratio, and surface roughness based on land-use data for the area surrounding the surface observation site from the 2016 National Land Cover Database (USGS 1992). AERSURFACE calculates the percentage of land-use type within each of 12 equal sectors of a circle centered on the surface station tower. The default study radii of 1 kilometer (km) for surface roughness and 10 km for the Bowen ratio and albedo were used. Default months were assigned in AERSURFACE to represent the four seasonal categories as follows: 1) mid-summer with lush vegetation; 2) autumn with unharvested cropland; 3) winter with continuous snow; and 4) transitional spring with partial green coverage or short annuals. The AERSURFACE designation for an airport location (with the assumed surface roughness calculated based on 95 percent transportation and 5 percent commercial and industrial) is appropriate for this site.

  Annual precipitation data for Quincy for each modeled year was obtained from the Western Regional Climate Center database. The annual precipitation was within the top 30th percentile of the past 30 years of annual precipitation totals for 2012 and 2016. Therefore, in accordance with EPA guidance, surface moisture conditions are considered wet when compared to historical norms and Bowen ratio values for wet surface moisture were used for those 2 years. The annual precipitation was between the top and bottom 30th percentile of the past 30 years of annual precipitation totals for 2014 and 2015, so the Bowen ratio values for average surface moisture were used for those 2 years. The annual precipitation was below the bottom 30th percentile of the past 30 years of annual precipitation totals for 2013, so the Bowen ratio values for dry surface moisture were used for that year.

7.1.5 NO_X to NO_2 Conversion

The ambient NO_2 concentrations were calculated using the Plume Volume Molar Ratio Method (PVMRM) option within AERMOD. This AERMOD option calculates the amount of NO_X that is converted to NO_2 in the ambient air using a user-specified NO_2/NO_X equilibrium ratio, NO_2/NO_X in-stack ratio, and ambient ozone concentration. The PVMRM parameters were set as follows:

- Default NO_2/NO_X equilibrium ratio of 0.90
- NO_2/NO_X in-stack ratio of 0.1
- Ambient ozone concentration of 52.1 micrograms per cubic meter ($\mu g/m^3$) from the Idaho Department of Environmental Quality (IDEQ) 2014-2017 design value of criteria pollutants website, for the project area (IDEQ; accessed August 14, 2020).

7.1.6 Background Concentration

This evaluation includes background concentrations contributed by existing regional and local background sources. Regional background concentrations were obtained from the IDEQ website (IDEQ; accessed August 14, 2020). Ecology provided local background concentrations based on the "StoryMap" data for use in the second-tier review of TAPs and NO_2 1-hour NAAQS. Regional and local background concentrations were added to the modeled project concentrations to estimate the projected cumulative concentrations for those pollutants and averaging periods with results above the significant impact level (SIL).

7.1.7 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 concentrations to ASILs. Table 7 shows the estimated project emission rates for each TAP expected to be released in the H5 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 7, estimated project-only emissions of NO_2, DEEP, and CO are greater than their respective SQERs, so an ambient impact analysis was completed for those TAPs.

Ecology requires facilities to conduct a first-tier screening analysis for each TAP with emissions exceeding the SQER by modeling the 1st-highest 1-hour, 1st-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).

7.1.8 Monte Carlo Statistical Analysis

Project generator 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 pollutant dispersion. Due to the random unpredictability of weather patterns and variable timing of operation for intermittent emission sources, a statistical approach has been developed by Ecology using a stochastic Monte Carlo analysis to demonstrate compliance with air quality standards that is based on a percentile of the daily maximum ambient impacts, such as the $PM_{2.5}$ 24-hour average, NO_2 1-hour average, and SO_2 1-hour SO_2 NAAQS.

Ecology has generated a Monte Carlo script, for the statistical freeware "R," that was designed specifically to evaluate compliance of intermittent emissions, such as from emergency generators at data centers, and it has been previously used to demonstrate compliance with the NO_2 1-hour and $PM_{2.5}$ 24-hour average NAAQS for emergency generators at other data centers located in Washington State. This script processes output files from several AERMOD runs that are representative of each engine operating scenario. The script iteratively tests 1,000 combinations of results from all the generator runtime scenarios and hourly results to estimate the probability, at any given receptor location, that the NAAQS standard will be violated. The script estimates the 98th-percentile concentration at each individual receptor location within the modeling domain.

7.2 Modeled Emission Rates

7.2.1 Annual Averaging Period

Annual potential-to-emit rates were established based on the annual runtime assumption of 26 hours of operation per generator. To demonstrate compliance for the "theoretical maximum year" during which H5 would perform commissioning and stack testing of new generators, emission rates for modeling were calculated based on a runtime of 54 hours[4] for the proposed new generators. The total theoretical maximum year emission rate was divided by the number of hours in a year (8,760 hours) to establish the pounds per hour emission rate input into AERMOD. These theoretical hours of operation occur only in the first year of operation of the source. These emission assumptions are used for the following:

- $PM_{2.5}$ annual average
- NO_2 annual average
- TAPs annual average (DEEP).

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[4] In the NOC report dated April 13, 2021, models based on an annual averaging period were conducted based on a runtime assumption of 38 hours per year or 54 hours in a maximum year. This revised NOC report documents a lower annual runtime limit and annual runtime assumption to reduce the annual average DEEP concentration and resulting potential health risk. Because the higher runtime assumption in the April 13 NOC report results in a conservatively high air quality impact, other pollutants that require annual average models were not revised to reflect the lower runtime assumption since compliance is already demonstrated with higher runtimes. See Appendix G for revised tables 1, 3, 4, 6, 7, 12 and D-1 reflecting the lower annual runtime limit and annual runtime assumption used for all DEEP models.

7.2.2 Short-Term Averaging Period

To determine the worst-case ambient impacts for short-term averages (i.e., 1-hour, 3-hour, and 8-hour), the modeling setup assumed all 12 generators would be concurrently operating for 24 hours per day, 365 days per year. 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. These emission assumptions were used for the following:

- CO, 1-hour and 8-hour average
- SO_2, 1-hour and 3-hour average
- Any applicable TAP with short-term averaging period (NO_2).

7.2.3 24-Hour Averaging Period

The $PM_{2.5}$ 24-hour average NAAQS is also a probabilistic standard based on the 98th percentile of the 24-hour average concentration (8th-highest 24-hour concentration) averaged over 3 years. Ecology allows compliance to be demonstrated with this standard by modeling the 1st-highest daily impact with the 8th-highest daily emissions. As shown in Table D-2, the 8th-highest emitting day occurs during maintenance operations when one engine operates at a time for up to 6 hours per day.

The PM_{10} 24-hour average NAAQS is not to be exceeded more than once per year on average over 3 years. Therefore, compliance with this standard was modeled based on the 2nd-highest emitting day, which is a scenario that assumes all generators are operating concurrently due to an emergency power outage for 4 hours. Therefore, this modeling scenario assumed a 4-hour utility outage per day and the 1st-highest concentration from AERMOD was compared to the PM_{10} 24-hour average NAAQS.

7.3 Predicted Criteria Pollutant Ambient Concentrations

The results of the criteria pollutant modeling are provided in Table 11. Emission rate estimates and stack parameters for these scenarios are provided in Appendices D and F.

The model predicted ambient impacts for SO_2 would be less than the SIL. The model predicted ambient impacts plus background for all other pollutants and averaging periods would be less than the NAAQS.

7.3.1.1 NO_2 1-Hour Average Modeling and Statistical Analysis

For demonstration of project compliance with the NO_2 1-hour average NAAQS, each engine runtime scenario was characterized based on worst-case potential project emissions and stack parameters, as shown in Appendix F. The operating days considered in the statistical analysis were as follows:

- All 12 generators activate concurrently at full-variable load during an unplanned outage for up to 2 days per year

- Annual maintenance operations where up to 12 generators operate at a time will occur for up to 4 days per year
- Commissioning integrated site test where up to 12 generators operate at a time will occur for up to 1 day per year
- Stack testing where a single generator will operate at a time will occur up to 2 days per year
- As-needed testing where a single generator will operate at a time will occur up to 3 days per year
- Commissioning where a single generator will operate at a time will occur up to 6 days per year
- Monthly maintenance where up to two generators operate at a time will occur up to twice per month or 22 days per year.

Each of the above-noted engine runtime scenarios were modeled using the PVMRM option. The resultant daily maximum 1-hour average concentration of each of the above-listed AERMOD runs were post-processed using Ecology's Monte Carlo script in "R." Parameters for the Monte Carlo simulation are provided in Appendix F and electronic copies of the AERMOD and Monte Carlo simulation output files are provided in Appendix E. This script was used to establish the 98th-percentile impact value at every receptor location within the modeling domain.

Based on the assumptions outlined above for the stochastic Monte Carlo analysis, the 3-year rolling average of the 98th-percentile of the project maximum daily 1-hour average concentration of NO_2 is predicted to be 85 $\mu g/m^3$ and to occur west of the facility along the fence line (as shown on Figure 3). As shown in Table 11, the estimated cumulative concentration at this maximum project impact location is 137 $\mu g/m^3$, which is less than the NO_2 1-hour average NAAQS of 188 $\mu g/m^3$.

7.4 Predicted Toxic Air Pollutant Ambient Concentrations

The first-tier ambient concentration screening analysis is summarized in Table 12. This screening analysis was conducted on all TAPs with expected emission rates that exceed the SQER (as presented in Table 7). As shown in Table 12, the maximum modeled ambient concentration for CO is less than its ASIL.

7.4.1 Annual Average DEEP Impacts

The DEEP modeling analysis was conducted by assuming that all generators at the facility would operate for the theoretical maximum annual runtime hours. Further details on the modeling input parameters are provided in Appendix G (revised Table D-1 reflects the lower annual runtime limit). The maximum modeled annual average ambient DEEP concentration was 0.37 $\mu g/m^3$ (Table G-12), which exceeds the ASIL of 0.0033 $\mu g/m^3$. The 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).

7.4.2 1-Hour NO_2 Impacts During Facility-Wide Concurrent Generator Operation

The AERMOD model for this scenario was set up to assume that H5 would operate 12 generators for 24 hours per day, 365 days per year. The maximum modeled 1st-highest 1-hour average ambient NO_2 concentration was 919 µg/m^3 (Table 12), which exceeds the ASIL of 470 µg/m^3. 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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8.0 REFERENCES

Cascade Analytical. 2020. Analytical Services Report: Well Water and Domestic Water (City), H5 Data Center, Quincy, Washington. Cascade Analytical, Inc. October 27.

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

Eisele, B. 2020. "Re: Quincy Air Permitting - Information Request." From Bruce Eisele, H5 Data Centers, to Mark Brunner, Landau Associates, Inc. June 1.

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

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

EPA. 2005. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions: Final Rule. US Environmental Protection Agency. 40 CFR Part 51. November 9. http://www.epa.gov/scram001/guidance/guide/appw_05.pdf.

EPA. 2019. EPA Air Pollution Control Cost Manual. US Environmental Protection Agency. Revised as of December 2019. https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution.

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

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

Kline, S.G. 2017. Telephone Conversation: "Reduction of Drift Droplet Rate." From Stephen G. Kline, Baltimore Air Coil, to Mark Brunner, Landau Associates, Inc. December 22.

Lakes Environmental. "webGIS." Lakes Environmental Software. http://www.webgis.com/.

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.

Shank, M. 2017. "Re: Cooling Tower Drift Rate." From Matthew Shank, Product Application Manager - Industrial Process Market, Evapco, to Saahil Tumber, Senior Associate, Environmental Systems Design, Inc. September 27.

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

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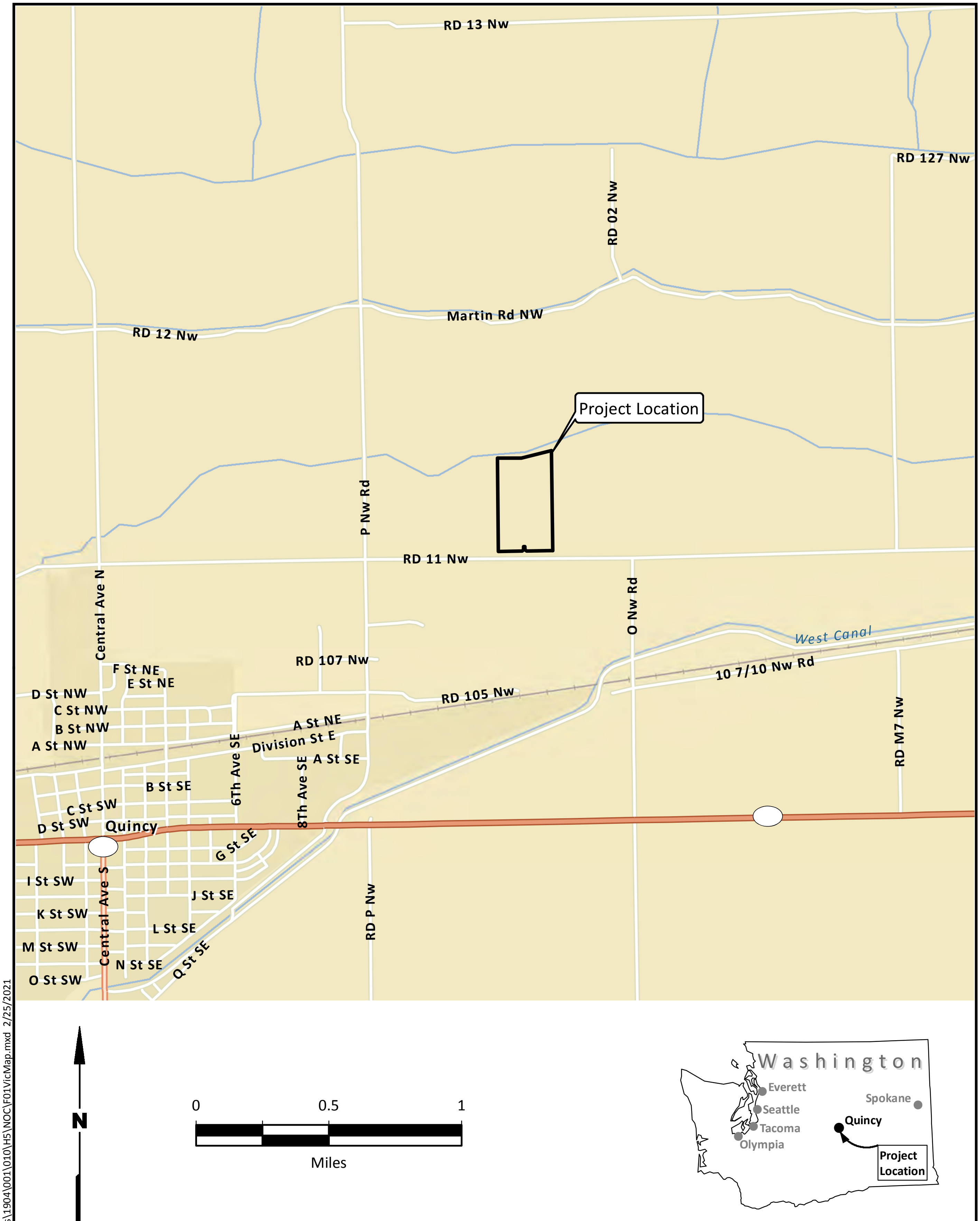

Data Sources: Douglas County GIS; Esri.

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H5 Data Centers Quincy, Washington	**Vicinity Map**	Figure 1

Legend

- 🟢 Cooling Tower Location
- 🔴 Generator Stack Location
- ✕ Fence Line
- ▭ Subject Property

Note

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

0 300 600

Scale in Feet

Data Sources: Grant County GIS; Esri World Imagery.

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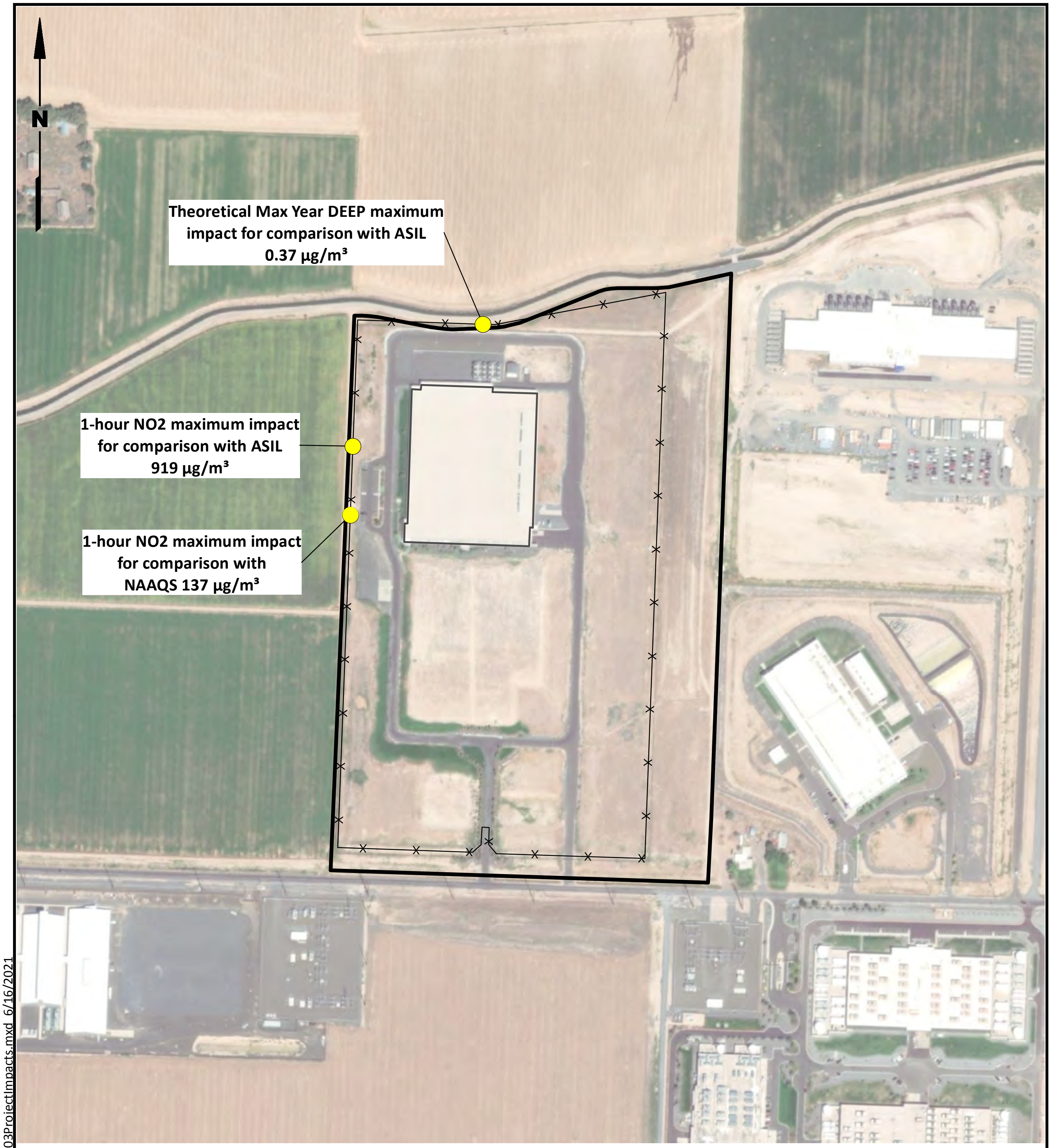
H5 Data Centers Quincy, Washington	**Site Map**	Figure 2



Legend

⌧ Fence Line

▭ Subject Property

Note

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

0 500 1,000

Scale in Feet

Data Sources: Grant County GIS; Esri World Imagery.

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LANDAU ASSOCIATES

H5 Data Centers Quincy, Washington	**Project Impacts**	Figure 3

Abbreviations and Acronyms
H5 Data Centers
Quincy, Washington

Abbreviations and Acronyms:

$\mu g/m^3$	micrograms per cubic meter
ASIL	acceptable source impact level
avg	averaging
BH	"back-half" condensable emissions
Btu	British thermal unit
CAS	Chemical Abstract Service number
cfm	cubic feet per minute
CO	carbon monoxide
DEEP	diesel engine exhaust particulate matter
E	Easting
FH	"front-half" filterable emissions
ft	feet
gph	gallons per hour
gpm	gallons per minute
HC	hydrocarbons
HQ	hazard quotient
hr	hour
in	inches
L	liter
lbs	pounds
lbs/hr	pounds per hour
m	meters
mg	milligrams
MMBtu	million British thermal units
MW	megawatts
MWe	megawatts electrical
N	Northing
NA	not applicable
NAAQS	National Ambient Air Quality Standards
No.	number
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NTE	not to exceed
PM	particulate matter
PM_{10}	particulate matter with aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$	particulate matter with aerodynamic diameter less than or equal to 2.5 microns
ppm	parts per million
PTE	potential-to-emit
Sec	section
SO2	sulfur dioxide
SQER	small-quantity emission rate
TAPs	toxic air pollutants
TPY	tons per year
UTM	universal transverse mercator coordinate system zone
VOCs	volatile organic compounds

Table 1
Equipment Summary and Operating Rates
H5 Data Centers
Quincy, Washington

Engine Parameter	Value
Generator output (kW)	2,250
Number of generators	12
Fuel type	ULSD
Fuel usage per genset (gph)[a]	167
Annual operating limit per genset (hr/yr)	38
Annual number of startups per genset	20
Maximum year operating hours per genset (hr/yr)[b]	66
Maximum year number of startups per genset (hr/yr)[b]	41

Notes:

[a] Maximum of proposed generator models at any load (≤100 percent load).

[b] Maximum Year hours accounts for commissioning and stack testing. Commissioning hours include 24 hours for each generator running one at a time and 4 hours of 12 generators running concurrently for site integration testing. A stack test is performed on one generator for 6 hours every 5 years.

Table 2
Vendor-Reported Air Pollutant Emission Rates
H5 Data Centers
Quincy, Washington

Pollutant	Worst-case Emissions[a] (lb/hr)
NO_X	47
CO	11
HC	2.6
DEEP[b]	1.6
PM (FH+BH)[c]	4.2

Notes:

[a] Pollutant-specific worst-case emission rate for any model at any load (≤100 percent load).

[b] DEEP is assumed equal to front-half NTE particulate emissions, as reported by the vendors.

[c] FH+BH (Front-half and back-half emissions) was calculated by summing vendor-reported PM and HC emission rates.

Table 3
Fuel-Based Emissions Summary
H5 Data Centers
Quincy, Washington

Engine Parameters	Value
Generator Output (kW)	2,250
Annual Operating Limit (hrs)	38
Maximum Year Operating Hours (hrs)[a]	66
No. of Generators	12
Fuel Usage Per Genset (gph)	167
Heat Input (MMBtu/hr)	23

Fuel Parameters	Value
Fuel Type	ULSD
Fuel Sulfur Content (ppmw)	15
Fuel Density (lb/gal)	7.1
Fuel Heat Content (Btu/gal)	137,000

Duration	Units	Hourly	Daily	Annual Average	Maximum Year[a]
Fuel Usage (per period)	Gallons	2,005	8,021	76,198	132,343
Heat Input (per period)	MMBtu	275	1,099	10,439	18,131

Pollutant	CAS Number	Emission factor	Short-Term Emission Rate[b] Each Genset Hourly (lb/hr)	Combined Hourly (lb/hr)	Combined Daily (lb/day)	Annual Emission Rate Average (tpy)	Maximum Year[a] (tpy)
SO_2	7446-09-5	0.0015% Sulfur (wt)	3.6E-02	4.3E-01	1.7E+00	8.1E-03	1.4E-02
1,3-Butadiene	106-99-0	3.91E-05 lb/MMBtu [c]	9.4E-04	1.1E-02	3.3E-02	2.1E-04	3.7E-04
Acetaldehyde	75-07-0	2.52E-05 lb/MMBtu [c]	6.1E-04	7.3E-03	2.1E-02	1.4E-04	2.4E-04
Acrolein	107-02-8	7.88E-06 lb/MMBtu [c]	1.9E-04	2.3E-03	6.7E-03	4.2E-05	7.4E-05
Benzene	71-43-2	7.76E-04 lb/MMBtu [c]	1.9E-02	2.2E-01	6.6E-01	4.2E-03	7.3E-03
Benz(a)anthracene	56-55-3	6.22E-07 lb/MMBtu [c]	1.5E-05	1.8E-04	5.3E-04	3.3E-06	5.8E-06
Benzo(a)pyrene	50-32-8	2.57E-07 lb/MMBtu [c]	6.2E-06	7.4E-05	2.2E-04	1.4E-06	2.4E-06
Benzo(b)fluoranthene	205-99-2	1.11E-06 lb/MMBtu [c]	2.7E-05	3.2E-04	9.4E-04	6.0E-06	1.0E-05
Benzo(k)fluoranthene	207-08-9	2.18E-07 lb/MMBtu [c]	5.3E-06	6.3E-05	1.8E-04	1.2E-06	2.0E-06
Chrysene	218-01-9	1.53E-06 lb/MMBtu [c]	3.7E-05	4.4E-04	1.3E-03	8.2E-06	1.4E-05
Dibenz(a,h)anthracene	53-70-3	3.46E-07 lb/MMBtu [c]	8.4E-06	1.0E-04	2.9E-04	1.9E-06	3.3E-06
Formaldehyde	50-00-0	7.89E-05 lb/MMBtu [c]	1.9E-03	2.3E-02	6.7E-02	4.2E-04	7.4E-04
Indeno(1,2,3-cd)pyrene	193-39-5	4.14E-07 lb/MMBtu [c]	1.0E-05	1.2E-04	3.5E-04	2.2E-06	3.9E-06
Naphthalene	91-20-3	1.30E-04 lb/MMBtu [c]	3.1E-03	3.8E-02	1.1E-01	7.0E-04	1.2E-03
Propylene	115-07-1	2.79E-03 lb/MMBtu [c]	6.7E-02	8.1E-01	2.4E+00	1.5E-02	2.6E-02
Toluene	108-88-3	2.81E-04 lb/MMBtu [c]	6.8E-03	8.1E-02	2.4E-01	1.5E-03	2.6E-03
Xylenes	95-47-6	1.93E-04 lb/MMBtu [c]	4.7E-03	5.6E-02	1.6E-01	1.0E-03	1.8E-03

Table 3
Fuel-Based Emissions Summary
H5 Data Centers
Quincy, Washington

Notes:

[a] Maximum Year hours accounts for commissioning and stack testing.

[b] Hourly emission rate accounts for one startup event per hour. Daily emission rate is based on a power outage scenario and accounts for one startup event.

[c] Source: AP-42 Sec 3.3 and 3.4 (EPA 1995).

Table 4
Startup Emissions Summary
H5 Data Centers
Quincy, Washington

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

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

Emissions per Cold-Start Event[a]

Pollutant	Emissions (lb/event) Startup (1 min)	 Warm (59 min)
NO_X[b]	0.79	47
CO	1.7	11
HC	0.19	2.6
DEEP	0.11	1.5
PM (FH+BH)	0.30	4.1

Total Emissions with Cold-Start

Pollutant	Hourly per Engine (lbs/hr)	Annual per Engine (lbs/yr)	Maximum Year per Engine (lbs/yr)
NO_X	47	1,801	3,136
CO	13	454	800
HC	2.8	103	181
DEEP[b]	1.6	61	106
PM (FH+BH)	4.4	164	287

Notes:

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

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

Table 5
Fluid Cooler Emissions Summary
H5 Data Centers
Quincy, Washington

Parameter	Value
Number of Cooling Towers	8
Hours of Operation	8,760 hr/yr
Feedwater TDS	442 mg/L
Cycles of Concentration	3 cycles
Recirculation Rate	7,352 gpm
Drift Rate	0.0005 % of recirc flow
Liquid Drift Droplet Emissions	147 lb/hr

		Emission Rate				
		Hourly per Cooling Tower (lbs/hr)	Total Hourly (lbs/hr)	Total Daily (lbs/day)	Total Annual	
Pollutant	Emission Factor				(lb/yr)	(tpy)
Criteria Pollutants						
PM	100% of TDS [a]	0.024	0.20	4.7	1,709	0.85
PM$_{10}$	100% of TDS [a]	0.024	0.20	4.7	1,709	0.85
PM$_{2.5}$	78% of TDS [a]	0.019	0.15	3.6	1,330	0.66
Toxic Air Pollutants						
Arsenic (As)	**2.9E-03 mg/L** [b]	**1.6E-07**	**1.3E-06**	**3.0E-05**	**1.1E-02**	**5.6E-06**
Beryllium (Be)	*1.0E-04 mg/L* [b]	*5.5E-09*	*4.4E-08*	*1.1E-06*	*3.9E-04*	*1.9E-07*
Cadmium (Cd)	*1.0E-04 mg/L* [b]	*5.5E-09*	*4.4E-08*	*1.1E-06*	*3.9E-04*	*1.9E-07*
Chromium (Cr)	**1.7E-04 mg/L** [b]	**9.4E-09**	**7.5E-08**	**1.8E-06**	**6.6E-04**	**3.3E-07**
Cobalt (Co)	*3.0E-03 mg/L* [b]	*1.7E-07*	*1.3E-06*	*3.2E-05*	*1.2E-02*	*5.8E-06*
Copper (Cu)	**0.327 mg/L** [b]	**1.8E-05**	**1.4E-04**	**3.5E-03**	**1.3**	**6.3E-04**
Lead (Pb)	**1.2E-02 mg/L** [b]	**6.6E-07**	**5.3E-06**	**1.3E-04**	**4.6E-02**	**2.3E-05**
Manganese (Mn)	**1.7E-02 mg/L** [b]	**9.2E-07**	**7.3E-06**	**1.8E-04**	**6.4E-02**	**3.2E-05**
Mercury (Hg)	*2.0E-04 mg/L* [b]	*1.1E-08*	*8.8E-08*	*2.1E-06*	*7.8E-04*	*3.9E-07*
Selenium (Se)	**1.7E-03 mg/L** [b]	**9.6E-08**	**7.7E-07**	**1.8E-05**	**6.7E-03**	**3.4E-06**
Vanadium (V)	**6.1E-02 mg/L** [b]	**3.4E-06**	**2.7E-05**	**6.5E-04**	**0.24**	**1.2E-04**
Total Cyanide	*0.010 mg/L* [b]	*5.5E-07*	*4.4E-06*	*1.1E-04*	*3.9E-02*	*1.9E-05*
Ammonia (as N)	*0.070 mg/L* [b]	*3.9E-06*	*3.1E-05*	*7.4E-04*	*0.27*	*1.4E-04*
Total Phosphorus	**0.070 mg/L** [b]	**3.9E-06**	**3.1E-05**	**7.4E-04**	**0.27**	**1.4E-04**

Notes:

[a] Methodology for calculating the evaporated solid particle size distribution based on the droplet size distribution is taken from "Calculating Realistic PM$_{10}$ Emissions from Cooling Towers," Reisman and Frisbie, Environmental Progress, July 2002.

[b] Italic text indicates reporting limits were used because the analyte was not detected. Bold text indicates the analyte was detected and the maximum value is used (Cascade Analytical 2020).

Table 6
Potential-to-Emit Emissions Summary
H5 Data Centers
Quincy, Washington

Pollutant	PTE Proposed Sources[a]			PTE Existing Sources[b]	PTE Facility-Wide Total	
	Hourly (lbs/hr)	Annual (tpy)	Maximum Year (tpy)	Annual (tpy)	Annual (tpy)	Maximum Year (tpy)
Criteria Pollutants						
NO_X	569	11	19	46	57	65
CO	152	2.7	4.8	6.4	9.1	11
VOCs	33	0.62	1.1	0.040	0.66	1.1
SO_2	0.43	0.0081	0.014	0.043	0.051	0.057
PM_{10}/$PM_{2.5}$ (gensets only)	53	1.0	1.7	0.43 [c]	1.4	2.2
PM_{10} (all Sources)	53	1.8	2.6	0.43 [c]	2.3	3.0
$PM_{2.5}$ (all sources)	53	1.6	2.4	0.43 [c]	2.1	2.8
Generator TAPs						
Primary NO_2[d]	57	1.1	1.9	4.6	5.7	6.5
DEEP	20	0.36	0.64	0.43 [c]	0.79	1.1
CO	152	2.7	4.8	6.4	9.1	11
SO_2	0.43	0.0081	0.014	0.043	0.051	0.057
1,3-Butadiene[e]	1.1E-02	2.1E-04	3.7E-04	9.9E-04	1.2E-03	1.4E-03
Acetaldehyde	7.3E-03	1.4E-04	2.4E-04	6.4E-04	7.8E-04	8.8E-04
Acrolein	2.3E-03	4.2E-05	7.4E-05	2.0E-04	2.4E-04	2.7E-04
Benzene	2.2E-01	4.2E-03	7.3E-03	2.0E-02	2.4E-02	2.7E-02
Benz(a)anthracene [e]	1.8E-04	3.3E-06	5.8E-06	1.6E-05	1.9E-05	2.2E-05
Benzo(a)pyrene [e]	7.4E-05	1.4E-06	2.4E-06	6.5E-06	7.9E-06	9.0E-06
Benzo(b)fluoranthene [e]	3.2E-04	6.0E-06	1.0E-05	2.8E-05	3.4E-05	3.9E-05
Benzo(k)fluoranthene [e]	6.3E-05	1.2E-06	2.0E-06	5.5E-06	6.7E-06	7.6E-06
Chrysene [e]	4.4E-04	8.2E-06	1.4E-05	3.9E-05	4.7E-05	5.3E-05
Dibenz(a,h)anthracene [e]	1.0E-04	1.9E-06	3.3E-06	8.8E-06	1.1E-05	1.2E-05
Formaldehyde	2.3E-02	4.2E-04	7.4E-04	2.0E-03	2.4E-03	2.7E-03
Indeno(1,2,3-cd)pyrene [e]	1.2E-04	2.2E-06	3.9E-06	1.1E-05	1.3E-05	1.4E-05
Naphthalene	3.8E-02	7.0E-04	1.2E-03	3.3E-03	4.0E-03	4.5E-03
Propylene [d]	8.1E-01	1.5E-02	2.6E-02	7.1E-02	8.6E-02	9.7E-02
Toluene	8.1E-02	1.5E-03	2.6E-03	7.1E-03	8.6E-03	9.8E-03
Xylenes	5.6E-02	1.0E-03	1.8E-03	4.9E-03	5.9E-03	6.7E-03
Cooling Tower TAPs						
Arsenic	1.3E-06	5.6E-06	5.6E-06	1.4E-06	6.9E-06	6.9E-06
Beryllium [e]	4.4E-08	1.9E-07	1.9E-07	4.8E-08	2.4E-07	2.4E-07
Cadmium	4.4E-08	1.9E-07	1.9E-07	2.1E-07	4.0E-07	4.0E-07
Chromium [f]	7.5E-08	3.3E-07	3.3E-07	3.2E-06	3.6E-06	3.6E-06
Cobalt	1.3E-06	5.8E-06	5.8E-06	1.4E-06	7.3E-06	7.3E-06
Copper	1.4E-04	6.3E-04	6.3E-04	2.2E-06	6.4E-04	6.4E-04
Lead	5.3E-06	2.3E-05	2.3E-05	3.4E-07	2.3E-05	2.3E-05
Manganese	7.3E-06	3.2E-05	3.2E-05	1.4E-06	3.4E-05	3.4E-05
Mercury	8.8E-08	3.9E-07	3.9E-07	2.1E-07	5.9E-07	5.9E-07
Selenium [e]	7.7E-07	3.4E-06	3.4E-06	8.3E-07	4.2E-06	4.2E-06
Vanadium [e]	2.7E-05	1.2E-04	1.2E-04	2.9E-05	1.5E-04	1.5E-04
Total Cyanide [e]	4.4E-06	1.9E-05	1.9E-05	4.8E-06	2.4E-05	2.4E-05
Ammonia [e]	3.1E-05	1.4E-04	1.4E-04	3.4E-05	1.7E-04	1.7E-04
Total Phosphorus [e]	3.1E-05	1.4E-04	1.4E-04	3.4E-05	1.7E-04	1.7E-04

Table 6
Potential-to-Emit Emissions Summary
H5 Data Centers
Quincy, Washington

Notes:

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

[b] From Permit 18AQ-E044.

[c] $PM_{2.5}$ and DEEP were not reported for existing sources. All PM_{10} is conservatively assumed to be $PM_{2.5}$. For Generators, all PM_{10} is conservatively assumed to be DEEP.

[d] Primary NO_2 is assumed to be 10% of the NO_X.

[e] Emergency generator TAPs not reported in Permit 18AQ-E044 were scaled using AP-42 emission factors and reported benzene PTE. Cooling tower taps not reported in Permit 18AQ-E044 were scaled based on Arsenic concentrations.

[f] All chromium was assumed to be chromium (III), soluble particulates.

Table 7
Project Emissions Compared to Small-Quantity Emission Rates
H5 Data Centers
Quincy, Washington

Pollutant	CAS Number	Averaging Period	Project Emissions	*De Minimis*	SQER	Required Action
			(lbs/averaging period)			
Primary NO_2	10102-44-0	1-hr	57	0.46	0.87	Model
DEEP	DPM	year	1,276	0.027	0.54	Model
CO	630-08-0	1-hr	152	1.1	43	Model
SO_2	7446-09-5	1-hr	0.43	0.46	1.2	
1,3-Butadiene	106-99-0	year	0.73	0.27	5.4	Report
Acetaldehyde	75-07-0	year	0.47	3.0	60	
Acrolein	107-02-8	24-hr	6.7E-03	1.3E-03	2.6E-02	Report
Benzene	71-43-2	year	15	1.0	21	Report
Benz(a)anthracene	56-55-3	year	1.2E-02	0.045	0.89	
Benzo(a)pyrene	50-32-8	year	4.8E-03	0.0082	0.16	
Benzo(b)fluoranthene	205-99-2	year	2.1E-02	0.045	0.89	
Benzo(k)fluoranthene	207-08-9	year	4.1E-03	0.045	0.89	
Chrysene	218-01-9	year	2.9E-02	0.45	8.9	
Dibenz(a,h)anthracene	53-70-3	year	6.5E-03	0.0041	0.082	Report
Formaldehyde	50-00-0	year	1.5	1.4	27	Report
Indeno(1,2,3-cd)pyrene	193-39-5	year	7.8E-03	0.045	0.89	
Naphthalene	91-20-3	year	2.4	0.24	4.8	Report
Propylene	115-07-1	24-hr	2.4	11	220	
Toluene	108-88-3	24-hr	0.24	19	370	
Xylenes	1330-20-7	24-hr	0.16	0.82	16	
Arsenic	—	year	1.1E-02	2.5E-03	0.049	Report
Beryllium	—	year	3.9E-04	3.4E-03	0.068	
Cadmium	—	year	3.9E-04	1.9E-03	0.039	
Chromium [a]	—	24-hr	1.8E-06	3.7E-04	7.4E-03	
Cobalt	7440-48-4	24-hr	3.2E-05	3.7E-04	7.4E-03	
Copper	—	1-hr	1.4E-04	9.3E-03	0.19	
Lead	—	year	4.6E-02	1.0E+01	14	
Manganese	—	24-hr	1.8E-04	1.1E-03	0.022	
Mercury	7439-97-6	24-hr	2.1E-06	1.1E-04	2.2E-03	
Selenium	—	24-hr	1.8E-05	7.4E-02	1.5	
Vanadium	7440-62-2	24-hr	6.5E-04	3.7E-04	7.4E-03	Report
Total Cyanide	74-90-8	24-hr	1.1E-04	3.0E-03	0.059	
Ammonia	7664-41-7	24-hr	7.4E-04	1.9E+00	37	
Total Phosphorus	7723-14-0	24-hr	7.4E-04	7.4E-02	1.5	

Notes:

Highlighted cells indicate pollutants that require ambient air dispersion model analysis

[a] All chromium was assumed to be Chromium (III), soluble particulates.

Table 8

Summary of Cost Effectiveness for Removal of Criteria Pollutants

H5 Data Centers

Quincy, Washington

	$PM_{10}/PM_{2.5}$	CO	Total VOCs	NO_x	Actual Cost for Combined Criteria Pollutants
Acceptable Unit Cost (dollars per ton)	$12,000	$5,000	$12,000	$12,000	
Control Option	**Actual Cost to Control (dollars per ton)**				
Tier 4 Integrated Control Package[a]	$2,022,000	$288,000	$1,442,000	$69,000	$52,000
SCR[b]	--	--	--	$40,000	$40,000
Catalyzed Passive DPF[c]	$485,000	$69,000	$346,000	--	$51,000
DOC[e]	$632,000	$26,000	$133,000	--	$21,000
	not acceptable	not acceptable	not acceptable	not acceptable	

Notes:

[a] The expected control efficiency for a Tier 4 integrated control package to reduce emission is 90% for NO_x, 85% for PM (front half), 80% for CO, and 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 85% for PM (front half), 80% for CO, and 70% for VOCs.

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

Abbreviations and Acronyms:

-- = 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
NO_x = Nitrogen oxides
$PM_{2.5}/PM_{10}$ = 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
VOC = Volatile organic compound

Table 9
Summary of Cost Effectiveness for Removal of Toxic Air Pollutants
H5 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 Passive DPF[c]	DOC[d]
DEEP	0.0033	6.9	$72,544	$2,022,000	--	$485,000	$632,000
CO	23,000	0.1	$731	$288,000	--	$69,000	$26,000
NO_2 (10% of NO_x)	470	1.8	$18,472	$644,000	$374,000	--	--
Benzene	0.035	5.9	$61,882	$214,767,000	--	$51,509,000	$19,744,000
1,3-Butadiene	0.0059	6.7	$69,951	$4,262,379,000	--	$1,022,280,000	$391,841,000
Acrolein	0.06	5.7	$59,359	$21,149,623,000	--	$5,072,481,000	$1,944,285,000
Naphthalene	0.029	6.0	$62,612	$1,281,993,000	--	$307,470,000	$117,854,000
Formaldehyde	0.17	5.2	$54,691	$2,112,282,000	--	$506,605,000	$194,182,000
Dibenz(a,h)anthracene	0.00083	7.5	$78,863	$481,673,492,000	--	$115,523,549,000	$44,280,254,000
Carcinogenic VOCs	NA	NA	NA	$47,600,000	--	$11,416,000	$4,376,000
Non-Carcinogenic VOCs	NA	NA	NA	$71,442,000	--	$17,135,000	$6,568,000
Combined TAPs Cost-effectiveness				$181,000	$374,000	$60,000	$25,000
Presumed Acceptable Annual Cost for Combined TAP Control (based on the Hanford Method)				$12,205	$18,472	$9,759	$3,715

Notes:

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

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

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

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

Abbreviations and Acronyms:

-- = Ineffective control technology
µg/m^3 = Micrograms per cubic meter
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
NO_2 = Nitrogen dioxide
SCR = Selective catalytic reduction
SO_2 = Sulfur dioxide
TAP = Toxic air pollutant
VOC = Volatile organic compound

Table 10
Worst-Case Load Screening Analysis Results
H5 Data Centers
Quincy, Washington

Worst-Case Load Screening Analysis Results

Load	Dispersion Factor			Model Results[a]						
	1-hour	24-hour	Annual	NO_X 1-hour	CO 1-hour	SO_2 and TAPs 1-hour	$PM_{10}/PM_{2.5}$ 24-hour	$PM_{2.5}$ Annual	NO_X Annual	DEEP Annual
	($\mu g/m^3$ per lb/hr)			($\mu g/m^3$)						
Proposed MTU 2.25-MWe Genset										
10%	67	13	1.3	184	306	0.20	54	5.5	11	2.0
25%	47	12	1.0	118	162	0.20	34	2.8	6	0.66
50%	37	11	0.82	143	144	0.69	26	2.0	13	0.41
75%	32	10	0.71	167	184	0.83	29	2.0	22	0.56
100%	27	10	0.62	173	251	0.93	21	1.3	30	0.31
Proposed Kohler 2.25-MWe Genset										
10%	62	13	1.2	146	275	0.46	8	0.81	6.5	0.20
25%	48	12	1.0	148	535	0.56	14	1.1	8.3	0.64
50%	36	11	0.79	142	218	0.73	10	0.76	13	0.28
75%	29	10	0.66	144	312	0.85	14	0.90	15	0.49
100%	28	10	0.64	177	200	0.99	11	0.75	32	0.25

Notes:

Highlighted cells indicate which operating load correlates to the highest modeled impact for each pollutant and averaging period.

Table 11
Estimated Project and Background Impacts Compared to National Ambient Air Quality Standards
H5 Data Centers
Quincy, Washington

Criteria Pollutant	Averaging Period	National and Washington AAQS (µg/m^3)	Significant Impact Level (µg/m^3)	Modeled Operating Scenario	AERMOD Filename	Modeled Project Concentration (µg/m^3)	Background Concentration[a] (µg/m^3)	Projected Cumulative Concentration[b] (µg/m^3)
CO	8-hour	10,000	500	Unplanned power outage	CO.ADI	2,250 [c]	885	3,135
	1-hour	40,000	2,000	Unplanned power outage	CO.ADI	4,945 [c]	1,266	6,211
SO_2	3-hour	1,310	25	Unplanned power outage	SO2.ADI	7.0 [c]	--	--
	1-hour	200	7.8	Unplanned power outage	SO2.ADI	7.7 [c]	--	--
PM_{10}	24-hour	150	5	Unplanned power outage	PM10_24HR_PO.ADI	71 [d]	78	149
$PM_{2.5}$	Annual	12	0.2	Maximum Year	PM25_ANN.ADI	1.0	5.6	6.6
	24-hour	35	1.2	Non-emergency operations (Ranked Day 8)[e]	PM25_24HR_MMT.ADI	15 [f]	18	33
NO_2	Annual	100	1	Maximum Year	NO2_ANN.ADI	3.5	4.7	8
	1-hour	188	7.5	Refer to Monte Carlo Evaluation (Appendix F)	Refer to Monte Carlo Evaluation (Appendix F)	85 [g]	52	137

Notes:

[a] Background concentrations obtained from Idaho Department of Environmental Quality for model and monitoring data from July 2014 through June 2017 (IDEQ; accessed August 14, 2020). Location-specific 1-hour NO_2 background concentrations provided by Ecology via the online Storymap tool for Quincy, WA.

[b] Cumulative concentrations are calculated for pollutants where project-related contributions are above the significant impact level.

[c] Reported values represent the 1st-highest modeled impacts over 5 years

[d] Reported values represent the 6th-highest modeled impacts over 5 years.

[e] Monthly maintenance operations are expected to occur on each engine for up to 1 hour per engine. Multiple sequential tests may occur within the same day for up to 6 hours per day.

[f] Reported values represent the average of the maximum 3 years of 1st-highest modeled impacts at each receptor.

[g] Reported value is based on the Monte Carlo assessment for NO_2. See the Monte Carlo Analysis (Appendix F) for further details.

Table 12
Estimated Project Impacts Compared to Acceptable Source Impact Levels
H5 Data Centers
Quincy, Washington

Pollutant	CAS No.	Averaging Period	Facility-wide Emission Rate (lbs/avg. period)	Project Concentration ($\mu g/m^3$)	ASIL ($\mu g/m^3$)
Primary NO_2	10102-44-0	1-hr	57	919	470
DEEP	DPM	year	1,276	0.42 [a]	0.0033
CO	630-08-0	1-hr	152	4,945	23,000

Notes:

[a] Predicted maximum impacts are based on emissions for the maximum year.

APPENDIX A

Vendor Specification Sheets

Emission Data Request Form - MTU 16V4000DS2250

Project Data

Project Name	Zach D
IPAS #	TBD
Requested by	Brian Ponstein
Request Date	
Requested response Date	-
Request for	Customer

Site Specific Data

Elevation	[m]	330.0
	[ft]	1083.0
Intake Air Temperature at air filter	[°C]	25.0
	[F]	77.0
Charge Air Coolant Temp.	[°C]	45.0
	[F]	113.0
Rel. Humidity	[%]	20-100%

Engine Data (ESCM Calculated Data)

Application	Genset					
Application Group	Standby		3D			
Engine Model	16V4000G84					
Emission Optimization	EPA Tier 2					
Fuel	#2 Diesel (ASTM975, EN590)					
Intake air depression	15	mbar	6.0	in H_2O		
max. Exhaust Backpressure	30	mbar	12.0	in H_2O		
ESCM derate?	no					
CyclePoint	[-]	n1	n2	n3	n4	n5
Power (P/Pcycle)	[-]	1	0.75	0.5	0.25	0.1
Power, mech.	[kW]	2500	1875	1250	625	250
Speed (n/nN)	[-]	1	1	1	1	1
Speed	[rpm]	1800	1800	1800	1800	1800
Fuel Consumption	gal/hr	163	123	86	20	14
Exhaust gas flow	kg/h	14327	13109	11239	8380	5530

Not to exceed:

Exhaust Temperature after turbo	[°C]	501	424	373	335	240
	[F]					
NOx	[g/kWh]	8.6	7.4	5.7	4.5	15.7
	[g/bhp-h]					
CO	[g/kWh]	1.7	1.4	1.4	2.5	8.3
	[g/bhp-h]					
HC	[g/kWh]	0.3	0.5	0.7	1.6	4.8
	[g/bhp-h]					
Residual O_2	[%]	9.5	11.6	13.3	14.7	16.2
Particulate (PM)	[g/kWh]	0.09	0.19	0.18	0.49	2.82
	[g/bhp-h]					

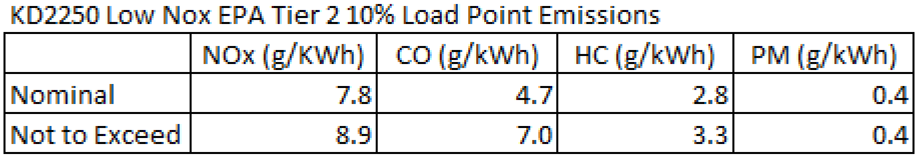
Amy Maule

From: Amy Maule
Sent: Tuesday, May 25, 2021 9:32 AM
To: Amy Maule
Subject: FW: [External Sender] RE: Emission Data for Kohler KD62V12

From: Vincent Biggart <Vincent.Biggart@powersystemswest.com>
Sent: Wednesday, September 30, 2020 9:46 AM
To: Bruce Eisele <Bruce.Eisele@H5datacenters.com>
Cc: Dave Hilley <Dave.Hilley@H5datacenters.com>; Steve Unger <Steve.Unger@H5datacenters.com>
Subject: RE: [External Sender] RE: Emission Data for Kohler KD62V12

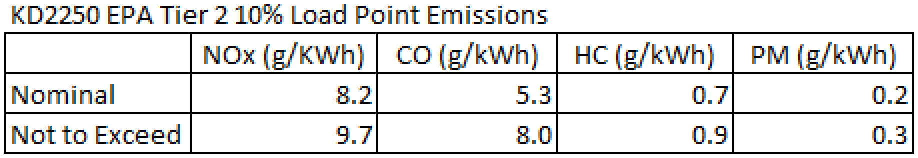
Hi Bruce,

Below is the emissions data at 10% load for standard and low NOx KD2250.



KD2250 Low Nox EPA Tier 2 10% Load Point Emissions

	NOx (g/KWh)	CO (g/kWh)	HC (g/kWh)	PM (g/kWh)
Nominal	7.8	4.7	2.8	0.4
Not to Exceed	8.9	7.0	3.3	0.4



KD2250 EPA Tier 2 10% Load Point Emissions

	NOx (g/KWh)	CO (g/kWh)	HC (g/kWh)	PM (g/kWh)
Nominal	8.2	5.3	0.7	0.2
Not to Exceed	9.7	8.0	0.9	0.3

Let me know if you need anything else.

Thanks

Vincent

POWER SYSTEMS WEST

Vincent Biggart
Application Engineer, Power Systems West
D: (503) 220-5361 | M: (503) 522-7404
E: Vincent.Biggart@powersystemswest.com | W: www.powersystemswest.com
A: 6110 N. Cutter Circle, Portland, Oregon 97217

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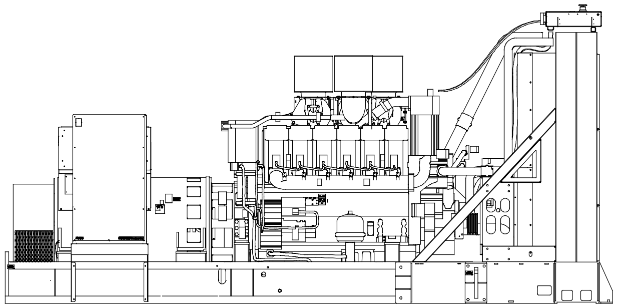
Industrial Diesel Generator Set - KD2250

Tier 2 EPA-Certified for Stationary Emergency Applications



KDxxxx designates a generator set with a Tier 2 EPA-Certified engine.
KDxxxx-F designates a 60 Hz generator set with a fuel optimized engine.

Ratings Range

		60 Hz
Standby:	**kW**	2210-2250
	kVA	2762-2812
Prime:	**kW**	1980-2040
	kVA	2475-2550

Standard Features

- Kohler Co. provides one-source responsibility for the generating system and accessories.
- The generator set and its components are prototype-tested, factory-built, and production-tested.
- The 60 Hz generator set offers a UL 2200 listing.
- The generator set accepts rated load in one step.
- The 60 Hz generator set meets NFPA 110, Level 1, when equipped with the necessary accessories and installed per NFPA standards.
- A standard three-year or 1000-hour limited warranty for standby applications. Five-year basic, five-year comprehensive, and ten-year extended limited warranties are also available.
- A standard two-year or 8700-hour limited warranty for prime power applications.
- Other features:
  - ○ Kohler designed controllers for one-source system integration and remote communication. See Controllers on page 4.
  - ○ The low coolant level shutdown prevents overheating (standard on radiator models only).

General Specifications

Orderable Generator Model Number	GMKD2250
Manufacturer	Kohler
Engine: model	KD62V12
Alternator Choices	KH05790TO4D KH06220TO4D KH06930TO4D KH07000TO4D KH07630TO4D KH07770TO4D KH08100TO4D KH08430TO4D KH09270TO4D
Performance Class	Per ISO 8528-5
One Step Load Acceptance	100%
Voltage	Wye, 600 V., 4160 V, or 6600-13800 V
Controller	APM603, APM802
Fuel Tank Capacity, L (gal.)	8577-16383 (2266-4328)
Fuel Consumption, L/hr (gal./hr) 100% at Standby	632 (167.1)
Fuel Consumption, L/hr (gal./hr) 100% at Prime Power	592 (156.5)
Emission Level Compliance (KDxxxx)	Tier 2
Open Unit Noise Level @ 7 m dB(A) at Rated Load	—
Data Center Continuous (DCC) Rating (Refer to TIB-101 for definitions)	Same as the Prime Rating below

Generator Set Ratings

				150°C Rise Standby Rating		130°C Rise Standby Rating		125°C Rise Prime Rating		105°C Rise Prime Rating	
Alternator	**Voltage**	**Ph**	**Hz**	**kW/kVA**	**Amps**	**kW/kVA**	**Amps**	**kW/kVA**	**Amps**	**kW/kVA**	**Amps**
KH05790TO4D	277/480	3	60	2250/2812	3383	2250/2812	3383	2040/2550	3068	2040/2550	3068
KH06930TO4D	277/480	3	60	2250/2812	3383	2250/2812	3383	2040/2550	3068	2040/2550	3068
KH07770TO4D	220/380	3	60	2250/2812	4273	2210/2762	4197	2040/2550	3875	1980/2475	3761
	240/416	3	60	2250/2812	3903	2250/2812	3903	2040/2550	3540	2040/2550	3540
	347/600	3	60	2250/2812	2706	2250/2812	2706	2040/2550	2454	2040/2550	2454
KH08430TO4D	220/380	3	60	2250/2812	4273	2250/2812	4273	2040/2550	3874	2040/2550	3874
	240/416	3	60	2250/2812	3903	2250/2812	3903	2040/2550	3540	2040/2550	3540
	277/480	3	60	2250/2812	3383	2250/2812	3383	2040/2550	3068	2040/2550	3068
	347/600	3	60	2250/2812	2706	2250/2812	2706	2040/2550	2454	2040/2550	2454
	2400/4160	3	60	2250/2812	391	2250/2812	391	2040/2550	354	2040/2550	354
KH07000TO4D	347/600	3	60	2250/2812	2706	2250/2812	2706	2040/2550	2454	2040/2550	2454
	2400/4160	3	60	2250/2812	391	2250/2812	391	2040/2550	354	2040/2550	354
KH06220TO4D	2400/4160	3	60	2250/2812	391	2250/2812	391	2040/2550	354	2000/2500	347

RATINGS: All three-phase units are rated at 0.8 power factor. *Standby Ratings:* The standby rating is applicable to varying loads for the duration of a power outage. There is no overload capability for this rating. *Prime Power Ratings:* At varying load, the number of generator set operating hours is unlimited. A 10% overload capacity is available for one hour in twelve. Ratings are in accordance with ISO-8528-1 and ISO-3046-1. For limited running time and continuous ratings, consult the factory. Obtain technical information bulletin (TIB-101) for ratings guidelines, complete ratings definitions, and site condition derates. The generator set manufacturer reserves the right to change the design or specifications without notice and without any obligation or liability whatsoever.

				130°C Rise Standby Rating		105°C Rise Prime Rating	
Alternator	**Voltage**	**Ph**	**Hz**	**kW/kVA**	**Amps**	**kW/kVA**	**Amps**
KH07630TO4D	3810/6600	3	60	2250/2812	246	2040/2550	224
	7200/12470	3	60	2250/2812	131	2040/2550	119
	7620/13200	3	60	2250/2812	123	2040/2550	112
	7970/13800	3	60	2250/2812	118	2040/2550	107
KH08100TO4D	3810/6600	3	60	2250/2812	246	2040/2550	224
	7200/12470	3	60	2250/2812	131	2040/2550	119
	7620/13200	3	60	2250/2812	123	2040/2550	112
	7970/13800	3	60	2250/2812	118	2040/2550	107
KH09270TO4D	3810/6600	3	60	2250/2812	246	2040/2550	224
	7200/12470	3	60	2250/2812	131	2040/2550	119
	7620/13200	3	60	2250/2812	123	2040/2550	112
	7970/13800	3	60	2250/2812	118	2040/2550	107

Three different sized alternators have 13,200 MV

Engine Specifications	**60 Hz**
Manufacturer	Kohler
Engine: model	KD62V12
Engine: type	4-Cycle, Turbocharged, Intercooled
Cylinder arrangement	12-V
Displacement, L (cu. in.)	62 (3783)
Bore and stroke, mm (in.)	175 x 215 (6.89 x 8.46)
Compression ratio	16.0:1
Piston speed, m/min. (ft./min.)	774 (2539)
Main bearings: quantity, type	7, Precision Half Shells
Rated rpm	1800
Max. power at rated rpm, kWm (BHP)	2500 (3352)
Cylinder head material	Cast Iron
Crankshaft material	Steel
Valve (exhaust) material	Steel
Governor: type, make/model	KODEC Electronic Control
Frequency regulation, no-load to-full load	Isochronous
Frequency regulation, steady state	±0.25%
Frequency	Fixed
Air cleaner type, all models	Dry

Lubricating System	**60 Hz**
Type	Full Pressure
Oil pan capacity with filter (initial fill), L (qt.) §	335 (354)
Oil filter: quantity, type §	6, Cartridge
Oil cooler	Water-Cooled

§ Kohler recommends the use of Kohler Genuine oil and filters.

Fuel System	**60 Hz**
Fuel supply line, min. ID, mm (in.)	25 (1.0)
Fuel return line, min. ID, mm (in.)	19 (0.75)
Max. fuel flow, Lph (gph)	848 (224.0)
Min./max. fuel pressure at engine supply connection, kPa (in. Hg)	- 30/30 (- 8.8/8.8)
Max. return line restriction, kPa (in. Hg)	30 (8.9)
Fuel filter: quantity, type	2, Primary Engine Filter 2, Fuel/Water Separator
Recommended fuel	#2 Diesel ULSD

Fuel Consumption	**60 Hz**
Diesel, Lph (gph) at % load	**Standby Rating**
100%	632 (167.1)
75%	518 (136.9)
50%	360 (95.2)
25%	210 (55.4)
Diesel, Lph (gph) at % load	**Prime Rating**
100%	592 (156.5)
75%	463 (122.2)
50%	333 (87.9)
25%	203 (53.7)

Radiator System	**60 Hz**	
Ambient temperature, °C (°F)*	50 (122)	40 (104)
Engine jacket water capacity, L (gal.)	356 (94)	
Radiator system capacity, including engine, L (gal.)	643 (170)	539 (142)
Engine jacket water flow, Lpm (gpm)	2082 (550)	
Heat rejected to cooling water at rated kW, dry exhaust, kW (Btu/min.)	820 (46632)	
Charge cooler water flow, Lpm (gpm)	662 (174)	
Heat rejected to charge cooling water at rated kW, dry exhaust, kW (Btu/min.)	730 (41514)	
Water pump type	Centrifugal	
Fan diameter, including blades, mm (in.)	2235 (88)	1901 (75)
Fan, kWm (HP)	90 (120.7)	85 (114)
Max. restriction of cooling air, intake and discharge side of radiator, kPa (in. H_2O)	0.125 (0.5)	

* Enclosure with enclosed silencer reduces ambient temperature capability by 5°C (9°F).

Remote Radiator System†	**60 Hz**
Exhaust manifold type	Dry
Connection sizes:	Class 150 ANSI Flange
Water inlet/outlet, mm (in.)	216 (8.5) Bolt Circle
Intercooler inlet/outlet, mm (in.)	178 (7.0) Bolt Circle
Static head allowable above engine, kPa (ft. H_2O)	70 (23.5)

† Contact your local distributor for cooling system options and specifications based on your specific requirements.

Exhaust System	60 Hz
Exhaust flow at rated kW, m^3/min. (cfm)	536 (18928)
Exhaust temperature at rated kW at 25°C (77°F) ambient, dry exhaust, °C (°F)	510 (950)
Maximum allowable back pressure, kPa (in. Hg)	8.5 (2.5)
Exh. outlet size at eng. hookup, mm (in.)	See ADV drawing

Electrical System	60 Hz
Battery charging alternator:	
Ground (negative/positive)	Negative
Volts (DC)	24
Ampere rating	140
Starter motor qty. at starter motor power rating, rated voltage (DC)	Standard: 2 @ 9 kW, 24; Redundant (optional); 2 @ 15 kW, 24
Battery, recommended cold cranking amps (CCA):	
Quantity, CCA rating each, type (with standard starters)	4, 1110, AGM
Quantity, CCA rating each, type (with redundant starters)	8, 1110, AGM
Battery voltage (DC)	12

Air Requirements	60 Hz	
	50°C	40°C
Radiator-cooled cooling air, m^3/min. (scfm)‡	2549 (90000)	2321 (82000)
Cooling air required for generator set when equipped with city water cooling or remote radiator, based on 14°C (25°F) rise, m^3/min. (scfm)‡	1002 (35385)	
Combustion air, m^3/min. (cfm)	191 (6745)	
Heat rejected to ambient air:		
Engine, kW (Btu/min.)	120 (6824)	
Alternator, kW (Btu/min.)	160 (9099)	

‡ Air density = 1.20 kg/m^3 (0.075 lbm/ft^3)

Alternator Specifications		60 Hz
Type		4-Pole, Rotating-Field
Exciter type		Brushless, Permanent-Magnet Pilot Exciter
Voltage regulator		Solid-State, Volts/Hz
Insulation:		NEMA MG1, UL 1446, Vacuum Pressure Impregnated (VPI)
Material		Class H, Synthetic, Nonhygroscopic
Temperature rise		130°C, 150°C Standby
Bearing: quantity, type		1 or 2, Sealed
Coupling type		Flexible Disc or Coupling
Amortisseur windings		Full
Alternator winding type (up to 600 V)		Random Wound
Alternator winding type (above 600 V)		Form Wound
Rotor balancing		125%
Voltage regulation, no-load to full-load		±0.25%
Unbalanced load capability		100% of Rated Standby Current
Peak motor starting kVA:		(35% dip for voltages below)
480 V	KH05790TO4D	5225
480 V	KH06930TO4D	5990
480 V	KH08430TO4D	9908

Alternator Standard Features

- The pilot-excited, permanent magnet (PM) alternator provides superior short-circuit capability.
- All models are brushless, rotating-field alternators.
- 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.
- Sustained short-circuit current enabling downstream circuit breakers to trip without collapsing the alternator field.
- Self-ventilated and dripproof construction.
- Superior voltage waveform from two-thirds pitch windings and skewed stator.
- Brushless alternator with brushless pilot exciter for excellent load response.

NOTE: See TIB-102 Alternator Data Sheets for alternator application data and ratings, efficiency curves, voltage dip with motor starting curves, and short circuit decrement curves.

Controllers

APM802 Controller
Provides advanced control, system monitoring, and system diagnostics for optimum performance and compatibility.

- 12-inch graphic display with touch screen and menu control provide easy local data access
- Measurements are selectable in metric or English units
- User language is selectable
- Two USB ports allow connection of a flash drive, mouse, or keypad
- Electrical data, mechanical data, and system settings can be saved to a flash drive
- Ethernet port allows connection to a PC type computer or Ethernet switch
- The controller supports Modbus® RTU and TCP protocols
- NFPA 110 Level 1 capability

Refer to G6-152 for additional controller features and accessories.

Modbus® is a registered trademark of Schneider Electric.

APM603 Controller
Provides advanced control, system monitoring, and system diagnostics for optimum performance and compatibility.

- 7-inch graphic display with touch screen and menu control provides easy local data access
- Measurements are selectable in metric or English units
- Paralleling capability to control up to 8 generators on an isolated bus with first-on logic, synchronizer, kW and kVAR load sharing, and protective relays
  Note: Parallel with other APM603 controllers only
- Generator management to turn paralleled generators off and on as required by load demand
- Load management to connect and disconnect loads as required
- Controller supports Modbus® RTU, Modbus® TCP, SNMP and BACnet®
- Integrated voltage regulator with ±0.25% regulation
- Built-in alternator thermal overload protection
- UL-listed overcurrent protective device
- NFPA 110 Level 1 capability

Refer to G6-162 for additional controller features and accessories.

BACNet® is a registered trademark of ASHRAE.

Codes and Standards

- Engine- generator set is designed and manufactured in facilities certified to ISO 9001.
- Generator set meets NEMA MG1, BS5000, ISO, DIN EN, and IEC standards, NFPA 110.
- Engine generator set is tested to ISO 8528-5 for transient response.
- The generator set and its components are prototype-tested, factory-built, and production-tested.

Third-Party Compliance

- Tier 2 EPA-Certified for Stationary Emergency Applications

Available Approvals and Listings

☐ California OSHPD Approval
☐ CSA Certified
☐ IBC Seismic Certification
☐ UL 2200 Listing
☐ cUL Listing (fuel tanks only)
☐ Florida Dept. of Environmental Protection (FDEP) Compliance (fuel tanks only)

Warranty Information

- A standard three-year or 1000-hour limited warranty for standby applications. Five-year basic, five-year comprehensive, and ten-year extended limited warranties are also available.
- A standard two-year or 8700-hour limited warranty for prime power applications.

Available Warranties for Standby Applications

☐ 5-Year Basic Limited Warranty
☐ 5-Year Comprehensive Limited Warranty
☐ 10-Year Major Components Limited Warranty

Standard Features

- Closed Crankcase Ventilation (CCV) Filters
- Customer Connection
- Local Emergency Stop Switch
- Oil Drain and Coolant Drain Extension
- Operation and Installation Literature
- Fan Bearing Grease Extension
- Fuel/Water Separator
- Generator Heater
- Spring Isolation Under the Skid

Available Options

Circuit Breakers

Type

☐ Magnetic Trip
☐ Thermal Magnetic Trip
☐ Electronic Trip (LI)
☐ Electronic Trip with Short Time (LSI)
☐ Electronic Trip with Ground Fault (LSIG)

Rating

☐ 80%
☐ 100%

Operation

☐ Manual
☐ Electrically Operated (for paralleling)

Circuit Breaker Mounting

☐ Generator Mounted
☐ Remote Mounted
☐ Bus Bar (for remote mounted breakers)

Enclosed Remote Mounted Circuit Breakers

☐ NEMA 1 (15-5000 A)
☐ NEMA 3R (15-1200 A)

Engine Type

☐ KDxxxx Tier 2 EPA-Certified Engine
☐ KDxxxx-F Fuel Optimized Engine

Approvals and Listings

☐ California OSHPD Approval
☐ CSA Certified
☐ IBC Seismic Certification
☐ UL 2200 Listing
☐ cUL Listing (fuel tanks only)
☐ Florida Dept. of Environmental Protection (FDEP) Compliance (fuel tanks only)

Enclosed Unit

☐ Sound Level 1 Enclosure/Fuel Tank Package
☐ Sound Level 2 Enclosure/Fuel Tank Package

Open Unit

☐ Exhaust Silencer, Critical (kits: PA-354880 qty. 3)
☐ Exhaust Silencer, Hospital (kits: PA-354900 qty. 3)
☐ Flexible Exhaust Connector, Stainless Steel

Controller

☐ Input/Output, Digital
☐ Input/Output, Thermocouple (standard on 4160 V and above)
☐ Load Shed (APM802 only)
☐ Manual Key Switch
☐ Remote Emergency Stop Switch
☐ Lockable Emergency Stop Switch
☐ Remote Serial Annunciator Panel

Cooling System

☐ Block Heater; 9000 W, 208 V, (Select 1 Ph or 3 Ph) *
☐ Block Heater; 9000 W, 240 V, (Select 1 Ph or 3 Ph) *
☐ Block Heater; 9000 W, 380 V, 3 Ph *
☐ Block Heater; 9000 W, 480 V, (Select 1 Ph or 3 Ph) *

* Required for Ambient Temperatures Below 10°C (50°F) and block heater kit includes air intake manifold grid heater

Electrical System

☐ Battery, AGM (kit with qty. 4)
☐ Battery Charger
☐ Battery Heater; 100 W, 120 V, 1Ph
☐ Battery Rack and Cables
☐ Redundant Starters

Fuel System

☐ Flexible Fuel Lines
☐ Restriction Gauge (for fuel/water separator)

Literature

☐ General Maintenance
☐ NFPA 110
☐ Overhaul
☐ Production

Miscellaneous

☐ Air Cleaner, Heavy Duty
☐ Air Cleaner Restriction Indicator
☐ Automatic Oil Replenishment System
☐ Engine Fluids (oil and coolant) Added
☐ Rated Power Factor Testing

Electrical Package (Requires Enclosure selection)

☐ Basic Electrical Package (select 1 Ph or 3 Ph)
☐ Wire Battery Charger (1 Ph)
☐ Wire Block Heater (select 1 Ph or 3 Ph)
☐ Wire Controller Heater (1 Ph)
☐ Wire Generator Heater (1 Ph)

Warranty (Standby Applications only)

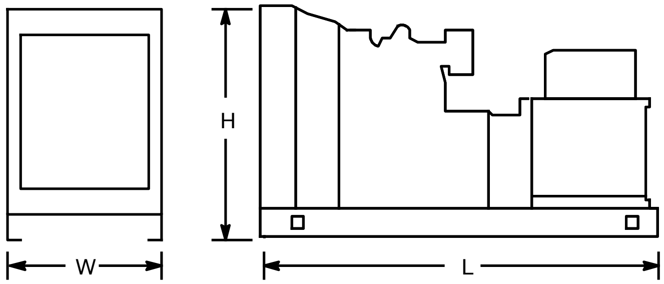
☐ 5-Year Basic Limited Warranty
☐ 5-Year Comprehensive Limited Warranty
☐ 10-Year Major Components Limited Warranty

Other

☐
☐

Dimensions and Weights

Overall Size, max., L x W x H, mm (in.):	6957 x 2852 x 3307 (273.9 x 112.3 x 130.2)
Weight, radiator model, max. wet, kg (lb.):	27033 (59598)

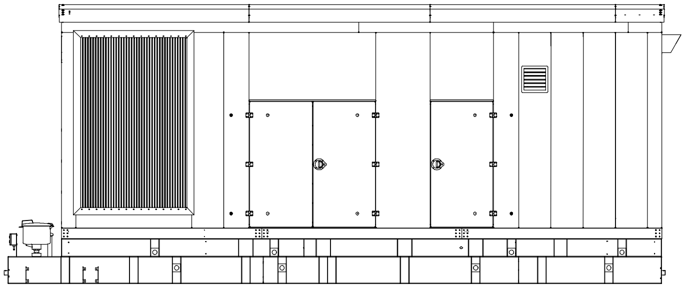


NOTE: This drawing is provided for reference only and should not be used for planning installation. Contact your local distributor for more detailed information.

Sound Enclosures and Subbase Fuel Tank

Sound Level 1 Enclosure Standard Features

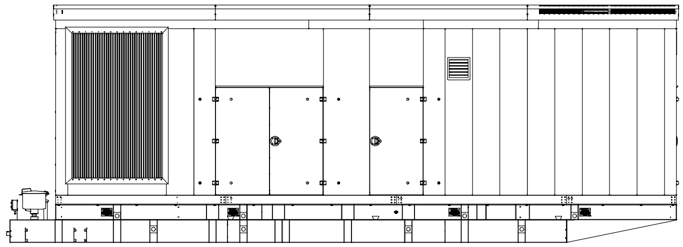
- Lift base or tank-mounted, aluminum construction enclosure with internal-mounted, exhaust silencers.
- Every enclosure has a sloped roof to reduce the buildup of moisture and debris.
- Sound attenuated enclosure that offers noise reduction using acoustic insulation, acoustic-lined air inlets and an acoustic-lined air discharge.
- Fade-, scratch-, and corrosion-resistant Kohler® Power Armor™ automotive-grade textured finish.
- Acoustic insulation that meets UL 94 HF1 flammability classification.
- Enclosure has large access doors that are hinged and removable which allow for easy maintenance.
- Lockable, flush-mounted door latches.
- Air inlet louvers reduce rain and snow entry.
- High wind bracing, 241 kph (150 mph).



Sound Level 1 Enclosure
(Shown with available spill containment)

Sound Level 2 Enclosure Standard Features

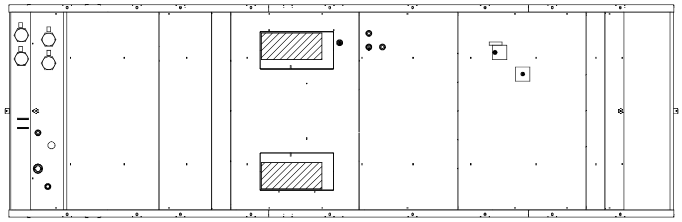
- Includes all of the sound level 1 enclosure features with the addition of up to 51 mm (2 in.) acoustic insulation material, intake sound baffles, vertical air discharge, and secondary silencers.
- Louvered air inlet and vertical outlet hood with 90 degree angles to redirect air and reduce noise.



Sound Level 2 Enclosure
(Shown with available spill containment)

Subbase Fuel Tank Features

- The fuel tank has a Power Armor Plus™ textured epoxy-based rubberized coating.
- The above-ground rectangular secondary containment tank mounts directly to the generator set, below the generator set skid (subbase).
- Both the inner and outer tanks have UL-listed emergency relief vents.
- Flexible fuel lines are provided with subbase fuel tank selection.
- The containment tank's construction protects against fuel leaks or ruptures. The inner (primary) tank is sealed inside the outer (secondary) tank. The outer tank contains the fuel if the inner tank leaks or ruptures.
- The above ground secondary containment subbase fuel tank meets UL 142 requirements.
- Features include:
  - ○ Additional fittings for optional accessories (qty. 3)
  - ○ Electrical stub-up area open to bottom
  - ○ Emergency inner and outer tank relief vents
  - ○ Fuel fill with lockable cap and 51 mm (2 in.) riser
  - ○ Fuel leak detection switch
  - ○ Fuel level mechanical gauge
  - ○ Fuel level sender
  - ○ Normal vent
  - ○ Removable engine supply and return diptubes



Subbase Fuel Tank (Top View)

DISTRIBUTED BY:

KOHLER

KD2250

60 Hz. Diesel Generator Set
Tier 2 EPA Certified for Stationary Emergency Applications
EMISSION OPTIMIZED DATA SHEET

ENGINE INFORMATION

Model:	KD62V12	Bore:	175 mm (6.89 in.)
Type:	4-Cycle, 12-V Cylinder	Stroke:	215 mm (8.46 in.)
Aspiration:	Turbocharged, Intercooled	Displacement:	62 L (3783 cu. in.)
Compression ratio:	16:0:1		
Emission Control Device:	Direct Diesel Injection, Engine Control Module, Turbocharger, Charge Air Cooler		

NOMINAL EMISSION DATA

Cycle point	**100% ESP**	**75% ESP**	**50% ESP**	**25% ESP**
Power [kW]	2500	1875	1250	625
Speed [rpm]	1800	1800	1800	1800
Exhaust Gas Flow [kg/h]	15017	14404	9978	5904
Exhaust Gas Temperature [C]	451	447	450	453
NO_x [g/kWh]	7.6	4.7	4.9	5.1
CO [g/kWh]	0.4	0.8	0.7	2.5
HC [g/kWh]	0.12	0.13	0.19	0.30
PM [g/kWh]	0.05	0.12	0.09	0.32

NOT TO EXCEED EMISSION DATA

Cycle point	**100% ESP**	**75% ESP**	**50% ESP**	**25% ESP**
NO_x [g/kWh]	9.0	5.6	5.8	6.1
CO [g/kWh]	1.3	2.6	2.2	8.1
HC [g/kWh]	0.14	0.15	0.22	0.35
PM [g/kWh]	0.07	0.18	0.13	0.47

10% load: Exhaust Temp 390C, Exhaust Flow 4042 kg/h, Fuel Flow 34.5 gal/hr

TEST METHODS AND CONDITIONS

Test Methods:
Steady-State emissions recorded per EPA CFR 40 Part 89, and ISO8178-1 during operation at rated engine speed (+/-2%) and stated constant load (+/-2%) with engine temperatures, pressures and emission rated stabilized.

Fuel Specification:
40-48 Cetane Number, 0.05 Wt. % max. Sulfur; Reference ISO8178-5, 40CFR86.1313-98 Type 2-D and ASTM D975 No. 2-D.

Reference Conditions:
25 °C (77 °F) Air Inlet Temperature, 40 °C (104 °F) Fuel Inlet Temperature, 100 kPa (29.53 in Hg) Barometric Pressure; 10.7 g/kg (75 grains H2O/lb.) of dry air Humidity (required for NOx correction); Intake Restriction set to maximum allowable limit for clean filter; Exhaust Back pressure set to maximum allowable limit.

Data was taken from a single engine test according to the test methods, fuel specification and reference conditions stated above and is subjected to instrumentation and engine-to-engine variability. Tests conducted with alternate test methods, instrumentation, fuel or reference conditions can yield different results.

Data and specifications subject to change without notice.

07/2018 Rev. -

Diesel Generator Set

MTU 16V4000 DS2250 50 °C

2,250 kWe/60 Hz/Standby/380 - 13,800V

System ratings

Voltage (L-L)	380V † ‡	416V † ‡	440V † ‡	480V † ‡	600V ‡
Phase	3	3	3	3	3
PF	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60
kW	2,250	2,250	2,250	2,250	2,250
kVA	2,812	2,812	2,812	2,812	2,812
Amps	4,273	3,903	3,691	3,383	2,706
skVA@30% voltage dip	6,885	5,573	4,047	4,914	6,271
Generator model*	841-L75-M	841-L75-M	641-VL95-M	641-VL90-M	841-S60-M
Temp rise	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C
Connection	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE

Voltage (L-L)	4,160V	12,470V	13,200V	13,800V
Phase	3	3	3	3
PF	0.8	0.8	0.8	0.8
Hz	60	60	60	60
kW	2,250	2,250	2,250	2,250
kVA	2,812	2,812	2,812	2,812
Amps	390	130	123	117
skVA@30% voltage dip	5,852	4,266	4,017	4,390
Generator model*	841-S60-M	4P6.6-2800-M	4P6.6-2800-M	4P6.6-2800-M
Temp rise	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C
Connection	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE

* Consult the factory for alternate configuration.

† UL 2200 offered

‡ CSA offered

A Rolls-Royce
solution

Certifications and standards

- Emissions
  - EPA Tier 2 certified
- Generator set is designed and manufactured in facilities certified to standards ISO 9001:2008 and ISO 14001:2004
- Seismic certification – optional
  - IBC certification
  - OSHPD pre-approval
- UL 2200 - optional (refer to *System ratings* for availability)
- CSA - optional (refer to *System ratings* for availability)
  - CSA C22.2 No. 100
  - CSA C22.2 No. 14
- Performance Assurance Certification (PAC)
  - 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 is a single source supplier
- Global product support
- 2 year standard warranty
- 16V4000 diesel engine
  - 76.3 liter displacement
  - Common rail fuel injection
  - 4-cycle
- Complete range of accessories
- Cooling system
  - Integral set-mounted
  - Engine-driven fan
- Generator
  - Brushless, rotating field generator
  - 2/3 pitch windings
  - PMG (Permanent Magnet Generator) supply to regulator
  - 300% short circuit capability
- Digital control panel(s)
  - UL recognized, CSA certified, NFPA 110
  - Complete system metering
  - LCD display

Standard equipment*

Engine

- Air cleaners
- Oil pump
- Oil drain extension and S/O valve
- Full flow oil filter
- Closed crankcase ventilation
- Jacket water pump
- Inter cooler water pump
- Thermostats
- Blower fan and fan drive
- Radiator - unit mounted
- Electric starting motor - 24V
- Governor – electronic isochronous
- Base - structural steel
- SAE flywheel and bell housing
- Charging alternator - 24V
- Battery box and 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-ventilated and drip-proof
- Superior voltage 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
- 1-bearing, sealed
- Flexible coupling
- Full amortisseur windings
- 125% rotor balancing
- 3-phase voltage sensing
- ±0.25% voltage regulation
- 100% of rated load - one step
- 5% maximum total harmonic distortion

Digital control panel(s)

- Digital metering
- Engine parameters
- Generator protection functions
- Engine protection
- CANBus ECU communications
- Windows®-based software
- Multilingual capability
- Remote communications to RDP-110 remote annunciator
- Programmable input and output contacts
- UL recognized, CSA certified, CE approved
- Event recording
- IP 54 front panel rating with integrated gasket
- NFPA 110 compatible

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* Represents standard product only. Consult the factory/MTU Distributor for additional configurations.

Application data

Engine

Manufacturer	MTU
Model	16V4000G84S
Type	4-cycle
Arrangement	16-V
Displacement: L (in^3)	76.3 (4,656)
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)	2,500 (3,353)
Speed regulation	± 0.25%
Air cleaner	dry

Liquid capacity (Lubrication)

Total oil system: L (gal)	300 (79.3)
Engine jacket water capacity: L (gal)	175 (46.2)
After cooler water capacity: L (gal)	50 (13.2)
System coolant capacity: L (gal)	719 (190)

Electrical

Electric volts DC	24
Cold cranking amps under -17.8 °C (0 °F)	2,800

Fuel system

Fuel supply connection size	-16 JIC 37° female 1” NPT adapter provided
Fuel return connection size	-16 JIC 37° female 1” NPT adapter provided
Maximum fuel lift: m (ft)	1 (3)
Recommended fuel	diesel #2
Total fuel flow: L/hr (gal/hr)	1,200 (317)

Fuel consumption

At 100% of power rating: L/hr (gal/hr)	617 (163)
At 75% of power rating: L/hr (gal/hr)	467 (123)
At 50% of power rating: L/hr (gal/hr)	325 (86)

Cooling - radiator system

Ambient capacity of radiator: °C (°F)	50 (122)
Maximum restriction of cooling air: intake and discharge side of radiator: kPa (in. H_2O)	0.12 (0.5)
Water pump capacity: L/min (gpm)	1,350 (357)
After cooler pump capacity: L/min (gpm)	583 (154)
Heat rejection to coolant: kW (BTUM)	930 (52,888)
Heat rejection to after cooler: kW (BTUM)	680 (38,671)
Heat radiated to ambient: kW (BTUM)	202.1 (11,493)
Fan power: kW (hp)	105.9 (142)

Air requirements

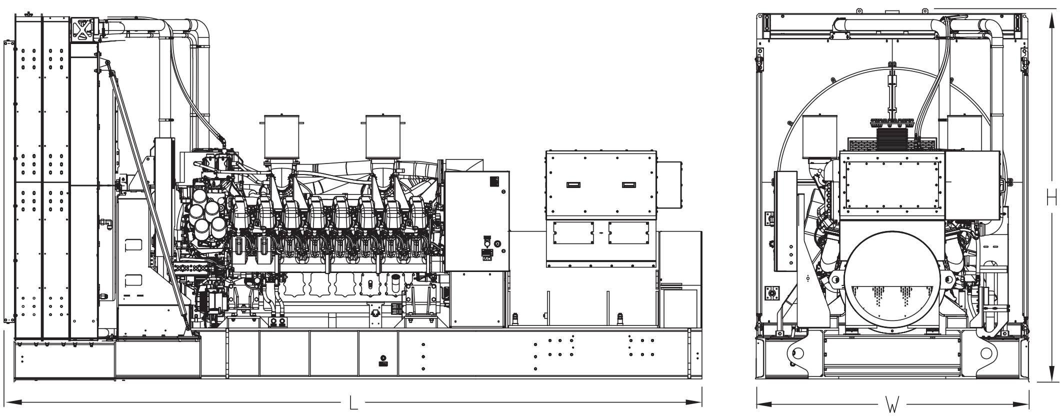
Aspirating: *m^3/min (SCFM)	192 (6,780)
Air flow required for radiator cooled unit: *m^3/min (SCFM)	3,089 (109,079)
Remote cooled applications; air flow required for dissipation of radiated generator set heat for a maximum of 25 °F rise: *m^3/min (SCFM)	739 (26,241)

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

Exhaust system

Gas temp. (stack): °C (°F)	505 (941)
Gas volume at stack temp: m^3/min (CFM)	504 (17,799)
Maximum allowable back pressure at outlet of engine, before piping: kPa (in. H_2O)	8.5 (34.1)

Weights and dimensions



Drawing above for illustration purposes only, based on standard open power 480 volt 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)
Open power unit (OPU)	6,474 x 2,539 x 3,434 mm (254.9 x 99.9 x 135.2 in)	21,554 kg (47,523 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 generator set.

Sound data

Unit type	Standby full load
Level 0: Open power unit: dB(A)	98.7

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

Emissions data

NO_x + NMHC	CO	PM
5.07	0.52	0.04

- All units are in g/hp-hr and shown at 100% load (not comparable to EPA weighted cycle values). Emission levels of the engine may vary with ambient temperature, barometric pressure, humidity, fuel type and quality, installation parameters, measuring instrumentation, etc. The data was obtained in compliance with US EPA regulations. The weighted cycle value (not shown) from each engine is guaranteed to be within the US EPA standards.

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, and AS 2789. Average load factor: ≤ 85%.
- Consult your local MTU Distributor for derating information.

MTU Detroit Diesel, Inc.

19 March 2008

Mr Pitzer,

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 emissions data provided for a given engine are laboratory results from one engine representing this rating. The data was obtained under controlled conditions with calibrated instrumentation traceable to the United States National Bureau of Standards, and in compliance with US EPA regulations found at 40 CFR Part 89 (Control of Emissions from new and In-Use Nonroad Compression Ignition engines).

The weighted cycle value is guaranteed to be below US EPA Standards at the US EPA defined conditions.

Best Regards,

Roman Gawlowski
Senior Engineer,
Power Generation Applications

MTU Detroit Diesel, Inc.
13400 Outer Drive, West
Detroit, Michigan 48239-4001 / Telephone: 313-592-7000
www.mtudetroitdiesel.com
an Equal Opportunity Employer

A Tognum Group Company

The D2 Cycle (ISO 8178-4)

MTU Detroit Diesel publishes the D2 emissions cycle because this is what the EPA certification is based upon. If you need 100% rated emissions data, it is available in the PEN data sheets.

D2 Cycle is defined as a 5 mode weighted cycle for constant speed applications

Cycle Point (% Rated Power)	Weighting Factor %
100%	5%
75%	25%
50%	30%
25%	30%
10%	10%

$$\text{D2 Cycle Modal Value} = \frac{\text{The sum of the weighted cycle point emission}}{\text{The sum of the weighted cycle point loads}}$$

$$\text{D2 Cycle Modal Value} = \frac{\begin{array}{l} 5\% * \text{Emission Value @ 100\% Load} \\ + 25\% * \text{Emission Value @ 75\% Load} \\ + 30\% * \text{Emission Value @ 50\% Load} \\ + 30\% * \text{Emission Value @ 25\% Load} \\ + 10\% * \text{Emission Value @ 10\% Load} \end{array}}{\begin{array}{l} 5\% * \text{Rated Power @ 100\% Load} \\ + 25\% * \text{Rated Power @ 75\% Load} \\ + 30\% * \text{Rated Power @ 50\% Load} \\ + 30\% * \text{Rated Power @ 25\% Load} \\ + 10\% * \text{Rated Power @ 10\% Load} \end{array}}$$

mtu

DETROIT DIESEL

TKF-Nr. 1127-07
Anlage

Emission (Nominal)[1]

Engine	Unit	16V4000G83 3D (Standby)			
		2500 kWm	1875 kWm	1250 kWm	625 kWm
NOx	g/kWh	7.174	5.631	5.175	4.747
HC	g/kWh	0.12	0.17	0.237	0.476
CO	g/kWh	0.943	0.74	0.742	1.547
PM	g/kWh	0.065	0.092	0.185	0.382

Emission (Nominal)[1]

Engine	Unit	16V4000G83 3B (Prime)			
		2280 kWm	1710 kWm	1140 kWm	570 kWm
NOx	g/kWh	6.933	5.456	4.64	4.549
HC	g/kWh	0.134	0.17	0.236	0.494
CO	g/kWh	0.799	0.831	0.905	1.883
PM	g/kWh	0.074	0.114	0.182	0.427

[1] Emission data measurement procedures are consistent with those described in EPA CFR 40 Part 89, and ISO 8178-1 for measuring NOx, HC, CO, and PM. Data shown is based on steady state operating conditions of 25°C and 960 mbar and diesel fuel due to EN 590. The nominal emission data shown is subject to instrumentation, measurement, facility, and engine-to-engine variations. Field emission test data are not guaranteed to these values. Emission data cannot be used to compare to EPA regulations which use values based on weighted cycle.

DETROIT DIESEL

16V4000G83 3D - EPA Tier II Exhaust Temperature and Flow

Engine Power	kWm	2500	1875	1250	625
Percent Load	%	100	75	50	25
Engine Speed	1/min	1800	1800	1800	1800
Exhaust Mass Flow	m^3/s	8.4	7.3	5.6	2.3
Exhaust Temperature	°C	505	425	370	325

APPENDIX B

Startup Emissions Estimation Method

APPENDIX B

Diesel Generator "Cold-Start Spike" Adjustment Factors

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

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

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

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

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

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

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

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

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

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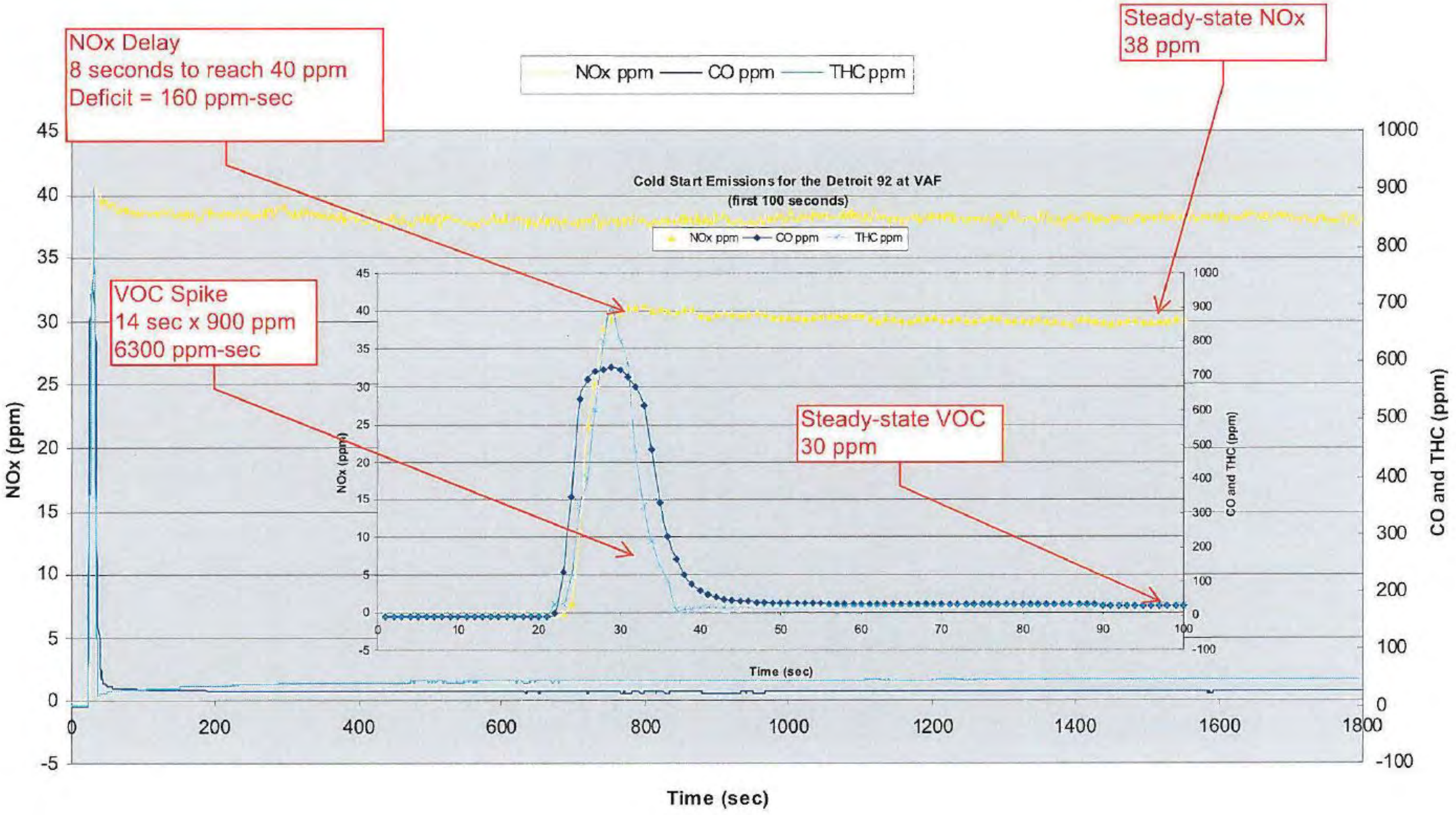
[1] Lents, J.M., L. Arth, M. Boretz, M. Chitjian, K. Cocker, N. Davis, K Johnson, Y Long, J.W. Miller, U. Mondragon, R.M. Nikkila, M. Omary, D. Pacocha, Y. Quin, S. Shah, and G. Tonnesen. 2005. Air Quality Implications of Backup Generators in California - Volume One: Generation Scenarios, Emissions and 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.

LANDAU ASSOCIATES

H5 Data Centers Quincy, Washington	**Cold-Start Emission Trends**	Figure B-1

APPENDIX C

Best Available Control Technology Cost Summary Tables

Table C-1
Tier 4 Integrated Control Package Capital Cost
H5 Data Centers
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,250-KWe Kohler emission control package	Cost estimate by Miratech		12	$266,000	$3,192,000
2,250-KWe Kohler miscellaneous parts	Assumed no cost			$0	$0
Combined systems cost					$3,192,000
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$207,480
Shipping (2,250-KWe Kohler)		NC Power	12	$ 13,000	$156,000
Subtotal Purchased Equipment Cost (PEC)					$3,555,480
Direct Installation Costs					
Enclosure structural supports (2,250-KWe Kohler)	Costs will vary; assumed no cost		12	$0	$0
Onsite Installation (2,250-KWe Kohler)	NC Power		12	$68,153	$817,836
Electrical	Included above		0	$0	$0.00
Piping	Included above		0	$0	$0.00
Insulation	Assumed no cost		0	$0	$0.00
Painting	Assumed no cost		0	$0	$0.00
Subtotal Direct Installation Costs (DIC)					$817,836
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0.00
Total Direct Costs, (DC = PEC + DIC + SP)					$4,373,316
Indirect Costs (Installation)					
Engineering		Johnson Matthey	12	$5,000	$60,000
Construction and field expenses		Johnson Matthey	12	$3,000	$36,000
Contractor Fees	From DIS data center		6.8%	--	$240,706
Startup		Johnson Matthey	12	$3,000	$36,000
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$35,555
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$355,548
Subtotal Indirect Costs (IC)					$763,809
Total Capital Investment (TCI = DC+IC)					**$5,137,125**

Table C-2
Tier 4 Integrated Control Package Cost Effectiveness
H5 Data Centers
Quincy, Washington

Item	Quantity	Units	Unit Cost	Units	Subtotal
Annualized Capital Recovery					
Total Capital Investment (TCI)					$5,137,125
Capital Recovery Factor:	30	years	5.5%	discount	0.069
Subtotal Annualized 30-year Capital Recovery Cost					$353,462
Direct Annual Cost					
Increased Fuel Consumption	Insignificant				$0
Reagent Consumption (estimated by Pacific Power Group)	16,855	gallons/year	$4.00	per gallon	$67,420
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 $171,986/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					$67,420
Indirect Annual Costs					
Annual Admin charges (EPA Manual)	2.0%	of Total Capital Investment			$102,742
Annual Property tax (EPA Manual)	1.0%	of Total Capital Investment			$51,371
Annual Insurance (EPA Manual)	1.0%	of Total Capital Investment			$51,371
Subtotal Indirect Annual Costs					$205,485
Total Annual Cost (Capital Recovery + Direct Annual Costs + Indirect Annual Costs)					**$626,366**
Uncontrolled Emissions (Combined Pollutants)					15
Annual Tons Removed (Combined Pollutants)					12
Cost Effectiveness ($ per tons combined pollutant destroyed)					**$51,914**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$171,986	per year per generator
2,250	KW-hr
456	annual generator hours
$1.50	per HP_M per year

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

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
NO_x	$12,000	9	$109,713 per year
CO	$5,000	2.2	$10,893 per year
VOCs	$12,000	0.43	$5,212 per year
PM	$12,000	0.31	$3,718 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$129,536 per year
Actual Annual Control Cost			$626,366 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)	0.36	2.7	0.62	11
Controlled Emissions (TPY)	0.055	0.5	0.19	1.7
TPY Removed	0.31	2.2	0.43	9
Combined Uncontrolled Emissions (TPY)	15			
Combined TPY Removed	12			
Expected Removal Efficiency	85%	80%	70%	90%
Annualized Cost ($/year)	$626,366			
Individual Pollutant $/Ton Removed	$2,021,537	$287,508	$1,442,150	$68,509

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	0.0033	6.9	$72,585	0.31	$22,490 per year
CO	23,000	0.070	$731	2.2	$1,593 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	1.0	$17,967 per year
Benzene	0.0345	5.9	$61,882	2.9E-03	$180 per year
1,3-Butadiene	0.00588	6.7	$69,951	1.5E-04	$10 per year
Acrolein	0.06	5.7	$59,359	3.0E-05	$2 per year
Naphthalene	0.0294	6.0	$62,612	4.9E-04	$31 per year
Formaldehyde	0.167	5.2	$54,691	3.0E-04	$16 per year
Dibenz(a,h)anthracene	8.33E-04	7.5	$78,863	1.3E-06	$0.10 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	1.3E-02	$132 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	8.8E-03	$44 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$42,289 per year
Actual Annual Control Cost					$626,366 per year
				Is the Control Device Reasonable?	**NO (Actual >> Acceptable)**

TOXIC AIR POLLUTANT CONTROL EFFICIENCIES[a]

TAP	Tier 2 Uncontrolled Emissions	Controlled Emissions (TPY)	TPY Removed	Expected Removal Efficiency	Individual Pollutant $/Ton Removed
DEEP	0.36	0.055	0.31	85%	$2,021,537
CO	2.72	0.5	2.2	80%	$287,508
NO_2 (10% of NOx)	1.08	0.11	1.0	90%	$643,989
Benzene	4.2E-03	1.2E-03	2.9E-03	70%	$214,766,789
1,3-Butadiene	2.1E-04	6.3E-05	1.5E-04	70%	$4,262,379,237
Acrolein	4.2E-05	1.3E-05	3.0E-05	70%	$21,149,622,864
Naphthalene	7.0E-04	2.1E-04	4.9E-04	70%	$1,281,992,524
Formaldehyde	4.2E-04	1.3E-04	3.0E-04	70%	$2,112,281,726
Dibenz(a,h)anthracene	1.9E-06	5.6E-07	1.3E-06	70%	$481,673,491,822
Carcinogenic VOCs	1.9E-02	5.6E-03	1.3E-02	70%	$47,599,607
Non-Carcinogenic VOCs	1.3E-02	3.8E-03	8.8E-03	70%	$71,442,181
Annualized Cost ($/yr)					$626,366
Combined Uncontrolled Emissions (TPY)					4.2
Combined TPY Removed					3.5
Combined TAPs $/Ton Removed					$180,771

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, 85% for PM (front half), 80% for CO, and 70% for VOCs.

Table C-3
Selective Catalytic Reduction Capital Cost
H5 Data Centers
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,250-KWe Kohler emission control package	Cost estimate by Miratech		12	$195,500	$2,346,000
2,250-KWe Kohler miscellaneous parts	Assumed no cost			$0	$0
Combined systems cost					$2,346,000
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$152,490
Shipping (2,250-KWe Kohler)		NC Power	12	$12,000	$144,000
Subtotal Purchased Equipment Cost (PEC)					$2,642,490
Direct Installation Costs					
Enclosure structural supports (2,250-KWe Kohler	Cost will vary		12	$0	$0
Onsite Installation (2,250-KWe Kohler)	NC Power		12	$9,635	$115,620
Electrical	Included above		0	$0	$0
Piping	Included above		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$115,620
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$2,758,110
Indirect Costs (Installation)					
Engineering		Johnson Matthey	12	$3,000	$36,000
Construction and field expenses		Johnson Matthey	12	$3,000	$36,000
Contractor Fees	From DIS data center		6.8%	--	$178,897
Startup		Johnson Matthey	12	$3,000	$36,000
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$26,425
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$264,249
Subtotal Indirect Costs (IC)					$577,570
Total Capital Investment (TCI = DC+IC)					**$3,335,680**

Table C-4
Selective Catalytic Reduction Cost Effectiveness
H5 Data Centers
Quincy, Washington

Item	Quantity	Units	Unit Cost	Units	Subtotal
Annualized Capital Recovery					
Total Capital Investment (TCI)					$3,335,680
Capital Recovery Factor:	30	years	5.5%	discount	0.069
Subtotal Annualized 30-year Capital Recovery Cost					$229,513
Direct Annual Cost					
Increased Fuel Consumption	Insignificant				$0
Reagent Consumption (estimated by Pacific Power Group)	16,855	gallons/year	$4.00	per gallon	$67,420
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 $171,986/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					$67,420
Indirect Annual Costs					
Annual Admin charges (EPA Manual)	2.0%	of Total Capital Investment			$66,714
Annual Property tax (EPA Manual)	0.0%	of Total Capital Investment			$0
Annual Insurance (EPA Manual)	0.0%	of Total Capital Investment			$0
Subtotal Indirect Annual Costs					$66,714
Total Annual Cost (Capital Recovery + Direct Annual Costs + Indirect Annual Costs)					**$363,646**
Uncontrolled Emissions (Combined Pollutants)					15
Annual Tons Removed (Combined Pollutants)					9
Cost Effectiveness ($ per tons combined pollutant destroyed)					**$39,774**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$171,986	per year per generator
2,250	KW-hr
456	annual generator hours
$1.50	per HP_M per year

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

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (TPY)[a]	Subtotal Reasonable Annual Cost ($/year)
NO_x	$12,000	9	$109,713 per year
CO	$5,000	0	$0 per year
VOCs	$12,000	0	$0 per year
PM	$12,000	0	$0 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$109,713 per year
Actual Annual Control Cost			$363,646 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)	0.36	2.7	0.62	11
Controlled Emissions (TPY)	0.36	2.7	0.62	1.7
TPY Removed	0	0	0	9
Combined Uncontrolled Emissions (TPY)	15			
Combined TPY Removed	9			
Expected Removal Efficiency	0%	0%	0%	90%
Annualized Cost ($/year)	$363,646			
Individual Pollutant $/Ton Removed	--	--	--	$39,774

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	0.0033	6.9	$72,585	0.0	$0 per year
CO	23,000	0.070	$731	0.0	$0 per year
NO_2 (10% of NO_x)	470	1.8	$18,472	1.0	$17,967 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
Dibenz(a,h)anthracene	8.33E-04	7.5	$78,863	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					$17,967 per year
Actual Annual Control Cost					$363,646 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	0.36	0.36	0.0	0%	--
CO	2.72	2.7	0.0	0%	--
NO_2 (10% of NO_x)	1.08	0.11	1.0	90%	$373,877
Benzene	0.004	0.004	0.0	0%	--
1,3-Butadiene	0.000	2.1E-04	0.0	0%	--
Acrolein	4.23E-05	4.2E-05	0.0	0%	--
Naphthalene	6.98E-04	7.0E-04	0.0	0%	--
Formaldehyde	4.24E-04	4.2E-04	0.0	0%	--
Dibenz(a,h)anthracene	1.86E-06	1.9E-06	0.0	0%	--
Carcinogenic VOCs	1.88E-02	0.019	0.0	0%	--
Non-Carcinogenic VOCs	1.25E-02	0.013	0.0	0%	--
Annualized Cost ($/yr)					$363,646
Combined Uncontrolled Emissions (TPY)					4
Combined TPY Removed					1.0
Combined TAPs $/Ton Removed					$373,877

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
Catalyzed Diesel Particulate Filter Capital Cost
H5 Data Centers
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,250-KWe Kohler emission control package	Cost estimate by Miratech		12	$73,500	$882,000
2,250-KWe Kohler miscellaneous parts	Assumed no cost			$0	$0
Combined systems cost					$882,000
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax	WA state tax	WA state tax	6.5%	--	$57,330
Shipping (2,250-KWe Kohler)		NC Power (CAT)	12	$10,000	$120,000
Subtotal Purchased Equipment Cost (PEC)					$1,059,330
Direct Installation Costs					
Enclosure structural supports (2,250-KWe Kohler	Cost will vary		12	$0	$0
Onsite Installation (2,250-KWe Kohler)	NC Power (CAT)		12	$7,593	$91,116
Electrical	Included above		0	$0	$0
Piping	Included above		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$91,116
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					$1,150,446
Indirect Costs (Installation)					
Engineering		Johnson Matthey	12	$2,000	$24,000
Construction and field expenses		Johnson Matthey	12	$0	$0
Contractor Fees	From DIS data center		6.8%	--	$71,717
Startup		Johnson Matthey	12	$1,500	$18,000
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$10,593
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$105,933
Subtotal Indirect Costs (IC)					$230,243
Total Capital Investment (TCI = DC+IC)					**$1,380,689**

Table C-6
Catalyzed Diesel Particulate Filter Cost Effectiveness
H5 Data Centers
Quincy, Washington

Item	Quantity	Units	Unit Cost	Subtotal
Annualized Capital Recovery				
Total Capital Investment (TCI)				**$1,380,689**
Capital Recovery Factor: lifetime =	30 years	interest rate = 5.5%		0.069
Subtotal Annualized 30-year Capital Recovery Cost				$94,999
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$27,614
Annual Property tax	1% of TCI (EPA Manual)		0.01	$13,807
Annual Insurance	1% of TCI (EPA Manual)		0.01	$13,807
Annual operation/labor/maintenance costs: Upper-bound estimate would assume CARB's value of $1.00/hp/year and would result in $114,657/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				$55,228
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$150,226**
Uncontrolled Emissions (Combined Pollutants)				15
Annual Tons Removed (Combined Pollutants)				2.9
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$51,398**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$114,657	per year per generator
2,250	KW-hr
456	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	2.2	$10,893 per year
VOCs	$12,000	0.43	$5,212 per year
PM	$12,000	0.31	$3,718 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$19,823 per year
Actual Annual Control Cost			$150,226 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)	0.36	2.7	0.62	11
Controlled Emissions (TPY)	0.055	0.5	0.19	11
TPY Removed	0.31	2.2	0.43	0
Combined Uncontrolled Emissions (TPY)	15			
Combined TPY Removed	2.9			
Expected Removal Efficiency	85%	80%	70%	0%
Annualized Cost ($/year)	$150,226			
Individual Pollutant $/Ton Removed	$484,841	$68,955	$345,882	--

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	0.0033	6.9	$72,585	0.31	$22,490 per year
CO	23,000	0.070	$731	2.2	$1,593 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	2.9E-03	$180 per year
1,3-Butadiene	0.00588	6.7	$69,951	1.5E-04	$10 per year
Acrolein	0.06	5.7	$59,359	3.0E-05	$1.8 per year
Naphthalene	0.0294	6.0	$62,612	4.9E-04	$31 per year
Formaldehyde	0.167	5.2	$54,691	3.0E-04	$16 per year
Dibenz(a,h)anthracene	8.33E-04	7.5	$78,863	1.3E-06	$0.10 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	1.3E-02	$132 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	8.8E-03	$44 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$24,323 per year
Actual Annual Control Cost					$150,226 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	0.36	0.05	0.31	85%	$484,841
CO	2.72	0.5	2.2	80%	$68,955
NO_2 (10% of NO_x)	1.08	1.1	0	0%	--
Benzene	4.2E-03	1.2E-03	2.9E-03	70%	$51,509,211
1,3-Butadiene	2.1E-04	6.3E-05	1.5E-04	70%	$1,022,280,000
Acrolein	4.2E-05	1.3E-05	3.0E-05	70%	$5,072,480,712
Naphthalene	7.0E-04	2.1E-04	4.9E-04	70%	$307,470,369
Formaldehyde	4.2E-04	1.3E-04	3.0E-04	70%	$506,605,171
Dibenz(a,h)anthracene	1.9E-06	5.6E-07	1.3E-06	70%	$115,523,549,170
Carcinogenic VOCs	1.9E-02	5.6E-03	1.3E-02	70%	$11,416,189
Non-Carcinogenic VOCs	1.3E-02	3.8E-03	8.8E-03	70%	$17,134,541
Annualized Cost ($/yr)					$150,226
Combined Uncontrolled Emissions (TPY)					4.2
Combined TPY Removed					2.5
Combined TAPs $/Ton Removed					$60,275

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

Table C-7
Diesel Oxidation Catalyst Capital Cost
H5 Data Centers
Quincy, Washington

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
2,250-KWe Kohler emission control package		Miratech	12	$15,500	$186,000
2,250-KWe Kohler miscellaneous parts	Assumed no cost			$0	$0
Combined systems cost					$186,000
Instrumentation	Assumed no cost		0	$0	$0
Sales Tax		WA state tax	6.5%	--	$12,090
Shipping (2,250-KWe Kohler)		NC Power	12	$11,000	$132,000
Subtotal Purchased Equipment Cost (PEC)					$330,090
Direct Installation Costs					
Enclosure structural supports (2,250-KWe Kohler)		Costs will vary	12	$0	$0
Onsite Installation (2,250-KWe Kohler)		NC Power	12	$9,006	$108,072
Electrical	Included above		0	$0	$0
Piping	Included above		0	$0	$0
Insulation	Assumed no cost		0	$0	$0
Painting	Assumed no cost		0	$0	$0
Subtotal Direct Installation Costs (DIC)					$108,072
Site Preparation and Buildings (SP)	Assumed no cost		0	$0	$0
Total Direct Costs, (DC = PEC + DIC + SP)					**$438,162**
Indirect Costs					
Engineering		Johnson Matthey	12	$1,200	$14,400
Construction and field expenses		Johnson Matthey	12	$0	$0
Contractor Fees	6.8%*PEC	From DIS data center	6.8%	--	$22,347
Startup		Johnson Matthey	12	$1,500	$18,000
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$3,301
Contingencies	0.10*PEC	EPA Cost Manual	10.0%	--	$33,009
Total Indirect Costs (IC)					**$91,057**
Total Capital Investment (TCI = DC+IC)					**$529,219**

Table C-8
Diesel Oxidation Catalyst Cost Effectiveness
H5 Data Centers
Quincy, Washington

Item	Variables	Subtotal
Annualized Capital Recovery		
Total Capital Investment (TCI)		$529,219
Capital Recovery Factor: lifetime =	30 years interest rate = 5.5%	0.069
Subtotal Annualized 30-year Capital Recovery Cost		**$36,413.12**
Direct Annual Costs		
Annual Admin charges	2.0% of TCI (EPA Manual)	$10,584
Annual Property tax	1.0% of TCI (EPA Manual)	$5,292
Annual Insurance	1.0% of TCI (EPA Manual)	$5,292
Catalyst Replacement	Assume cost of zero.	$0
Annual Operation/Labor/Maintenance cost	Upper-bound estimate would assume CARB's value of $0.20/hp/year and would result in $22,931/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		**$21,169**
Total Annual Cost (Capital Recovery + Direct Annual Costs)		**$57,582**
Cost Effectiveness		
Uncontrolled Emissions (Combined Pollutants)		15
Annual Tons Removed (Combined Pollutants)		2.7
Cost Effectiveness ($ per tons combined pollutant destroyed)		**$21,295**

Annual O&M Cost Based on CARB Factors (lowermost CARB estimate)	
$22,931	per year per generator
2,250	KW-hr
456	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	2.2	$10,893 per year
VOCs	$12,000	0.43	$5,212 per year
PM	$12,000	0.09	$1,094 per year
Total Reasonable Annual Control Cost for Combined Pollutants			$17,199 per year
Annual Control Cost			$57,582 per year
		Is the Control Device Cost Effective?	**No**

CRITERIA POLLUTANT CONTROL EFFICIENCIES[a]

Pollutant	PM (FH)	CO	VOCs	NO_x
Tier 2 Uncontrolled Emissions (TPY)	0.36	2.72	0.62	10.81
Controlled Emissions (TPY)	0.27	0.54	0.19	11
TPY Removed	0.09	2.2	0.43	0
Combined Uncontrolled Emissions (TPY)	15			
Combined TPY Removed	2.7			
Expected Removal Efficiency	25%	80%	70%	0%
Annualized Cost ($/year)	$57,582			
Individual Pollutant $/Ton Removed	$631,856	$26,431	$132,577	--

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	0.0033	6.9	$72,585	0.09	$6,615 per year
CO	23,000	0.070	$731	2.2	$1,593 per year
NO_2 (10% of NO_X)	470	1.8	$18,472	--	-- per year
Benzene	0.0345	5.9	$61,882	0.0029	$180 per year
1,3-Butadiene	0.00588	6.7	$69,951	1.5E-04	$10 per year
Acrolein	0.06	5.7	$59,359	3.0E-05	$1.8 per year
Naphthalene	0.0294	6.0	$62,612	0.0005	$31 per year
Formaldehyde	0.167	5.2	$54,691	3.0E-04	$16 per year
Dibenz(a,h)anthracene	8.33E-04	7.5	$78,863	1.3E-06	$0.10 per year
Carcinogenic VOCs	n.a.	n.a.	$9,999	0.0132	$132 per year
Non-Carcinogenic VOCs	n.a.	n.a.	$5,000	8.8E-03	$43.84 per year
Total Reasonable Annual Control Cost for Combined Pollutants					$8,447 per year
Annual Control Cost					$57,582 per year
				Is the Control Device Cost Effective?	**No**

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	0.36	0.27	0.09	25%	$631,856
CO	2.7	0.5	2.2	80%	$26,431
NO_2 (10% of NOx)	1.1	1.1	0	0%	--
Benzene	4.17E-03	0.0012	0.0029	70%	$19,743,515
1,3-Butadiene	2.10E-04	6.3E-05	1.5E-04	70%	$391,840,607
Acrolein	4.23E-05	1.3E-05	3.0E-05	70%	$1,944,285,244
Naphthalene	6.98E-04	2.1E-04	0.0005	70%	$117,853,598
Formaldehyde	4.24E-04	1.3E-04	3.0E-04	70%	$194,182,100
Dibenz(a,h)anthracene	1.86E-06	5.6E-07	1.3E-06	70%	$44,280,253,534
Carcinogenic VOCs	1.88E-02	0.0056	0.0132	70%	$4,375,833
Non-Carcinogenic VOCs	1.25E-02	3.8E-03	8.8E-03	70%	$6,567,681
Annualized Cost ($/yr)					$57,582
Combined Uncontrolled Emissions (TPY)					4.2
Combined TPY Removed					2.3
Combined TAPs $/Ton Removed					$25,326

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.

APPENDIX D

Summary of AERMOD Inputs and Selected Isopleths

Table D-1
Modeling Stack Parameters and Emission Rates
H5 Data Centers
Quincy, Washington

Stack Dimensions

Source	Actual Stack Height (ft)	Actual Stack Diameter (in)
Proposed 2.25-MWe Genset	43	24
Cooling Towers	20	12

Proposed 2.25-MWe Genset

			Operating Hours		Exhaust Parameters[a]				
Pollutant	**Averaging Period**	**Emissions Scenario**	**Total hours of operation**	**Number of cold-starts**	**Exhaust Temp. (°F)**	**Exhaust Flow (cfm)**	**Adjusted Velocity[b] (ft/min)**	**Effective Stack Diameter[b] (in)**	**Emissions per Point Source[a] (lb/hr)**
Criteria Air Pollutants									
CO	1- and 8-hour	Power Outage at 25% Load	1	1	805	6,772	--	--	1.3E+01
SO_2	1- and 3-hour	Power Outage at 100% Load	1	1	802	17,178	--	--	3.6E-02
PM_{10}	24-hour	Power Outage at 10% Load	4	1	441	4,483	601	37	7.1E-01
$PM_{2.5}$	Annual	Maximum Year at 10% Load	66	41	441	4,483	601	37	3.3E-02
	24-hour	Non-Emergency at 10% Load	6	6	441	4,483	601	37	2.2E+00
NO_X	Annual	Maximum Year at 100% Load	66	41	802	17,178	--	--	3.7E-01
	1-hour	See Monte Carlo (Appendix F)	1	--	441	4,483	601	37	8.7E+00
Toxic Air Pollutants									
DEEP	Annual	Maximum Year at 10% Load	66	41	441	4,483	601	37	2.4E-02
NO_X	1-hour	Power Outage at 10% Load	1	1	441	4,483	--	--	8.7E+00

Table D-1
Modeling Stack Parameters and Emission Rates
H5 Data Centers
Quincy, Washington

Proposed Cooling Towers

Pollutant	Averaging Period	Emissions Scenario	Hours of Operation per Period	Exhaust Parameters				Emissions per Point Source (lb/hr)
				Exhaust Temp. (°F)	Exhaust Flow (cfm)	Adjusted Velocity (ft/min)	Effective Stack Diameter (in)	
PM_{10}	24-hour	24 hours of operation	24	80	132,967	--	--	2.4E-02
$PM_{2.5}$	Annual	Maximum Year	8,760	80	132,967	--	--	1.9E-02
	24-hour	24 hours of operation	24	80	132,967	--	--	1.9E-02

Notes:

[a] Startup emissions were included for applicable pollutants. A screening analysis was run to determine the worst-case load for each pollutant and averaging period. SO_2 was used as a surrogate for all fuel-based pollutants.

[b] Velocity for operations at 10 percent load were adjusted using a scaling factor to represent a vertical stack with a rain cap open to a 45 degree angle. The effective stack diameter was calculated by dividing the actual flow by the adjusted velocity.

Table D-2
Modeling Stack Parameters and Emission Rates for PM_{10} and $PM_{2.5}$
H5 Data Centers
Quincy, Washington

Ranked Day	Activity	Activity Duration (hrs/genset)	Number of Generators Operating Concurrently	Max. Daily Operating Hours (hrs/day)	Max. Annual Operating Days (days/yr)	Max. Daily $PM_{2.5}$/PM_{10} Emissions[a] (lbs/day)
1-2	Emergency Power Outage	4	12	4	2	204
3	Commissioning Integrated Site Test	4	12	4	1	204
4-7	Annual Maintenance[b]	4	12	4	4	204
8-29	Monthly Maintenance[c]	1	1	6	22	27

Notes:

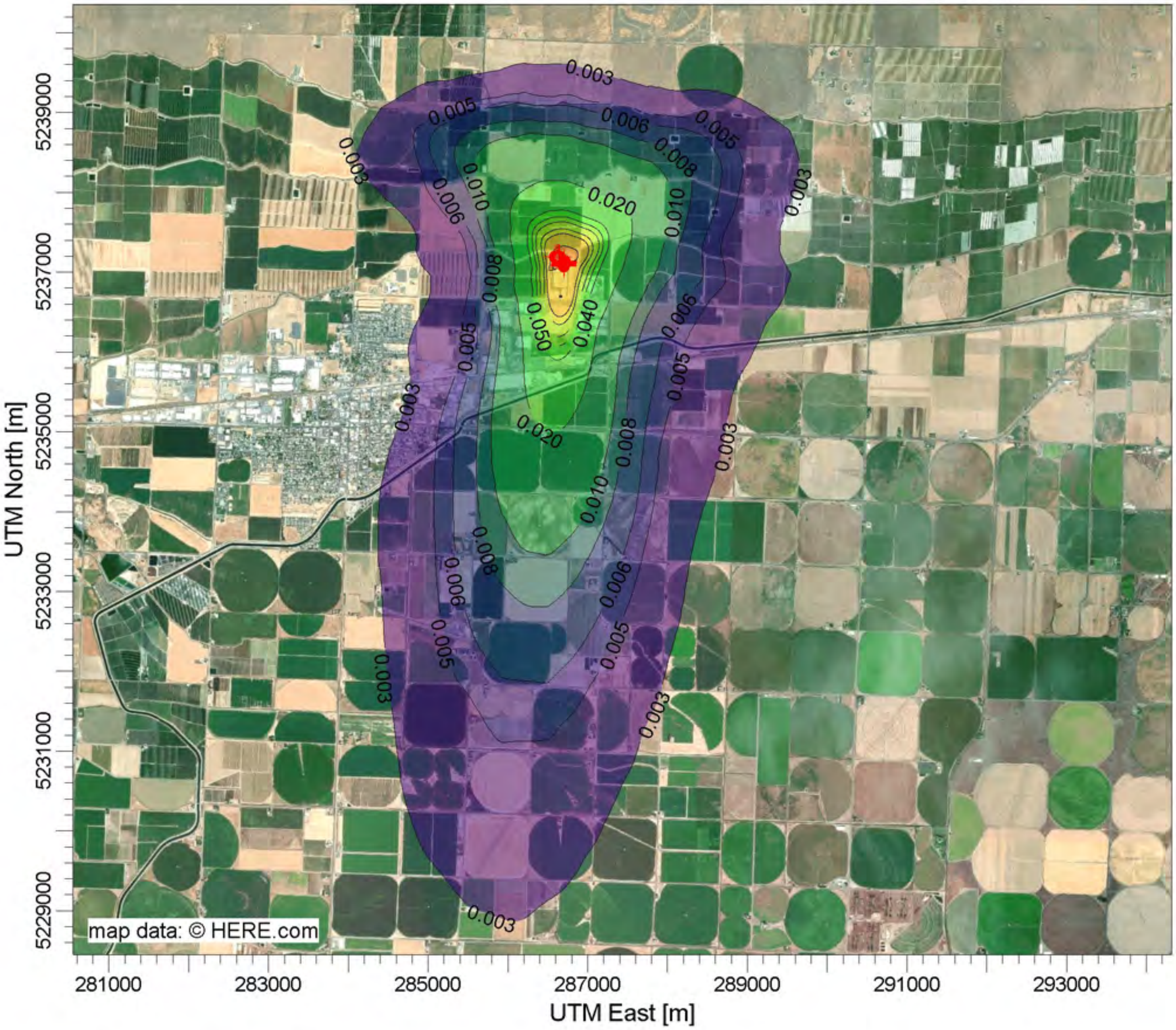
[a] Startup emissions are included.

[b] Annual load bank testing operations are expected to occur on each engine for 4 hours per engine. At most, 12 engines may be tested concurrently in one day for up to 4 hr/dy.

[c] Monthly maintenance operations are expected to occur on a single engine for 60 minutes per engine. In the event that complications arise during testing, this duration may be greater. Likewise, multiple sequential tests may occur within the same day for up to 6 hr/day.

PROJECT TITLE:

H5 Data Centers - Quincy, WA



PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

Max: 0.423 [ug/m^3] at (286663.14, 5237242.09)

0.003 0.005 0.006 0.008 0.010 0.020 0.040 0.050 0.060 0.080 0.100 0.200 0.400 0.423

COMMENTS:

Deep Annual Average Concentration

ASIL = 0.00333 ug/m3

SOURCES:

20

COMPANY NAME:

Landau Associates, Inc.

RECEPTORS:

9478

OUTPUT TYPE:

Concentration

SCALE: 1:86,568

0 3 km

MAX:

0.423 ug/m^3

DATE:

3/16/2021

PROJECT NO.:

1904001.010

AERMOD View - Lakes Environmental Software

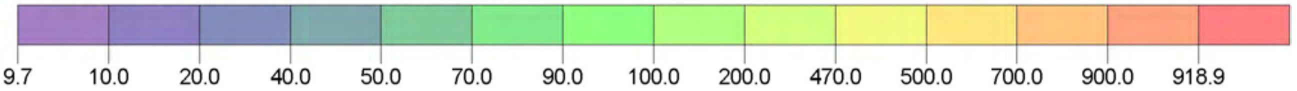
PROJECT TITLE:

H5 Data Centers - Quincy, WA

PLOT FILE OF HIGH 1ST HIGH 1-HR VALUES FOR SOURCE GROUP: PO

ug/m^3

Max: 918.9 [ug/m^3] at (286524.18, 5237111.53)



COMMENTS:

NO2 1-hour Average Concentration

ASIL = 470 ug/m3

SOURCES:

20

COMPANY NAME:

Landau Associates, Inc.

RECEPTORS:

9489

MODELER:

Chloe Gore

OUTPUT TYPE:

Concentration

SCALE: 1:17,394

0 0.5 km

MAX:

918.9 ug/m^3

DATE:

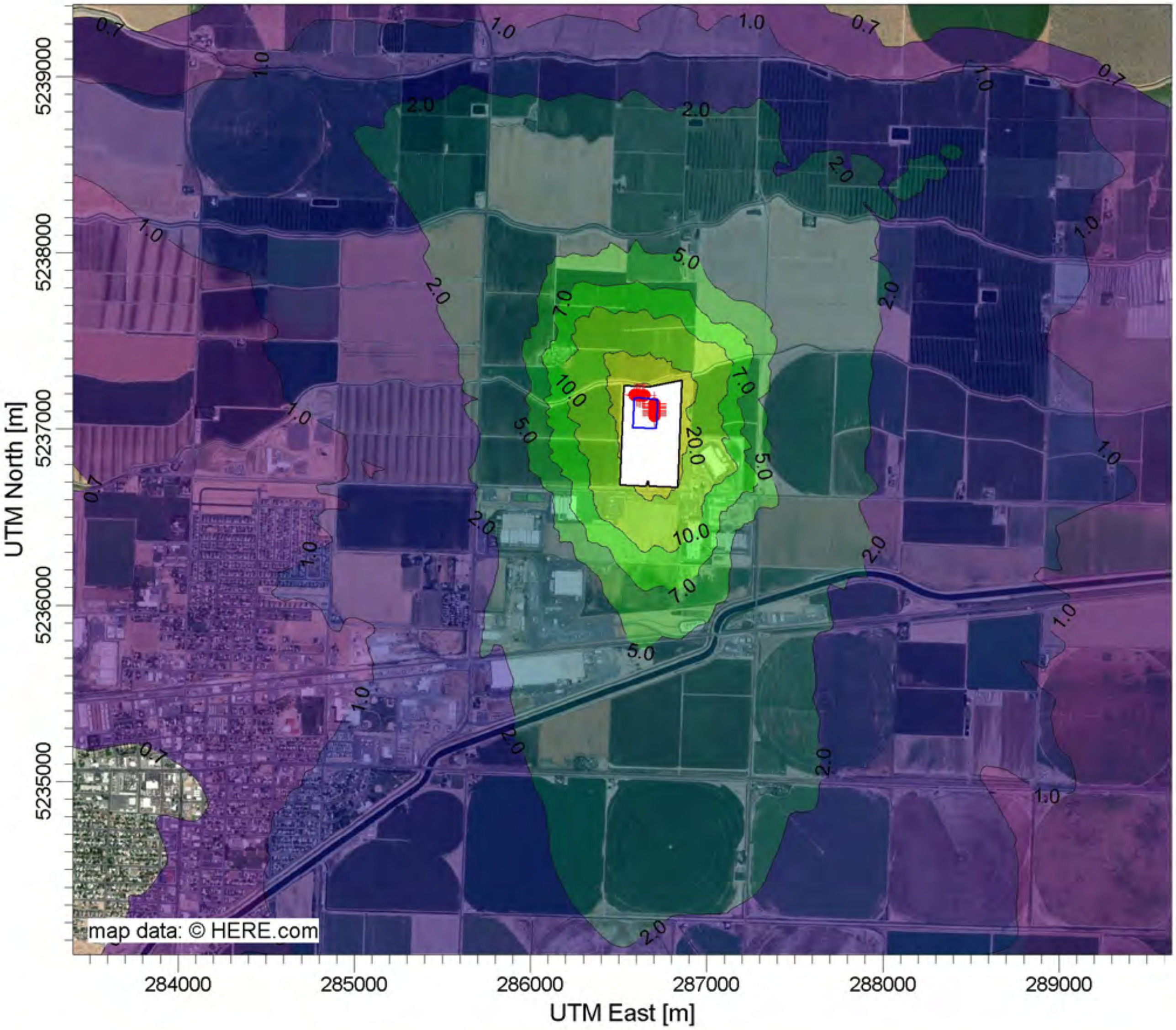
3/1/2021

PROJECT NO.:

1904001.010

PROJECT TITLE:

H5 Data Centers - Quincy, WA



PLOT FILE OF HIGH 6TH HIGH 24-HR VALUES FOR SOURCE GROUP: ALL

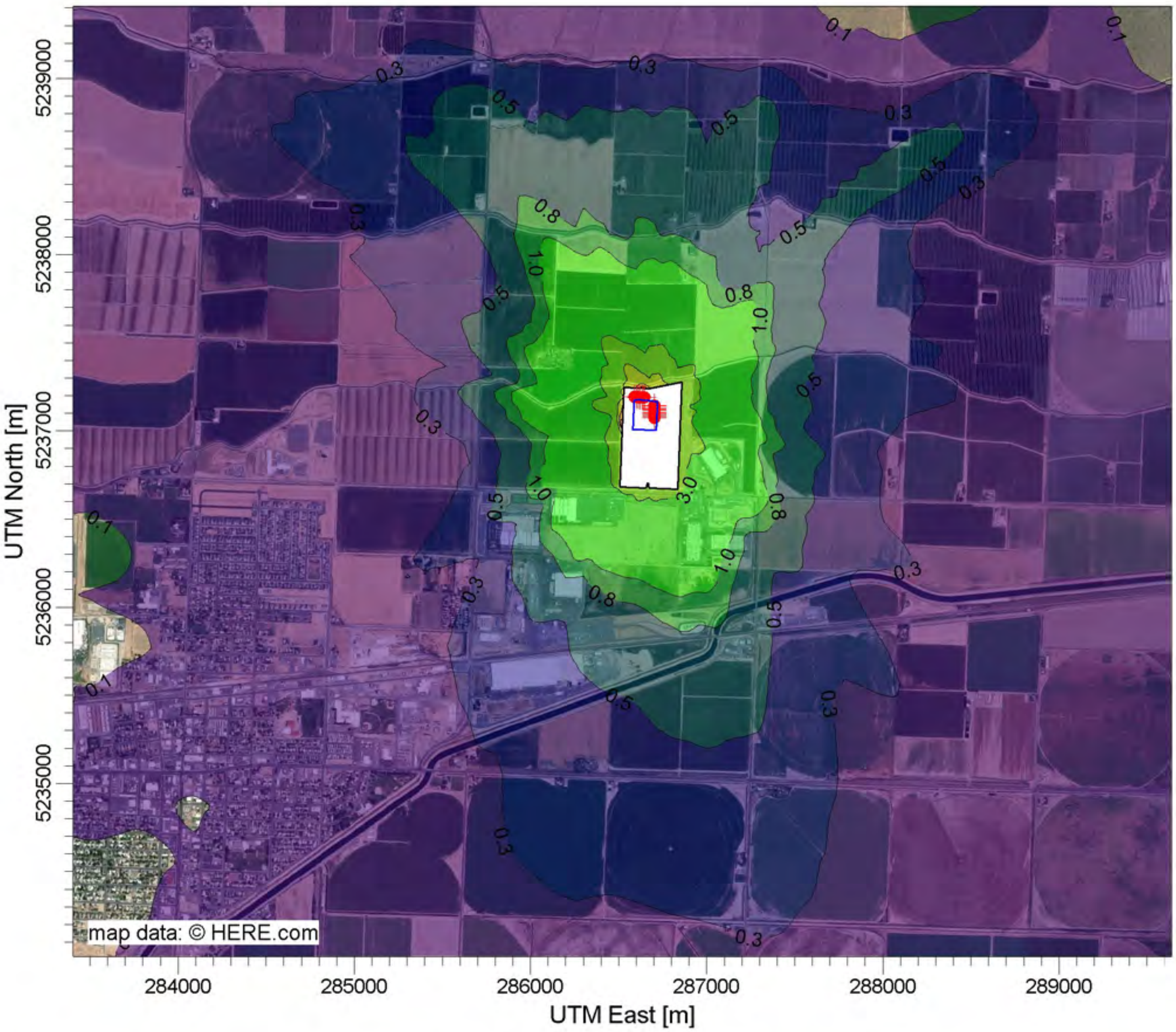
ug/m^3

Max: 71.5 [ug/m^3] at (286638.82, 5237242.91)

COMMENTS: PM10 24-hour Average Concentration National Ambient Air Quality Standard = 150 ug/m3 Add 78 ug/m3 to modeled concentration to account for background sources.	SOURCES: **20**	COMPANY NAME: **Landau Associates, Inc.**	
	RECEPTORS: **9489**	MODELER: **Chloe Gore**	
	OUTPUT TYPE: **Concentration**	SCALE: 1:39,210 0 1 km	
	MAX: **71.5 ug/m^3**	DATE: **3/1/2021**	PROJECT NO.: **1904001.010**

PROJECT TITLE:

H5 Data Centers - Quincy, WA



PLOT FILE OF 1ST-HIGHEST MAX DAILY 24-HR VALUES AVERAGED OVER 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

Max: 13.0 [ug/m^3] at (286521.35, 5237037.83)

0.1 0.3 0.5 0.8 1.0 3.0 5.0 8.0 10.0 13.0

COMMENTS:

PM2.5 24-hour Average Concentration

National Ambient Air Quality Standard = 35 ug/m3

Add 18 ug/m3 to modeled concentration to account for background sources.

SOURCES:

20

COMPANY NAME:

Landau Associates, Inc.

RECEPTORS:

9489

MODELER:

Chloe Gore

OUTPUT TYPE:

Concentration

SCALE: 1:39,210

0 1 km

MAX:

13.0 ug/m^3

DATE:

3/1/2021

PROJECT NO.:

1904001.010

AERMOD View - Lakes Environmental Software F:\1904H5\SetA\Base_BL01\Base_BL01.isc

APPENDIX E

Electronic Files Archive

(on DVD)

APPENDIX F

Monte Carlo Analysis

Table F-1
Modeling Stack Parameters and Emission Rates for NO_2 1-Hour
H5 Data Centers
Quincy, Washington

Ranked Generator Runtime Scenarios - NO_X

Ranked Day	Activity	Number of Generators Operating Concurrently	Max. Annual Operating Days (days/yr)	Max. Hourly NO_X Emissions (lbs/hour)
1-7	Emergency Power Outage, Annual Maintenance, Commissioning (Integrated Site Test) [a]	12	7	104
8-43	Monthly Maintenance, Stack Testing, As-Needed Testing, Commissioning (Burn-in) [b]	1	36	9

Notes:

[a] All engines are run concurrently each hour.

[b] A single engine is run each hour.

Table F-2
Summary of NO_2 Monte Carlo Assessment
H5 Data Centers
Quincy, Washington

Monte Carlo Predicted NO_2 98th Percentile

Parameter	Easting (m)	Northing (m)
Location, UTM Zone 11 NAD83	286,521.35	5,237,037.83
Parameter	**Concentration (μg/m^3)**	
Median 98th Percentile	85	
Background	52	
Predicted Cumulative	137	
National Ambient Air Quality Standard	188	

Monte Carlo Days Array

Generator Runtime Activity	Source Group Monte Carlo Input Filename AERMOD Filename	Simulation Days of Operation
Monthly Maintenance (1 generator at a time for one hour)[a]	MT MAXDAILY_NO2_MT.DAT NO2_1HR_MT.ADI	22
Stack Testing, As-Needed Testing, Commissioning Burn-in (1 generator at a time for one hour)[b]	ONE MAXDAILY_NO2_ONE.DAT NO2_1HR_ONE.ADI	14
Facility-Wide Emergency Power Outage, Annual Maintenance, Commissioning Integrated Site Test (all generators concurrently)[c]	PO MAXDAILY_NO2_PO.DAT NO2_1HR_PO.ADI	7

Notes:

[a] Monthly maintenance operations are expected to occur on a single engine for 60 minutes per engine. In the event that complications arise during testing, this duration may be greater. Likewise, multiple sequential tests may occur within the same day for up to 6 hr/dy.

[b] Operation of a single generator for up to one hour for 2 days of stack testing, 6 days of as-needed testing, and 6 days of commissioning

[c] Concurrent operation of all twelve generators for 2 days of power outage, 4 days of annual maintenance, and 1 day of Commissioning Integrated Site Test.

APPENDIX G

DEEP Tables and Models Reflecting Revised Runtime Limits

Table G-1
Revised - Equipment Summary and Operating Rates
H5 Data Centers
Quincy, Washington

Engine Parameter	Value
Generator output (kW)	2,250
Number of generators	12
Fuel type	ULSD
Fuel usage per genset (gph)[a]	167
Annual operating limit per genset (hr/yr)	26
Annual number of startups per genset	17
Maximum year operating hours per genset (hr/yr)[b]	54
Maximum year number of startups per genset (hr/yr)[b]	38

Notes:

[a] Maximum of proposed generator models at any load (≤100 percent load).

[b] Maximum Year hours accounts for commissioning and stack testing. Commissioning hours include 24 hours for each generator running one at a time and 4 hours of 12 generators running concurrently for site integration testing. A stack test is performed on one generator for 6 hours every 5 years.

Table G-3
Revised - Fuel-Based Emissions Summary
H5 Data Centers
Quincy, Washington

Engine Parameters	Value
Generator Output (kW)	2,250
Annual Operating Limit (hrs)	26
Maximum Year Operating Hours (hrs)[a]	54
No. of Generators	12
Fuel Usage Per Genset (gph)	167
Heat Input (MMBtu/hr)	23

Fuel Parameters	Value
Fuel Type	ULSD
Fuel Sulfur Content (ppmw)	15
Fuel Density (lb/gal)	7.1
Fuel Heat Content (Btu/gal)	137,000

Duration	Units	Hourly	Daily	Annual Average	Maximum Year[a]
Fuel Usage (per period)	Gallons	2,005	8,021	52,135	108,281
Heat Input (per period)	MMBtu	275	1,099	7,143	14,834

Table G-4
Revised - Startup Emissions Summary (DEEP Only)
H5 Data Centers
Quincy, Washington

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

Pollutant	Spike Duration (seconds)	Measured Concentration Cold-Start Emission Spike (ppm)	Measured Concentration Steady-State (Warm) Emissions (ppm)	Cold-Start Scaling Factor
PM+HC	14	900	30	4.3

Emissions per Cold-Start Event[a]

Pollutant	Emissions (lb/event) Startup (1 min)	Emissions (lb/event) Warm (59 min)
DEEP	0.11	1.5

Total Emissions with Cold-Start

Pollutant	Hourly per Engine (lbs/hr)	Annual per Engine (lbs/yr)	Maximum Year per Engine (lbs/yr)
DEEP[b]	1.6	42	87

Notes:

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

Table G-6
Revised Potential-to-Emit Emissions Summary (DEEP only)
H5 Data Centers
Quincy, Washington

Pollutant	PTE Proposed Sources[a]			PTE Existing Sources[b]	PTE Facility-Wide Total	
	Hourly (lbs/hr)	Annual (tpy)	Maximum Year (tpy)	Annual (tpy)	Annual (tpy)	Maximum Year (tpy)
DEEP	20	0.25	0.52	0.43 [c]	0.68	1.0

Notes:

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

[b] From Permit 18AQ-E044.

[c] $PM_{2.5}$ and DEEP were not reported for existing sources. All PM_{10} is conservatively assumed to be $PM_{2.5}$. For Generators, all PM_{10} is conservatively assumed to be DEEP.

Table G-7
Revised - Project Emissions Compared to Small-Quantity Emission Rates (DEEP Only)
H5 Data Centers
Quincy, Washington

Pollutant	CAS Number	Averaging Period	Project Emissions	*De Minimis*	SQER	Required Action
			(lbs/averaging period)			
DEEP	DPM	year	1,049	0.027	0.54	Model

Notes:

Highlighted cells indicate pollutants that require ambient air dispersion model analysis

Table G-12

Revised - Estimated Project Impacts Compared to Acceptable Source Impact Levels (DEEP Only)

H5 Data Centers

Quincy, Washington

Pollutant	CAS No.	Averaging Period	Facility-wide Emission Rate (lbs/avg. period)	Project Concentration ($\mu g/m^3$)	ASIL ($\mu g/m^3$)
DEEP	DPM	year	1,049	0.37 [a]	0.0033

Notes:

[a] Predicted maximum impacts are based on emissions for the maximum year.

Revised Table D-1
Revised - Modeling Stack Parameters and Emission Rates (DEEP Only)
H5 Data Centers
Quincy, Washington

Stack Dimensions

Source	Actual Stack Height (ft)	Actual Stack Diameter (in)
Proposed 2.25-MWe Genset	43	24
Cooling Towers	20	12

Proposed 2.25-MWe Genset

Pollutant	Averaging Period	Emissions Scenario	Operating Hours		Exhaust Parameters[a]				Emissions per Point Source[a] (lb/hr)
			Total hours of operation	Number of cold-starts	Exhaust Temp. (°F)	Exhaust Flow (cfm)	Adjusted Velocity[b] (ft/min)	Effective Stack Diameter[b] (in)	
DEEP	Annual	Maximum Year at 10% Load	54	38	441	4,483	601	37	2.1E-02

Notes:

[a] Startup emissions were included for applicable pollutants. A screening analysis was run to determine the worst-case load for each pollutant and averaging period. SO_2 was used as a surrogate for all fuel-based pollutants.

[b] Velocity for operations at 10 percent load were adjusted using a scaling factor to represent a vertical stack with a rain cap open to a 45 degree angle. The effective stack diameter was calculated by dividing the actual flow by the adjusted velocity.