Department of Ecology Notice of Construction Minor Source Air Permit Application (Revised)

Microsoft Corporation

CO7/CO8 – Columbia Data Center Project
Project No. 131341

Original Submittal: October 7, 2021
Revised Submittals: December 7, 2021 and March 12, 2022

Department of Ecology Notice of Construction Minor Source Air Permit Application (Revised)

prepared for

Microsoft Corporation
CO7/CO8 – Columbia Data Center Project
Quincy, Washington

Project No. 131341

Original Submittal: October 7, 2021
Revised Submittals: December 7, 2021 and March 12, 2022

prepared by

Burns & McDonnell

TABLE OF CONTENTS

LIST OF TABLES

Page No.

LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
$\mu g/m^3$	micrograms per cubic meter
AERMAP	AERMOD terrain pre-processor
AERMOD	American Meteorological Society/EPA Regulatory Model
ASIL	Acceptable Source Impact Level
ASOS	Automated Surface Observing System
BACT	Best Available Control Technology
BPIPPRM	Building Profile Input Program for Plume Rise Model Enhancements
bhp	brake horsepower
Btu	British thermal units
CAQT	critical air quality threshold
CEC	California Energy Commission
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2e	carbon dioxide equivalent
CPM	condensable particulate matter
DEEP	diesel engine exhaust particulate matter
DOC	Diesel Oxidation Catalyst
DNS	Determination of Nonsignificance
DPF	Diesel Particulate Filter
DPM	Diesel Particulate Matter
dscfm	dry standard cubic feet per minute

Abbreviation	**Term/Phrase/Name**
Ecology	State of Washington Department of Ecology
EMISFACT	emission factor
EP	emission point
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
g/kW-hr	gram per kilowatt hour
g/hp-hr	gram per horsepower hour
gal/hr	gallons per hour
gal/yr	gallons per year
GEP	Good Engineering Practice
gr/dscf	grains per dry standard cubic foot
H1H	highest-first-high
H2H	highest-second-high
H_2SO_4	sulfuric acid
HC	hydrocarbon
HAP	hazardous air pollutant
HIA	Health Impact Assessment
hp	horsepower
hr/yr	hours per year
ISR	In-stack Ratio
kW	kilowatt
kWe	kilowatts of electrical power

Abbreviation	**Term/Phrase/Name**
kWm	kilowatts of mechanical power
lb/hr	pounds per hour
LNC	Lean NO_X Catalyst
m/s	meters per second
MACT	Maximum Achievable Control Technology
MERP	Modeled Emission Rates for Precursors
Microsoft	Microsoft Corporation
MMBtu/hr	million British thermal units per hour
NAAQS	National Ambient Air Quality Standards
NAD 83	North American Datum of 1983
N/A	Not Applicable
NED	National Elevation Dataset
NESHAP	National Emission Standards for Hazardous Air Pollutants
NLCD	National Land Cover Database
NMHC	non-methane hydrocarbons
NOC	Notice of Construction
NO_X	nitrogen oxides
NAC	NO_X Adsorber Catalyst
NO_2	nitrogen dioxide
NSPS	New Source Performance Standard
NSR	New Source Review
NTP	Non-thermal Plasma

Abbreviation	**Term/Phrase/Name**
OLM	Ozone Limiting Method
PBL	Planetary Boundary Layers
PM	total particulate matter
$PM_{Filterable}$	filterable portion of particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
POC	Particle Oxygen Catalyst
ppb	parts per billion
ppm	parts per million
PRIME	Plume Rise Model Enhancements algorithm
PSD	Prevention of Significant Deterioration
PVMRM	Plume Volume Molar Ratio Method
RICE	Reciprocating Internal Combustion Engine
scfm	standard cubic feet per minute
SCR	Selective Catalytic Reduction
SEPA	State Environmental Policy Act
SIL	Significant Impact Level
SO_2	sulfur dioxide
SQER	Small Quantity Emission Rate
TAP	toxic air pollutant
tBACT	Best Available Control Technology for Toxics
tpy	tons per year

Abbreviation	Term/Phrase/Name
ULSD	ultra-low sulfur diesel
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	volatile organic compound
WAC	Washington Administrative Code
WBAN	Weather Bureau Army Navy

1.0 INTRODUCTION

Microsoft Corporation (Microsoft) proposes to install six (6) new diesel emergency generators to provide emergency back-up electrical power for two (2) new data center buildings (CO7 and CO8) to be constructed at the Microsoft Columbia Data Center, located in Quincy, Washington (Grant County) (Project). The primary objective of this minor source application is to acquire Notice of Construction (NOC) approval to install the new emergency generator engines. Additionally, this application requests approval to burn ultra-low sulfur diesel (ULSD) fuels, renewable diesel fuels, or a blend of both fuels in the new generator engines and the existing engines at the Columbia Data Center.

The facility emissions, as affected by the Project, will be limited to less than 100 tons per year (tpy) for each applicable regulated criteria pollutant and will be an area (minor) source of hazardous air pollutants (HAPs). As such, the facility will be classified as a minor source for both Prevention of Significant Deterioration (PSD) and Title V. Maximum potential emissions from the Project, combined with potential emissions from existing permitted units, are listed in Table 1-1.

Table 1-1: Facility Potential Emissions and Major Source Thresholds

Pollutant	Potential Emissions of Existing Permitted Units (tpy)	Project Potential Emissions (tpy)	Total Facility Potential Emissions (tpy)	Title V Applicability Threshold[a]	PSD Major Source Thresholds (tpy)[b]	PSD Review Applicable (Yes, No)
NO_X	37.10	0.50	37.60	100	250	No
CO	5.71	0.78	6.49	100	250	No
$PM/PM_{10}/PM_{2.5}$[c]	14.18	0.11	14.29	100	250	No
SO_2	0.05	< 0.01	0.05	100	250	No
VOC	2.31	0.11	2.42	100	250	No
Total HAPs	0.05	< 0.01	0.05	25	N/A	N/A
Largest single HAP	0.02	< 0.01	0.02	10	N/A	N/A

[a] The Title V applicability thresholds are 100 tons per year (tpy) for regulated criteria pollutants, 10 tpy for any HAP, or 25 tpy for total HAPs.
[b] The major source threshold for requiring PSD permits is 250 tons per year of regulated criteria pollutants.
[c] Filterable plus condensable particulate matter.

This permit application is divided into the following sections:

- Section 1 – Introduction
- Section 2 – Project Description
- Section 3 – Emissions Estimates
- Section 4 – Regulatory Review
- Section 5 – BACT and tBACT Analysis
- Section 6 – Air Dispersion Modeling
- Section 7 – References
- Appendices

This application demonstrates that the Project meets the requirements for a NOC application under Washington Administrative Code (WAC) 173-400-110(2)(a). The required NOC form and supplemental information are included in Appendices A through G.

2.0 PROJECT DESCRIPTION

The Microsoft Columbia Data Center complex is located at 501 Port Industrial Parkway, in Quincy, Washington (Grant County), as depicted in Exhibit A-1 of Appendix A.

2.1 Emergency Diesel Generators

Two (2) new support emergency diesel generators, with 350-kilowatts of electrical power (kWe), 2 new primary 1,500-kWe emergency diesel generators, and 2 new reserve 1,500-kWe emergency diesel generators will be installed for providing emergency back-up electrical power, in the event of a power interruption, to support the 2 new data center buildings (CO7 and CO8).

Microsoft proposes to operate each of the support 350-kWe emergency diesel generator engines for a maximum of 100 operating hours annually. Microsoft proposes to operate each combination of primary and reserve 1,500-kWe emergency diesel generator engines for a combined maximum of 110 operating hours annually. The generator engines will be operated for required reliability testing, maintenance, emergency use, or other non-emergency purposes and will therefore be considered “emergency” per the New Source Performance Standard (NSPS), Subpart IIII.[1] Microsoft requests that annual fuel usage, as described in Section 2.2, will be incorporated into the permit as the surrogate parameter for tracking annual generator engine operating hours.

The projected start date for construction is during the first calendar quarter of 2022 and the projected completion date for construction is during the second calendar quarter of 2022.

2.2 Ultra-Low Sulfur and Renewable Diesel Fuels

Microsoft requests that the new emergency generator engines being installed with this Project and the existing emergency generator engines included in the permit be approved to burn ultra-low sulfur diesel (ULSD) fuels, renewable diesel fuels, or a blend of both fuels. The sulfur content of ULSD has an upper limit 15 parts per million (ppm). As shown in the certificate of analysis in Appendix F,[2] renewable diesel fuel has an equally low sulfur content, satisfies the criteria of ASTM D975, *Standard Specification for Diesel Fuel Oils*, and qualifies as a *diesel fuel* as defined in 40 CFR Part 80, *Regulation of Fuels and Fuel Additives*. Approval for the use of renewable diesel fuel, with its significantly reduced lifecycle carbon

[1] Potential operating time for one engine will include operations for emergency use and specified non-emergency uses; there is no intent to surpass the 40 CFR Part 60 Subpart IIII limits of 100 hr/yr for non-emergency use or 50 hr/yr for operations other than emergencies, maintenance, or testing.
[2] The certificate of analysis in Appendix F is provided for REG 9000, a representative brand of renewable diesel fuels, otherwise known as paraffinic diesel fuels or hydrogenated vegetable oil (HVO) diesel fuels.

footprint, will support Microsoft's goal of becoming carbon negative by 2030 [1] and it will support the objectives of the State of Washington's Climate Commitment Act.

As described above, Microsoft requests that annual fuel usage be incorporated into the permit conditions as the surrogate parameter for tracking annual generator engine operating hours. Based on projected operating hours as described in Section 2.1, the estimated annual fuel usage for the three (3) emergency diesel generator engines at each of the new data center buildings (CO7 and CO8) is 10,360 gallons per year (gal/yr), including 1,992 gal/yr for each support 350-kWe emergency diesel generator engine and 8.368 gal/yr for each combination of primary and reserve 1,500-kWe emergency diesel generator engines.

The estimated annual fuel usage for all 6 emergency diesel generator engines for this Project is 20,720 gal/yr. Combined with the annual fuel usage of 439,493 gal/yr for the existing permitted engines, estimated total fuel usage for the facility will be 460,213 gal/yr.

2.3 Diesel Storage Tanks

Each emergency generator will have a diesel storage tank (belly-tank), for a total of 6 diesel storage tanks on-site. These tanks will store ULSD, renewable diesel fuel, or a blend of both fuels. The tanks associated with the 350-kWe generators are estimated to be 1,100 gallons in size and the tanks associated with the 1,500-kWe generators are estimated to be 5,000 gallons in size. These tanks meet an emissions-based exemption from permitting, as described in Section 4.3.2.

[1] Microsoft Corporation announced on January 16, 2020 the goal of becoming carbon negative by 2030 – announcement available at: https://news.microsoft.com/2020/01/16/microsoft-announces-it-will-be-carbon-negative-by-2030/.

3.0 EMISSIONS ESTIMATES

Emissions of criteria pollutants from the Project will result from the combustion of ULSD or renewable diesel fuel in the emergency generator engines as well as fugitive emissions from the diesel storage tanks. Based on potential annual emissions, the facility emissions, as affected by the Project, will be limited to less than 100 tpy for each applicable regulated NSR pollutant and the facility will also maintain its status as an area (minor) source of HAPs.

3.1 Emergency Diesel Generator Engine Emissions

The 6 new emergency diesel generators will be installed to support the 2 new data center buildings (CO7 and CO8), providing emergency back-up electrical power in the event of a power interruption. Microsoft is requesting a maximum of 100 operating hours annually for each 350-kWe support generator engine and a maximum of 110 operating hours annually for each combination of primary and reserve 1,500-kWe generator engines. That is, emissions from 2 worst-case operating scenarios for the emergency diesel generator engines were estimated, assuming annual testing, maintenance, emergency use, or other non-emergency use as follows:

- Operating Scenario A – 100 hours annually for each 350-kWe support generator engine, 110 hours annually for each primary 1,500-kWe generator engine, and 0 hours annually for each reserve 1,500-kWe generator engine.
- Operating Scenario B – 100 hours annually for each 350-kWe support generator engine, 0 hours annually for each primary 1,500-kWe generator engine, and 110 hours annually for each reserve 1,500-kWe generator engine.

These worst-case operating scenarios were incorporated into the emission calculations in Appendix C and are represented in the air dispersion modeling (refer to Section 6.0). Annual operating hours for each engine will be between these upper and/or lower bounds, not-to-exceed 100 hours annually for each 350-kWe support generator engine and 110 hours annually for each combination of primary and reserve 1,500-kWe generator engines.[1] Microsoft requests that annual fuel usage, as described in Section 2.2, will be incorporated into the permit as the surrogate parameter for tracking annual generator engine operating hours.

[1] As an example, if the CO7 reserve 1,500-kWe generator engine has operated for 20 hours during an annual period, the CO7 primary 1,500-kWe generator engine will be limited to operating for a maximum of 90 hours during that same annual period, so that the combination of CO7 primary and reserve engines will not operate more than 110 hours during the annual period.

The emissions for the emergency generator engines were calculated as per the requirements of WAC 173-400-103 and WAC 173-460-050 (refer to Appendix C). Vendor-supplied emissions data were incorporated into estimates of not-to-exceed emission rates from each generator engine, at varying load conditions, on diesel fuel (refer to Appendix E).[1] The not-to-exceed hourly emission rates were calculated based on the following conservative approaches:

- Maximum Project hourly emissions are based on 350-kWe support generator engines and 1,500-kWe primary generator engines operating simultaneously at each building (i.e., CO7 and/or CO8) or 350-kWe support generator engines and 1,500-kWe reserve generator engines operating simultaneously at each building. Both primary and reserve 1,500-kWe generator engines at each building will not operate at the same time.
- Maximum performance data across all loads was used to determine the hourly not-to-exceed emission rates for nitrogen oxides (NO_X), carbon monoxide (CO), and the filterable portion of particulate matter ($PM_{Filterable}$).
- Maximum hydrocarbons (HC) performance data across all loads was used to determine the hourly not-to-exceed emission rate for volatile organic compounds (VOC). The HC emission rates are also conservatively assumed to be equal to condensable particulate matter (CPM) emissions.
- Emissions of total particulate matter (PM), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) are considered as the sum of $PM_{Filterable}$ and CPM (or VOC) emissions determined above.
- An upper limit of 15 ppm sulfur content, per 40 CFR 80.§510(b), was used to determine not-to-exceed sulfur dioxide (SO_2) emissions, using the emission factor calculation from Table 3.4-1 of AP-42, Section 3.4, *Large Stationary Diesel and All Stationary Dual-fuel Engines*. The maximum engine power at 100% load was used.
- For hazardous air pollutant (HAP) and toxic air pollutant (TAP) emissions emitted by the generator engines, emission factors in units of pounds per million British Thermal Units (lb/MMBtu) were obtained from Tables 3.4-3 and 3.4-4 of AP-42, Section 3.4. The maximum hourly fuel consumption rate at full load and a default diesel heat content of 0.1384 MMBtu per gallon of diesel fuel were used to determine the not-to-exceed emission rates for each HAP/TAP, with the following exceptions:

[1] For criteria pollutants, vendor-supplied emission factors, in units of gram per horsepower hour (g/hp-hr), were acquired from the "Rated Speed Potential Site Variation" emissions data tables at mechanical engine loads of varying brake horsepower (bhp), provided in pages 6 and 24 of the Equipment Specifications of Appendix E.

  - Diesel engine exhaust particulate matter (DEEP) was characterized as being equivalent to $PM_{Filterable}$ and was based on the filterable particulate matter emissions calculated for the criteria pollutant.
  - SO_2 and CO are both criteria pollutants and TAPs. Values calculated for these criteria pollutants were presented for the TAP emissions for these pollutants.
  - Nitrogen dioxide (NO_2) is a TAP and was calculated as 10% of NO_X emissions.
- Greenhouse gas emissions were estimated based on the emission factors in 40 Code of Federal Regulations (CFR) Part 98.
- As described in Section 5.0, engines certified to the EPA Tier 2 (for the 1,500-kWe generators) and Tier 3 (for the 350-kWe generators) emission standards are recommended for this project. These standards rely on good combustion and the use of fuel with ≤ 15 ppm sulfur content, without post-combustion treatment, to minimize emissions. Nevertheless, Microsoft has opted to voluntarily equip the generator engines with diesel particulate filters, which will reduce filterable particulate emissions by approximately 85%.[1] In addition, Microsoft will voluntarily install urea-injection selective catalytic reduction systems, which will reduce NO_X and NO_2 emissions by approximately 90%.
- With the addition of the urea-injection control systems, excess emissions of ammonia are estimated by the control system manufacturer at up to 8 ppm (for the 1,500-kWe generators) and up to 10 ppm (for the 350-kWe generators), corrected to 15% stack oxygen.
- Cold-start emissions occurring during the first minute of engine start-up were calculated for VOC, NO_X, CO, and PM_{10}/$PM_{2.5}$ based on the data from California Energy Commission (CEC) “Air Quality Implications of Backup Generators in California.” Maximum emission rate calculations conservatively assume 12 cold-start events per year for monthly reliability testing and maintenance associated with all engines (with approximately 10 operating hours per year allotted for this purpose). For the remaining hours allotted for other uses (emergency use or other non-emergency uses), the calculations conservatively allow for one cold-start period for every five (5) operating hours. This resulted in estimates of 30 cold-start events annually for each 350-kWe support generator engine[2] and 42 cold-start events annually for each combination of primary

[1] The particulate emission reductions are applicable to filterable particulate matter, including $PM_{Filterable}$ and DEEP emissions.
[2] For each support engine, 12 cold-start events (monthly startups for reliability testing and maintenance, accounting for approximately 10 of 80 operating hours) + 18 cold-start events (remaining 90 operating hours ÷ 5 hours per cold start) = 30 cold events per year.

and reserve 1,500-kWe generator engines.[1] Each cold-start event assumes that the first minute of operation is impacted by the cold-start and the remaining 59 minutes in the hour are at normal emission rates. Detailed cold-start emission calculations are provided in Appendix C.

- Cold-start adjustments are also applied to the NO_X and NO_2 reductions acquired from the selective catalytic reduction systems. As shown in the vendor descriptions at Appendix E, emissions reductions cannot occur until the injection temperatures reach 500 °F and the catalyst temperatures reach 540 °F. To provide time for these temperature conditions to be achieved, we estimate that warm-up periods of approximately 10 minutes at high load conditions and 15 minutes at idle loads are needed. As a conservative measure, the emissions calculations assume that NO_X and NO_2 emissions will not be reduced during warm-up periods consisting of the first 15 minutes of each cold-start event. For the remaining 45 minutes in the hour, the 90% reductions are applied, as shown in Appendix C.

3.2 Emissions While Firing On Renewable Diesel Fuels

Based on the results from recent emissions testing, emission rates from firing the emergency generator engines on renewable diesel fuels are considered to be at the same levels, on the basis of equivalent fuel usage, as when firing on ULSD. During comparative tests conducted in November 2020 on a large generator engine of the same manufacturer as the engines associated with the Columbia facility,[2] emissions of criteria pollutants while burning renewable diesel fuel compared favorably to emissions while burning ULSD. In most cases, the emissions were reduced when burning renewable diesel fuel. Emissions test descriptions, data, and comparison charts from the testing are provided at Appendix F.

3.3 Diesel Storage Tank Emissions

The Project will include 2 diesel storage tanks on-site with an estimated 1,100-gallon capacity and four (4) diesel storage tanks on-site with an estimated 5,000-gallon capacity. Due to the low vapor pressure of diesel (<0.01 psia) and the maximum operation of the generator engines being at or below 110 hours per year (on average), the VOC emissions from the diesel storage tanks (working and standing losses) are expected to be minimal (< 1 tpy). Diesel fuel generally contains trace amounts of HAPs/TAPs, but the

[1] For each combination of primary and reserve 1,500-kWe generator engines, 24 cold-start events (monthly startups for reliability testing and maintenance on each engine, accounting for approximately 20 of 110 operating hours) + 18 cold-start events (remaining 90 operating hours ÷ 5 hours per cold start) = 42 cold events per year.
[2] The emissions testing, described in Appendix F, was conducted on a Caterpillar C175-16 engine, with a maximum power rating of 3,140 kWm. The testing was conducted by Advanced Industrial Resources, Inc. at the Yancy Caterpillar testing facility in Griffin, GA.

emissions are expected to be negligible. Therefore, these tanks meet an emissions-based exemption from permitting, as described in Section 4.3.2, and their VOC and HAP/TAP emissions are not quantified.

4.0 REGULATORY REVIEW

The Project is subject to various Federal and State air regulations. Below is a discussion of applicable Federal and Washington State Department of Ecology (Ecology) provisions. Where applicable, reference to general limitations is provided when there is no specific requirement that applies to an emission source.

In certain instances, there may be multiple applicable regulatory requirements that identify differing levels of emission limitations. In these situations, it is understood that compliance with the most restrictive requirement would demonstrate compliance with other less stringent requirements.

4.1 New Source Performance Standards

WAC 173-400-115 adopts federal New Source Performance Standards (NSPS) by reference. Relevant NSPS standards are listed below, and if applicable, a description of how Microsoft plans to meet the standards.

4.1.1 40 CFR Part 60, Subpart Kb – Not Applicable

NSPS 40 CFR Part 60, Subpart Kb (§60.110b et seq.) applies to each storage vessel with a capacity greater than or equal to 75 cubic meters used to store volatile organic liquids for which construction, reconstruction, or modification is commenced after July 23, 1984. All diesel storage tanks will have a capacity less than 75 cubic meters (19,812 gallons); therefore, the 1,100-gallon storage tanks and 5,000-gallon storage tanks will not be subject to Subpart Kb.

4.1.2 40 CFR Part 60, Subpart IIII

NSPS 40 CFR Part 60, Subpart IIII (§60.4200 et seq.) applies to stationary compression ignition internal combustion engines and the manufacturers and/or owners and operators of these engines. For purposes of this application, Subpart IIII is applicable to the 6 emergency generator engines. The emergency generator engines will meet the definition of “emergency stationary internal combustion engine” under this subpart. For purposes of estimating potential emissions associated with each emergency generator engine, Microsoft proposes to operate each 350-kWe support generator engine for 100 hours annually and each combination of primary and reserve 1,500-kWe generator engines for 110 hours annually, on average. The generator engines will be operated for required reliability testing, maintenance, emergency use, or other non-emergency purposes.

The emergency generator engines will be certified in accordance with the limits in 40 CFR §60.4202(a), which refers to the emission standards of Tables 2 and 3 of 40 CFR §1039, Appendix I. If the emergency generator engine is model year 2006 or newer, then the limits are as follows for engines greater than 560 kilowatts of mechanical power (kWm)[1] per Table 2 of 40 CFR §1039, Appendix I:

- 6.4 gram per kilowatt hour (g/kW-hr) for non-methane hydrocarbons (NMHC) plus NO_X
- 3.5 g/kW-hr for CO
- 0.20 g/kW-hr for PM

The above limits are considered "Tier 2" and each of the 1,500-kWe generator engines will be certified to meet these limits. The following limits are applicable to emergency generator engines whose model year is 2006 or newer and the rated power is greater than or equal to 130 kWm and less than or equal to 560 kWm[2] per Table 3 of 40 CFR §1039, Appendix I:

- 4.0 g/kW-hr for NMHC plus NO_X
- 3.5 g/kW-hr for CO
- 0.20 g/kW-hr for PM

The above limits are considered "Tier 3" and each of the 350-kWe generator engines will be certified to meet these limits.

Pursuant to 40 CFR §60.4207(b), owners and operators of compression ignition internal combustion engines subject to Subpart IIII with a displacement of less than 30 liters per cylinder that use diesel fuel must purchase diesel fuel that meets the requirements of 40 CFR §1090.305 for nonroad diesel fuel. As stated in 40 CFR §1090.305, non-road diesel fuel must be limited to 15 ppm maximum sulfur content. The cetane index is required to be a minimum of 40, and the maximum aromatic content is limited to 35 volume percent. Microsoft will be subject to the applicable requirements of this rule for the Project emergency generator engines. This requirement will apply to ULSD and to renewable diesel fuel.[3]

4.2 National Emission Standards for Hazardous Air Pollutants and Maximum Achievable Control Technology

The National Emission Standards for Hazardous Air Pollutants (NESHAPs) are emissions standards set by the U.S. Environmental Protection Agency (EPA) for particular source categories. The NESHAP require the maximum degree of emission reduction of certain HAP emissions that EPA determines to be

[1] This category of engine is applicable to the 1,500-kW generators, with an engine power of 2,206 bhp, which converts to 1,645 kWm.
[2] This category of engine is applicable to the 350-kW generators, with an engine power of 539 bhp, which converts to 402 kWm.
[3] As shown in the certificate of analysis of Appendix F, renewable diesel fuel meets the ULSD standards for sulfur content, cetane index, and aromatic content.

achievable. These Maximum Achievable Control Technology (MACT) standards are contained in 40 CFR Part 63. One MACT standard is applicable to the Project.

4.2.1 40 CFR Part 63, Subpart ZZZZ

The Stationary Reciprocating Internal Combustion Engine (RICE) MACT is applicable to stationary RICE at both major and area sources of HAP emissions.

The emergency generator engines will be affected sources under Subpart ZZZZ (§63.6580 et seq.). The engines will be subject only to the requirements of 40 CFR 60 Subpart IIII based on their classification as new emergency stationary RICE located at an area source of HAP emissions pursuant to 40 CFR §63.6590(c)(1).

The emergency generator engines will comply with the applicable requirements of this rule, as described above.

4.3 Washington Air Quality Standards and Regulations

This section describes the regulations that apply to the Project emission sources, according to the Washington Administrative Code (WAC).

4.3.1 State Emission Standards

As listed in WAC 173-400-040, Ecology provides general limitations on opacity (limited to 20% for more than 3 minutes each hour) and SO_2 (1,000 ppm on a dry basis, corrected to 7% oxygen). WAC 173-400-050(1) limits particulate matter emissions from combustion sources to 0.1 grains/dscf. Table 4-1 below demonstrates that all engines under any operating load will comply with this limit.

Table 4-1: State Particulate Emission Standard Compliance

Emission Unit	Maximum PM Emission Rate[a]	Minimum Flow Rate[b]	Maximum PM Emission Rate[c]	PM Emission Limit	In Compliance?
	(lb/hr)	(scfm)	(gr/dscf)	(gr/dscf)	
Primary and Reserve Engines	0.06	3,338.5	0.002	0.1	Yes
Support Engines	0.04	759	0.005	0.1	Yes

[a] Maximum $PM_{Filterable}$, including cold-start emissions, for a single engine across all loads.
[b] Minimum flow rate across all loads for a single engine
[c] gr/dscf = lb/hr divided by ((1 lb/7000 grains) * dscfm * 60 min/hr)

4.3.2 Notice of Construction Permitting Applicability

A NOC permit application must be filed, and an approval order issued by Ecology, prior to the construction or modification of an affected facility per WAC 173-400-110(2)(a), unless the installation meets exemptions under WAC 173-400-110(4) or (5). The Project involves construction of 2 primary, 2 reserve, and 2 support emergency generator engines. These emission units do not meet any of the exemption criteria under WAC 173-460-110; therefore, the construction of the units requires NOC approval.

As described in Section 3.3, the emission estimates for diesel storage tanks are expected to have minimal VOC emission, well below the exemption criteria of 2 tpy of WAC 173-400-110(5)(a)(i). Therefore, the diesel storage tanks are not included in this application for permitting purposes. Microsoft requests Ecology's review and concurrence with this interpretation.

4.3.3 Major Stationary Sources under New Source Review

A project in an attainment area is subject to the Prevention of Significant Deterioration (PSD) permitting program under WAC 173-400-700 if the project is or becomes, when combined with the existing facility, a major stationary source under the New Source Review (NSR) program.

The Columbia Data Center is not one of the listed source categories with a major stationary source threshold of 100 tpy for regulated criteria pollutants.[1] Therefore, the major stationary source threshold for the facility is 250 tpy of any regulated criteria pollutants. As shown in Table 1-1, the potential to emit for the existing facility, combined with Project emissions, is well below the 250 tpy threshold for all criteria pollutants. Therefore, the Columbia Data Center will remain a minor source under NSR and will not trigger PSD permitting.

4.3.4 Major Sources under Title V

A major source under the Title V program is defined as a facility with:

- Potential emissions greater than or equal to 100 tpy of a criteria pollutant.
- Potential emissions greater than or equal to 10 tpy of any single HAP or greater than or equal to 25 tpy for total HAPs. Such sources are also known as major sources of HAP emissions, whereas sources with emissions below these levels are known as area sources of HAP emissions.[2]

[1] The source categories, with major source thresholds of 100 tpy, are listed in 40 CFR §52.21(b)(i)(a), incorporated into the definitions for major stationary sources under WAC 173-400-710.
[2] Refer to definition of "major source" in WAC 173-401-200.

Major sources are required to obtain Title V operating permits. As shown in Table 1-1, the potential to emit for the existing facility, combined with Project emissions, is well below the major source thresholds. Therefore, the Columbia Data Center will remain a minor source under the Title V program.

4.3.5 Best Available Control Technology

As required in WAC 173-400-113, a new source in an attainment area will employ the best available control technology (BACT) for each criteria pollutant which shows an increase in emissions. Additionally, according to WAC 173-460-060(2), BACT for toxics (tBACT) is required to control TAPs showing increases above de minimis levels found in WAC 173-460-150. Analysis for the appropriate BACT and tBACT controls is provided in Section 5.0.

4.3.6 Toxic Air Pollutants

All new sources emitting TAPs are required to show compliance with the Washington TAP program pursuant to WAC 173-460. Ecology has established a de minimis emission rate, a small quantity emission rate (SQER), and an acceptable source impact level (ASIL) for each listed TAP. If the total project-related TAP emissions increase exceeds the de minimis level for a pollutant, then permitting and a control technology review is triggered.[1] If the emissions increase exceeds its respective SQER, further determination of compliance with the ASIL using air dispersion modeling is required.[2]

Table 4-2 summarizes the Project TAP emissions and illustrates a comparison of the emissions, on a lb/averaging period basis, with the de minimis and SQER levels. TAPs showing rates that exceed the de minimis levels include CO, DEEP, NO_2, acrolein, ammonia, benzene, and naphthalene – these pollutants are included in the tBACT analysis of Section 5.0. TAPs showing rates that exceed the SQER levels include DEEP and NO_2 – these pollutants are included in the air dispersion modeling, described in Section 6.0. This modeling constitutes the first-tier review of the potential impact from TAP emissions. Detailed calculations, from which Project emissions estimates are derived, are included in Appendix C.

4.3.7 Health Impact Assessments

If air dispersion modeling, referenced in Section 4.3.6 and described in Section 6.0, shows that an ASIL for a TAP is exceeded, second-tier review of the potential impact from TAP emissions is triggered.[3] If this were to occur, a health impact assessment (HIA) protocol would be developed, and an HIA would be

[1] Refer to WAC 173-460-060(2) and WAC 173-460-080(1).
[2] Refer to WAC 173-460-080(2).
[3] Refer to WAC 173-460-090.

performed according to the protocol. Ecology would be petitioned to perform the second-tier review. The protocol would be intended to ensure that the HIA:

- Presents data about the emissions source and its surrounding built and natural environment, including site description, TAP concentrations and toxicity, identification of exposed populations, exposure assessment;
- Utilizes current scientific information on the toxicological characteristics of TAPs; and
- Considers background concentrations of TAPs, estimated using the latest National Ambient Toxics Assessment data for the appropriate census tracts, ambient monitoring data for the Project's location, or modeling of emissions of the TAPs from all stationary sources within 1.5 kilometers of the source location.

Table 4-2: Project TAP Emission Summary

TAP	Averaging Period[a]	Project Emissions	De Minimis[a]	SQER[a]	Permitting/ Controls Required?	Modeling Required?
		(lb/averaging period)[b]				
CO	1-hour	16.70	1.10	43.00	Yes	No
DEEP	1-year	20.11	2.70E-02	0.54	Yes	Yes
SO_2	1-hour	0.07	0.46	N/A	No	No
NO_2	1-hour	2.46	0.46	0.87	Yes	Yes
Acetaldehyde	1-year	0.61	3.00	N/A	No	No
Acrolein	24-hour	2.08E-02	1.30E-03	2.60E-02	Yes	No
Ammonia	24-hour	10.34	1.90	37.00	Yes	No
Benz(a)anthracene	1-year	3.14E-03	4.50E-02	N/A	No	No
Benzene	1-year	3.11	1.00	21.00	Yes	No
Benzo(a)pyrene	1-year	9.48E-04	8.20E-03	N/A	No	No
Benzo(b)fluoranthene	1-year	3.60E-03	4.50E-02	N/A	No	No
Benzo(k)fluoranthene	1-year	8.01E-04	4.50E-02	N/A	No	No
1,3-Butadiene	1-year	0.15	0.27	N/A	No	No
Chrysene	1-year	5.12E-03	0.45	N/A	No	No
Dibenz(a,h)anthracene	1-year	1.50E-03	4.10E-03	N/A	No	No
Formaldehyde	1-year	1.06	1.40	N/A	No	No
Indeno(1,2,3-cd)pyrene	1-year	1.58E-03	4.50E-02	N/A	No	No
Naphthalene	1-year	0.47	0.24	4.80	Yes	No
Propylene	24-hour	2.37	11.00	N/A	No	No
Toluene	24-hour	0.26	19.00	N/A	No	No
Xylenes	24-hour	0.18	0.82	N/A	No	No

[a] Values provided in WAS 173-460-150. SQER values are listed if Project emissions are greater than de minimis thresholds. SQER values are represented as "N/A" if project emissions were below de minimis thresholds (i.e., if emissions did not exceed de minimis thresholds, no further analysis is required).
[b] lb/averaging period estimated by multiplying lb/hr estimates by 1 and 24 for the 1-hr and 24-hr averaging periods and by multiplying tpy estimates by 2,000 for 1-year averaging periods.

Ecology would likely accept a second-tier review if:

- the HIA demonstrates that the increase in TAP emissions is not likely to result in an increased cancer risk of more than one in one hundred thousand; and
- Ecology determines that the noncancer hazard is acceptable.

If a second-tier review does not satisfy the above conditions for permit approval, third-tier review of the potential impact from the TAP emissions is triggered.[1] If this were to occur, a third-tier petition would be submitted to Ecology for approval of the project based on a third-tier risk management analysis. The petition, which may be submitted concurrently with the second-tier review request, must demonstrate that proposed emission controls fulfill tBACT and project approval would result in a greater environmental benefit to the state than disapproval. In addition to satisfying tBACT, measures may be proposed to reduce community exposure, especially that portion subject to the greatest additional risk to comparable TAPs, provided that such measures are not already required. Ecology would initiate a 60-day public notice period (see sections on public notices and public hearings) and a public hearing would be held to:

- Present the results of the health impact analysis, the proposed emission controls, pollution prevention methods, additional proposed measures, and remaining risks; and
- Participate in discussions and answer questions.

Based on the modeling results, as described in Section 6.0, there are no TAPs with emissions which exceed their ASIL. Therefore, a second-tier HIA is not triggered by this Project.

4.3.8 Public Notice Period

After receipt of this application, Ecology will post an announcement on its web site for 15 days, providing notice of receipt of the application and the type of proposed action anticipated by Ecology.[2] A formal 30-day public notice period may follow, depending on responses from the informal web notice. Additionally, a public hearing may be held due to a petition for a third-tier HIA or if Ecology determines a hearing is warranted due to significant public interest.[3]

4.3.9 State Environmental Policy Act Checklist Review

An update of the previously completed State Environmental Policy Act (SEPA) checklist is required for permit approval. The updated checklist was submitted to the City of Quincy and the City processed a

[1] Refer to WAC 173-460-100.
[2] Refer to WAC 173-400-171.
[3] As noted in Section 4.3.7, a second-tier HIA is not triggered by this Project; therefore, it follows that a third-tier HIA will not apply.

Notice of Application with a Determination of Nonsignificance (DNS). Ecology submitted comments, which did not affect the City's determination. The City deemed the DNS determination to be complete upon the completion of the public comment period. The SEPA checklist and determination documents are provided in Appendix G.

5.0 BACT AND tBACT ANALYSIS

As stated in Step VIII in the Notice of Construction application (refer to Appendix B), Ecology requires that a complete evaluation of BACT for new stationary sources of emissions be performed. This step requires a case-by-case determination of BACT for the control of regulated NSR pollutant emissions from these sources, taking into account energy, environmental, and economic impacts. In addition, Ecology requires that the analysis include a determination of BACT for toxics (tBACT), which applies to TAPs with emission greater than the de minimis thresholds listed in WAC 173-460-150.[1]

In a 1987 memorandum (EPA, 1987), the EPA directed that guidance would be developed for a "top-down" approach for determining BACT for new sources being evaluated under the prevention of significant deterioration (PSD) rules. That guidance was developed in 1990 and incorporated into the 1990 version of the New Source Review Workshop Manual (EPA, 1990). This approach is the standard for major stationary source BACT analysis. Although the major source PSD rules do not apply to this minor source permit application, Ecology has indicated that the "top-down" approach is preferred. Based on the 1990 guidance (EPA, 1990), the evaluation includes:

1. Identification of alternative emission control techniques
2. Technical feasibility analysis of each alternative
3. Ranking of technically feasible alternatives
4. Control evaluation, based on:
    a. energy impacts
    b. environmental impacts
    c. solid or hazardous waste generation
    d. control device water discharges
    e. emissions of air toxics and other non-NSR pollutants
    f. economic impacts
5. Selection of BACT (and tBACT)

5.1 Alternative Techniques[2]

Post-combustion controls are available to reduce emissions of NO_X, CO, VOC, particulate matter ($PM/PM_{10}/PM_{2.5}$), and TAPs (which are generally present as constituents of the other pollutants).

[1] Refer to WAC 173-460-020 and 040.
[2] Alternative techniques were acquired from Table 3, *Exhaust aftertreatment technologies*, for compression ignition (diesel) engines, in the DieselNet Technology Guide at: https://dieselnet.com/tech/engine_emission-control.php.

Additionally, while post-combustion controls may also reduce SO_2 emissions, these emissions are more readily reduced through use of diesel fuels containing low quantities of sulfur. Potential treatment technologies include the following:

- Selective Catalytic Reduction (SCR) – SCR systems employ injection of urea or ammonia into the flue gas, reducing reduce NO_X by 90% or greater.
- NO_X Adsorber Catalyst (NAC) – The NAC technique has applications for cold starts or transitions between lean and rich fuel mixtures, in which adsorbers temporarily store and then release NO_X for catalytic treatment; NO_X may be reduced by up to 70% in some applications, or the technique may be used to enhance downstream catalytic NO_X treatment.
- Lean NO_X Catalyst (LNC) – NO_X reductions of 10% to 20% may be experienced through targeted catalytic reactions with hydrocarbons in the exhaust gas stream.
- Diesel Oxidation Catalyst (DOC) – Reduction of VOC, CO, the organic fraction of particulates, ($PM/PM_{10}/PM_{2.5}$), and oxidation of NO to NO_2 (either increasing NO_2 and NO_X emissions or enhancing SCR performance for NO_X reduction). SO_2 may also be oxidized, resulting in the formation of sulfuric acid and sulfate particulates.
- Diesel Particulate Filter (DPF) – DPF systems reduce filterable particulates ($PM_{Filterable}$ and DEEP emissions) by 85% and greater through physical capture of diesel particulates.
- Particle Oxygen Catalyst (POC) – POC systems may result in reductions in particulates ($PM/PM_{10}/PM_{2.5}$) by up to 50% through capture and oxidation of carbonaceous particulates via reactions with a catalyst such as NO_2 (which may be generated by an upstream DOC system).
- Non-thermal Plasma (NTP) – This control technique reduces NO_X and particulate emissions through oxidation by exposure of the gas stream to plasma discharges.
- Tier 4 System – Tier 4 control systems employ a combination of above-described technologies, including SCR, DPF, and DOC, to treat the full range of criterial pollutants.
- Tier 2 and Tier 3 Certified Engine – Engines certified to the EPA Tier 2[1] and Tier 3[2] standards rely on good combustion and the use of ultra-low sulfur diesel fuel (≤ 15 ppm sulfur content).

Details regarding each technology were acquired via links to specific *Emission Aftertreatment* technologies found at: https://dieselnet.com/tg#at (Ecopoint, 2021).

[1] Tier 2 standards are specified for engines of power output > 560 kWm in Table 2 of 40 CFR §1039, Appendix I.

[2] Tier 3 standards are specified for engines of power outputs ≥ 130 kWm and < 560 kWm in Table 3 of 40 CFR §1039, Appendix I.

5.2 Technical Feasibility[1]

The technical feasibility of the various alternatives depends on whether they may be employed singly or in combination. Low-sulfur fuels, such as ultra-low sulfur diesel (ULSD) fuel, are readily available for reduction of SO_2 emissions. Renewable diesel fuels are also available with similarly low sulfur content. The technical feasibility of the various treatment options for fixed, diesel fuel-powered, internal combustion engines is evaluated as follows:

- Selective Catalytic Reduction – SCR systems are commonly employed to provide signification reductions in NO_X emissions for fixed engines. Injection of urea into the flue gas (rather than ammonia) is the typical approach. These systems are often used in combination with DPF and/or DOC systems.
- NO_X Adsorber Catalyst – NAC systems are employed for light-duty engine applications, but they have not been shown to be viable for heavy-duty fixed engines.
- Lean NO_X Catalyst – NO_X reductions of 10% to 20% may be experienced through targeted catalytic reactions with hydrocarbons in the exhaust gas stream. Research is ongoing for the viability of these systems, but application to fixed engines has not yet been shown to be viable.
- Diesel Oxidation Catalyst – DOC systems are commonly employed, especially in combination with DPF and/or SCR systems, to reduce VOC, CO, and particulates in fixed engines; DOC units are also used to oxidize NO to NO_2, thereby enhancing SCR performance for NO_X reduction. Unless SO_2 is reduced via fuel selection, the DOC system may also convert SO_2 to form sulfuric acid and sulfate particulates.
- Diesel Particulate Filter – DPF systems are commonly added to fixed engines to provide significant reductions in particulate emissions. Treatment may be enhanced when DPF systems are installed in combination with DOC systems.
- Particle Oxygen Catalyst – While this method is being applied to vehicle engines, it is not currently being used for fixed engines, most likely because the reductions are not generally achieved to the level needed for fixed engines. Therefore, technical feasibility for use on fixed engines is yet to be tested.

[1] Descriptions of the technical viability of the specific treatment technologies was based on review of the details regarding each technology, acquired via links to the various *Emission Aftertreatment* technologies found at: https://dieselnet.com/tg#at (Ecopoint Inc. 2021).

- Non-thermal Plasma – Combinations of plasma discharge with catalyst systems are being researched to determine viable applications, but these have not yet been proven.
- Tier 4 Control System – Fixed engines are commonly fitted with Tier 4 control systems, when reductions are required for the full range of criteria pollutants – these systems include the above-described SCR, DPF, and DOC technologies.
- Tier 2 and Tier 3 Certified Engine – Newer model fixed engines are typically designed to meet Tier 2 standards (for large engines) and Tier 3 standards (for smaller engines).[1]

5.3 Ranking of Technically Feasible Alternatives

Based on the evaluations in Section 5.2, the technically feasible treatment options for fixed, diesel fuel-powered, internal combustion engines are ranked as follows, based on treatment effectiveness:

1. Tier 4 Control Systems – Combines the effectiveness of SCR, DPF, and DOC technologies into an integrated system.
2. Selective Catalytic Reduction – Reduces NO_X emissions by 90% or greater.
3. Diesel Particulate Filter – Captures 85% or more of filterable particulate emissions.
4. Diesel Oxidation Catalyst – Reduces VOC, CO, and particulates; additionally, DOC systems enhance SCR performance for NO_X reduction.
5. Tier 2 and Tier 3 Certified Engine – Reduces NO_X, VOC, CO, and particulate emissions through engine design without post-combustion treatment, meeting the EPA standards in Tables 2 and 3 of 40 CFR §1039, Appendix I for Project engines.

5.4 Control Evaluation

The above-ranked treatment alternatives are evaluated below based on energy impacts, environmental impacts, solid or hazardous waste generation, control device water discharges, emissions of air toxics and other non-NSR pollutants, and economic impacts:

- Selective Catalytic Reduction – For SCR systems, overall energy requirements for engine operation or increase by the need to (1) manufacture, transport, and store urea and to (2) pump and inject urea into the flue gas via a controlled process. Although a risk of urea spills or leaks would be present, generation of waste products or wastewater discharges would not normally be

[1] Refer to Table 2 of 40 CFR §1039, Appendix I for engines of power output > 560 kWm and Table 3 of 40 CFR §1039, Appendix I for power outputs ≥ 130 kWm and < 560 kWm.

anticipated. The proper quantity of urea/ammonia injected, along with uniform flow distribution and thorough mixing in the flue gas stream, will minimize emissions of unconverted NO_X or unutilized ammonia. As shown in the Tables D-A6 and D-A7 of Appendix D, the cost analyses for control of criteria pollutants and toxic air pollutants show that the cost for installation of the SCR system does not pass the reasonability test. Therefore, SCR system installation should be eliminated from consideration.

- Diesel Particulate Filter – DPF systems employ filters to capture filterable particulates from the flue gas stream. Manufacture of the replacement filters and disposal of spent filters will increase energy requirements and result in waste generation. Emission increases for other pollutants are not anticipated. As shown in the Tables D-B6 and D-B7 of Appendix D, the cost analyses for control of criteria pollutants and toxic air pollutants show that the cost for installation of the DPF system does not pass the reasonability test. Therefore, DPF system installation should be eliminated from consideration.

- Diesel Oxidation Catalyst – DOC systems employ catalysts in the flue gas stream to reduce VOC, CO, and particulates. Manufacture of the replacement catalyst and disposal of spent catalyst materials will increase energy requirements and result in waste generation. Also, if sulfur content in the flue gas is not minimized via use of ultra-low sulfur fuels, SO_2 may also be oxidized, resulting in the formation of sulfuric acid and sulfate particulates beyond the exhaust outlet. As shown in the Tables D-C6 and D-C7 of Appendix D, the cost analyses for control of criteria pollutants and toxic air pollutants show that the cost for installation of the DOC system does not pass the reasonability test. Therefore, DOC system installation should be eliminated from consideration.

- Tier 4 Control Systems – The Tier 4 system provides an integrated combination of the SCR, DPF, and DOC technologies. Therefore, the same or similar impacts as described above for these systems is applicable to the Tier 4 system. As shown in the Tables D-D6 and D-D7 of Appendix D, the cost analyses for control of criteria pollutants and toxic air pollutants show that the cost for installation of the Tier 4 system does not pass the reasonability test. Therefore, Tier 4 system installation should be eliminated from consideration.

- Tier 2 and Tier 3 Certified Engines – Engines certified to the EPA Tier 2[1] and Tier 3[2] standards rely on good combustion and the use of fuel with ≤ 15 ppm sulfur content, applicable to USLD

[1] Tier 2 standards are specified for engines of power outputs > 560 kWm in Table 2 of 40 CFR §1039, Appendix I.
[2] Tier 3 standards are specified for engines of power outputs ≥ 130-kWm and < 560 kWm in Table 3 of 40 CFR §1039, Appendix I.

and renewable diesel fuels. Additional energy requirements, generation of waste or water discharges, and emission increases are not anticipated. Because these engines fulfill the EPA BACT standard for fixed, diesel fuel-powered, internal combustion engines and they meet the required EPA emission standards for NO_X, VOC, CO, and particulates, a cost analysis is not appropriately applied. Tier 2 and Tier 3 certified engines are considered an effective option.

5.5 BACT-tBACT Selection

As described in Section 5.4, SCR, DPF, DOC, and Tier 4 systems are recommended for elimination from consideration based on the evaluation for each. The Tier 2 certified engine (for the 1,500-kWe generators) and the Tier 3 certified engine (for the 350-kWe generators) represent the remaining effective options and are recommended for selection as meeting BACT and tBACT for these engines.

Regardless of the above recommendation, Microsoft has opted to voluntarily equip the generator engines with DPF controls to reduce filterable particulate emissions by approximately 85%.[1] Additionally, Microsoft will voluntarily install urea-injection SCR systems to reduce NO_X and NO_2 emissions by approximately 90%.

[1] The DPF emission reductions are applicable to filterable particulate matter, including $PM_{Filterable}$ and DEEP emissions.

6.0 AIR DISPERSION MODELING

Air dispersion modeling was performed to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) for criteria pollutants and the applicable ASILs that trigger an air dispersion modeling analysis. A summary of the models, the modeling techniques, and modeling results for the Project are discussed in the following sections.

6.1 Air Dispersion Model

Air dispersion modeling was performed using the latest version of the EPA-approved American Meteorological Society/EPA Regulatory Model (AERMOD) model (Version 21112). The AERMOD model is an EPA-approved, steady-state Gaussian air dispersion model that is designed to estimate downwind ground-level concentrations from single or multiple sources using detailed meteorological data.

Ecology requires that regulatory compliance be demonstrated by using AERMOD. Major features of the AERMOD model are as follows:

- Plume rise, in stable conditions, is calculated using Briggs equations that consider wind and temperature gradients at stack top and half the distance to plume rise; in unstable conditions, plume rise is superimposed on the displacements by random convective velocities, accounting for updrafts and downdrafts due to momentum and buoyancy as a function of downwind distance for stack emissions.
- Plume dispersion receives Gaussian treatment in horizontal and vertical directions for stable conditions and non-Gaussian probability density function in vertical direction for unstable conditions.
- AERMOD creates profiles of wind, temperature, and turbulence, using all available measurement levels and accounts for meteorological data throughout the plume depth.
- Surface characteristics, such as Bowen ratio, albedo, and surface roughness length, may be specified to better simulate the modeling domain.
- Planetary Boundary Layers (PBL), such as friction velocity, Monin-Obukhov length, convective velocity scale, mechanical and convective height, and sensible heat flux, may be specified.
- AERMOD uses a convective mixing height (based upon hourly accumulation of sensible heat flux) and a mechanical mixed layer height.

- AERMOD's terrain pre-processor (AERMAP) provides information for the advanced critical dividing streamline height algorithms and uses the National Elevation Dataset (NED) to obtain elevations.
- AERMOD uses vertical and horizontal turbulence-based plume growth (from measurements and/or PBL theory) that varies with height and uses continuous growth functions.
- AERMOD uses convective updrafts and downdrafts in a probability density function to predict plume interaction with the effective mixing lid in convective conditions while using a mechanically mixed layer near the ground.
- Plume reflection above the mixing lid is considered.
- AERMOD models impacts that occur within the cavity regions of building downwash, via the use of the plume rise model enhancements (PRIME) algorithm, and then uses the standard AERMOD algorithms for areas without downwash.

Details of the AERMOD modeling options may be found in the AERMOD User's Guide (EPA, 2021b).

The following regulatory default model options were selected for this analysis:

- Elevated Terrain Algorithms
- Stack-tip Downwash
- Gradual Plume Rise
- Buoyancy-induced Dispersion
- Calms and Missing Data Processing Routine
- Calculate Wind Profiles
- Default Vertical Potential Temperature Gradient
- Rural Dispersion

6.2 Model Parameters

Modeling runs were conducted at full load and partial loads of the engines. The modeling parameters and the emission rate parameters for the engines are shown in Table 6-1 and Table 6-2, respectively. On a long-term basis, as described in Section 3.1, Microsoft is requesting a maximum of 100 operating hours annually for each 350-kWe support generator engine and a maximum of 110 operating hours annually for each combination of primary and reserve 1,500-kWe generator engines. Annual operating hours for each 1,500-kWe generator engine will be between the upper and lower bounds represented by two operating scenarios. Project emissions, calculated according to these worst-case operating scenarios as shown in

Table 6-2, represent projected worst-case ambient conditions under various operating loads and include start-up emissions (also refer to Section 3.1 and Appendix C).

Table 6-1: Engine Modeling Parameters (Single Engine)

Unit	Engine	Load	Stack Height (feet)	Design Temperature (°F)	Modeled Temperature[a] (°F)	Design Exit Velocity (feet/second)	Modeled Exit Velocity[b] (feet/second)	Stack Diameter (inches)
CO07_01 and CO08_01	1,500-kWe Primary	100%	46.0	756.6	628.9	140.1	133.1	16.0
		75%	46.0	706.7	587.4	117.8	111.9	16.0
		50%	46.0	696.7	579.1	88.7	84.3	16.0
		25%	46.0	664.9	552.7	57.0	54.2	16.0
		10%	46.0	540.6	449.4	39.8	27.9	19.1[c]
CO07_02 and CO08_02	1,500-kWe Reserve	100	46.0	756.6	628.9	140.1	133.1	16.0
		75	46.0	706.7	587.4	117.8	111.9	16.0
		50	46.0	696.7	579.1	88.7	84.3	16.0
		25	46.0	664.9	552.7	57.0	54.2	16.0
		10	46.0	540.6	449.4	39.8	27.9	19.1[c]
CO07_03 and CO08_03	350-kWe Support	100	46.0	1,062.6	827.8	55.6	52.8	12.0
		75	46.0	1,021.9	796.1	53.7	51.0	12.0
		50	46.0	942.7	734.4	41.4	39.3	12.0
		25	46.0	795.4	619.6	23.7	22.5	12.0
		10	46.0	599.4	466.9	16.1	11.3	14.3[c]

[a] A safety factor was applied, which reduced the stack temperature by 5 percent for loads 100% to 10% to account for variations in onsite environmental conditions. Additional reductions in stack temperature by 12.5% (for 1,500-kWe engines) and 18% (for 350-kWe engines) were applied due to the presence of the DPF system in the exhaust stacks.
[b] For loads 100% to 25%, an additional safety factor was applied to the design exit velocity, which reduced the exit velocity by 5 percent to account for variations in onsite environmental conditions. For the 10% load condition, the exit velocity was reduced by 30 percent to account for a vertical stack with a rain cap that has an angle of 45 degrees.
[c] For the 10% load condition, an effective stack diameter was derived to simulate the widening of the plume. This was calculated by dividing the actual flow rate by the adjusted exit velocity.

Table 6-2: Criteria Pollutant Emission Rate Parameters (Single Engine)

Engine	Pollutant	Units[a]	100% Load	75% Load	50% Load	25% Load	10% Load
1,500-kWe Primary	$PM_{2.5}$	lb/hr	0.86	0.92	0.90	0.74	0.82
		tpy	0.044	0.048	0.047	0.038	0.042
	PM_{10}	lb/hr	0.86	0.92	0.90	0.74	0.82
	CO	lb/hr	4.81	3.21	4.30	4.94	4.80
	NO_2	lb/hr	10.40	9.21	8.81	8.61	8.47
		tpy	0.21	0.13	0.11	0.10	0.09
	SO_2	lb/hr	0.027	0.027	0.027	0.027	0.027
1,500-kWe Reserve	$PM_{2.5}$	lb/hr	0.86	0.92	0.90	0.74	0.82
		tpy	0.044	0.048	0.047	0.038	0.042
	PM_{10}	lb/hr	0.86	0.92	0.90	0.74	0.82
	CO	lb/hr	4.81	3.21	4.30	4.94	4.80
	NO_2	lb/hr	10.40	9.21	8.81	8.61	8.47
		tpy	0.21	0.13	0.11	0.10	0.09
	SO_2	lb/hr	0.027	0.027	0.027	0.027	0.027
350-kWe Support	$PM_{2.5}$	lb/hr	0.082	0.11	0.14	0.13	0.20
		tpy	3.51E-03	4.82E-03	6.34E-03	6.21E-03	9.31E-03
	PM_{10}	lb/hr	0.082	0.11	0.14	0.13	0.20
	CO	lb/hr	3.41	2.72	2.65	2.72	2.11
	NO_2	lb/hr	1.91	1.63	1.56	1.56	1.53
		tpy	0.03	0.02	0.01	0.01	0.01
	SO_2	lb/hr	6.54E-03	6.54E-03	6.54E-03	6.54E-03	6.54E-03

[a] Maximum tpy values for each engine are based on 110 hours per year for the 1,500-kWe primary and reserve engines and 100 hours per year for 350-kWe support engines.

6.3 Modeling Methodology

The modeling methodology used for this analysis is summarized in the sections below.

6.3.1 Intermittent Emissions

The engines will not operate continuously throughout the year and will be operated for required reliability testing, maintenance, emergency use, or other non-emergency purposes. Additionally, on a short-term basis the primary engines will not operate at the same time as the reserve engines. $PM_{2.5}$ (24-hour), PM_{10}

(24-hour), CO (1-hour and 8-hour), NO_2 (1-hour), and SO_2 (1-hour and 3-hour) were modeled with the following engine grouping, as described in Section 3.1 and Section 6.2, to demonstrate compliance with the short-term ambient air quality standards:

- Operating Scenario A – CO7 and CO8 primary engines (1,500-kWe each) and CO7 and CO08 support engines (350-kWe each).
- Operating Scenario B – CO7 and CO8 reserve engines (1,500-kWe each) and CO7 and CO8 support engines (350-kWe each).

6.3.2 Emission Factors

Emissions factor (EMISFACT) modeling options in AERMOD allow a user to model emissions only when certain criteria are met, such as specifying the season, month, or time of day when facility operations will occur. The emergency generators will be restricted to a 10-hour period per day, between the hours of 7 A.M. to 5 P.M., for reliability testing, maintenance, and other non-emergency uses. The following hour of day EMISFACT was applied to the short-term pollutant specific modeling runs:

- NO_2 (1-hour) – Time-of-day factor from 7 A.M. to 5 P.M for reliability testing, maintenance, and other non-emergency operation
- $PM_{2.5}$ (24-hour) – Time-of-day factor from 7 A.M. to 5 P.M for reliability testing, maintenance, and other non-emergency operation

As a conservative approach, no EMISFACT was applied to any other short-term modeled pollutant and the hour of day EMISFACT was not applied to the annual averaging period.

6.3.3 Rain Caps or Horizontal Stacks

AERMOD allows the user to select options for capped and/or horizontal releases by specifying the POINTCAP or POINTHOR keywords within the AERMOD input file to account for restriction of vertical flow. The POINTCAP or POINTHOR keywords were not used for any Project sources. For loads 100 percent to 10 percent, a safety factor was applied, which reduced the stack temperature by 5 percent to account for variations in onsite environmental conditions. Additional reductions in stack temperature by 12.5% (for 1,500-kWe engines) and 18% (for 350-kWe engines) were applied due to the presence of the DPF system in the exhaust stacks. For loads 100 percent to 25 percent, an additional safety factor was applied to the design exit velocity, which reduced the exit velocity by 5 percent to account for variations in onsite environmental conditions. For the 10 percent load condition, the design exit velocity was reduced by 30 percent to account for a vertical stack with a rain cap that has an angle of 45 degrees. Additionally, an effective stack diameter was derived to simulate the widening of the plume, calculated by dividing the actual flow rate by the adjusted exit velocity.

6.3.4 Good Engineering Practice Stack Height

Sources are subject to Good Engineering Practice (GEP) stack height requirements outlined in 40 CFR Part 51, §§51.100 and 51.118. As defined by the regulations, the GEP height is calculated as the greater of 65 meters (measured from the ground level elevation at the base of the stack) or the height resulting from the following formula:

$$GEP = H + 1.5L$$

Where

H = the building height; and

L = the lesser of the building height or the greatest crosswind distance of the building - also known as maximum projected width.

To meet stack height requirements, the point sources were evaluated in terms of the proximity to nearby structures. The purpose of this evaluation was to determine if the discharge from each stack would become caught in the turbulent wake of a building or other structure, resulting in downwash of the plume. Downwash of the plume can result in elevated ground-level concentrations. In EPA's 1985 *Guideline for Determination of Good Engineering Practice Stack Height* (EPA, 1985), EPA provided guidance for determining whether building downwash will occur. The downwash analysis was performed consistent with the methods prescribed.

Calculations for determining the direction-specific downwash parameters were performed using the most current version of the EPA's Building Profile Input Program (BPIP) for Plume Rise Model Enhancements (PRIME), otherwise referred to as the BPIPPRM downwash algorithm (Version 04274). After running the BPIPPRM model, it was determined that the GEP stack heights do not exceed the greater of 65 meters or the calculated GEP stack height. The BPIPPRM files were included in the electronic file transfer to the Ecology.

6.3.5 Receptor Grid

The overall purpose of the modeling analysis is to demonstrate that operation of the Project will not result in, or contribute to, concentrations above the NAAQS for criteria pollutants and ASILs for TAPs. Modeling runs were conducted using the AERMOD model in simple and complex terrain mode within a 12- by 12-kilometer Cartesian grid to determine the significant impact area for each pollutant. Based on guidance from Ecology, the grid incorporated the receptor spacing as specified in Table 6-3. Receptors were also be placed along the fence line boundary at a spacing of 12.5 meters. A flagpole receptor height of 1.5 meters above ground to capture the approximate average the human breathing zone was used for all receptors.

Table 6-3: Receptor Spacing from Fence Line Boundary

Distance from Fence Line (kilometers)	Receptor Spacing (meters)
0 – 0.15	12.5
0.15 – 0.4	25
0.4 – 0.9	50
0.9 – 2	100
2 – 4.5	350
4.5 – 6	600

Source: Ecology, *Air Quality Program Guidance*, August 2019 (Ecology, 2019).

Terrain elevations were incorporated into the model using 1/3 arc-second U.S. Geological Survey (USGS) National Elevation Dataset (NED) data to obtain the necessary receptor elevations. North American Datum of 1983 (NAD 83) was used to develop the Universal Transverse Mercator (UTM) coordinates for this Project.

AERMOD has a terrain preprocessor (AERMAP) which uses gridded terrain data for the modeling domain to calculate not only a XYZ coordinate, but also a representative terrain-influence height associated with each receptor location selected. This terrain-influenced height is called the height scale and is separate for each individual receptor. AERMAP (Version 18081) utilized the electronic NED data to populate the model with receptor elevations.

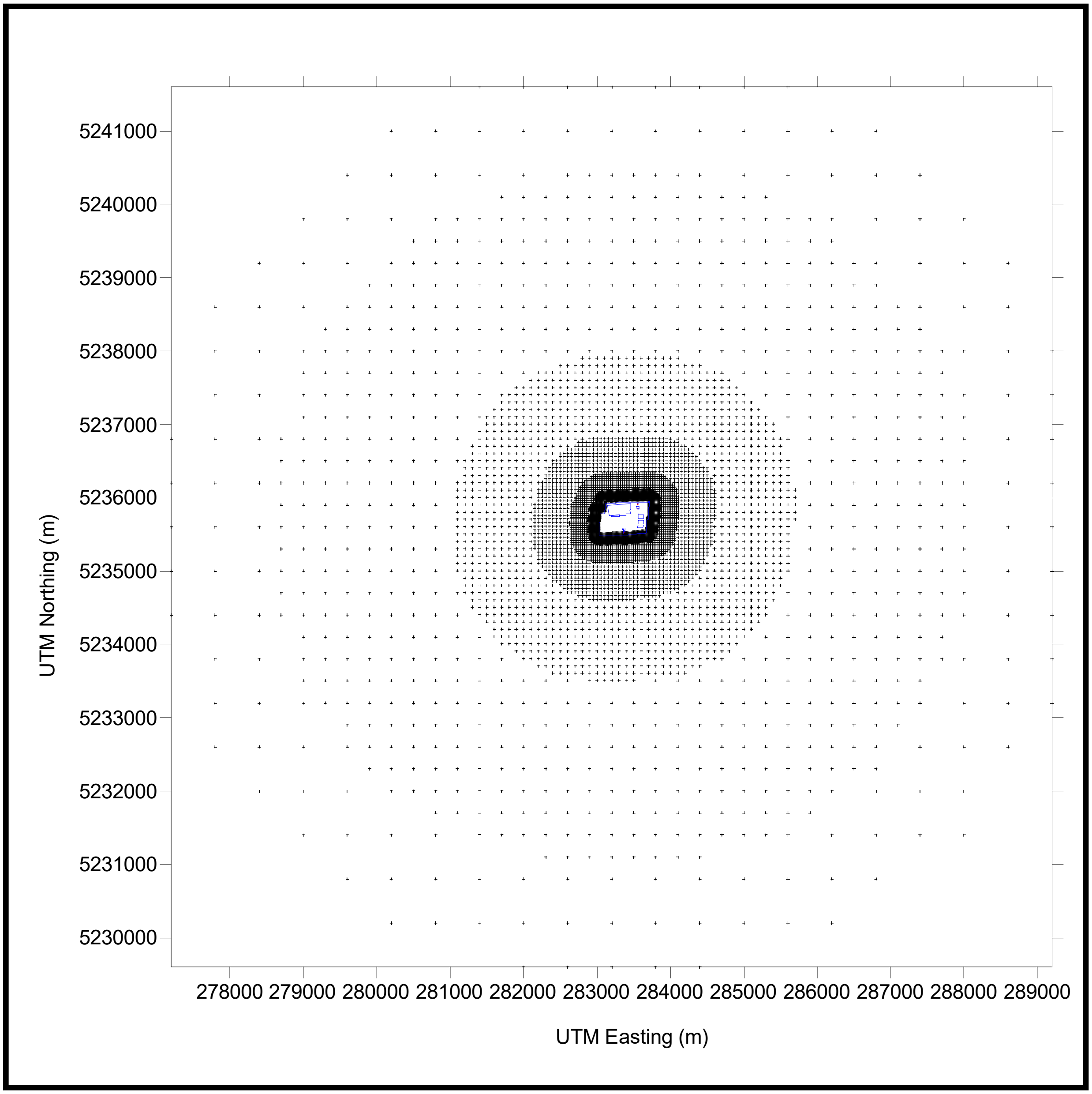
Refer to a depiction of the Receptor Grid at Figure 6.1 on the following page.

6.3.6 Meteorological Data

AERMOD requires a preprocessor called AERMET (Version 21112) to process meteorological data for 5 years from offsite locations to estimate the boundary layer parameters for the dispersion calculations. AERMET requires the input of surface roughness length, albedo, and Bowen ratio to define land surface characteristics for its calculations.

Quincy onsite meteorological data and surface air meteorological data from Grant County International Airport, in Moses Lake, Washington (WBAN ID 24110) using 1-minute Automated Surface Observing System (ASOS) data and upper air data from Spokane International Airport, in Spokane, Washington (WBAN ID 04106) was used in the analysis. The most recent 3-year data set available covers the period of 2018 to 2020. A profile base elevation of 356 meters was used in the model. The meteorological data used to develop these data sets was analyzed for data completeness, and these data sets have good data quality.

Figure 6-1: Receptor Grid



When processing the 1-minute ASOS data the following specifications were used:

- AERMINUTE Version 15272
- "Ice-free winds group" option selected
- 1-minute wind speed threshold of 0.5 meter per second applied

Figure H-1 in Appendix H shows a wind rose that presents a graphical distribution of the average wind speeds and direction for the meteorological data used for the analysis. As shown in Figure H-1, the prevailing winds are blowing to the southeast.

6.3.7 AERSURFACE

The land surface characteristics were generated using the most current version of AERSURFACE (Version 20060). AERSURFACE incorporates the most current recommended procedures for determining surface characteristics required by AERMET (EPA, 2020). Because characterizing land use could be a subjective process, the AERSURFACE program was developed by the EPA to standardize the methodology of determining the surface roughness length, albedo, and Bowen ratio.

The inputs used in the AERSURFACE analysis are listed in Table 6-4. AERSURFACE was performed for both the onsite location and the airport location. The 1-kilometer study radius is a default setting that is recommended by the AERSURFACE user guide. 2016 National Land Cover Database (NLCD) files for land cover, tree canopy, and impervious were used as inputs for AERSURFACE.

Table 6-4: AERSURFACE Inputs

Input Parameter	Airport AERSURFACE Input	Onsite AERSURFACE Input
Study radius	1 kilometer	1 kilometer
Latitude	47.21	47.239
Longitude	-119.32	-119.863
Number of sectors	12	12
Temporal resolution	Seasonal	Seasonal
Continuous snow cover	No	No
Reassign months to different seasons?	Default	Default
Arid region	No	No
Surface moisture	Average	Average

A historical precipitation analysis was performed to determine the surface moisture conditions for AERSURFACE. Thirty years of monthly Moses Lake precipitation data was obtained from the National Climatic Data Center. The precipitation data was analyzed to determine whether the moisture condition for the 5-year period (2016 to 2020) is wet, dry, or average based on historical conditions. Data from this 5-year period was averaged for each month and compared to the monthly 30th and 70th percentile values of the 30-year historical data set. If the average monthly value was less than the 30th percentile value, it was designated “dry;” if the average monthly value was greater than the 70th percentile value it was designated "wet;" and if the average monthly value was between the 30th and 70th percentile value, it was designated "average." The moisture condition with the highest number of months was determined to be the representative moisture condition for the 5-year data set. Based on this analysis, the moisture conditions for the 5-year period were determined to be average.

Full documentation for determining the surface moisture conditions as well as the AERSURFACE files are included in the electronic file transfer to Ecology.

6.3.8 Modeling Thresholds

The NAAQS and modeling significance levels for the modeled pollutants are shown in Table 6-5.

Table 6-5: NAAQS and Significant Impact Levels

Pollutant	Averaging Period	Significant Impact Level[a]	NAAQS[b]
	micrograms per cubic meter ($\mu g/m^3$)		
NO_2	Annual	1	100
	1-hour	7.5	188
CO	8-hour	500	10,000
	1-hour	2,000	40,000
PM_{10}	24-hour	5	150
$PM_{2.5}$	Annual	0.2[c]	12
	24-hour	1.2[c]	35
SO_2	3-hour	25	1,300
	1-hour	7.8	196

Sources:
[a] Title 40 CFR §51.165(b)(2)
[b] Chapter 173-476 WAC Ambient Air Quality Standards
[c] EPA Memorandum, 2018, "Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program" (EPA, 2018).

The modeled values were modeled using the appropriate form of the standard for each pollutant and averaging period. For significance modeling, all short-term and annual averaging periods were modeled with the impact shown in Table 6-6. Where applicable, the NAAQS thresholds were modeled using the highs shown in Table 6-6 for each averaging period.

Table 6-6: Modeled Highs

Pollutant	Averaging Period	Significant Impact Level High	NAAQS Modeled High
NO_2	Annual	1st highest	1st highest
	1-hour	5-year average 1st high hour day	5-year average 8th high hour day
CO	8-hour	1st highest	High 2nd highest
	1-hour	1st highest	High 2nd highest
PM_{10}	24-hour	1st highest	6th highest in 5 years
$PM_{2.5}$	Annual	5-year average year	5-year average year
	24-hour	5-year average 1st high day	5-year average 8th high day
SO_2	3-hour	1st highest	High 2nd highest
	1-hour	5-year average 1st high hour day	5-year average 4th high hour-day

Sources:
(1) Title 40 CFR §51.165(b)(2)
(2) WAC 173-476, Ambient Air Quality Standards.

6.3.9 NAAQS Analysis

When the maximum impacts exceed the significant impact level for any pollutant and averaging time, then a refined modeling analysis is required. The inventories of sources were developed in accordance with applicable EPA guidance and were obtained from Ecology. For the NAAQS, all stationary sources identified by Ecology that emit pollutants subject to this analysis and are located within the radius of impact were addressed.

Background air quality concentrations (as described in Section 6.3.10) were added to model-predicted concentrations for comparison to the NAAQS. If the comprehensive analysis did not result in any concentrations above the NAAQS, no further modeling was conducted.

6.3.10 Background Air Quality

The NAAQS are established to protect the air quality for all sensitive populations, and attainment is determined by the comparison to the NAAQS thresholds. As such, there are existing concentrations of each criteria pollutant that are present in ambient air that must be included in an analysis to account for items, such as mobile source emissions, that are not already accounted for in the model. Monitored ambient emission levels were added to the modeled ground level impacts to account for these sources.

The NO_2 1-hour background value is based on Quincy hyper-local background contributed by all sources, including regional background, obtained from the Quincy Diesel Particulate Matter (DPM) and NO_2

analyses.[1] Regional background values for PM_{10} and $PM_{2.5}$ were obtained from the Idaho Department of Environmental Quality's database.[2]. The values are interpolated from modeled and measured data from July 2014 to June 2017 and account for nearby emission sources. The values listed in Table 6-7 were used as background levels and added to the modeled impacts.

Table 6-7: Background Concentrations

Pollutant	Averaging Period	Background Concentration (µg/m³)[a]
NO_2	1-hour	58.75[b]
PM_{10}	24-hour	77.6[c]
$PM_{2.5}$	24-hour	18.9[c]

[a] µg/m³ = micrograms per cubic meter
[b] Quincy DPM and NO_2 Analyses, https://waecy.maps.arcgis.com/apps/MapSeries/index.html?appid=12d296d4ce9c41ffba73175b76ad8716 (Quincy, 2021)
[c] Idaho Department of Environmental Quality, https://arcg.is/1jXmHH, accessed July 2021 (Idaho, 2021).

6.3.11 NO_2 Modeling – Multi-Tiered Screening Approach

The AERMOD model gives the emission results for all pollutants, including NO_X. However, impacts of NO_2 must be examined for comparison to the NAAQS. The EPA has a three-tier approach to modeling NO_2 concentrations (EPA, 2017):

- Tier I – total conversion, or all $NO_X = NO_2$
- Tier II – use a default NO_2/NO_X ratio
- Tier III – case-by-case detailed screening methods, such as the Ozone Limiting Method (OLM) or Plume Volume Molar Ratio Method (PVMRM)

The Tier III approach (PVMRM) was used to model the 1-hour averaging period for both the SIL and ASIL analysis. A NO_2/NO_X ratio of 0.1 for all engines was used, which aligns with other recent approved data center analyses and is a conservative value based on EPA's In-stack Ratio (ISR) database. A background ozone value of 52 parts per billion (ppb) was incorporated, which was obtained from the Idaho Department of Environmental Quality's database (Idaho, 2021). The background ozone value was

[1] Quincy hyper-local NO_2 background was obtained from the Quincy DPM and NO_2 analyses, accessed at: https://waecy.maps.arcgis.com/apps/MapSeries/index.html?appid=12d296d4ce9c41ffba73175b76ad8716 (Quincy, 2021)
[2] Regional background air quality values were obtained from the Idaho Department of Environmental Quality's database, accessed at: https://arcg.is/1jXmHH (Idaho, 2021).

interpolated from modeled and measured data from July 2014 to June 2017 and accounts for nearby emission sources. Additionally, a default equilibrium ratio of 0.9 was applied.

The Tier I approach was utilized to model the annual averaging period.

6.4 SIL Modeling Results

Significance modeling was performed for NO_2, CO, PM_{10}, $PM_{2.5}$, and SO_2 for the Project emission sources. The modeled impacts are shown in Table 6-8 below. Isopleths of the maximum impact concentrations for each pollutant and averaging period are shown in Figures H-2 to H-10 in Appendix H.

Table 6-8: Maximum Modeled Concentrations for Significance Modeling

Pollutant	Averaging Period	UTM Coordinates[a]		Year	Worse-Case Maximum Operating Load	Predicted Concentration	Modeling Significance Level[b]
		Easting (meters)	Northing (meters)			micrograms per cubic meter (μg/m³)	
NO_2	Annual	283,500.00	5,235,450.00	3 years	Primary 10%	0.02	1
	1-hour	283,585.92	5,235,938.59	3 years	Reserve 10%	110.9[c]	7.5
CO	8-hour	283,300.00	5,235,375.00	2019	Reserve 10%	62.6	500
	1-hour	283,625.00	5,236,037.50	2019	Reserve 10%	120.2	2,000
PM_{10}	24-hour	283,362.50	5,235,375.00	2020	Reserve 10%	6.7	5
$PM_{2.5}$	Annual	283,500.00	5,235,450.00	3 years	Primary 10%	0.012	0.2[d]
	24-hour	283,375.00	5,235,375.00	3 years	Reserve 10%	3.0	1.2[d]
SO_2	3-hour	283,600.00	5,236,025.00	2019	Reserve 10%	0.44	25
	1-hour	283,625.00	5,236,025.00	3 years	Reserve 10%	0.51	7.8

[a] UTM = Universal Transverse Mercator: NAD83.
[b] Source: Title 40 CFR §51.165(b)(2).
[c] PVMRM methodology was applied to the model.
[d] Source: EPA Memorandum, 2018, "Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program."

After examining the modeling results at all load levels, it was determined that exceedances of the NO_2 (1-hour), PM_{10} (24-hour), and $PM_{2.5}$ (24-hour) modeling significance levels occurred, and refined modeling will be required for these pollutants and averaging periods. For all other pollutants and averaging periods, it was determined that no exceedances of the modeling significance levels occurred at all load levels, and no further modeling is required.

6.5 NAAQS Modeling Results

Refined modeling was performed for 1-hour NO_2, 24-hour PM_{10}, and 24-hour $PM_{2.5}$. Inventories were incorporated into the PM_{10} and $PM_{2.5}$ NAAQS modeling analyses. The modeling results showed that the

Project will not contribute to any NAAQS exceedance for the pollutants and averaging periods modeled. Therefore, the Project will comply with the NAAQS. The NAAQS analysis modeling results are shown in Table 6-9. Isopleths of the maximum impact concentrations for each pollutant and averaging period are shown in Figures H-11 to H-13 in Appendix H.

Table 6-9: Maximum Modeled Concentrations for NAAQS Modeling

Pollutant and Averaging Period		UTM Coordinates[a]		Year	Worse-Case Maximum Operating Load	Predicted Concentration	Background Concentration	Total Concentration	NAAQS[b]
		Easting (meters)	Northing (meters)			micrograms per cubic meter (µg/m³)			
NO_2	1-hour	2,83,598.18	5,235,938.72	3 years	Reserve 10%	80.7[c]	58.75	139.45	188
PM_{10}	24-hour	283,702.01	5,235,743.36	2020	Primary 10%	12.5	77.6	90.1	150
$PM_{2.5}$	24-hour	283,275.00	5,235,150.00	3 years	Reserve 10%	3.6	18.9	22.5	35

[a] UTM = Universal Transverse Mercator: NAD83
[b] Source: Title 40 CFR Part 50
[c] PVMRM methodology was applied to the model.

6.6 Toxic Air Pollutant Analysis

All new sources that emit TAPs are required to show compliance with the TAP program, which establishes emission limits for certain air pollutants that are particularly harmful to the surrounding environment and people. Each listed TAP has a de minimis emission rate, a small quantity emission rate (SQER), and an ASIL. Potential TAPs from the Project were determined and compared to the applicable thresholds listed in WAC 173-460-150.

If the project-wide emissions are below the de minimis rate then no further analysis is required for that pollutant. If the de minimis is exceeded, then further analysis is required to assess if the Project impacts are below the SQER. If the Project impacts exceed the SQER, further analysis is required to determine compliance with the ASIL using air dispersion modeling.

The TAP emissions summary is shown in Appendix C. As shown in the TAP summary and in Table 4-2, DEEP and NO_2 exceed the SQER and require modeling.

A first-tier TAP analysis using AERMOD is to be conducted to compare the impacts of DEEP and NO_2 to their respective ASIL as shown in Table 6-10.

Table 6-10: ASIL Thresholds

Pollutant	Averaging Period	ASIL Threshold[a] (µg/m³)
DEEP	1-year	0.0033
NO_2	1-hour	470

[a] Source: WAC 173-460-150.

An ASIL modeling analysis was performed using the stack parameters shown in Table 6-1 and emissions parameters in Table 6-11. The following engine groupings were modeled for NO_2 and DEEP.

- Operating Scenario A – CO7 and CO8 primary engines (1,500-kWe each) and CO7 and CO8 support engines (350-kWe each).
- Operating Scenario B – CO7 and CO8 reserve engines (1,500-kWe each) and CO7 and CO8 support engines (350-kWe each).

Table 6-11: TAP Emission Rate Parameters (Single Engine)

TAP	Engine	Units	100% Load	75% Load	50% Load	25% Load	10% Load
DEEP	1,500-kWe Primary	tpy	1.62E-03	1.82E-03	2.71E-03	3.33E-03	2.05E-03
NO_2		lb/hr	10.40	9.21	8.81	8.61	8.47
DEEP	1,500-kWe Reserve	tpy	1.62E-03	1.82E-03	2.71E-03	3.33E-03	2.05E-03
NO_2		lb/hr	10.40	9.21	8.81	8.61	8.47
DEEP	350-kWe Support	tpy	1.69E-03	1.67E-03	1.67E-03	9.04E-04	6.23E-04
NO_2		lb/hr	1.91	1.63	1.56	1.56	1.53

The modeling analysis determined that all modeled TAPs comply with their respective ASILs as shown in Table 6-12 and no further modeling will be required. Isopleths of the maximum impact concentrations for each pollutant and averaging period are shown in Figures H-14 to H-15 in Appendix H.

Table 6-12: Maximum Modeled Concentrations for ASIL Modeling

Pollutant	Averaging Period	UTM Coordinates[a]		Year	Worse-Case Maximum Operating Load	Predicted Concentration	ASIL Threshold[b]
		Easting (meters)	Northing (meters)			micrograms per cubic meter (µg/m³)	
DEEP	1-year	283,512.50	5,235,450.00	3-years	Primary 25%	6.90E-04	0.0033
NO_2	1-hour	283,585.92	5,235,938.59	3 years	Reserve 10%	110.9[c]	470

[a] UTM = Universal Transverse Mercator: NAD83
[b] Source: WAC 173-460-150
[c] PVMRM methodology was applied to the model.

6.7 Dispersion Modeling Conclusion

The modeling results shown in Table 6-8 demonstrate that no exceedances of the modeling significance levels are predicted for NO_2 (annual averaging period), CO, $PM_{2.5}$ (annual averaging period), and SO_2; consequently, no further modeling is required for these pollutants and averaging periods. A refined modeling analysis was conducted, with results as shown in Table 6-9, to demonstrate compliance with the NAAQS for the $PM_{2.5}$ 24-hour, PM_{10} 24-hour, and NO_2 1-hour averaging periods. The Project will not cause or contribute to any modeled NAAQS exceedances. The modeling analysis also determined that all modeled TAPs comply with their respective ASILs, as shown in Table 6-12, and no further modeling is required.

The operation of the Project will not cause or contribute to a significant degradation of ambient air quality. After examining the results of the modeling, it has been determined that the modeling requirements for NO_2, CO, PM_{10}, $PM_{2.5}$, DEEP, and SO_2 have been fulfilled, and no further modeling is required.

7.0 REFERENCES

Bankrate, LLC (Bankrate, 2021). *Prime rate, federal funds rate, COFI.* https://www.bankrate.com/rates/interest-rates/prime-rate.aspx. Accessed July 2021.

Ecopoint Inc (Ecopoint, 2021). *Dieselnet Technology Guide: Emission Aftertreatment*. https://dieselnet.com/tg#at. Accessed August 2021.

Idaho Department of Environmental Quality (Idaho, 2021). https://arcg.is/1jXmHH. Accessed July 2021.

Landau Associates (Landau, 2019). *Notice of Construction Application Supporting Information Report, CO6 Expansion – Columbia Data Center, Quincy Washington.* December 6, 2019.

Quincy DPM and NO_2 Analyses (Quincy, 2021). https://waecy.maps.arcgis.com/apps/MapSeries/index.html?appid=12d296d4ce9c41ffba73175b76ad8716. Accessed September 2021.

U.S. Department of Energy (DOE, 2010). *Evaluation of Best Available Control Technology for Toxics (tBACT), Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations.* Richland, WA. DE-AC27-08RV14800. June 3, 2010.

U.S. Environmental Protection Agency (EPA, 2021a). *Air Pollution Control Cost Manual, 7th Edition.* Most current update accessed July 2021.

U.S. Environmental Protection Agency (EPA, 2018). *Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program* (Memorandum from Peter Tsirigotis). April 17, 2018.

U.S. Environmental Protection Agency (EPA, 1985). *Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for Stack Height Regulations)*. EPA-450/4-80-023LR. North Carolina: Office of Air Quality Planning and Standards, 1985.

U.S. Environmental Protection Agency (EPA, 1987). *Improving New Source Review (NSR) Implementation* (Memorandum from J. Craig Potter). Washington, D. C. December 1, 1987.

U.S. Environmental Protection Agency (EPA, 1990). *New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting.* 906R98101. Washington, D. C. Draft, October 1990.

U.S. Environmental Protection Agency (EPA, 2017). *Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches To Address Ozone and Fine Particulate Matter*. EPA-HQ-OAR-2015-0310. Final rule, January 17, 2017. (82 FR 5182).

U.S. Environmental Protection Agency (EPA, 2020). *User's Guide for AERSURFACE Tool*. EPA-454/B-20-008. North Carolina: Office of Air Quality Planning and Standards, February 2020.

U.S. Environmental Protection Agency (EPA, 2021b). *User's Guide for the AMS/EPA Regulatory Model – AERMOD*. EPA-454/B-21-001. North Carolina: Office of Air Quality Planning and Standards, April 2021.

State of Washington Department of Ecology (Ecology, 2016). *BACT and t-BACT Cost Effectiveness Thresholds.* (Memorandum from Robert Koster). August 2, 2016.

State of Washington Department of Ecology (Ecology, 2015). *Guidance Document First, Second, and Third Tier Review of Toxic Air Pollution Sources (Chapter 173-460 WAC)*. Publication Number: 08-02-025 (revised August 2015).

State of Washington Department of Ecology (Ecology, 2019). *Guidance on Typical AERMOD Modeling Protocol Parameters*. August 2019.

State of Washington Department of Revenue (Revenue, 2021). *Sales and Use Tax Rates.* https://dor.wa.gov/taxes-rates/sales-and-use-tax-rates. Accessed July 2021.

Trinity Consultants (Trinity, 2020). *Project Report, Sabey Data Center Properties, Quincy, WA, Integrated Quincy Notice of Construction*. April 2020 Revision.

University of California, Riverside (UCR, 2005). *Air Quality Implications of Backup Generators in Califormia; Volume Two: Emission Measurements from Controlled and Uncontrolled Backup Generators (prepared for the California Energy Commission)*. CEC-500-2005-049. July 2005.

APPENDIX A – PROCESS FLOW DIAGRAM AND PLAN VIEW SITE MAPS

Process Flow Diagram
CO7/CO8 Columbia Data Center Project
Microsoft Corporation

Emission Points CO7, Unit IDs 1, 2, 3, and CO8, Unit IDs 1, 2, 3

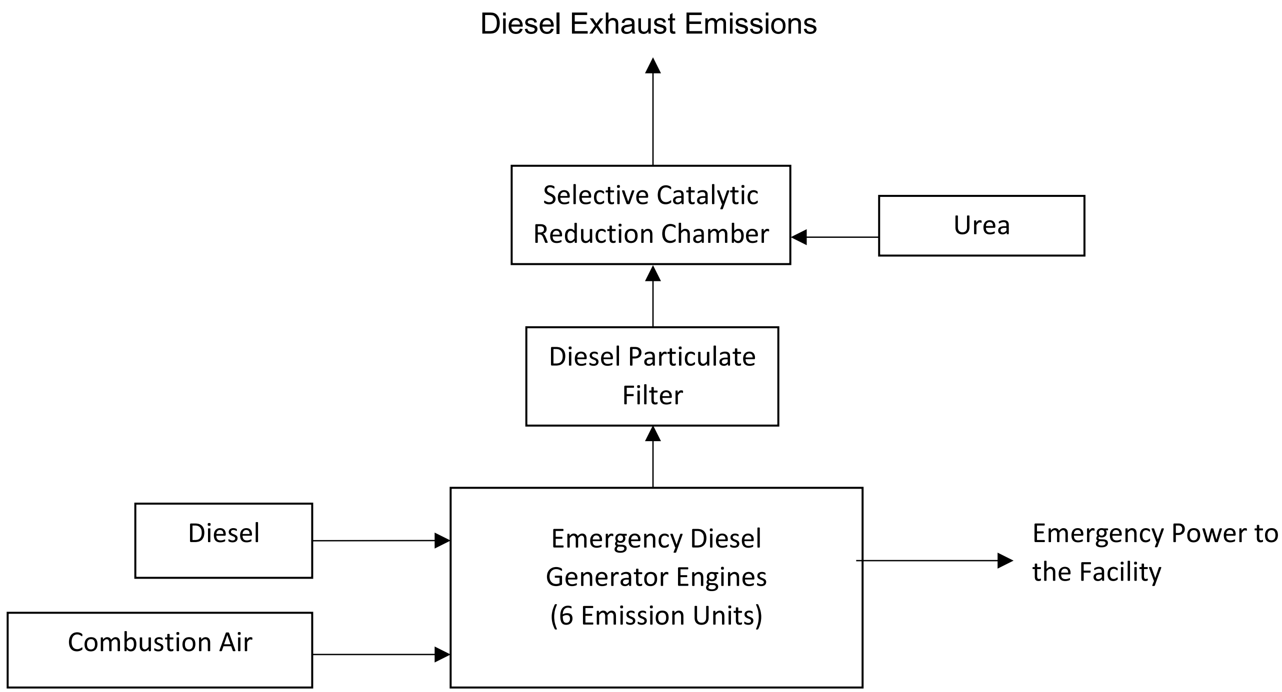


Exhibit A-1 – Plan View Site Map, Columbia Data Center

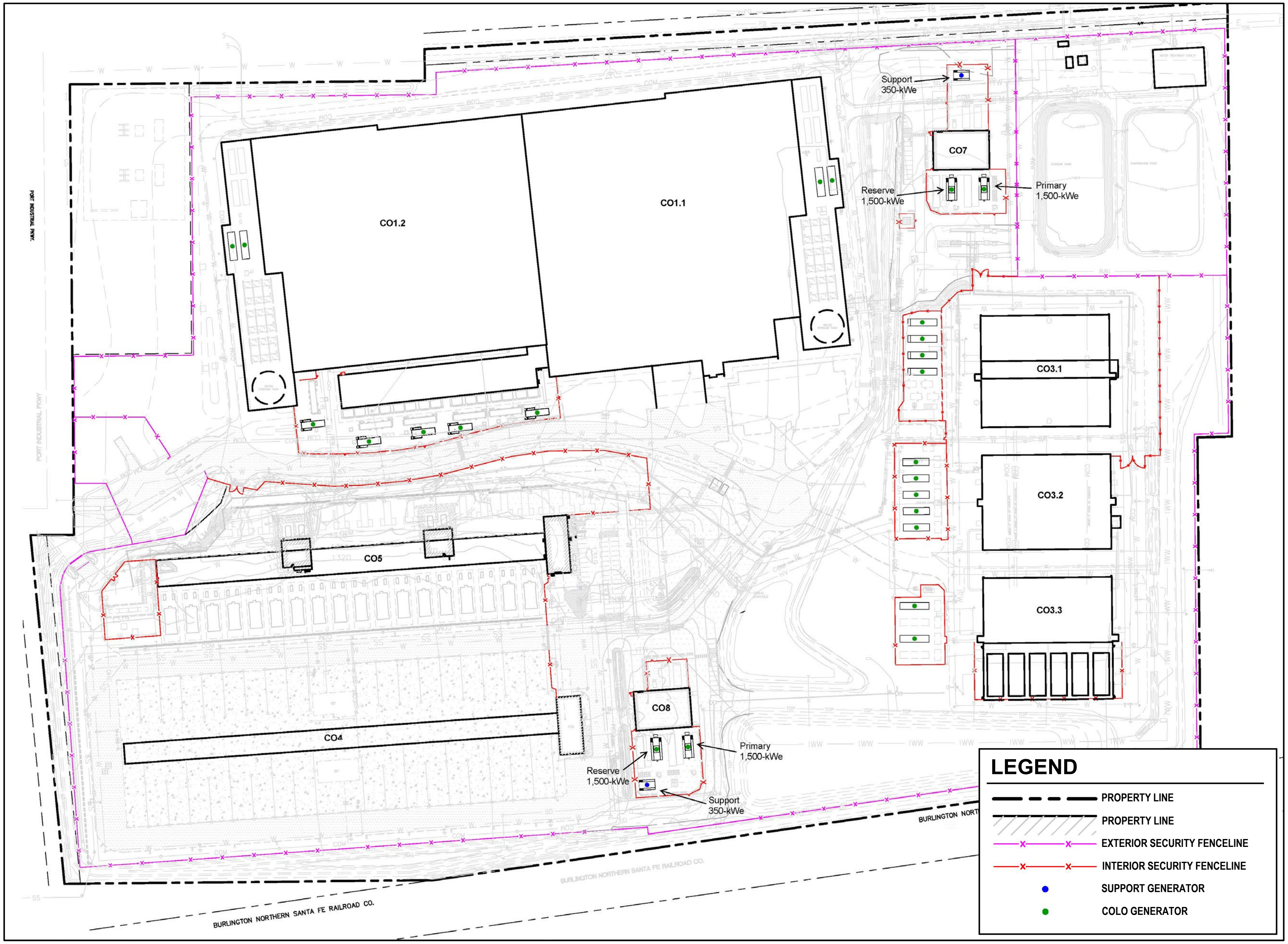


Exhibit A-2 – Plan View Site Map, CO7 Building and Generator Engines

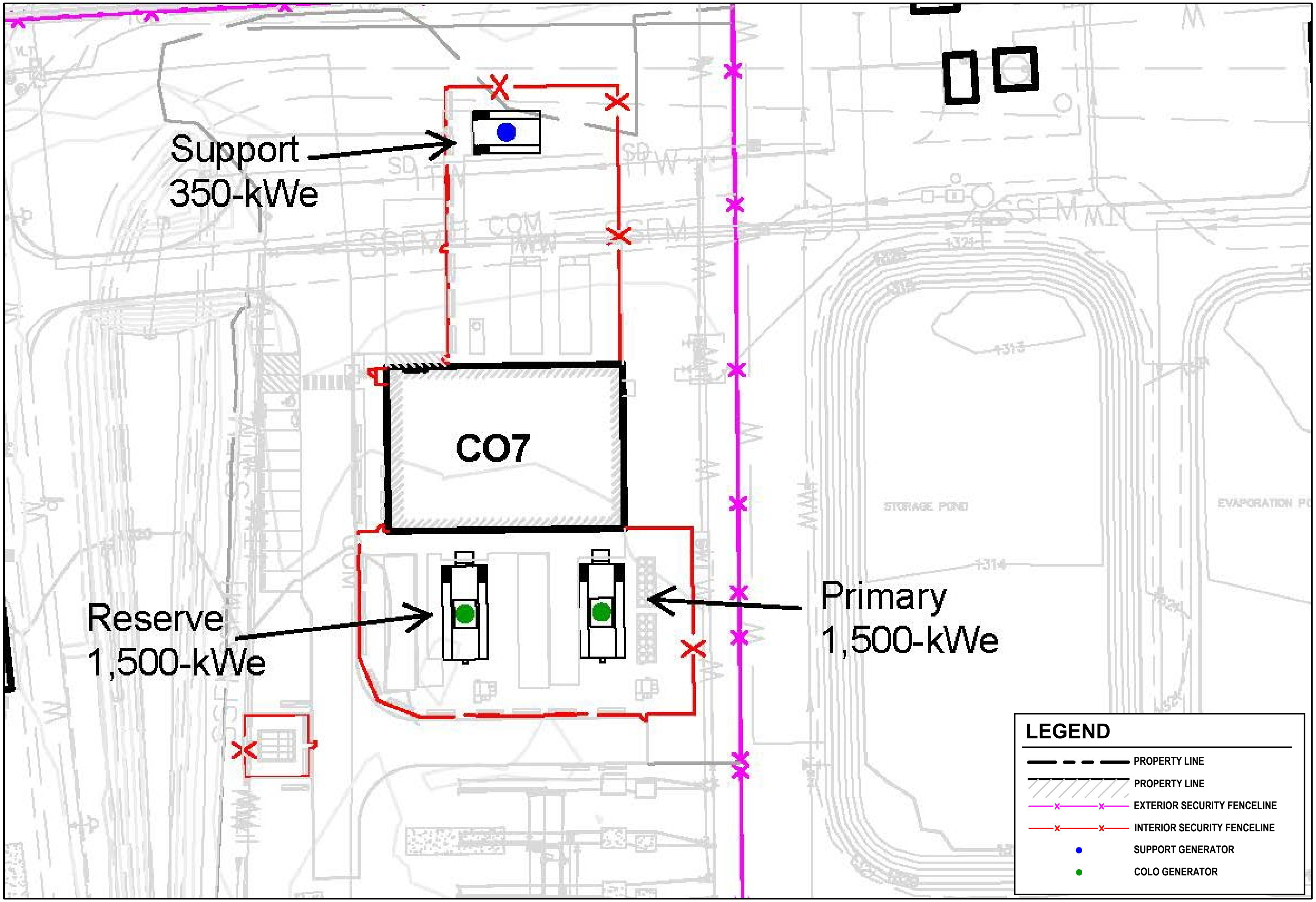
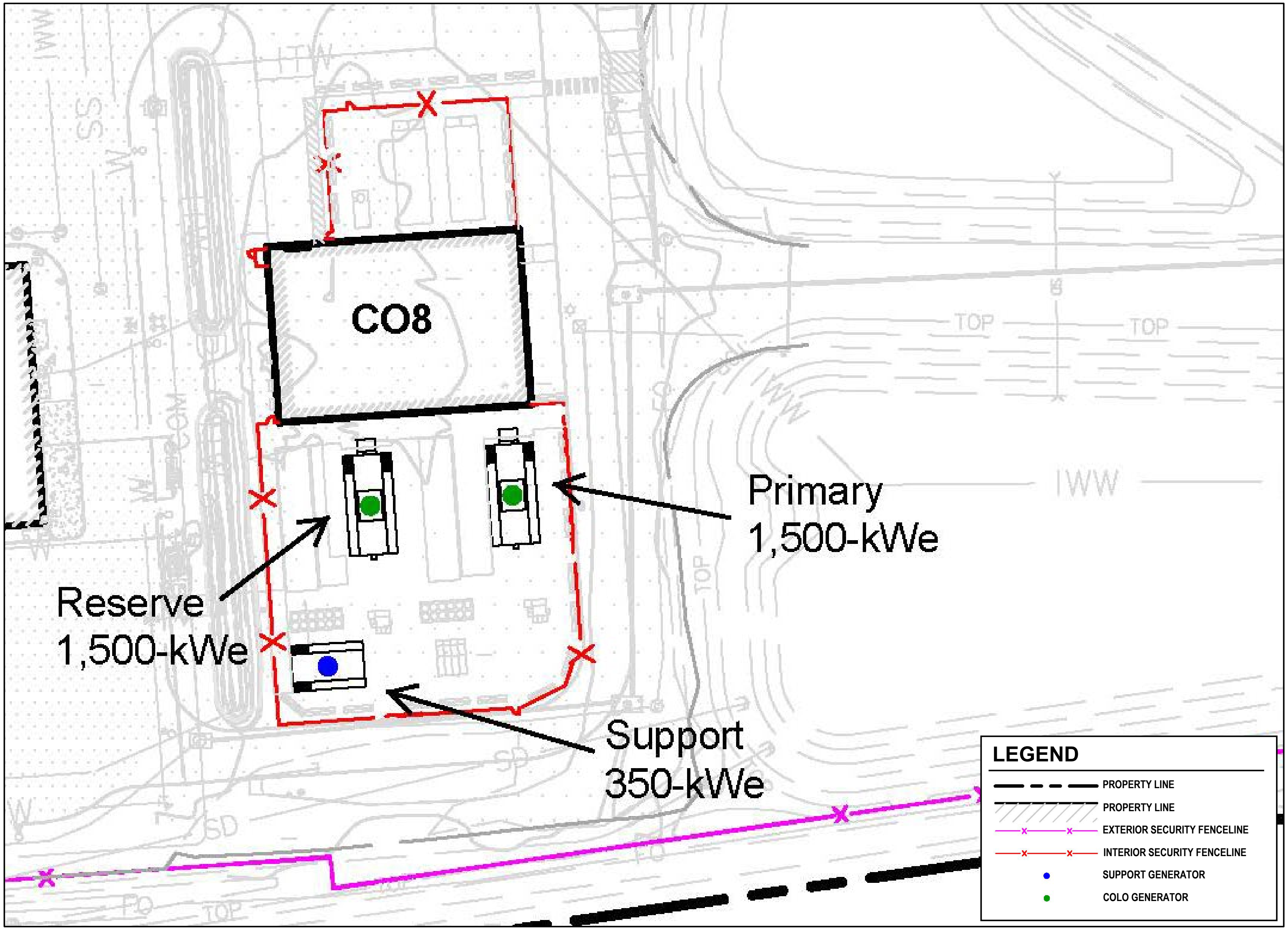


Exhibit A-3 – Plan View Site Map, CO8 Building and Generator Engines



APPENDIX B – NOTICE OF CONSTRUCTION APPLICATION FORM

Notice of Construction Application

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

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

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

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

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

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

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

Notice of Construction Application

New project or equipment:

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

Change to an existing permit or equipment:

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

Read each statement, then check the box next to it to acknowledge that you agree.

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

DEPARTMENT OF ECOLOGY
State of Washington

Notice of Construction Application

Part 1: General Information

I. Project, Facility, and Company Information

1. Project Name CO7/CO8 Columbia Data Center
2. Facility Name Columbia Data Center
3. Facility Street Address 501 Port Industrial Parkway, Quincy, Washington
4. Facility Legal Description Grant County Parcel No. 313675001 – Lot 1 MSN Data Center SP 27-28 (TGW 313675000 TCA 0017). Grant County Parcel No. 313675000 – Lot 1 MSN Data Center SP 27-28 (TGW 313675001 TCA 0023)
5. Company Legal Name (if different from Facility Name) Microsoft Corporation
6. Company Mailing Address (street, city, state, zip) P.O. Box 187, Quincy, WA 98848

II. Contact Information and Certification

1. Facility Contact Name (who will be onsite) Dale Stansbury	
2. Facility Contact Mailing Address (if different than Company Mailing Address) 501 Port Industrial Parkway, Quincy, Washington 98848	
3. Facility Contact Phone Number +1 (509) 760-8747	4. Facility Contact E-mail ristansb@microsoft.com
5. Billing Contact Name (who should receive billing information) Carson Linstead	
6. Billing Contact Mailing Address (if different than Company Mailing Address) 100 Energy Way, Suite 1700, Fort Worth, TX 76102	
7. Billing Contact Phone Number +1 (580) 302-1523	8. Billing Contact E-mail clinstead@burnsmcd.com
9. Consultant Name (optional – if 3rd party hired to complete application elements) Michael Cook	
10. Consultant Organization/Company Burns & McDonnell Engineering Company, Inc.	
11. Consultant Mailing Address (street, city, state, zip) 100 Energy Way, Suite 1700, Fort Worth, TX 76102	
12. Consultant Phone Number +1 (682) 291-9341	13.Consultant E-mail mkcook@burnsmcd.com
14. Responsible Official Name and Title (who is responsible for project policy or decision-making) Hichem Garnaoui, Campus Director	
16. Responsible Official Phone +1 (425) 538-3684	17. Responsible Official E-mail hichem.garnaoui@microsoft.com
18. Responsible Official Certification and Signature I certify that the information on this application is accurate and complete. Signature [signature] Date 03-19-21	

To request ADA accommodation, call (360) 407-6800, 711 (relay service), or 877-833-6341(TTY).

DEPARTMENT OF ECOLOGY
State of Washington

Notice of Construction Application

Part 2: Technical Information

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

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

III. Project Description

Please attach the following to your application.

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

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

IV. State Environmental Policy Act (SEPA) Compliance

Check the appropriate box below.

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

☐ SEPA review has not been conducted:

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

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

To request ADA accommodation, call (360) 407-6800, 711 (relay service), or 877-833-6341(TTY).

Notice of Construction Application

V. Emissions Estimations of Criteria Pollutants

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

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

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

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

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

VI. Emissions Estimations of Toxic Air Pollutants

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

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

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

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

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

VII. Emission Standard Compliance

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

VIII. Best Available Control Technology

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

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

IX. Ambient Air Impacts Analyses

Please provide the following:

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

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

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

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

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

APPENDIX C – EMISSION CALCULATIONS

Table EC - 1: Total Facility Emissions
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
Microsoft Corporation

Pollutant	PTE from Existing Permitted Sources	Project Emissions	Existing + Project Emissions
	Annual (tpy)	Annual (tpy)	Annual (tpy)
NO_X	37.10	0.50	37.60
CO	5.71	0.78	6.49
VOC	2.31	0.11	2.42
DEEP	0.60	0.01	0.61
PM_{10}	14.18	0.11	14.29
$PM_{2.5}$	6.38	0.11	6.49
$PM_{2.5}$ (Gens Only)	2.88	0.11	2.99
SO_2	0.05	3.60E-03	0.05
NO_2	3.67	0.04	3.71
Acetaldehyde	7.50E-04	3.04E-04	1.05E-03
Acrolein	2.39E-03	4.44E-05	2.44E-03
Acenaphthylene	0	1.64E-05	1.64E-05
Acenaphthene	0	7.94E-06	7.94E-06
Ammonia	0	0.02	0.02
Anthracene	0	2.60E-06	2.60E-06
Benz(a)anthracene	1.85E-05	1.57E-06	2.01E-05
Benzene	0.02	1.56E-03	0.02
Benzo(a)pyrene	7.50E-06	4.74E-07	7.97E-06
Benzo(b)fluoranthene	3.31E-05	1.80E-06	3.49E-05
Benzo(g,h,l)perylene	0	1.05E-06	1.05E-06
Benzo(k)fluoranthene	6.50E-06	4.01E-07	6.90E-06
1,3-Butadiene	1.16E-03	7.57E-05	1.24E-03
Chrysene	4.58E-05	2.56E-06	4.84E-05
Dibenz(a,h)anthracene	1.07E-05	7.52E-07	1.15E-05
Fluoranthene	0	9.04E-06	9.04E-06
Fluorene	0	3.04E-05	3.04E-05
Formaldehyde	2.33E-03	5.32E-04	2.86E-03
Indeno(1,2,3-cd)pyrene	1.27E-05	7.89E-07	1.35E-05
Naphthalene	3.90E-03	2.36E-04	4.14E-03
Phenanthrene	0	7.51E-05	7.51E-05
Propylene	0.08	5.33E-03	0.09
Pyrene	0	7.56E-06	7.56E-06
Toluene	8.30E-03	5.88E-04	8.89E-03
Xylenes	5.73E-03	4.06E-04	6.14E-03
Bromodichloromethane	1.80E-04	0	1.80E-04
Bromoform	4.60E-03	0	4.60E-03
Chloroform	1.80E-04	0	1.80E-04
Copper	1.80E-04	0	1.80E-04
Fluoride	5.50E-03	0	5.50E-03
Manganese	5.40E-04	0	5.40E-04
Vanadium	3.60E-04	0	3.60E-04
Total HAPs	0.05	3.74E-03	0.05
Total TAPs	10.17	0.87	11.04
CO_2	0	315.87	315.87
CH_4	0	0.01	0.01
N_2O	0	2.56E-03	2.56E-03
CO_2e	0	316.95	316.95

Notes:
CH_4 - Methane
CO - Carbon monoxide
CO_2 - Carbon dioxide
CO_2e - Carbon dioxide equivalents
DEEP - Diesel engine exhaust particulate matter
HAP - Hazardous air pollutants
NO_X - Nitrogen oxides
NO_2 - Nitrogen dioxide
N_2O - Nitrous oxide
PAH - Polycyclic aromatic hydrocarbons
PM - Particulate matter
$PM_{2.5}$ - Particulate matter less than 2.5 microns in diameter
PM_{10} - Particulate matter less than 10 microns in diameter
SO_2 - Sulfur dioxide
VOC - Volatile organic compounds
TAP - Toxic air pollutants

Table EC - 2: CO7/CO8 Project Emissions
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
Microsoft Corporation

Pollutant	Emissions for New Generator Engines	
	lb/hr	Annual (tpy)
NO_X	24.62	0.50
CO	16.70	0.78
VOC	2.14	0.11
DEEP	0.20	1.01E-02
PM_{10}	2.24	0.11
$PM_{2.5}$	2.24	0.11
SO_2	0.07	3.60E-03
NO_2	2.46	0.04
Acetaldehyde	6.02E-03	3.04E-04
Acrolein	8.66E-04	4.44E-05
Acenaphthylene	3.02E-04	1.64E-05
Acenaphthene	1.45E-04	7.94E-06
Ammonia	4.31E-01	2.32E-02
Anthracene	4.85E-05	2.60E-06
Benz(a)anthracene	2.96E-05	1.57E-06
Benzene	2.89E-02	1.56E-03
Benzo(a)pyrene	8.74E-06	4.74E-07
Benzo(b)fluoranthene	3.28E-05	1.80E-06
Benzo(g,h,l)perylene	1.95E-05	1.05E-06
Benzo(k)fluoranthene	7.38E-06	4.01E-07
1,3-Butadiene	1.40E-03	7.57E-05
Chrysene	4.67E-05	2.56E-06
Dibenz(a,h)anthracene	1.40E-05	7.52E-07
Fluoranthene	1.69E-04	9.04E-06
Fluorene	5.72E-04	3.04E-05
Formaldehyde	1.04E-02	5.32E-04
Indeno(1,2,3-cd)pyrene	1.46E-05	7.89E-07
Naphthalene	4.35E-03	2.36E-04
Phenanthrene	1.38E-03	7.51E-05
Propylene	9.86E-02	5.33E-03
Pyrene	1.40E-04	7.56E-06
Toluene	1.10E-02	5.88E-04
Xylenes	7.55E-03	4.06E-04
Total HAPs	0.07	3.74E-03
Total TAPs	20.10	0.87
CO_2	5,845.27	315.87
CH_4	0.24	0.01
N_2O	0.05	2.56E-03
CO_2e	5,865.33	316.95

Note:
CH_4 - Methane
CO - Carbon monoxide
CO_2 - Carbon dioxide
CO_2e - Carbon dioxide equivalents
DEEP - Diesel engine exhaust particulate matter
HAP - Hazardous air pollutants
NO_X - Nitrogen oxides
NO_2 - Nitrogen dioxide
N_2O - Nitrous oxide
PAH - Polycyclic aromatic hydrocarbons
PM - Particulate matter
$PM_{2.5}$ - Particulate matter less than 2.5 microns in diameter
PM_{10} - Particulate matter less than 10 microns in diameter
SO_2 - Sulfur dioxide
VOC - Volatile organic compounds
TAP - Toxic air pollutants

Table EC - 3: CO7/CO8 Project Emissions for Criteria Pollutants
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
Microsoft Corporation (Operating Scenario A)

Parameter	Units	Primary Engines	Reserve Engines	Support Engines
Annual Hours of Operation (per engine)	**Hours**	110	0	100
Number of Cold-Startup Events per year (per engine) [1]	**Events**	42	0	30
Duration of Each Cold-Startup Event	**Hours/Event**	0.017	0.017	0.017
Total Duration of Cold Conditions (per engine)	**Hours**	0.70	0.00	0.50
Duration of Each Cold-Start SCR Warmup	**Hours/Event**	0.250	0.250	0.250
Total Duration of SCR Warmup Conditions (per engine)	**Hours**	10.50	0.00	7.50

Estimate of hourly emissions from each engine

Pollutant	Primary Generator Engines		Reserve Generator Engines		Support Generator Engines	
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions
	lb/hr/engine	lb/hr/engine	lb/hr/engine	lb/hr/engine	lb/hr/engine	lb/hr/engine
NO_X	3.20	10.40	0.00	0.00	0.59	1.91
CO	4.36	4.94	0.00	0.00	3.01	3.41
VOC	0.84	0.89	0.00	0.00	0.17	0.18
DEEP	0.06	0.06	0.00	0.00	0.03	0.04
PM_{10}	0.88	0.92	0.00	0.00	0.19	0.20
$PM_{2.5}$	0.88	0.92	0.00	0.00	0.19	0.20
SO_2	0.03	0.03	0.00	0.00	0.01	0.01
NO_2	0.32	1.04	0.00	0.00	0.06	0.19

Annual Emissions from each engine

Pollutant	Primary Generator Engines		Reserve Generator Engines		Support Generator Engines	
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions
	tpy/engine	tpy/engine	tpy/engine	tpy/engine	tpy/engine	tpy/engine
NO_X	0.16	5.46E-02	0.00	0.00E+00	0.03	7.17E-03
CO	0.24	1.73E-03	0.00	0.00E+00	0.15	8.52E-04
VOC	0.05	3.11E-04	0.00	0.00E+00	0.01	4.58E-05
DEEP	0.00	2.24E-05	0.00	0.00E+00	0.00	8.93E-06
PM_{10}	0.05	3.23E-04	0.00	0.00E+00	0.01	4.91E-05
$PM_{2.5}$	0.05	3.23E-04	0.00	0.00E+00	0.01	4.91E-05
SO_2	1.46E-03	9.37E-06	0.00E+00	0.00E+00	3.25E-04	1.64E-06
NO_2	0.02	3.64E-04	0.00	0.00E+00	0.00	4.78E-05

Table EC - 3: CO7/CO8 Project Emissions for Criteria Pollutants
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
Microsoft Corporation (Operating Scenario A)

Total Annual Emissions

Pollutant	Total Annual Emissions						
	Primary Generator Engines		Reserve Generator Engines		Support Generator Engines		All Engines
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions	Warm + Cold
	tpy	tpy	tpy	tpy	tpy	tpy	tpy
NO_X	0.32	1.09E-01	0.00	0.00E+00	0.05	1.43E-02	0.50
CO	0.48	3.46E-03	0.00	0.00E+00	0.30	1.70E-03	0.78
VOC	0.09	6.22E-04	0.00	0.00E+00	0.02	9.16E-05	0.11
DEEP	0.01	4.47E-05	0.00	0.00E+00	0.00	1.79E-05	0.01
PM_{10}	0.10	6.46E-04	0.00	0.00E+00	0.02	9.82E-05	0.11
$PM_{2.5}$	0.10	6.46E-04	0.00	0.00E+00	0.02	9.82E-05	0.11
SO_2	2.93E-03	1.87E-05	0.00E+00	0.00E+00	6.51E-04	3.27E-06	3.60E-03
NO_2	0.03	7.28E-04	0.00	0.00E+00	0.01	9.56E-05	0.04

Notes:

1) See explanation in Section 3.1 of the application narrative for a description of how the number of cold-start events were calculated.

CO - Carbon monoxide

DEEP - Diesel engine exhaust particulate matter

NO_X - Nitrogen oxides

NO_2 - Nitrogen dioxide

$PM_{2.5}$ - Particulate matter less than 2.5 microns in diameter

PM_{10} - Particulate matter less than 10 microns in diameter

SO_2 - Sulfur dioxide

VOC - Volatile organic compounds

Table EC - 3: CO7/CO8 Project Emissions for Criteria Pollutants
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
Microsoft Corporation (Operating Scenario B)

Parameter	Units	Primary Engines	Reserve Engines	Support Engines
Annual Hours of Operation (per engine)	**Hours**	0	110	100
Number of Cold-Startup Events per year (per engine) [1]	**Events**	0	42	30
Duration of Each Cold-Startup Event	**Hours/Event**	0.017	0.017	0.017
Total Duration of Cold Conditions (per engine)	**Hours**	0.00	0.70	0.50
Duration of Each Cold-Start SCR Warmup	**Hours/Event**	0.250	0.250	0.250
Total Duration of SCR Warmup Conditions (per engine)	**Hours**	0.00	10.50	7.50

Estimate of hourly emissions from each engine

Pollutant	Primary Generator Engines		Reserve Generator Engines		Support Generator Engines	
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions
	lb/hr/engine	lb/hr/engine	lb/hr/engine	lb/hr/engine	lb/hr/engine	lb/hr/engine
NO_X	0.00	0.00	3.20	10.40	0.59	1.91
CO	0.00	0.00	4.36	0.00	3.01	3.41
VOC	0.00	0.00	0.84	0.00	0.17	0.18
DEEP	0.00	0.00	0.06	0.00	0.03	0.04
PM_{10}	0.00	0.00	0.88	0.00	0.19	0.20
$PM_{2.5}$	0.00	0.00	0.88	0.00	0.19	0.20
SO_2	0.00	0.00	0.03	0.03	0.01	0.01
NO_2	0.00	0.00	0.32	1.04	0.06	0.19

Annual Emissions from each engine

Pollutant	Primary Generator Engines		Reserve Generator Engines		Support Generator Engines	
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions
	tpy/engine	tpy/engine	tpy/engine	tpy/engine	tpy/engine	tpy/engine
NO_X	0.00	0.00E+00	0.16	5.46E-02	0.03	7.17E-03
CO	0.00	0.00E+00	0.24	0.00E+00	0.15	8.52E-04
VOC	0.00	0.00E+00	0.05	0.00E+00	0.01	4.58E-05
DEEP	0.00	0.00E+00	0.00	0.00E+00	0.00	8.93E-06
PM_{10}	0.00	0.00E+00	0.05	0.00E+00	0.01	4.91E-05
$PM_{2.5}$	0.00	0.00E+00	0.05	0.00E+00	0.01	4.91E-05
SO_2	0.00E+00	0.00E+00	1.46E-03	9.37E-06	3.25E-04	1.64E-06
NO_2	0.00	0.00E+00	0.02	3.64E-04	0.00	4.78E-05

Table EC - 3: CO7/CO8 Project Emissions for Criteria Pollutants
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
Microsoft Corporation (Operating Scenario B)

Total Annual Emissions

Pollutant	Total Annual Emissions						
	Primary Generator Engines		Reserve Generator Engines		Support Generator Engines		All Engines
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions	Warm + Cold
	tpy	tpy	tpy	tpy	tpy	tpy	tpy
NO_X	0.00	0.00E+00	0.32	1.09E-01	0.05	1.43E-02	0.50
CO	0.00	0.00E+00	0.48	0.00E+00	0.30	1.70E-03	0.78
VOC	0.00	0.00E+00	0.09	0.00E+00	0.02	9.16E-05	0.11
DEEP	0.00	0.00E+00	0.01	0.00E+00	0.00	1.79E-05	0.01
PM_{10}	0.00	0.00E+00	0.10	0.00E+00	0.02	9.82E-05	0.11
$PM_{2.5}$	0.00	0.00E+00	0.10	0.00E+00	0.02	9.82E-05	0.11
SO_2	0.00E+00	0.00E+00	2.93E-03	1.87E-05	6.51E-04	3.27E-06	3.60E-03
NO_2	0.00	0.00E+00	0.03	7.28E-04	0.01	9.56E-05	0.04

Notes:

1) See explanation in Section 3.1 of the application narrative for a description of how the number of cold-start events were calculated.

CO - Carbon monoxide

DEEP - Diesel engine exhaust particulate matter

NO_X - Nitrogen oxides

NO_2 - Nitrogen dioxide

$PM_{2.5}$ - Particulate matter less than 2.5 microns in diameter

PM_{10} - Particulate matter less than 10 microns in diameter

SO_2 - Sulfur dioxide

VOC - Volatile organic compounds

Table EC - 4a: Generator Parameters
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
Microsoft Corporation

Parameters for One Engine

Description	Support Emergency Generator Engines		Source	Primary and Reserve Emergency Generator Engines		Source
Engine Rating	350	kWe	Manufacturer Data	1,500	kWe	Manufacturer Data
	402	kWm	Manufacturer Data	1,645	kWm	Manufacturer Data
	539	bhp	Manufacturer Data	2,206	bhp	Manufacturer Data
Operating Hours	100	hr/yr	--	110	hr/yr	--
Tier	3		Manufacturer Data	2		Manufacturer Data
Fuel Type	ULSD or Renewable Diesel		Fuel Specification	ULSD or Renewable Diesel		Fuel Specification
Full Load Consumption Rate	24.9	gal/hr	Manufacturer Data	104.6	gal/hr	Manufacturer Data
	2,490	gal/yr	--	11,506	gal/yr	--
Diesel HHV	0.1384	MMBtu/gal	Engineering Basis	0.1384	MMBtu/gal	Engineering Basis
Heat Value	3.45	MMBtu/hr	--	14.48	MMBtu/hr	--
Sulfur Content	15	ppmw	Fuel Specification	15	ppmw	Fuel Specification
	0.0015	wt%	--	0.0015	wt%	--

Total Annual Fuel Consumption from Engines at Each Building (CO7 and CO8)

Description	Support Emergency Generator Engines	Combination of Primary and Reserve Emergency Generator Engines	Total Emergency Generator Engines at Each Building
Number of Engines	1	2	3
Annual Fuel Use	2,490	11,506	13,996

Total Annual Fuel Consumption from All Engines

Description	Support Emergency Generator Engines	Combination of Primary and Reserve Emergency Generator Engines	Total Project Emergency Generator Engines	Existing Permitted Emergency Engines	Total Facility Emergency Engines
Number of Engines	2	4	6	37	43
Annual Fuel Use	4,980	23,012	27,992	439,493	467,485

Table EC - 4b: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 3 and CO8, Unit ID 3 - Calculations for Both Support 350-kW Engines
Microsoft Corporation

Description	Emergency Generators	Source
Operating Hours	100 hr/yr	--
Full Load Consumption Rate	24.9 gal/hr	Manufacturer Data
Diesel HHV	0.1384 MMBtu/gal	Engineering Basis
Heat Value	3.45 MMBtu/hr	--
No. of Units	2 Engines	--
Global Warming Potentials		
CO_2	1 tCO_2e	40 CFR Part 98 Subpart A, Table A-1
CH_4	25 tCO_2e	
N_2O	298 tCO_2e	

Pollutant	Emission Factor & Units [1, 2]		Emissions [3, 4]	
			lb/hr	tpy
Acetaldehyde	7.67E-04	lb/MMBtu	5.29E-03	2.64E-04
Acrolein	9.25E-05	lb/MMBtu	6.38E-04	3.19E-05
Acenaphthylene	5.06E-06	lb/MMBtu	3.49E-05	1.74E-06
Acenaphthene	1.42E-06	lb/MMBtu	9.79E-06	4.89E-07
Ammonia	1.43E-02	lb/MMBtu	9.88E-02	4.94E-03
Anthracene	1.87E-06	lb/MMBtu	1.29E-05	6.44E-07
Benz(a)anthracene	1.68E-06	lb/MMBtu	1.16E-05	5.79E-07
Benzene	9.33E-04	lb/MMBtu	6.43E-03	3.22E-04
Benzo(a)pyrene	1.88E-07	lb/MMBtu	1.30E-06	6.48E-08
Benzo(b)fluoranthene	9.91E-08	lb/MMBtu	6.83E-07	3.42E-08
Benzo(g,h,l)perylene	4.89E-07	lb/MMBtu	3.37E-06	1.69E-07
Benzo(k)fluoranthene	1.55E-07	lb/MMBtu	1.07E-06	5.34E-08
1,3-Butadiene	3.91E-05	lb/MMBtu	2.70E-04	1.35E-05
Chrysene	3.53E-07	lb/MMBtu	2.43E-06	1.22E-07
Dibenz(a,h)anthracene	5.83E-07	lb/MMBtu	4.02E-06	2.01E-07
Fluoranthene	7.61E-06	lb/MMBtu	5.25E-05	2.62E-06
Fluorene	2.92E-05	lb/MMBtu	2.01E-04	1.01E-05
Formaldehyde	1.18E-03	lb/MMBtu	8.13E-03	4.07E-04
Indeno(1,2,3-cd)pyrene	3.75E-07	lb/MMBtu	2.58E-06	1.29E-07
Naphthalene	8.48E-05	lb/MMBtu	5.85E-04	2.92E-05
Phenanthrene	2.94E-05	lb/MMBtu	2.03E-04	1.01E-05
Propylene	2.58E-03	lb/MMBtu	1.78E-02	8.89E-04
Pyrene	4.78E-06	lb/MMBtu	3.29E-05	1.65E-06
Toluene	4.09E-04	lb/MMBtu	2.82E-03	1.41E-04
Xylenes	2.85E-04	lb/MMBtu	1.96E-03	9.82E-05
CO_2	73.96	kg/MMBtu	1,124	56.20
CH_4	0.003	kg/MMBtu	0.046	2.28E-03
N_2O	0.0006	kg/MMBtu	9.12E-03	4.56E-04
CO_2e	--	--	1,128	56.39

Table EC - 4b: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 3 and CO8, Unit ID 3 - Calculations for Both Support 350-kW Engines

Notes:

1) Emission factors for HAPs are from AP-42, Table 3.3.2.
2) GHG Emission Factors for Diesel Distillate Fuel Oil No. 2 from EPA's Emission Factors for Greenhouse Gas Inventories, April 2014, https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf
3) Example Calculations (Acetaldehyde):
Hourly Acetaldehyde Emissions = 3.45 MMBtu/hr * 0.0007670 lb/MMBtu * 2 engines = 0.00529 lb/hr
Annual Acetaldehyde Emissions = 0.00529 lb/hr * 100 hr/yr / 2,000 lb/tons = 0.000264 tpy
4) Example Calculations (CO_2e):
(i) Hourly CO2 Emissions = 3.45 MMBtu/hr * 73.96 kg/MMBtu / 453.5924 g/lb * 1,000 kg/g * 2 engine = 1,124 lb/hr
(ii) Annual CO2 Emissions = 1,123.92 lb/hr * 100 hr/yr / 2,000 lb/tons = 56.20 tpy
Therefore, CO_2e Emissions = CO_2 Emissions + (CH_4 Emissions * GWP of CH_4) + (N_2O Emissions * GWP of N_2O)
(iii) Hourly CO2e Emissions = 1,123.92 lb/hr + (0.05 * 25) + (0.01 * 298) = 1,128 lb/hr
(iv) Annual CO2e Emissions = 1,127.77 lb/hr * 100 hr/yr / 2,000 lb/tons = 56.39 tpy

Table EC - 4c: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 1 and CO8, Unit ID 1 - Calculations for Both Primary 1500-kW Engines (Operating Scenario A)
Microsoft Corporation

Description	Emergency Generators		Source
Operating Hours	110	hr/yr	--
Full Load Consumption Rate	104.6	gal/hr	Manufacturer Data
Diesel HHV	0.1384	MMBtu/gal	Engineering Basis
Heat Value	14.48	MMBtu/hr	--
No. of Units	2	Engines	--
Global Warming Potentials			
CO_2	1	tCO_2e	40 CFR Part 98 Subpart A, Table A-1
CH_4	25	tCO_2e	
N_2O	298	tCO_2e	

Pollutant	Emission Factor & Units [1, 2]		Emissions [3, 4]	
			lb/hr	tpy
Acetaldehyde	2.52E-05	lb/MMBtu	7.30E-04	4.01E-05
Acrolein	7.88E-06	lb/MMBtu	2.28E-04	1.25E-05
Acenaphthylene	9.23E-06	lb/MMBtu	2.67E-04	1.47E-05
Acenaphthene	4.68E-06	lb/MMBtu	1.36E-04	7.45E-06
Ammonia	1.15E-02	lb/MMBtu	3.32E-01	1.83E-02
Anthracene	1.23E-06	lb/MMBtu	3.56E-05	1.96E-06
Benz(a)anthracene	6.22E-07	lb/MMBtu	1.80E-05	9.91E-07
Benzene	7.76E-04	lb/MMBtu	2.25E-02	1.24E-03
Benzo(a)pyrene	2.57E-07	lb/MMBtu	7.44E-06	4.09E-07
Benzo(b)fluoranthene	1.11E-06	lb/MMBtu	3.21E-05	1.77E-06
Benzo(g,h,l)perylene	5.56E-07	lb/MMBtu	1.61E-05	8.85E-07
Benzo(k)fluoranthene	2.18E-07	lb/MMBtu	6.31E-06	3.47E-07
1,3-Butadiene	3.91E-05	lb/MMBtu	1.13E-03	6.23E-05
Chrysene	1.53E-06	lb/MMBtu	4.43E-05	2.44E-06
Dibenz(a,h)anthracene	3.46E-07	lb/MMBtu	1.00E-05	5.51E-07
Fluoranthene	4.03E-06	lb/MMBtu	1.17E-04	6.42E-06
Fluorene	1.28E-05	lb/MMBtu	3.71E-04	2.04E-05
Formaldehyde	7.89E-05	lb/MMBtu	2.28E-03	1.26E-04
Indeno(1,2,3-cd)pyrene	4.14E-07	lb/MMBtu	1.20E-05	6.59E-07
Naphthalene	1.30E-04	lb/MMBtu	3.76E-03	2.07E-04
Phenanthrene	4.08E-05	lb/MMBtu	1.18E-03	6.50E-05
Propylene	2.79E-03	lb/MMBtu	8.08E-02	4.44E-03
Pyrene	3.71E-06	lb/MMBtu	1.07E-04	5.91E-06
Toluene	2.81E-04	lb/MMBtu	8.14E-03	4.48E-04
Xylenes	1.93E-04	lb/MMBtu	5.59E-03	3.07E-04
CO_2	73.96	kg/MMBtu	4,721	259.67
CH_4	0.003	kg/MMBtu	0.192	1.05E-02
N_2O	0.0006	kg/MMBtu	3.83E-02	2.11E-03
CO_2e	--	--	4,738	260.57

Table EC - 4c: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 1 and CO8, Unit ID 1 - Calculations for Both Primary 1500-kW Engines (Operating Scenario A)
Microsoft Corporation

Notes:

1) Emission factors for HAPs (except 1,3-Butadiene) are from AP-42, Table 3.4.3 and Table 3.4.4. Emission factor for 1,3-Butadiene is from AP-42, Table 3.3.2.
2) GHG Emission Factors for Diesel Distillate Fuel Oil No. 2 from EPA's Emission Factors for Greenhouse Gas Inventories, April 2014, https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf
3) Example Calculations (Acetaldehyde):
Hourly Acetaldehyde Emissions = 14.48 MMBtu/hr * 0.0000252 lb/MMBtu * 2 engines = 0.00073 lb/hr
Annual Acetaldehyde Emissions = 0.00073 lb/hr * 110 hr/yr / 2,000 lb/tons = 0.000040 tpy
4) Example Calculations (CO_2e):
(i) Hourly CO2 Emissions = 14.48 MMBtu/hr * 73.96 kg/MMBtu / 453.5924 g/lb * 1,000 kg/g * 2 engine = 4,721 lb/hr
(ii) Annual CO2 Emissions = 4,721.35 lb/hr * 110 hr/yr / 2,000 lb/tons = 259.67 tpy
Therefore, CO_2e Emissions = CO_2 Emissions + (CH_4 Emissions * GWP of CH_4) + (N_2O Emissions * GWP of N_2O)
(iii) Hourly CO2e Emissions = 4,721.35 lb/hr + (0.19 * 25) + (0.04 * 298) = 4,738 lb/hr
(iv) Annual CO2e Emissions = 4,737.56 lb/hr * 110 hr/yr / 2,000 lb/tons = 260.57 tpy

Table EC - 4d: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 2 and CO8, Unit ID 2 - Calculations for Both Reserve 1500-kW Engines (Operating Scenario A)
Microsoft Corporation

Description	Emergency Generators	Source
Operating Hours	0 hr/yr	--
Full Load Consumption Rate	104.6 gal/hr	Manufacturer Data
Diesel HHV	0.1384 MMBtu/gal	Engineering Basis
Heat Value	0.00 MMBtu/hr	--
No. of Units	2 Engines	--
Global Warming Potentials		
CO_2	1 tCO_2e	40 CFR Part 98 Subpart A, Table A-1
CH_4	25 tCO_2e	
N_2O	298 tCO_2e	

Pollutant	Emission Factor & Units [1, 2]		Emissions [3, 4]	
			lb/hr	tpy
Acetaldehyde	2.52E-05	lb/MMBtu	0.00E+00	0.00E+00
Acrolein	7.88E-06	lb/MMBtu	0.00E+00	0.00E+00
Acenaphthylene	9.23E-06	lb/MMBtu	0.00E+00	0.00E+00
Acenaphthene	4.68E-06	lb/MMBtu	0.00E+00	0.00E+00
Ammonia	1.15E-02	lb/MMBtu	0.00E+00	0.00E+00
Anthracene	1.23E-06	lb/MMBtu	0.00E+00	0.00E+00
Benz(a)anthracene	6.22E-07	lb/MMBtu	0.00E+00	0.00E+00
Benzene	7.76E-04	lb/MMBtu	0.00E+00	0.00E+00
Benzo(a)pyrene	2.57E-07	lb/MMBtu	0.00E+00	0.00E+00
Benzo(b)fluoranthene	1.11E-06	lb/MMBtu	0.00E+00	0.00E+00
Benzo(g,h,l)perylene	5.56E-07	lb/MMBtu	0.00E+00	0.00E+00
Benzo(k)fluoranthene	2.18E-07	lb/MMBtu	0.00E+00	0.00E+00
1,3-Butadiene	3.91E-05	lb/MMBtu	0.00E+00	0.00E+00
Chrysene	1.53E-06	lb/MMBtu	0.00E+00	0.00E+00
Dibenz(a,h)anthracene	3.46E-07	lb/MMBtu	0.00E+00	0.00E+00
Fluoranthene	4.03E-06	lb/MMBtu	0.00E+00	0.00E+00
Fluorene	1.28E-05	lb/MMBtu	0.00E+00	0.00E+00
Formaldehyde	7.89E-05	lb/MMBtu	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	4.14E-07	lb/MMBtu	0.00E+00	0.00E+00
Naphthalene	1.30E-04	lb/MMBtu	0.00E+00	0.00E+00
Phenanthrene	4.08E-05	lb/MMBtu	0.00E+00	0.00E+00
Propylene	2.79E-03	lb/MMBtu	0.00E+00	0.00E+00
Pyrene	3.71E-06	lb/MMBtu	0.00E+00	0.00E+00
Toluene	2.81E-04	lb/MMBtu	0.00E+00	0.00E+00
Xylenes	1.93E-04	lb/MMBtu	0.00E+00	0.00E+00
CO_2	73.96	kg/MMBtu	-	0.00
CH_4	0.003	kg/MMBtu	0.000	0.00E+00
N_2O	0.0006	kg/MMBtu	0.00E+00	0.00E+00
CO_2e	--	--	-	-

Table EC - 4d: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 2 and CO8, Unit ID 2 - Calculations for Both Reserve 1500-kW Engines (Operating Scenario A)
Microsoft Corporation

Notes:

1) Emission factors for HAPs (except 1,3-Butadiene) are from AP-42, Table 3.4.3 and Table 3.4.4. Emission factor for 1,3-Butadiene is from AP-42, Table 3.3.2.

2) GHG Emission Factors for Diesel Distillate Fuel Oil No. 2 from EPA's Emission Factors for Greenhouse Gas Inventories, April 2014, https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

3) Example Calculations (Acetaldehyde):

Hourly Acetaldehyde Emissions = 0.00 MMBtu/hr * 0.0000252 lb/MMBtu * 2 engines = 0.00000 lb/hr

Annual Acetaldehyde Emissions = 0.00000 lb/hr * 0 hr/yr / 2,000 lb/tons = 0.000000 tpy

4) Example Calculations (CO_2e):

(i) Hourly CO2 Emissions = 0.00 MMBtu/hr * 73.96 kg/MMBtu / 453.5924 g/lb * 1,000 kg/g * 2 engine = 0 lb/hr

(ii) Annual CO2 Emissions = 0.00 lb/hr * 0 hr/yr / 2,000 lb/tons = 0.00 tpy

Therefore, CO_2e Emissions = CO_2 Emissions + (CH_4 Emissions * GWP of CH_4) + (N_2O Emissions * GWP of N_2O)

(iii) Hourly CO2e Emissions = 0.00 lb/hr + (0.00 * 25) + (0.00 * 298) = 0 lb/hr

(iv) Annual CO2e Emissions = 0.00 lb/hr * 0 hr/yr / 2,000 lb/tons = 0.00 tpy

Table EC - 4c: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 1 and CO8, Unit ID 1 - Calculations for Both Primary 1500-kW Engines (Operating Scenario B)
Microsoft Corporation

Description	Emergency Generators	Source
Operating Hours	0 hr/yr	--
Full Load Consumption Rate	104.6 gal/hr	Manufacturer Data
Diesel HHV	0.1384 MMBtu/gal	Engineering Basis
Heat Value	0.00 MMBtu/hr	--
No. of Units	2 Engines	--
Global Warming Potentials		
CO_2	1 tCO_2e	40 CFR Part 98 Subpart A, Table A-1
CH_4	25 tCO_2e	
N_2O	298 tCO_2e	

Pollutant	Emission Factor & Units [1, 2]		Emissions [3, 4]	
			lb/hr	tpy
Acetaldehyde	2.52E-05	lb/MMBtu	0.00E+00	0.00E+00
Acrolein	7.88E-06	lb/MMBtu	0.00E+00	0.00E+00
Acenaphthylene	9.23E-06	lb/MMBtu	0.00E+00	0.00E+00
Acenaphthene	4.68E-06	lb/MMBtu	0.00E+00	0.00E+00
Ammonia	1.15E-02	lb/MMBtu	0.00E+00	0.00E+00
Anthracene	1.23E-06	lb/MMBtu	0.00E+00	0.00E+00
Benz(a)anthracene	6.22E-07	lb/MMBtu	0.00E+00	0.00E+00
Benzene	7.76E-04	lb/MMBtu	0.00E+00	0.00E+00
Benzo(a)pyrene	2.57E-07	lb/MMBtu	0.00E+00	0.00E+00
Benzo(b)fluoranthene	1.11E-06	lb/MMBtu	0.00E+00	0.00E+00
Benzo(g,h,l)perylene	5.56E-07	lb/MMBtu	0.00E+00	0.00E+00
Benzo(k)fluoranthene	2.18E-07	lb/MMBtu	0.00E+00	0.00E+00
1,3-Butadiene	3.91E-05	lb/MMBtu	0.00E+00	0.00E+00
Chrysene	1.53E-06	lb/MMBtu	0.00E+00	0.00E+00
Dibenz(a,h)anthracene	3.46E-07	lb/MMBtu	0.00E+00	0.00E+00
Fluoranthene	4.03E-06	lb/MMBtu	0.00E+00	0.00E+00
Fluorene	1.28E-05	lb/MMBtu	0.00E+00	0.00E+00
Formaldehyde	7.89E-05	lb/MMBtu	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	4.14E-07	lb/MMBtu	0.00E+00	0.00E+00
Naphthalene	1.30E-04	lb/MMBtu	0.00E+00	0.00E+00
Phenanthrene	4.08E-05	lb/MMBtu	0.00E+00	0.00E+00
Propylene	2.79E-03	lb/MMBtu	0.00E+00	0.00E+00
Pyrene	3.71E-06	lb/MMBtu	0.00E+00	0.00E+00
Toluene	2.81E-04	lb/MMBtu	0.00E+00	0.00E+00
Xylenes	1.93E-04	lb/MMBtu	0.00E+00	0.00E+00
CO_2	73.96	kg/MMBtu	-	0.00
CH_4	0.003	kg/MMBtu	0.000	0.00E+00
N_2O	0.0006	kg/MMBtu	0.00E+00	0.00E+00
CO_2e	--	--	-	-

Table EC - 4c: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 1 and CO8, Unit ID 1 - Calculations for Both Primary 1500-kW Engines (Operating Scenario B)
Microsoft Corporation

Notes:

1) Emission factors for HAPs (except 1,3-Butadiene) are from AP-42, Table 3.4.3 and Table 3.4.4. Emission factor for 1,3-Butadiene is from AP-42, Table 3.3.2.
2) GHG Emission Factors for Diesel Distillate Fuel Oil No. 2 from EPA's Emission Factors for Greenhouse Gas Inventories, April 2014, https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf
3) Example Calculations (Acetaldehyde):
Hourly Acetaldehyde Emissions = 0.00 MMBtu/hr * 0.0000252 lb/MMBtu * 2 engines = 0.00000 lb/hr
Annual Acetaldehyde Emissions = 0.00000 lb/hr * 0 hr/yr / 2,000 lb/tons = 0.000000 tpy
4) Example Calculations (CO_2e):
(i) Hourly CO2 Emissions = 0.00 MMBtu/hr * 73.96 kg/MMBtu / 453.5924 g/lb * 1,000 kg/g * 2 engine = 0 lb/hr
(ii) Annual CO2 Emissions = 0.00 lb/hr * 0 hr/yr / 2,000 lb/tons = 0.00 tpy
Therefore, CO_2e Emissions = CO_2 Emissions + (CH_4 Emissions * GWP of CH_4) + (N_2O Emissions * GWP of N_2O)
(iii) Hourly CO2e Emissions = 0.00 lb/hr + (0.00 * 25) + (0.00 * 298) = 0 lb/hr
(iv) Annual CO2e Emissions = 0.00 lb/hr * 0 hr/yr / 2,000 lb/tons = 0.00 tpy

Table EC - 4d: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 2 and CO8, Unit ID 2 - Calculations for Both Reserve 1500-kW Engines (Operating Scenario B)
Microsoft Corporation

Description	Emergency Generators	Source
Operating Hours	110 hr/yr	--
Full Load Consumption Rate	104.6 gal/hr	Manufacturer Data
Diesel HHV	0.1384 MMBtu/gal	Engineering Basis
Heat Value	14.48 MMBtu/hr	--
No. of Units	2 Engines	--
Global Warming Potentials		
CO_2	1 tCO_2e	40 CFR Part 98 Subpart A, Table A-1
CH_4	25 tCO_2e	
N_2O	298 tCO_2e	

Pollutant	Emission Factor & Units (1, 2)		Emissions (3, 4)	
			lb/hr	tpy
Acetaldehyde	2.52E-05	lb/MMBtu	7.30E-04	4.01E-05
Acrolein	7.88E-06	lb/MMBtu	2.28E-04	1.25E-05
Acenaphthylene	9.23E-06	lb/MMBtu	2.67E-04	1.47E-05
Acenaphthene	4.68E-06	lb/MMBtu	1.36E-04	7.45E-06
Ammonia	1.15E-02	lb/MMBtu	3.32E-01	1.83E-02
Anthracene	1.23E-06	lb/MMBtu	3.56E-05	1.96E-06
Benz(a)anthracene	6.22E-07	lb/MMBtu	1.80E-05	9.91E-07
Benzene	7.76E-04	lb/MMBtu	2.25E-02	1.24E-03
Benzo(a)pyrene	2.57E-07	lb/MMBtu	7.44E-06	4.09E-07
Benzo(b)fluoranthene	1.11E-06	lb/MMBtu	3.21E-05	1.77E-06
Benzo(g,h,l)perylene	5.56E-07	lb/MMBtu	1.61E-05	8.85E-07
Benzo(k)fluoranthene	2.18E-07	lb/MMBtu	6.31E-06	3.47E-07
1,3-Butadiene	3.91E-05	lb/MMBtu	1.13E-03	6.23E-05
Chrysene	1.53E-06	lb/MMBtu	4.43E-05	2.44E-06
Dibenz(a,h)anthracene	3.46E-07	lb/MMBtu	1.00E-05	5.51E-07
Fluoranthene	4.03E-06	lb/MMBtu	1.17E-04	6.42E-06
Fluorene	1.28E-05	lb/MMBtu	3.71E-04	2.04E-05
Formaldehyde	7.89E-05	lb/MMBtu	2.28E-03	1.26E-04
Indeno(1,2,3-cd)pyrene	4.14E-07	lb/MMBtu	1.20E-05	6.59E-07
Naphthalene	1.30E-04	lb/MMBtu	3.76E-03	2.07E-04
Phenanthrene	4.08E-05	lb/MMBtu	1.18E-03	6.50E-05
Propylene	2.79E-03	lb/MMBtu	8.08E-02	4.44E-03
Pyrene	3.71E-06	lb/MMBtu	1.07E-04	5.91E-06
Toluene	2.81E-04	lb/MMBtu	8.14E-03	4.48E-04
Xylenes	1.93E-04	lb/MMBtu	5.59E-03	3.07E-04
CO_2	73.96	kg/MMBtu	4,721	259.67
CH_4	0.003	kg/MMBtu	0.192	1.05E-02
N_2O	0.0006	kg/MMBtu	3.83E-02	2.11E-03
CO_2e	--	--	4,738	260.57

Table EC - 4d: HAP and GHG Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
CO7, Unit ID 2 and CO8, Unit ID 2 - Calculations for Both Reserve 1500-kW Engines (Operating Scenario B)
Microsoft Corporation

Notes:

1) Emission factors for HAPs (except 1,3-Butadiene) are from AP-42, Table 3.4.3 and Table 3.4.4. Emission factor for 1,3-Butadiene is from AP-42, Table 3.3.2.

2) GHG Emission Factors for Diesel Distillate Fuel Oil No. 2 from EPA's Emission Factors for Greenhouse Gas Inventories, April 2014, https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

3) Example Calculations (Acetaldehyde):

Hourly Acetaldehyde Emissions = 14.48 MMBtu/hr * 0.0000252 lb/MMBtu * 2 engines = 0.00073 lb/hr

Annual Acetaldehyde Emissions = 0.00073 lb/hr * 110 hr/yr / 2,000 lb/tons = 0.000040 tpy

4) Example Calculations (CO_2e):

(i) Hourly CO2 Emissions = 14.48 MMBtu/hr * 73.96 kg/MMBtu / 453.5924 g/lb * 1,000 kg/g * 2 engine = 4,721 lb/hr

(ii) Annual CO2 Emissions = 4,721.35 lb/hr * 110 hr/yr / 2,000 lb/tons = 259.67 tpy

Therefore, CO_2e Emissions = CO_2 Emissions + (CH_4 Emissions * GWP of CH_4) + (N_2O Emissions * GWP of N_2O)

(iii) Hourly CO2e Emissions = 4,721.35 lb/hr + (0.19 * 25) + (0.04 * 298) = 4,738 lb/hr

(iv) Annual CO2e Emissions = 4,737.56 lb/hr * 110 hr/yr / 2,000 lb/tons = 260.57 tpy

Table EC - 5a: Fuel-based Emissions Summary (Controlled)
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario A)
Microsoft Corporation

Support Gnerator Engines
Number of Engines = 2
Annual Hours of Operation = 100

SO_2 Emission Factor = 1.21E-05 lb/hp-hr
Max HP for Support gensets = 539

Pollutant	Warm Emissions	Total Hourly Warm Emissions for 2 Engines	Annual Warm emissions for 2 Engines
	lb/hr/engine	lb/hr	tpy
NO_X	0.59	1.18	0.059
CO	3.01	6.01	0.30
VOC	0.17	0.35	0.017
$PM_{Filterable}$	0.034	0.068	3.37E-03
PM_{10}	0.186	0.372	1.85E-02
$PM_{2.5}$	0.186	0.372	1.85E-02
SO_2	6.54E-03	0.013	6.51E-04

Primary Gnerator Engines
Number of Engines = 2
Annual Hours of Operation = 110

SO_2 Emission Factor = 1.21E-05 lb/hp-hr
Max HP for Primary gensets = 2,206

Pollutant	Warm Emissions	Total Hourly Warm Emissions for 2 Engines	Annual Warm emissions for 2 Engines
	lb/hr/engine	lb/hr	tpy
NO_X	3.20	6.40	0.35
CO	4.36	8.72	0.48
VOC	0.84	1.69	0.092
$PM_{Filterable}$	0.061	0.12	6.62E-03
PM_{10}	0.88	1.75	0.096
$PM_{2.5}$	0.88	1.75	0.096
SO_2	0.027	0.054	2.93E-03

Reserve Gnerator Engines
Number of Engines = 2
Annual Hours of Operation = 0

SO_2 Emission Factor = 1.21E-05 lb/hp-hr
Max HP for Reserve gensets = 2,206

Pollutant	Warm Emissions	Total Hourly Warm Emissions for 2 Engines	Annual Warm emissions for 2 Engines
	lb/hr/engine	lb/hr	tpy
NO_X	0.00	0.00	0.00
CO	0.00	0.00	0.00
VOC	0.00	0.00	0.00
$PM_{Filterable}$	0.00	0.00	0.00
PM_{10}	0.00	0.00	0.00
$PM_{2.5}$	0.00	0.00	0.00
SO_2	0.00	0.00	0.00

Notes:

1) $PM_{Filterable}$, NO_x, CO, and VOC hourly emissions for each engine are the maximum based on engine specifications across all loads (see Table EC - 5b).

2) The VOC emission rates are also conservatively assumed to estimate condensable particulate matter (CPM) emissions. PM_{10} and $PM_{2.5}$ emissions are equal to the $PM_{Filterable}$ emission rates plus the CPM emission rates.

3) SO_2 emissions for each engine are calculated conservatively assuming constant operation at 100% load (i.e., maximum engine power). SO_2 emissions are based on maximum sulfur content allowed in ULSD (15 ppm) and are calculated according to methodology presented in AP-42, Chapter 3.4, Table 3.4-1.

4) The annual warm emissions (tpy) are calculated by multiplying the total hourly warm emissions by the annual warm hours (which is the difference between the annual operating hours and the annual duration of cold hours).

Table EC - 5a: Fuel-based Emissions Summary (Controlled)
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario B)
Microsoft Corporation

Support Gnerator Engines
Number of Engines = 2
Annual Hours of Operation = 100

SO_2 Emission Factor = 1.21E-05 lb/hp-hr
Max HP for Support gensets = 539

Pollutant	Warm Emissions	Total Hourly Warm Emissions for 2 Engines	Annual Warm emissions for 2 Engines
	lb/hr/engine	lb/hr	tpy
NO_X	0.59	1.18	0.059
CO	3.01	6.01	0.30
VOC	0.17	0.35	0.017
$PM_{Filterable}$	0.034	0.068	3.37E-03
PM_{10}	0.186	0.372	1.85E-02
$PM_{2.5}$	0.186	0.372	1.85E-02
SO_2	6.54E-03	0.013	6.51E-04

Primary Gnerator Engines
Number of Engines = 2
Annual Hours of Operation = 0

SO_2 Emission Factor = 1.21E-05 lb/hp-hr
Max HP for Primary gensets = 2,206

Pollutant	Warm Emissions	Total Hourly Warm Emissions for 2 Engines	Annual Warm emissions for 2 Engines
	lb/hr/engine	lb/hr	tpy
NO_X	0.00	0.00	0.00
CO	0.00	0.00	0.00
VOC	0.00	0.00	0.00
$PM_{Filterable}$	0.00	0.00	0.00
PM_{10}	0.00	0.00	0.00
$PM_{2.5}$	0.00	0.00	0.00
SO_2	0.00	0.00	0.00

Reserve Gnerator Engines
Number of Engines = 2
Annual Hours of Operation = 110

SO_2 Emission Factor = 1.21E-05 lb/hp-hr
Max HP for Reserve gensets = 2,206

Pollutant	Warm Emissions	Total Hourly Warm Emissions for 2 Engines	Annual Warm emissions for 2 Engines
	lb/hr/engine	lb/hr	tpy
NO_X	3.20	6.40	0.35
CO	4.36	8.72	0.48
VOC	0.84	1.69	0.092
$PM_{Filterable}$	0.061	0.12	6.62E-03
PM_{10}	0.88	1.75	0.096
$PM_{2.5}$	0.88	1.75	0.096
SO_2	2.68E-02	5.35E-02	2.93E-03

Notes:

1) $PM_{Filterable}$, NO_x, CO, and VOC hourly emissions for each engine are the maximum based on engine specifications across all loads (see Table EC - 5b).

2) The VOC emission rates are also conservatively assumed to estimate condensable particulate matter (CPM) emissions. PM_{10} and $PM_{2.5}$ emissions are equal to the $PM_{Filterable}$ emission rates plus the CPM emission rates.

3) SO_2 emissions for each engine are calculated conservatively assuming constant operation at 100% load (i.e., maximum engine power). SO_2 emissions are based on maximum sulfur content allowed in ULSD (15 ppm) and are calculated according to methodology presented in AP-42, Chapter 3.4, Table 3.4-1.

4) The annual warm emissions (tpy) are calculated by multiplying the total hourly warm emissions by the annual warm hours (which is the difference between the annual operating hours and the annual duration of cold hours).

Table EC - 5b: Hourly Emissions at Various Load Percentages - For one engine (Uncontrolled)
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario A)
Microsoft Corporation

Support Generator Engines

Engine Model:	Caterpillar C13
Engine Rating:	350 kWe 539 hp
Operating Hours:	100 hr/yr

Emission Factors at Various Load Percentages [1]					
Brake Horsepower	539	405	281	160	83
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	4.95	2.31	1.86	3.38	4.39
CO (g/bhp-hr)	2.53	2.58	3.61	6.54	9.23
VOC (g/bhp-hr)	0.03	0.07	0.15	0.30	0.95
PM (g/bhp-hr)	0.19	0.25	0.36	0.34	0.45

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	5.88	2.06	1.15	1.19	0.80
CO (lb/hr)	3.01	2.30	2.24	2.31	1.69
VOC (lb/hr)	0.04	0.06	0.09	0.11	0.17
$PM_{Filterable}$ (lb/hr)	0.23	0.22	0.22	0.12	0.08
$PM_{10}/PM_{2.5}$ (lb/hr)	0.26	0.29	0.32	0.23	0.26

Primary Generator Engines

Engine Model:	Caterpillar 3512
Engine Rating:	1,500 kWe 2,206 hp
Operating Hours:	110 hr/yr

Emission Factors at Various Load Percentages [2]					
Brake Horsepower	2,206	1,662	1,144	632	312
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	6.58	4.41	4.26	5.85	9.14
CO (g/bhp-hr)	0.87	0.71	1.47	3.13	6.13
VOC (g/bhp-hr)	0.16	0.23	0.32	0.45	1.06
PM (g/bhp-hr)	0.04	0.06	0.13	0.29	0.36

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	32.00	16.16	10.74	8.15	6.29
CO (lb/hr)	4.23	2.60	3.71	4.36	4.22
VOC (lb/hr)	0.78	0.84	0.81	0.63	0.73
$PM_{Filterable}$ (lb/hr)	0.19	0.22	0.33	0.40	0.25
$PM_{10}/PM_{2.5}$ (lb/hr)	0.97	1.06	1.13	1.03	0.98

Reserve Generator Engines

Engine Model:	Caterpillar 3512
Engine Rating:	1,500 kWe 2,206 hp
Operating Hours:	0 hr/yr

Emission Factors at Various Load Percentages [2]					
Brake Horsepower	2,206	1,662	1,144	632	312
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	6.58	4.41	4.26	5.85	9.14
CO (g/bhp-hr)	0.87	0.71	1.47	3.13	6.13
VOC (g/bhp-hr)	0.16	0.23	0.32	0.45	1.06
PM (g/bhp-hr)	0.04	0.06	0.13	0.29	0.36

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	0.00	0.00	0.00	0.00	0.00
CO (lb/hr)	0.00	0.00	0.00	0.00	0.00
VOC (lb/hr)	0.00	0.00	0.00	0.00	0.00
$PM_{Filterable}$ (lb/hr)	0.00	0.00	0.00	0.00	0.00
$PM_{10}/PM_{2.5}$ (lb/hr)	0.00	0.00	0.00	0.00	0.00

Notes:

1) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for the 350-kWe Caterpillar C13 generator engine (see product specifications sheets in Appendix E).

2) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for the 1500-kWe Caterpillar 3512 generator engine (see product specifications sheets in Appendix E).

3) Hourly emissions (lb/hr) at various load percentages are calculated by multiplying the emission factor by the BHP value and dividing by 453.592 g/lb. $PM_{10}/PM_{2.5}$ emissions are set equal to the $PM_{Filterable}$ emission rates plus the VOC emission rates (conservatively assumed to estimate CPM emissions).

Table EC - 5b: Hourly Emissions at Various Load Percentages - For one engine (Uncontrolled)
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario B)
Microsoft Corporation

Support Generator Engines

Engine Model:	Caterpillar C13
Engine Rating:	350 kWe 539 hp
Operating Hours:	100 hr/yr

Emission Factors at Various Load Percentages [1]					
Brake Horsepower	539	405	281	160	83
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	4.95	2.31	1.86	3.38	4.39
CO (g/bhp-hr)	2.53	2.58	3.61	6.54	9.23
VOC (g/bhp-hr)	0.03	0.07	0.15	0.30	0.95
PM (g/bhp-hr)	0.19	0.25	0.36	0.34	0.45

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	5.88	2.06	1.15	1.19	0.80
CO (lb/hr)	3.01	2.30	2.24	2.31	1.69
VOC (lb/hr)	0.04	0.06	0.09	0.11	0.17
$PM_{Filterable}$ (lb/hr)	0.23	0.22	0.22	0.12	0.08
$PM_{10}/PM_{2.5}$ (lb/hr)	0.26	0.29	0.32	0.23	0.26

Primary Generator Engines

Engine Model:	Caterpillar 3512
Engine Rating:	1,500 kWe 2,206 hp
Operating Hours:	0 hr/yr

Emission Factors at Various Load Percentages [2]					
Brake Horsepower	2,206	1,662	1,144	632	312
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	6.58	4.41	4.26	5.85	9.14
CO (g/bhp-hr)	0.87	0.71	1.47	3.13	6.13
VOC (g/bhp-hr)	0.16	0.23	0.32	0.45	1.06
PM (g/bhp-hr)	0.04	0.06	0.13	0.29	0.36

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	0.00	0.00	0.00	0.00	0.00
CO (lb/hr)	0.00	0.00	0.00	0.00	0.00
VOC (lb/hr)	0.00	0.00	0.00	0.00	0.00
$PM_{Filterable}$ (lb/hr)	0.00	0.00	0.00	0.00	0.00
$PM_{10}/PM_{2.5}$ (lb/hr)	0.00	0.00	0.00	0.00	0.00

Reserve Generator Engines

Engine Model:	Caterpillar 3512
Engine Rating:	1,500 kWe 2,206 hp
Operating Hours:	110 hr/yr

Emission Factors at Various Load Percentages [2]					
Brake Horsepower	2,206	1,662	1,144	632	312
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	6.58	4.41	4.26	5.85	9.14
CO (g/bhp-hr)	0.87	0.71	1.47	3.13	6.13
VOC (g/bhp-hr)	0.16	0.23	0.32	0.45	1.06
PM (g/bhp-hr)	0.04	0.06	0.13	0.29	0.36

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	32.00	16.16	10.74	8.15	6.29
CO (lb/hr)	4.23	2.60	3.71	4.36	4.22
VOC (lb/hr)	0.78	0.84	0.81	0.63	0.73
$PM_{Filterable}$ (lb/hr)	0.19	0.22	0.33	0.40	0.25
$PM_{10}/PM_{2.5}$ (lb/hr)	0.97	1.06	1.13	1.03	0.98

Notes:

1) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for the 350-kWe Caterpillar C13 generator engine (see product specifications sheets in Appendix E).

2) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for the 1500-kWe Caterpillar 3512 generator engine (see product specifications sheets in Appendix E).

3) Hourly emissions (lb/hr) at various load percentages are calculated by multiplying the emission factor by the BHP value and dividing by 453.592 g/lb. $PM_{10}/PM_{2.5}$ emissions are set equal to the $PM_{Filterable}$ emission rates plus the VOC emission rates (conservatively assumed to estimate CPM emissions).

Table EC - 5b: Hourly Emissions at Various Load Percentages - For one engine (Controlled)
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario A)
Microsoft Corporation

Support Generator Engines

Engine Model:	Caterpillar C13
Engine Rating:	350 kWe 539 hp
Operating Hours:	100 hr/yr

Emission Factors at Various Load Percentages [1]					
Brake Horsepower	539	405	281	160	83
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	4.95	2.31	1.86	3.38	4.39
CO (g/bhp-hr)	2.53	2.58	3.61	6.54	9.23
VOC (g/bhp-hr)	0.03	0.07	0.15	0.30	0.95
PM (g/bhp-hr)	0.19	0.25	0.36	0.34	0.45

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	0.59	0.21	0.12	0.12	0.08
CO (lb/hr)	3.01	2.30	2.24	2.31	1.69
VOC (lb/hr)	0.04	0.06	0.09	0.11	0.17
$PM_{Filterable}$ (lb/hr)	0.03	0.03	0.03	0.02	0.01
$PM_{10}/PM_{2.5}$ (lb/hr)	0.07	0.10	0.13	0.12	0.19

Primary Generator Engines

Engine Model:	Caterpillar 3512
Engine Rating:	1,500 kWe 2,206 hp
Operating Hours:	110 hr/yr

Emission Factors at Various Load Percentages [2]					
Brake Horsepower	2,206	1,662	1,144	632	312
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	6.58	4.41	4.26	5.85	9.14
CO (g/bhp-hr)	0.87	0.71	1.47	3.13	6.13
VOC (g/bhp-hr)	0.16	0.23	0.32	0.45	1.06
PM (g/bhp-hr)	0.04	0.06	0.13	0.29	0.36

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	3.20	1.62	1.07	0.82	0.63
CO (lb/hr)	4.23	2.60	3.71	4.36	4.22
VOC (lb/hr)	0.78	0.84	0.81	0.63	0.73
$PM_{Filterable}$ (lb/hr)	0.03	0.03	0.05	0.06	0.04
$PM_{10}/PM_{2.5}$ (lb/hr)	0.81	0.88	0.86	0.69	0.77

Reserve Generator Engines

Engine Model:	Caterpillar 3512
Engine Rating:	1,500 kWe 2,206 hp
Operating Hours:	0 hr/yr

Emission Factors at Various Load Percentages [2]					
Brake Horsepower	2,206	1,662	1,144	632	312
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	6.58	4.41	4.26	5.85	9.14
CO (g/bhp-hr)	0.87	0.71	1.47	3.13	6.13
VOC (g/bhp-hr)	0.16	0.23	0.32	0.45	1.06
PM (g/bhp-hr)	0.04	0.06	0.13	0.29	0.36

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	0.00	0.00	0.00	0.00	0.00
CO (lb/hr)	0.00	0.00	0.00	0.00	0.00
VOC (lb/hr)	0.00	0.00	0.00	0.00	0.00
$PM_{Filterable}$ (lb/hr)	0.00	0.00	0.00	0.00	0.00
$PM_{10}/PM_{2.5}$ (lb/hr)	0.00	0.00	0.00	0.00	0.00

Notes:

1) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for the 350-kWe Caterpillar C13 generator engine (see product specifications sheets in Appendix E).

2) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for the 1500-kWe Caterpillar 3512 generator engine (see product specifications sheets in Appendix E).

3) Hourly emissions (lb/hr) at various load percentages are calculated by multiplying the emission factor by the BHP value and dividing by 453.592 g/lb. $PM_{10}/PM_{2.5}$ emissions are set equal to the $PM_{Filterable}$ emission rates plus the VOC emission rates (conservatively assumed to estimate CPM emissions).

Table EC - 5b: Hourly Emissions at Various Load Percentages - For one engine (Controlled)
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario B)
Microsoft Corporation

Support Generator Engines

Engine Model:	Caterpillar C13
Engine Rating:	350 kWe 539 hp
Operating Hours:	100 hr/yr

Emission Factors at Various Load Percentages [1]					
Brake Horsepower	539	405	281	160	83
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	4.95	2.31	1.86	3.38	4.39
CO (g/bhp-hr)	2.53	2.58	3.61	6.54	9.23
VOC (g/bhp-hr)	0.03	0.07	0.15	0.30	0.95
PM (g/bhp-hr)	0.19	0.25	0.36	0.34	0.45

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	0.59	0.21	0.12	0.12	0.08
CO (lb/hr)	3.01	2.30	2.24	2.31	1.69
VOC (lb/hr)	0.04	0.06	0.09	0.11	0.17
$PM_{Filterable}$ (lb/hr)	0.03	0.03	0.03	0.02	0.01
$PM_{10}/PM_{2.5}$ (lb/hr)	0.07	0.10	0.13	0.12	0.19

Primary Generator Engines

Engine Model:	Caterpillar 3512
Engine Rating:	1,500 kWe 2,206 hp
Operating Hours:	0 hr/yr

Emission Factors at Various Load Percentages [2]					
Brake Horsepower	2,206	1,662	1,144	632	312
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	6.58	4.41	4.26	5.85	9.14
CO (g/bhp-hr)	0.87	0.71	1.47	3.13	6.13
VOC (g/bhp-hr)	0.16	0.23	0.32	0.45	1.06
PM (g/bhp-hr)	0.04	0.06	0.13	0.29	0.36

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	0.00	0.00	0.00	0.00	0.00
CO (lb/hr)	0.00	0.00	0.00	0.00	0.00
VOC (lb/hr)	0.00	0.00	0.00	0.00	0.00
$PM_{Filterable}$ (lb/hr)	0.00	0.00	0.00	0.00	0.00
$PM_{10}/PM_{2.5}$ (lb/hr)	0.00	0.00	0.00	0.00	0.00

Reserve Generator Engines

Engine Model:	Caterpillar 3512
Engine Rating:	1,500 kWe 2,206 hp
Operating Hours:	110 hr/yr

Emission Factors at Various Load Percentages [2]					
Brake Horsepower	2,206	1,662	1,144	632	312
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	6.58	4.41	4.26	5.85	9.14
CO (g/bhp-hr)	0.87	0.71	1.47	3.13	6.13
VOC (g/bhp-hr)	0.16	0.23	0.32	0.45	1.06
PM (g/bhp-hr)	0.04	0.06	0.13	0.29	0.36

Hourly Emissions at Various Load Percentages [3]					
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	3.20	1.62	1.07	0.82	0.63
CO (lb/hr)	4.23	2.60	3.71	4.36	4.22
VOC (lb/hr)	0.78	0.84	0.81	0.63	0.73
$PM_{Filterable}$ (lb/hr)	0.03	0.03	0.05	0.06	0.04
$PM_{10}/PM_{2.5}$ (lb/hr)	0.81	0.88	0.86	0.69	0.77

Notes:

1) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for the 350-kWe Caterpillar C13 generator engine (see product specifications sheets in Appendix E).

2) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for the 1500-kWe Caterpillar 3512 generator engine (see product specifications sheets in Appendix E).

3) Hourly emissions (lb/hr) at various load percentages are calculated by multiplying the emission factor by the BHP value and dividing by 453.592 g/lb. $PM_{10}/PM_{2.5}$ emissions are set equal to the $PM_{Filterable}$ emission rates plus the VOC emission rates (conservatively assumed to estimate CPM emissions).

Table EC - 6: Startup Emissions Summary
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario A)
Microsoft Corporation

Cold-Start Scaling Factors

Pollutant	Spike Duration [1]	Cold-Start Emission Spike [1]	Steady-State (Warm) Emissions [1]	Cold-Start	Steady State (Warm)	Cold-Start Scaling Factor
	seconds	ppm	ppm	ppm-seconds	ppm-seconds	
NO_X	8	40	38	160	1,976	0.94
CO	20	750	30	15,000	1,200	9.00
PM + HC	14	900	30	6,300	1,380	4.27

Worst-case Emission Rates

Pollutant	Worst-case Emission Rate (lb/hr/engine)					
	Primary Generator Engines		Reserve Generator Engines		Support Generator Engines	
	Warm	Cold-Start/Warm-up [2]	Warm	Cold-Start/Warm-up [2]	Warm	Cold-Start/Warm-up [2]
NO_X [3]	3.20	32.00	0.00	0.00	0.59	5.88
CO	4.36	39.25	0.00	0.00	3.01	27.06
HC	0.84	3.60	0.00	0.00	0.17	0.74
DEEP/ $PM_{Filterable}$	0.06	0.26	0.00	0.00	0.03	0.14
PM_{10}/ $PM_{2.5}$	0.88	3.74	0.00	0.00	0.19	0.79

Startup emission rates (for 1 engine)

Pollutant	Primary Generator Engines - Single Hour Emissions (lb/hr) [4]			Reserve Generator Engines - Single Hour Emissions (lb/hr) [4]			Support Generator Engines - Single Hour Emissions (lb/hr) [4]		
	Cold-Start (1-min) / Warm-up (15-min)	Warm (59 or 45 min)	Total (1 hr)	Cold-Start (1-min) / Warm-up (15-min)	Warm (59 or 45 min)	Total (1 hr)	Cold-Start (1-min) / Warm-up (15-min)	Warm (59 or 45 min)	Total (1 hr)
NO_X	8.00	2.40	10.40	0.00	0.00	0.00	1.47	0.44	1.91
CO	0.65	4.29	4.94	0.00	0.00	0.00	0.45	2.96	3.41
HC	0.06	0.83	0.89	0.00	0.00	0.00	0.01	0.17	0.18
DEEP/ $PM_{Filterable}$	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.03	0.04
PM_{10}/ $PM_{2.5}$	0.06	0.86	0.92	0.00	0.00	0.00	0.01	0.18	0.20

Table EC - 6: Startup Emissions Summary
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario A)
Microsoft Corporation

Hourly Startup emission rates (for all engines)

Pollutant	Primary Generators (2 Engines)	Reserve Generators (2 Engines)	Support Generators (2 Engines)
	lb/hr	lb/hr	lb/hr
NO_X	20.80	0.00	3.82
CO	9.89	0.00	6.81
HC	1.78	0.00	0.37
DEEP/ $PM_{Filterable}$	0.13	0.00	0.07
PM_{10}/ $PM_{2.5}$	1.85	0.00	0.39

Duration of Cold Start Conditions

Parameter	Units	Primary Gensets	Reserve Gensets	Support Gensets
Cold-Startup Events per year [5]	Events	42	0	30
Duration of Each Cold-Startup Event	Hours/Event	0.017	0.017	0.017
Total Duration of Cold Start Conditions	Hours	0.70	0.00	0.50
Duration of Each Cold-Start SCR Warmup	Hours/Event	0.250	0.250	0.250
Total Duration of SCR Warmup Conditions	Hours	10.50	0.00	7.50

Annual Startup emission rates (for all engines) [6]

Pollutant	Primary Generators (2 Engines)	Reserve Generators (2 Engines)	Support Generators (2 Engines)
	tpy	tpy	tpy
NO_X	0.1092	0.0000	0.0143
CO	0.0035	0.00E+00	1.70E-03
HC	6.22E-04	0.00E+00	9.16E-05
DEEP/ $PM_{Filterable}$	4.47E-05	0.00E+00	1.79E-05
PM_{10}/ $PM_{2.5}$	6.46E-04	0.00E+00	9.82E-05

Notes:

1) Spike duration, cold-start emission spike, and steady-state (warm) emissions are based on data from Section 3.4 of *Air Quality Implications of Backup Generators in California, Volume Two* (UCR, 2005) - see excerpt next page. The cold-start scaling factor is derived as the ratio of the spike concentration and duration to the steady-state emissions for the initial 60 seconds. Since a cold-start curve was not developed for PM, it is assumed that PM will experience the same trend as HC.
2) Cold-start emission rate, a lb/hr rate for the first minute of operation, is calculated by multiplying the warm emission rate by the cold-start scaling factor. The warm-up emission rate applies to the SCR for NO_X emissions, a lb/hr rate for the first 15 minutes of operation, is calculated from the maximum non-reduced lb/hr rate for NO_X emissions.
3) Although the startup emission factor derived for NO_X is less than 1 (i.e., decreased emissions), this analysis conservatively assumes a factor of 1.0.
4) The startup hourly emission rate assumes one minute of cold-start emissions and 59 minutes of warm engine emissions.
5) See explanation in Section 3.1 of the application narrative for a description of how the number of cold-start events were calculated.
6) Annual startup emission rate is calculated by multiplying the hourly startup emission rate (from 2 engines) by the total duration of cold start conditions.

Excerpt, *Air Quality Implications of Backup Generators in Califormia; Volume Two* (UCR, 2005).

3.4. Emission Factors for the Transient Cold Start

For each of the BUGs, the raw data were compiled during the testing, then adjustments were made to correct for ambient values and moisture. One of the data sets that was unique to this work was the measurement of transient emissions during the cold start. A representative example of the startup transient data is shown in Figure 19. The salient features are the high CO, total hydrocarbons, and the low NO_x initial values for about the first 30 seconds, and then a leveling out of the emissions.

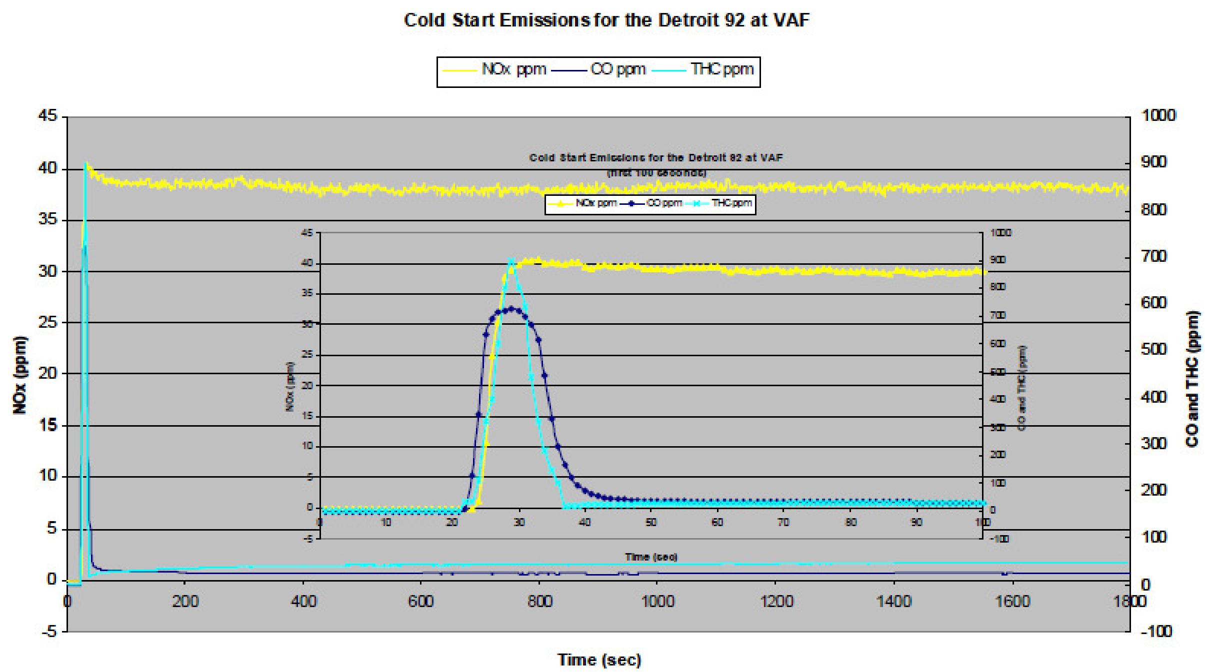


Figure 19. Cold-start emissions for CO and NO_X as a function of time

Table EC - 6: Startup Emissions Summary
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario B)
Microsoft Corporation

Cold-Start Scaling Factors

Pollutant	Spike Duration [1]	Cold-Start Emission Spike [1]	Steady-State (Warm) Emissions [1]	Cold-Start	Steady State (Warm)	Cold-Start Scaling Factor
	seconds	ppm	ppm	ppm-seconds	ppm-seconds	
NO_X	8	40	38	160	1,976	0.94
CO	20	750	30	15,000	1,200	9.00
PM + HC	14	900	30	6,300	1,380	4.27

Worst-case Emission Rate

Pollutant	Worst-case Emission Rate (lb/hr/engine)					
	Primary Generator Engines		Reserve Generator Engines		Support Generator Engines	
	Warm	Cold-Start/Warm-up [2]	Warm	Cold-Start/Warm-up [2]	Warm	Cold-Start/Warm-up [2]
NO_X [3]	0.00	0.00	3.20	32.00	0.59	5.88
CO	0.00	0.00	4.36	39.25	3.01	27.06
HC	0.00	0.00	0.84	3.60	0.17	0.74
DEEP/ PM	0.00	0.00	0.06	0.26	0.03	0.14
PM_{10}/ $PM_{2.5}$	0.00	0.00	0.88	3.74	0.19	0.79

Startup emission rates (for 1 engine)

Pollutant	Primary Generator Engines - Single Hour Emissions (lb/hr) [4]			Reserve Generator Engines - Single Hour Emissions (lb/hr) [4]			Support Generator Engines - Single Hour Emissions (lb/hr) [4]		
	Cold-Start (1-min) / Warm-up (15-min)	Warm (59 or 45 min)	Total (1 hr)	Cold-Start (1-min) / Warm-up (15-min)	Warm (59 or 45 min)	Total (1 hr)	Cold-Start (1-min) / Warm-up (15-min)	Warm (59 or 45 min)	Total (1 hr)
NO_X	0.00	0.00	0.00	8.00	2.40	10.40	1.47	0.44	1.91
CO	0.00	0.00	0.00	0.65	4.29	4.94	0.45	2.96	3.41
HC	0.00	0.00	0.00	0.06	0.83	0.89	0.01	0.17	0.18
DEEP/ $PM_{Filterable}$	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.03	0.04
PM_{10}/ $PM_{2.5}$	0.00	0.00	0.00	0.06	0.86	0.92	0.01	0.18	0.20

Table EC - 6: Startup Emissions Summary
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center (Operating Scenario B)
Microsoft Corporation

Hourly Startup emission rates (for all engines)

Pollutant	Primary Generators (2 Engines)	Reserve Generators (2 Engines)	Support Generators (2 Engines)
	lb/hr	lb/hr	lb/hr
NO_X	0.00	20.80	3.82
CO	0.00	9.89	6.81
HC	0.00	1.78	0.37
DEEP/ $PM_{Filterable}$	0.00	0.13	0.07
PM_{10}/ $PM_{2.5}$	0.00	1.85	0.39

Duration of Cold Start Conditions

Parameter	Units	Primary Gensets	Reserve Gensets	Support Gensets
Cold-Startup Events per year [5]	Events	0	42	30
Duration of Each Cold-Startup Event	Hours/Event	0.017	0.017	0.017
Total Duration of Cold Start Conditions	Hours	0.00	0.70	0.50
Duration of Each Cold-Start SCR Warmup	Hours/Event	0.250	0.250	0.250
Total Duration of SCR Warmup Conditions	Hours	0.00	10.50	7.50

Annual Startup emission rates (for all engines) [6]

Pollutant	Primary Generators (2 Engines)	Reserve Generators (2 Engines)	Support Generators (2 Engines)
	tpy	tpy	tpy
NO_X	0.0000	0.1092	0.0143
CO	0.0000	0.0035	1.70E-03
HC	0.00E+00	6.22E-04	9.16E-05
DEEP/ $PM_{Filterable}$	0.00E+00	4.47E-05	1.79E-05
PM_{10}/ $PM_{2.5}$	0.00E+00	6.46E-04	9.82E-05

Notes:

1) Spike duration, cold-start emission spike, and steady-state (warm) emissions are based on data from Section 3.4 of *Air Quality Implications of Backup Generators in California, Volume Two* (UCR, 2005) - see excerpt next page. The cold-start scaling factor is derived as the ratio of the spike concentration and duration to the steady-state emissions for the initial 60 seconds. Since a cold-start curve was not developed for PM, it is assumed that PM will experience the same trend as HC.
2) Cold-start emission rate, a lb/hr rate for the first minute of operation, is calculated by multiplying the warm emission rate by the cold-start scaling factor. The warm-up emission rate applies to the SCR for NO_X emissions, a lb/hr rate for the first 15 minutes of operation, is calculated from the maximum non-reduced lb/hr rate for NO_X emissions.
3) Although the startup emission factor derived for NO_X is less than 1 (i.e., decreased emissions), this analysis conservatively assumes a factor of 1.0.
4) The startup hourly emission rate assumes one minute of cold-start emissions and 59 minutes of warm engine emissions.
5) See explanation in Section 3.1 of the application narrative for a description of how the number of cold-start events were calculated.
6) Annual startup emission rate is calculated by multiplying the hourly startup emission rate (from 2 engines) by the total duration of cold start conditions.

Excerpt, *Air Quality Implications of Backup Generators in California; Volume Two* (UCR, 2005).

3.4. Emission Factors for the Transient Cold Start

For each of the BUGs, the raw data were compiled during the testing, then adjustments were made to correct for ambient values and moisture. One of the data sets that was unique to this work was the measurement of transient emissions during the cold start. A representative example of the startup transient data is shown in Figure 19. The salient features are the high CO, total hydrocarbons, and the low NO_x initial values for about the first 30 seconds, and then a leveling out of the emissions.

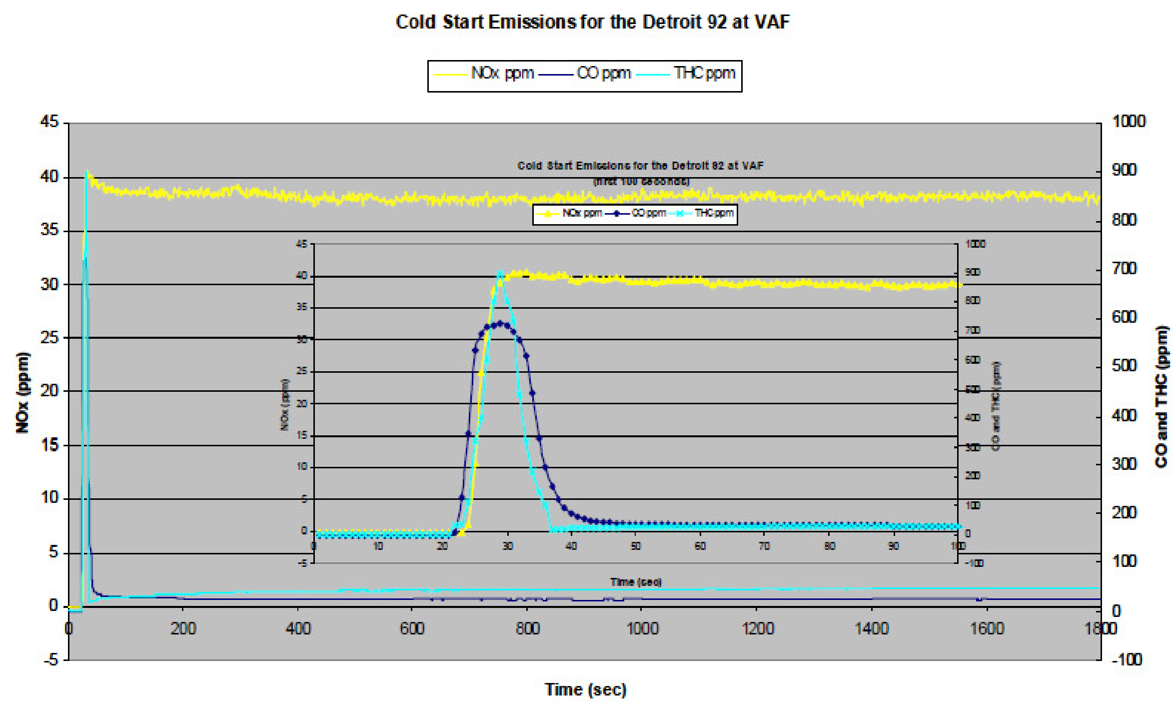


Figure 19. Cold-start emissions for CO and NO_X as a function of time

Table EC - 7: Ammonia Emissions Summary
Emergency Generator Diesel Engine Emissions Calculations
CO7/CO8 Addition - Columbia Data Center
Microsoft Corporation

Ammonia: Conversion from ppm to lb/MMBtu

Pollutant	NH_3	
Fuel	Diesel	
Equation	K x F_d x 20.9 ÷ (20.9 - %O_2)	
K-value =	4.403E-08	
F_d =	9,190	dscf/MMBtu
Ammonia (1500-kWe Engine), ppm =	8	ppm
Ammonia (350-kWe Engine), ppm =	10	ppm
% O_2 value =	15	%O_2
Ammonia (1500-kWe Engine), lb/MMBtu =	0.0115	lb/MMBtu
Ammonia (350-kWe Engine), lb/MMBtu =	0.0143	lb/MMBtu

Notes:
1) K-factor constant corrects for the molecular weight of ammonia
2) Fd is fuel-specific oxygen-based F factor, dry basis, from Method 19 [scf / 10^6 Btu].
3) For diesel, Fd = 9,190 dscf/MMBtu

APPENDIX D – BACT AND tBACT COST CALCULATIONS

Table D-A1. General Cost Calculation Inputs for SCR System	
Number of 1.5-MW Engines being Added	4
Number of 350-kW Engines being Added	2
Bank Prime Rate (July 2021) [1]	3.25%
Lifespan of Control Equipment (years) [2]	30

Notes:

(1) Bank Prime Rate for July 2021 acquired from: https://www.bankrate.com/rates/interest-rates/prime-rate.aspx (Bankrate, 2021).

(2) A useful lifespan of 30 years is incorporated for control equipment, consistent with information provided for the 2.5-MW Caterpillar engines used at Building CO6 (Landau,

Table D-A2. Criteria Pollutant Emission Rates and Control Efficiencies for SCR System [1]			
Pollutant	**Emissions (TPY)**	**SCR Removal**	**TPY Removed[2]**
$PM_{10}/PM_{2.5}$	0.1565	0%	0.0000
NO_X	4.1083	90%	3.6975
VOC	0.1101	0%	0.0000
CO	0.7810	0%	0.0000

Notes:

(1) SCR treatment efficiency percentages acquired from specifications for Caterpillar add-on equipment, with appropriate comparisons to previous Columbia (Landau, 2019) and Sabey data center (Trinity, 2020) permit applications.

(2) Annual TPY Removed is applied to the use of the SCR system for emissions control, acquired by multiplying annual emissions by the SCR system removal efficiency.

Table D-A3. Toxic Air Pollutant Emission Rates and Control Efficiencies for SCR System [1]			
Pollutant	**Emissions (TPY)**	**SCR Removal**	**Annual TPY [2] Removed**
Acrolein	0.000044	0%	0.000000
Ammonia	0.0232	0%	0.0000
Benzene	0.0016	0%	0.0000
CO	0.7810	0%	0.0000
DEEP	0.0670	0%	0.0000
Naphthalene	0.00024	0%	0.00000
NO_2 (10% of NO_X)	0.4108	90%	0.3697

Notes:

(1) SCR treatment efficiency percentages based on efficiencies for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) which are identical in kind or to which the toxic air pollutant is a constituent of, with appropriate comparisons to previous Columbia (Landau, 2019) and Sabey data center (Trinity, 2020) permit applications.

(2) Annual TPY Removed is applied to the use of the SCR system for emissions control, acquired by multiplying annual emissions by the SCR system removal efficiency.

Table D-A4. Capital Costs for SCR System		
Cost Type and Description	**Key Parameter**	**Calculated Cost**
Direct Costs		
Emission Control Package (1.5-MW Engines) (1)	$140,851	$507,064
Emission Control Package (350-kW Engines) (1)	$140,851	$211,277
Sales Tax (2),(6)	6.5%	$46,692
Shipping (3)	$3,500	$18,900
Enclosure Structural Supports (3)	$2,500	$13,500
Installation (3)	$12,000	$64,800
Total Direct Costs		**$862,232**
Indirect Costs		
Engineering (4)	$3,000	$18,000
Construction and Field Expenses (4)	$3,000	$18,000
Contractor Fees (5)	6.8%	$48,847
Startup (4)	$3,000	$18,000
Performance Test Tech Support (5)	1.0%	$7,183
Contingencies (5)	10.0%	$71,834
Total Indirect Costs		**$181,865**
Total Capital Costs		**$1,044,097**

Notes:

(1) Emission control package equipment costs for the SCR system are based on the equipment cost of $140,851 provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). This cost was adjusted for use with the 1.5-MW engines in the 2021 permit application by applying a multiplier of 0.9 and then multiplying by the number of 1.5-MW engines being added for the project. Similarly, the cost was adjusted for use with the 350-kW engines by applying a multiplier of 0.75 and then multiplying by the number of 350-kW engines being added for the project. Both engine- and cost-specific and update multipliers were provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(2) State Sales and Use Tax Rate was acquired from: https://dor.wa.gov/taxes-rates/sales-and-use-tax-rates (Revenue, 2021).

(3) Emission control package shipping, enclosure structural supports, and installations costs are based on the costs, shown above, provided by Caterpillar in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). This cost was adjusted for use with the 1.5-MW engines in the 2021 permit application by applying a multiplier of 0.9 and then multiplying by the number of 1.5-MW engines being added for the project. Similarly, the cost was adjusted for use with the 350-kW engines by applying a multiplier of 0.9 and then multiplying by the number of 350-kW engines being added for the project. Both engine- and cost-specific and update multipliers were provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(4) Engineering, construction and field, and startup costs are based on the those cost provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). These cost were projected not to change and were applied equally to both 1.5-MW and 350-kW engines, being multiplied only by the number of each type of engine being added for the project. This cost projection was provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(5) Contractor fees, performance test tech support, and contingency rate percentages are based on the those rates provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). These rates were not projected to change and were applied to the capital costs for the emission control packages calculated previously. This cost projection was provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

Table D-A5. Operating Costs for SCR System		
Cost Type and Description	**Key Parameter**	**Calculated Cost**
Direct Annual Costs		
Maintenance (1)	0.5%	$5,220
Reagent/Catalyst Cost (2)	$4.26/gal	$4,425
Total Direct Annual Costs		**$9,645**
Indirect Annual Costs		
Administrative Costs (1)	2.0%	$20,882
Property Tax (1)	1.0%	$10,441
Insurance (1)	1.0%	$10,441
Capital Recovery Factor (30 years) (3)	3.25%	0.0527
Annual Capital Recovery Costs (4)	30 years	$55,005
Total Indirect Annual Costs		**$96,769**
Total Annual Costs		**$106,414**

Notes:

(1) Maintenance, administrative, property tax, and insurance are based on the those cost provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). The indirect portion are consistent with the total rate of 4 percent as shown in Section 1, Chapter 2, 2.6.5.8 of the EPA's Air Pollution Control Cost Manual, 7th Edition (EPA, 2021). These rates were applied to the total capital costs derived in the previous table.

(2) Unit cost of reagent/catalyst for Tier 4 and SCR control packages are based on $4.00 per gallon costs provided by Caterpillar, as shown in the 2019 permit application for the five 2.5-MW engines used at Building CO6 (Landau, 2019). To update the cost to 2021 dollars, it was multiplied a cost annualizing adjustment factor of (1+i)n, where "i" is the current bank prime rate and "n" is "2" for the 2-year period (see 2021 unit cost as calculated above). Based on data provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/31/2022, the urea consumption rate is approximately 10% of the fuel consumption rate. The annual consumption rate is calculated by multiplying the rate for each engine type by the projected annual operating hours for each engine. Based on this data, the annual reagent/catalyst costs is derived as shown above.

(3) A capital recovery factor is derived, in accordance with Section 4, Chapter 2 of the EPA's Air Pollution Control Cost Manual, 7th Edition (EPA, 2021), using this equation: $[i(1+i)^n] \div [(1+i)^n-1]$, where "i" is the current bank prime rate (3.25%) and "n" is the useful lifespan in years (30) for the control equipment.

(4) Annual capital recovery cost is derived by multiplying the capital recovery factor by the total capital costs.

Table D-A6. Criteria Pollutant Cost Effectiveness for SCR System			
Pollutant	**Removal (TPY)**	**Ecology Acceptable Unit Cost ($/ton) [1]**	**Acceptable Annual Cost [2]**
$PM_{10}/PM_{2.5}$	0.0000	$12,000	$0
NO_X	3.6975	$12,000	$44,370
VOC	0.0000	$12,000	$0
CO	0.0000	$5,000	$0
Total Acceptable Annual Costs			**$44,370**
Actual Annual Costs			**$106,414**
Is the Control Device Cost Reasonable? (YES = Actual Costs ≤ Acceptable Costs)? [3]			**NO**

Notes:

(1) Acceptable unit costs ($/ton) acquired from Ecology memorandum, from Mr. Robert Koster, *BACT and t-BACT Cost Effectiveness Thresholds.* August 2, 2016 (Ecology, 2016).

(2) Acceptable annual costs for each criteria pollutant acquired by multiplying Annual TPY Removed (from previous calculations above) by the acceptable unit costs. These costs are summed to derive total acceptable annual costs for criterial pollutants. Actual annual costs are the total annual costs derived previously.

(3) The reasonability test involves a comparison of acceptable vs. actual annual costs. If the actual costs are less than or equal to the acceptable costs, the costs are considered reasonable and the control device should be installed.

Table D-A7. Toxic Air Pollutant Cost Effectiveness for SCR System [1]					
Pollutant	**Removal (TPY)**	**ASIL (µg/m3) [2]**	**Hanford Cost Factor [3]**	**Ecology Ceiling Cost ($/ton) [4]**	**Acceptable Annual Cost [5]**
Acrolein	0.000000	3.5E-01	4.89	$51,317	$0
Ammonia	0.0000	5.0E+02	1.73	$18,190	$0
Benzene	0.0000	1.3E-01	5.32	$55,833	$0
CO	0.0000	2.3E+04	0.07	$731	$0
DEEP	0.0000	3.3E-03	6.91	$72,585	$0
Naphthalene	0.00000	2.9E-02	5.97	$62,674	$0
NO_2 (10% of NO_X)	0.3697	4.7E+02	1.76	$18,472	$6,830
Total Acceptable Annual Costs					**$6,830**
Actual Annual Costs					**$106,414**
Is the Control Device Cost Reasonable? (YES = Actual Costs ≤ Acceptable Costs)? [6]					**NO**

Notes:

(1) Cost effective calculations for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) uses the Hanford ceiling cost method, described in the Department of Energy's *Evaluation of Best Available Control Technology for Toxics (tBACT), Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations* (DOE, 2010).

(2) The Acceptable Source Impact Level (ASIL) for each toxic air pollutant is acquired from the table at WAC 173-460-150.

(3) The Hanford Cost Factor is calculated as Log_{10}(27,000/ASIL), acquired from Ecology memorandum, from Mr. Robert Koster, dated August 2, 2016 (confirmed to be most current guidance).

(4) Ecology Ceiling costs ($/ton) for each toxic air pollutant acquired by multiplying the Hanford Cost Factor by 10,500, as described Ecology memorandum, from Mr. Robert Koster, dated August 2, 2016 (Ecology, 2016).

(5) Acceptable annual costs for each toxic air pollutant acquired by multiplying Annual TPY Removed (from previous calculations above) by the Ecology ceiling cost. These costs are summed to derive total acceptable annual costs for toxic air pollutants. Actual annual costs are the total annual costs derived previously.

(6) The reasonability test involves a comparison of acceptable vs. actual annual costs. If the actual costs are less than or equal to the acceptable costs, the costs are considered reasonable and the control device should be installed.

Table D-B1. General Cost Calculation Inputs for DPF System	
Number of 1.5-MW Engines being Added	4
Number of 350-kW Engines being Added	2
Bank Prime Rate (July 2021) (1)	3.25%
Lifespan of Control Equipment (years) (2)	30

Notes:

(1) Bank Prime Rate for July 2021 acquired from: https://www.bankrate.com/rates/interest-rates/prime-rate.aspx (Bankrate, 2021).

(2) A useful lifespan of 30 years is incorporated for control equipment, consistent with information provided for the 2.5-MW Caterpillar engines used at Building CO6 (Landau,

Table D-B2. Criteria Pollutant Emission Rates and Control Efficiencies for DPF System (1)			
Pollutant	**Emissions (TPY)**	**DPF Removal**	**TPY Removed(2)**
$PM_{10}/PM_{2.5}$	0.1565	85%	0.1330
NO_X	4.1083	0%	0.0000
VOC	0.1101	0%	0.0000
CO	0.7810	0%	0.0000

Notes:

(1) DPF treatment efficiency percentages based on efficiencies for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) which are identical in kind or to which the toxic air pollutant is a constituent of, with appropriate comparisons to previous Columbia (Landau, 2019) and Sabey data center (Trinity, 2020) permit applications.

(2) Annual TPY Removed is applied to the use of the DPF system for emissions control, acquired by multiplying annual emissions by the DPF system removal efficiency.

Table D-B3. Toxic Air Pollutant Emission Rates and Control Efficiencies for DPF System [1]			
Pollutant	**Emissions (TPY)**	**DPF Removal**	**Annual TPY [2] Removed**
Acrolein	0.000044	0%	0.000000
Ammonia	0.0232	0%	0.0000
Benzene	0.0016	0%	0.0000
CO	0.7810	0%	0.0000
DEEP	0.0670	85%	0.0570
Naphthalene	0.00024	0%	0.00000
NO_2 (10% of NO_X)	0.4108	0%	0.0000

Notes:

(1) DPF treatment efficiency percentages based on efficiencies for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) which are identical in kind or to which the toxic air pollutant is a constituent of, with appropriate comparisons to previous Columbia (Landau, 2019) and Sabey data center (Trinity, 2020) permit applications.

(2) Annual TPY Removed is applied to the use of the DPF system for emissions control, acquired by multiplying annual emissions by the DPF system removal efficiency.

Table D-B4. Capital Costs for DPF System		
Cost Type and Description	**Key Parameter**	**Calculated Cost**
Direct Costs		
Emission Control Package (1.5-MW Engines) (1)	$66,579	$239,684
Emission Control Package (350-kW Engines) (1)	$66,579	$99,869
Sales Tax (2),(6)	6.5%	$22,071
Shipping (3)	$3,000	$16,200
Enclosure Structural Supports (3)	$1,000	$5,400
Installation (3)	$10,000	$54,000
Total Direct Costs		**$437,224**
Indirect Costs		
Engineering (4)	$2,000	$12,000
Construction and Field Expenses (4)	$0	$0
Contractor Fees (5)	6.8%	$23,090
Startup (4)	$1,500	$9,000
Performance Test Tech Support (5)	1.0%	$3,396
Contingencies (5)	10.0%	$33,955
Total Indirect Costs		**$81,440**
Total Capital Costs		**$518,664**

Notes:

(1) Emission control package equipment costs for the DPF system are based on the equipment cost of $66,579 provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). This cost was adjusted for use with the 1.5-MW engines in the 2021 permit application by applying a multiplier of 0.9 and then multiplying by the number of 1.5-MW engines being added for the project. Similarly, the cost was adjusted for use with the 350-kW engines by applying a multiplier of 0.75 and then multiplying by the number of 350-kW engines being added for the project. Both engine- and cost-specific and update multipliers were provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(2) State Sales and Use Tax Rate was acquired from: https://dor.wa.gov/taxes-rates/sales-and-use-tax-rates (Revenue, 2021).

(3) Emission control package shipping, enclosure structural supports, and installations costs are based on the costs, shown above, provided by Caterpillar in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). This cost was adjusted for use with the 1.5-MW engines in the 2021 permit application by applying a multiplier of 0.9 and then multiplying by the number of 1.5-MW engines being added for the project. Similarly, the cost was adjusted for use with the 350-kW engines by applying a multiplier of 0.9 and then multiplying by the number of 350-kW engines being added for the project. Both engine- and cost-specific and update multipliers were provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(4) Engineering, construction and field, and startup costs are based on the those cost provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). These cost were projected not to change and were applied equally to both 1.5-MW and 350-kW engines, being multiplied only by the number of each type of engine being added for the project. This cost projection was provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(5) Contractor fees, performance test tech support, and contingency rate percentages are based on the those rates provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). These rates were not projected to change and were applied to the capital costs for the emission control packages calculated previously. This cost projection was provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

Table D-B5. Operating Costs for DPF System		
Cost Type and Description	**Key Parameter**	**Calculated Cost**
Direct Annual Costs		
Maintenance (1)	0.5%	$2,593
Reagent/Catalyst Cost	$0	$0
Total Direct Annual Costs		**$2,593**
Indirect Annual Costs		
Administrative Costs (1)	2.0%	$10,373
Property Tax (1)	1.0%	$5,187
Insurance (1)	1.0%	$5,187
Capital Recovery Factor (30 years) (2)	3.25%	0.0527
Annual Capital Recovery Costs (3)	30 years	$27,324
Total Indirect Annual Costs		**$48,071**
Total Annual Costs		**$50,664**

Notes:

(1) Maintenance, administrative, property tax, and insurance are based on the those cost provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). The indirect portion are consistent with the total rate of 4 percent as shown in Section 1, Chapter 2, 2.6.5.8 of the EPA's Air Pollution Control Cost Manual, 7th Edition (EPA, 2021). These rates were applied to the total capital costs derived in the previous table.

(2) A capital recovery factor is derived, in accordance with Section 4, Chapter 2 of the EPA's Air Pollution Control Cost Manual, 7th Edition (EPA, 2021), using this equation: $[i(1+i)^{n}] \div [(1+i)^{n}-1]$, where "i" is the current bank prime rate (3.25%) and "n" is the useful lifespan in years (30) for the control equipment.

(3) Annual capital recovery cost is derived by multiplying the capital recovery factor by the total capital costs.

Table D-B6. Criteria Pollutant Cost Effectiveness for DPF System			
Pollutant	**Removal (TPY)**	**Ecology Acceptable Unit Cost ($/ton) (1)**	**Acceptable Annual Cost (2)**
$PM_{10}/PM_{2.5}$	0.1330	$12,000	$1,596
NO_X	0.0000	$12,000	$0
VOC	0.0000	$12,000	$0
CO	0.0000	$5,000	$0
Total Acceptable Annual Costs			**$1,596**
Actual Annual Costs			**$50,664**
Is the Control Cost Device Reasonable? (YES = Actual Costs ≤ Acceptable Costs)? (3)			**NO**

Notes:

(1) Acceptable unit costs ($/ton) acquired from Ecology memorandum, from Mr. Robert Koster, *BACT and t-BACT Cost Effectiveness Thresholds.* August 2, 2016 (Ecology, 2016).

(2) Acceptable annual costs for each criteria pollutant acquired by multiplying Annual TPY Removed (from previous calculations above) by the acceptable unit costs. These costs are summed to derive total acceptable annual costs for criterial pollutants. Actual annual costs are the total annual costs derived previously.

(3) The reasonability test involves a comparison of acceptable vs. actual annual costs. If the actual costs are less than or equal to the acceptable costs, the costs are considered reasonable and the control device should be installed.

Table D-B7. Toxic Air Pollutant Cost Effectiveness for DPF System [1]					
Pollutant	**Removal (TPY)**	**ASIL (µg/m3) [2]**	**Hanford Cost Factor [3]**	**Ecology Ceiling Cost ($/ton) [4]**	**Acceptable Annual Cost [5]**
Acrolein	0.000000	3.5E-01	4.89	$51,317	$0
Ammonia	0.0000	5.0E+02	1.73	$18,190	$0
Benzene	0.0000	1.3E-01	5.32	$55,833	$0
CO	0.0000	2.3E+04	0.07	$731	$0
DEEP	0.0570	3.3E-03	6.91	$72,585	$4,137
Naphthalene	0.00000	2.9E-02	5.97	$62,674	$0
NO_2 (10% of NO_X)	0.0000	4.7E+02	1.76	$18,472	$0
Total Acceptable Annual Costs					**$4,137**
Actual Annual Costs					**$50,664**
Is the Control Cost Device Reasonable? (YES = Actual Costs ≤ Acceptable Costs)? [6]					**NO**

Notes:

(1) Cost effective calculations for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) uses the Hanford ceiling cost method, described in the Department of Energy's *Evaluation of Best Available Control Technology for Toxics (tBACT), Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations* (DOE, 2010).

(2) The Acceptable Source Impact Level (ASIL) for each toxic air pollutant is acquired from the table at WAC 173-460-150.

(3) The Hanford Cost Factor is calculated as Log_{10}(27,000/ASIL), acquired from Ecology memorandum, from Mr. Robert Koster, dated August 2, 2016 (confirmed to be most current guidance).

(4) Ecology Ceiling costs ($/ton) for each toxic air pollutant acquired by multiplying the Hanford Cost Factor by 10,500, as described Ecology memorandum, from Mr. Robert Koster, dated August 2, 2016 (Ecology, 2016).

(5) Acceptable annual costs for each toxic air pollutant acquired by multiplying Annual TPY Removed (from previous calculations above) by the Ecology ceiling cost. These costs are summed to derive total acceptable annual costs for toxic air pollutants. Actual annual costs are the total annual costs derived previously.

(6) The reasonability test involves a comparison of acceptable vs. actual annual costs. If the actual costs are less than or equal to the acceptable costs, the costs are considered reasonable and the control device should be installed.

Table D-C1. General Cost Calculation Inputs for DOC System	
Number of 1.5-MW Engines being Added	4
Number of 350-kW Engines being Added	2
Bank Prime Rate (July 2021) (1)	3.25%
Lifespan of Control Equipment (years) (2)	30

Notes:

(1) Bank Prime Rate for July 2021 acquired from: https://www.bankrate.com/rates/interest-rates/prime-rate.aspx (Bankrate, 2021).

(2) A useful lifespan of 30 years is incorporated for control equipment, consistent with information provided for the 2.5-MW Caterpillar engines used at Building CO6 (Landau,

Table D-C2. Criteria Pollutant Emission Rates and Control Efficiencies for DOC System (1)

Pollutant	Emissions (TPY)	DOC Removal	TPY Removed(2)
$PM_{10}/PM_{2.5}$	0.1565	20%	0.0313
NO_X	4.1083	0%	0.0000
VOC	0.1101	70%	0.0771
CO	0.7810	80%	0.6248

Notes:

(1) DOC treatment efficiency percentages acquired from specifications for Caterpillar add-on equipment, with appropriate comparisons to previous Columbia (Landau, 2019) and Sabey data center (Trinity, 2020) permit applications.

(2) Annual TPY Removed is applied to the use of the SCR system for emissions control, acquired by multiplying annual emissions by the SCR system removal efficiency.

Table D-C3. Toxic Air Pollutant Emission Rates and Control Efficiencies for DOC System [1]			
Pollutant	**Emissions (TPY)**	**DOC Removal**	**Annual TPY [2] Removed**
Acrolein	0.000044	70%	0.000031
Ammonia	0.0232	0%	0.0000
Benzene	0.0016	70%	0.0011
CO	0.7810	80%	0.6248
DEEP	0.0670	20%	0.0134
Naphthalene	0.00024	70%	0.00017
NO_2 (10% of NO_X)	0.4108	0%	0.0000

Notes:

(1) DOC treatment efficiency percentages based on efficiencies for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) which are identical in kind or to which the toxic air pollutant is a constituent of, with appropriate comparisons to previous Columbia (Landau, 2019) and Sabey data center (Trinity, 2020) permit applications.

(2) Annual TPY Removed is applied to the use of the DOC system for emissions control, acquired by multiplying annual emissions by the DOC system removal efficiency.

Table D-C4. Capital Costs for DOC System		
Cost Type and Description	**Key Parameter**	**Calculated Cost**
Direct Costs		
Emission Control Package (1.5-MW Engines) (1)	$11,846	$42,646
Emission Control Package (350-kW Engines) (1)	$11,846	$17,769
Sales Tax (2),(6)	6.5%	$3,927
Shipping (3)	$500	$2,700
Enclosure Structural Supports (3)	$0	$0
Installation (3)	$3,000	$16,200
Total Direct Costs		**$83,242**
Indirect Costs		
Engineering (4)	$1,200	$7,200
Construction and Field Expenses (4)	$0	$0
Contractor Fees (5)	6.8%	$4,108
Startup (4)	$1,500	$9,000
Performance Test Tech Support (5)	1.0%	$604
Contingencies (5)	10.0%	$6,041
Total Indirect Costs		**$26,954**
Total Capital Costs		**$110,195**

Notes:

(1) Emission control package equipment costs for the DOC system are based on the equipment cost of $11,846 provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). This cost was adjusted for use with the 1.5-MW engines in the 2021 permit application by applying a multiplier of 0.9 and then multiplying by the number of 1.5-MW engines being added for the project. Similarly, the cost was adjusted for use with the 350-kW engines by applying a multiplier of 0.75 and then multiplying by the number of 350-kW engines being added for the project. Both engine- and cost-specific and update multipliers were provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(2) State Sales and Use Tax Rate was acquired from: https://dor.wa.gov/taxes-rates/sales-and-use-tax-rates (Revenue, 2021).

(3) Emission control package shipping, enclosure structural supports, and installations costs are based on the costs, shown above, provided by Caterpillar in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). This cost was adjusted for use with the 1.5-MW engines in the 2021 permit application by applying a multiplier of 0.9 and then multiplying by the number of 1.5-MW engines being added for the project. Similarly, the cost was adjusted for use with the 350-kW engines by applying a multiplier of 0.9 and then multiplying by the number of 350-kW engines being added for the project. Both engine- and cost-specific and update multipliers were provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(4) Engineering, construction and field, and startup costs are based on the those cost provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). These cost were projected not to change and were applied equally to both 1.5-MW and 350-kW engines, being multiplied only by the number of each type of engine being added for the project. This cost projection was provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(5) Contractor fees, performance test tech support, and contingency rate percentages are based on the those rates provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). These rates were not projected to change and were applied to the capital costs for the emission control packages calculated previously. This cost projection was provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

Table D-C5. Operating Costs for DOC System		
Cost Type and Description	**Key Parameter**	**Calculated Cost**
Direct Annual Costs		
Maintenance [(1)]	0.5%	$551
Reagent/Catalyst Cost	$0	$0
Total Direct Annual Costs		**$551**
Indirect Annual Costs		
Administrative Costs [(1)]	2.0%	$2,204
Property Tax [(1)]	1.0%	$1,102
Insurance [(1)]	1.0%	$1,102
Capital Recovery Factor (30 years) [(2)]	3.25%	0.0527
Annual Capital Recovery Costs [(3)]	30 years	$5,805
Total Indirect Annual Costs		**$10,213**
Total Annual Costs		**$10,764**

Notes:

(1) Maintenance, administrative, property tax, and insurance are based on the those cost provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). The indirect portion are consistent with the total rate of 4 percent as shown in Section 1, Chapter 2, 2.6.5.8 of the EPA's Air Pollution Control Cost Manual, 7th Edition (EPA, 2021). These rates were applied to the total capital costs derived in the previous table.

(2) A capital recovery factor is derived, in accordance with Section 4, Chapter 2 of the EPA's Air Pollution Control Cost Manual, 7th Edition (EPA, 2021), using this equation: $[i(1+i)^n] \div [(1+i)^n-1]$, where "i" is the current bank prime rate (3.25%) and "n" is the useful lifespan in years (30) for the control equipment.

(3) Annual capital recovery cost is derived by multiplying the capital recovery factor by the total capital costs.

Table D-C6. Criteria Pollutant Cost Effectiveness for DOC System			
Pollutant	**Removal (TPY)**	**Ecology Acceptable Unit Cost ($/ton) (1)**	**Acceptable Annual Cost (2)**
$PM_{10}/PM_{2.5}$	0.0313	$12,000	$376
NO_X	0.0000	$12,000	$0
VOC	0.0771	$12,000	$925
CO	0.6248	$5,000	$3,124
Total Acceptable Annual Costs			**$4,424**
Actual Annual Costs			**$10,764**
Is the Control Cost Device Reasonable? (YES = Actual Costs ≤ Acceptable Costs)? (3)			**NO**

Notes:

(1) Acceptable unit costs ($/ton) acquired from Ecology memorandum, from Mr. Robert Koster, *BACT and t-BACT Cost Effectiveness Thresholds.* August 2, 2016 (Ecology, 2016).

(2) Acceptable annual costs for each criteria pollutant acquired by multiplying Annual TPY Removed (from previous calculations above) by the acceptable unit costs. These costs are summed to derive total acceptable annual costs for criterial pollutants. Actual annual costs are the total annual costs derived previously.

(3) The reasonability test involves a comparison of acceptable vs. actual annual costs. If the actual costs are less than or equal to the acceptable costs, the costs are considered reasonable and the control device should be installed.

Table D-C7. Toxic Air Pollutant Cost Effectiveness for DOC System [1]					
Pollutant	**Removal (TPY)**	**ASIL (µg/m3) [2]**	**Hanford Cost Factor [3]**	**Ecology Ceiling Cost ($/ton) [4]**	**Acceptable Annual Cost [5]**
Acrolein	0.000031	3.5E-01	4.89	$51,317	$2
Ammonia	0.0000	5.0E+02	1.73	$18,190	$0
Benzene	0.001090	1.3E-01	5.32	$55,833	$61
CO	0.624773	2.3E+04	0.07	$731	$457
DEEP	0.013409	3.3E-03	6.91	$72,585	$973
Naphthalene	0.000165	2.9E-02	5.97	$62,674	$10
NO_2 (10% of NO_X)	0.000000	4.7E+02	1.76	$18,472	$0
Total Acceptable Annual Costs					**$1,503**
Actual Annual Costs					**$10,764**
Is the Control Cost Device Reasonable? (YES = Actual Costs ≤ Acceptable Costs)? [6]					**NO**

Notes:

(1) Cost effective calculations for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) uses the Hanford ceiling cost method, described in the Department of Energy's *Evaluation of Best Available Control Technology for Toxics (tBACT), Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations* (DOE, 2010).

(2) The Acceptable Source Impact Level (ASIL) for each toxic air pollutant is acquired from the table at WAC 173-460-150.

(3) The Hanford Cost Factor is calculated as Log_{10}(27,000/ASIL), acquired from Ecology memorandum, from Mr. Robert Koster, dated August 2, 2016 (confirmed to be most current guidance).

(4) Ecology Ceiling costs ($/ton) for each toxic air pollutant acquired by multiplying the Hanford Cost Factor by 10,500, as described Ecology memorandum, from Mr. Robert Koster, dated August 2, 2016 (Ecology, 2016).

(5) Acceptable annual costs for each toxic air pollutant acquired by multiplying Annual TPY Removed (from previous calculations above) by the Ecology ceiling cost. These costs are summed to derive total acceptable annual costs for toxic air pollutants. Actual annual costs are the total annual costs derived previously.

(6) The reasonability test involves a comparison of acceptable vs. actual annual costs. If the actual costs are less than or equal to the acceptable costs, the costs are considered reasonable and the control device should be installed.

Table D-D1. General Cost Calculation Inputs for Tier 4 System	
Number of 1.5-MW Engines being Added	4
Number of 350-kW Engines being Added	2
Bank Prime Rate (July 2021) (1)	3.25%
Lifespan of Control Equipment (years) (2)	30

Notes:

(1) Bank Prime Rate for July 2021 acquired from: https://www.bankrate.com/rates/interest-rates/prime-rate.aspx (Bankrate, 2021).

(2) A useful lifespan of 30 years is incorporated for control equipment, consistent with information provided for the 2.5-MW Caterpillar engines used at Building CO6 (Landau,

Table D-D2. Criteria Pollutant Emission Rates and Control Efficiencies for Tier 4 System (1)			
Pollutant	**Emissions (TPY)**	**Tier 4 System Removal**	**TPY Removed(2)**
$PM_{10}/PM_{2.5}$	0.1565	85%	0.1330
NO_X	4.1083	90%	3.6975
VOC	0.1101	70%	0.0771
CO	0.7810	80%	0.6248

Notes:

(1) Tier 4 and component treatment efficiency percentages acquired from specifications for Caterpillar add-on equipment, with appropriate comparisons to previous Columbia (Landau, 2019) and Sabey data center (Trinity, 2020) permit applications.

(2) Annual TPY Removed is applied to the use of the Tier 4 system for emissions control, acquired by multiplying annual emissions by the Tier 4 system removal efficiency.

Table D-D3. Toxic Air Pollutant Emission Rates and Control Efficiencies for Tier 4 System [1]			
Pollutant	**Emissions (TPY)**	**Tier 4 System Removal**	**Annual TPY [2] Removed**
Acrolein	0.000044	70%	0.000031
Ammonia	0.0232	0%	0.0000
Benzene	0.0016	70%	0.0011
CO	0.7810	80%	0.6248
DEEP	0.0670	85%	0.0570
Naphthalene	0.00024	70%	0.00017
NO_2 (10% of NO_X)	0.4108	90%	0.3697

Notes:

(1) Tier 4 and component treatment efficiency percentages based on efficiencies for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) which are identical in kind or to which the toxic air pollutant is a constituent of, with appropriate comparisons to previous Columbia (Landau, 2019) and Sabey data center (Trinity, 2020)

(2) Annual TPY Removed is applied to the use of the Tier 4 system for emissions control, acquired by multiplying annual emissions by the Tier 4 system removal efficiency.

Table D-D4. Capital Costs for Tier 4 System		
Cost Type and Description	**Key Parameter**	**Calculated Cost**
Direct Costs		
Emission Control Package (1.5-MW Engines) (1)	$207,430	$746,748
Emission Control Package (350-kW Engines) (1)	$207,430	$311,145
Sales Tax (2),(6)	6.5%	$68,763
Shipping (3)	$4,500	$24,300
Enclosure Structural Supports (3)	$3,500	$18,900
Installation (3)	$22,000	$118,800
Total Direct Costs		**$1,288,656**
Indirect Costs		
Engineering (4)	$5,000	$30,000
Construction and Field Expenses (4)	$3,000	$18,000
Contractor Fees (5)	6.8%	$71,937
Startup (4)	$3,000	$18,000
Performance Test Tech Support (5)	1.0%	$10,579
Contingencies (5)	10.0%	$105,789
Total Indirect Costs		**$254,305**
Total Capital Costs		**$1,542,961**

Notes:

(1) Emission control package equipment costs for the Tier 4 system are based on the equipment cost of $207,430 provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). This cost was adjusted for use with the 1.5-MW engines in the 2021 permit application by applying a multiplier of 0.9 and then multiplying by the number of 1.5-MW engines being added for the project. Similarly, the cost was adjusted for use with the 350-kW engines by applying a multiplier of 0.75 and then multiplying by the number of 350-kW engines being added for the project. Both engine- and cost-specific and update multipliers were provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(2) State Sales and Use Tax Rate was acquired from: https://dor.wa.gov/taxes-rates/sales-and-use-tax-rates (Revenue, 2021).

(3) Emission control package shipping, enclosure structural supports, and installations costs are based on the costs, shown above, provided by Caterpillar in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). This cost was adjusted for use with the 1.5-MW engines in the 2021 permit application by applying a multiplier of 0.9 and then multiplying by the number of 1.5-MW engines being added for the project. Similarly, the cost was adjusted for use with the 350-kW engines by applying a multiplier of 0.9 and then multiplying by the number of 350-kW engines being added for the project. Both engine- and cost-specific and update multipliers were provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(4) Engineering, construction and field, and startup costs are based on the those cost provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). These cost were projected not to change and were applied equally to both 1.5-MW and 350-kW engines, being multiplied only by the number of each type of engine being added for the project. This cost projection was provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

(5) Contractor fees, performance test tech support, and contingency rate percentages are based on the those rates provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). These rates were not projected to change and were applied to the capital costs for the emission control packages calculated previously. This cost projection was provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/28/2022.

Table D-D5. Operating Costs for Tier 4 System		
Cost Type and Description	**Key Parameter**	**Calculated Cost**
Direct Annual Costs		
Maintenance [(1)]	0.5%	$7,715
Reagent/Catalyst Cost [(2)]	$4.26/gal	$4,425
Total Direct Annual Costs		**$12,140**
Indirect Annual Costs		
Administrative Costs [(1)]	2.0%	$30,859
Property Tax [(1)]	1.0%	$15,430
Insurance [(1)]	1.0%	$15,430
Capital Recovery Factor (30 years) [(3)]	3.25%	0.0527
Annual Capital Recovery Costs [(4)]	30 years	$81,286
Total Indirect Annual Costs		**$143,004**
Total Annual Costs		**$155,144**

Notes:

(1) Maintenance, administrative, property tax, and insurance are based on the those cost provided by Caterpillar, as shown in the 2019 permit application for the 2.5-MW engines used at Building CO6 (Landau, 2019). The indirect portion are consistent with the total rate of 4 percent as shown in Section 1, Chapter 2, 2.6.5.8 of the EPA's Air Pollution Control Cost Manual, 7th Edition (EPA, 2021). These rates were applied to the total capital costs derived in the previous table.

(2) Unit cost of reagent/catalyst for Tier 4 and SCR control packages are based on $4.00 per gallon costs provided by Caterpillar, as shown in the 2019 permit application for the five 2.5-MW engines used at Building CO6 (Landau, 2019). To update the cost to 2021 dollars, it was multiplied a cost annualizing adjustment factor of (1+i)n, where "i" is the current bank prime rate and "n" is "2" for the 2-year period (see 2021 unit cost as calculated above). Based on data provided by Arkadiy Ter-Meliksetov of Caterpillar on 1/31/2022, the urea consumption rate is approximately 10% of the fuel consumption rate. The annual consumption rate is calculated by multiplying the rate for each engine type by the projected annual operating hours for each engine. Based on this data, the annual reagent/catalyst costs is derived as shown above.

(3) A capital recovery factor is derived, in accordance with Section 4, Chapter 2 of the EPA's Air Pollution Control Cost Manual, 7th Edition (EPA, 2021), using this equation: $[i(1+i)^n] \div [(1+i)^n-1]$, where "i" is the current bank prime rate (3.25%) and "n" is the useful lifespan in years (30) for the control equipment.

(4) Annual capital recovery cost is derived by multiplying the capital recovery factor by the total capital costs.

Table D-D6. Criteria Pollutant Cost Effectiveness for Tier 4 System			
Pollutant	**Removal (TPY)**	**Ecology Acceptable Unit Cost ($/ton) [1]**	**Acceptable Annual Cost [2]**
$PM_{10}/PM_{2.5}$	0.1330	$12,000	$1,596
NO_X	3.6975	$12,000	$44,370
VOC	0.0771	$12,000	$925
CO	0.6248	$5,000	$3,124
Total Acceptable Annual Costs			**$50,015**
Actual Annual Costs			**$155,144**
Is the Control Cost Device Reasonable? (YES = Actual Costs ≤ Acceptable Costs)? [3]			**NO**

(1) Acceptable unit costs ($/ton) acquired from Ecology memorandum, from Mr. Robert Koster, *BACT and t-BACT Cost Effectiveness Thresholds.* August 2, 2016 (Ecology, 2016).

(2) Acceptable annual costs for each criteria pollutant acquired by multiplying Annual TPY Removed (from previous calculations above) by the acceptable unit costs. These costs are summed to derive total acceptable annual costs for criterial pollutants. Actual annual costs are the total annual costs derived previously.

(3) The reasonability test involves a comparison of acceptable vs. actual annual costs. If the actual costs are less than or equal to the acceptable costs, the costs are considered reasonable and the control device should be installed.

Table D-D7. Toxic Air Pollutant Cost Effectiveness for Tier 4 System [1]					
Pollutant	**Removal (TPY)**	**ASIL (µg/m3) [2]**	**Hanford Cost Factor [3]**	**Ecology Ceiling Cost ($/ton) [4]**	**Acceptable Annual Cost [5]**
Acrolein	0.000031	3.5E-01	4.89	$51,317	$2
Ammonia	0.0000	5.0E+02	1.73	$18,190	$0
Benzene	0.0011	1.3E-01	5.32	$55,833	$61
CO	0.6248	2.3E+04	0.07	$731	$457
DEEP	0.0570	3.3E-03	6.91	$72,585	$4,137
Naphthalene	0.00017	2.9E-02	5.97	$62,674	$10
NO_2 (10% of NO_X)	0.3697	4.7E+02	1.76	$18,472	$6,830
Total Acceptable Annual Costs					**$11,496**
Actual Annual Costs					**$155,144**
Is the Control Cost Device Reasonable? (YES = Actual Costs ≤ Acceptable Costs)? [6]					**NO**

Notes:

(1) Cost effective calculations for toxic air pollutants (exceeding de minimis thresholds listed in WAC 173-460-150) uses the Hanford ceiling cost method, described in the Department of Energy's *Evaluation of Best Available Control Technology for Toxics (tBACT), Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations* (DOE, 2010).

(2) The Acceptable Source Impact Level (ASIL) for each toxic air pollutant is acquired from the table at WAC 173-460-150.

(3) The Hanford Cost Factor is calculated as Log_{10}(27,000/ASIL), acquired from Ecology memorandum, from Mr. Robert Koster, dated August 2, 2016 (confirmed to be most current guidance).

(4) Ecology Ceiling costs ($/ton) for each toxic air pollutant acquired by multiplying the Hanford Cost Factor by 10,500, as described Ecology memorandum, from Mr. Robert Koster, dated August 2, 2016 (Ecology, 2016).

(5) Acceptable annual costs for each toxic air pollutant acquired by multiplying Annual TPY Removed (from previous calculations above) by the Ecology ceiling cost. These costs are summed to derive total acceptable annual costs for toxic air pollutants. Actual annual costs are the total annual costs derived previously.

(6) The reasonability test involves a comparison of acceptable vs. actual annual costs. If the actual costs are less than or equal to the acceptable costs, the costs are considered reasonable and the control device should be installed.

APPENDIX E – EQUIPMENT SPECIFICATIONS

Cat® 3512C

Diesel Generator Sets

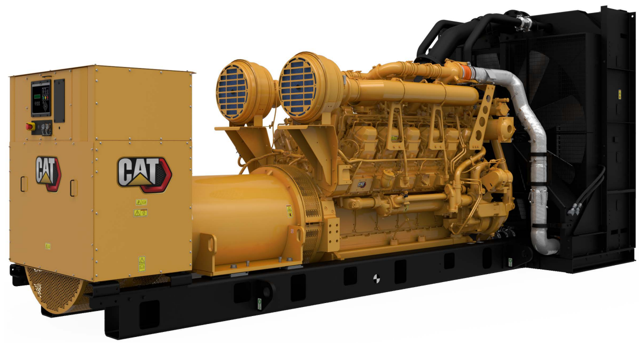


Image shown may not reflect actual configuration

Bore – mm (in)	170 (6.69)
Stroke – mm (in)	190 (7.48)
Displacement – L (in^3)	51.8 (3161.03)
Compression Ratio	14.7:1
Aspiration	TA
Fuel System	EUI
Governor Type	ADEM™ A3

Mission Critical 60 Hz ekW (kVA)	Emissions Performance
1500 (1875)	U.S. EPA Stationary Emergency Use Only. (Tier 2)

Standard Features

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

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

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

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

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

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

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

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

Optional Equipment

Engine

Air Cleaner
- ☑ Single element
- ❑ Dual element
- ❑ Heavy duty

Muffler
- ❑ Industrial grade (15 dB)

Starting
- ☑ Standard batteries
- ❑ Oversized batteries
- ☑ Standard electric starter(s)
- ❑ Dual electric starter(s)
- ❑ Air starter(s)
- ☑ Jacket water heater

Alternator

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

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

Winding type
- ☑ Random wound
- ❑ Form wound

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

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

Power Termination

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

Trip Unit
- ☑ LSI ❑ LSI-G
- ❑ LSIG-P

Control System

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

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

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

Vibration Isolators
- ☑ Spring
- ☑ Seismic rated

Cat Connect

Connectivity
- ❑ Ethernet
- ❑ Cellular
- ❑ Satellite

Extended Service Options

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

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

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

Certifications
- ☑ UL 2200 Listed
- ❑ CSA
- ☑ IBC seismic certification
- ❑ OSHPD pre-approval

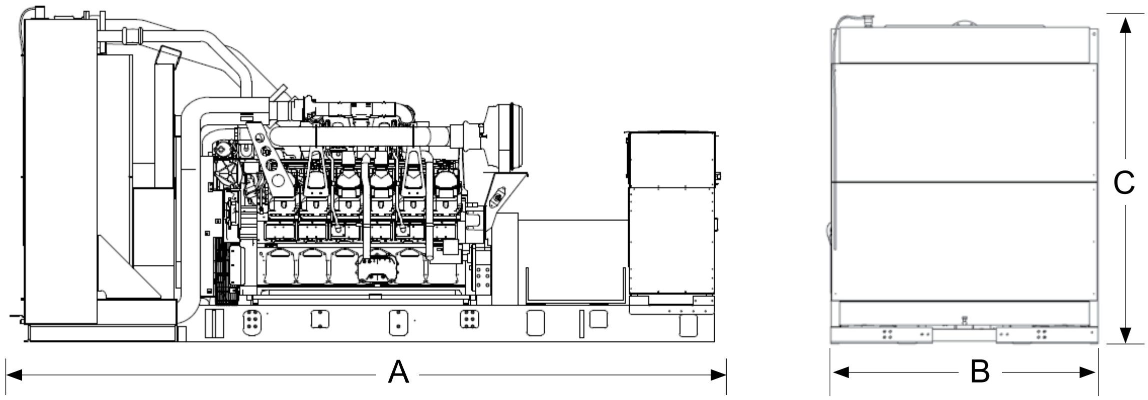
Note: *Some options may not be available on all models. Certifications may not be available with all model configurations. Consult factory for availabilit .*

Package Performance

Performance	Mission Critical	
Frequency	60 Hz	
Gen set power rating with fan	1500 ekW	
Gen set power rating with fan @ 0.8 power factor	1875 kVA	
Emissions	EPA Stationary Emergency (Tier 2)	
Performance number	EM1899-00	
Fuel Consumption		
100% load with fan – L/hr (gal/hr)	395.9	(104.6)
75% load with fan – L/hr (gal/hr)	310.5	(82.0)
50% load with fan – L/hr (gal/hr)	219.7	(58.0)
25% load with fan – L/hr (gal/hr)	128.4	(33.9)
Cooling System		
Radiator air flow restriction (system) – kPa (in. water)	0.12	(0.48)
Radiator air flow – m³/min (cfm)	2075	(73278)
Engine coolant capacity – L (gal)	156.8	(41.4)
Radiator coolant capacity – L (gal)	234.0	(61.0)
Total coolant capacity – L (gal)	390.8	(102.4)
Inlet Air		
Combustion air inlet flow rate – m³/min (cfm)	139.8	(4937.2)
Exhaust System		
Exhaust stack gas temperature – °C (°F)	402.6	(756.6)
Exhaust gas flow rate – m³/min (cfm)	332.3	(11734.1)
Exhaust system backpressure (maximum allowable – kPa (in. water)	6.7	(27.0)
Heat Rejection		
Heat rejection to jacket water – kW (Btu/min)	502	(28541)
Heat rejection to exhaust (total) – kW (Btu/min)	1398	(79477)
Heat rejection to aftercooler – kW (Btu/min)	519	(29539)
Heat rejection to atmosphere from engine – kW (Btu/min)	124	(7072)
Heat rejection from alternator – kW (Btu/min)	74	(4208)
Emissions* (Nominal)		
NOx mg/Nm³ (g/hp-h)	2373.9	(5.48)
CO mg/Nm³ (g/hp-h)	237.3	(0.48)
HC mg/Nm³ (g/hp-h)	51.7	(0.12)
PM mg/Nm³ (g/hp-h)	13.0	(0.03)
Emissions* (Potential Site Variation)		
NOx mg/Nm³ (g/hp-h)	2848.7	(6.58)
CO mg/Nm³ (g/hp-h)	427.2	(0.87)
HC mg/Nm³ (g/hp-h)	68.8	(0.16)
PM mg/Nm³ (g/hp-h)	18.2	(0.04)

**mg/Nm³ levels are corrected to 5% O_2. Contact your local Cat dealer for further information.*

Weights and Dimensions



Dim "A" mm (in)	Dim "B" mm (in)	Dim "C" mm (in)	Dry Weight kg (lb)
5920 (233.1)	2281 (89.8)	2794 (110.0)	13 970 (30,790)

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

Ratings Definitions

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

Applicable Codes and Standards
AS 1359, CSA C22.2 No. 100-04, UL 142, UL 489, UL 869, UL 2200, NFPA 37, NFPA 70, NFPA 99, NFPA 110, IBC, IEC 60034-1, ISO 3046, ISO 8528, NEMA MG1-22, NEMA MG1-33, 2014/35/EU, 2006/42/EC, 2014/30/EU.

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

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

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

www.cat.com/electricpower

PERFORMANCE DATA[EM1899]

Performance Number: EM1899 **Change Level: 00**

SALES MODEL:	3512C
BRAND:	CAT
ENGINE POWER (BHP):	2,206
GEN POWER WITH FAN (EKW):	1,500.0
COMPRESSION RATIO:	14.7
RATING LEVEL:	MISSION CRITICAL STANDBY
PUMP QUANTITY:	1
FUEL TYPE:	DIESEL
MANIFOLD TYPE:	DRY
GOVERNOR TYPE:	ADEM3
ELECTRONICS TYPE:	ADEM3
CAMSHAFT TYPE:	STANDARD
IGNITION TYPE:	CI
INJECTOR TYPE:	EUI
FUEL INJECTOR:	3920220
UNIT INJECTOR TIMING (IN):	64.34
REF EXH STACK DIAMETER (IN):	10
MAX OPERATING ALTITUDE (FT):	3,937
COMBUSTION:	DIRECT INJECTION
ENGINE SPEED (RPM):	1,800
HERTZ:	60
FAN POWER (HP):	88.5
ASPIRATION:	TA
AFTERCOOLER TYPE:	ATAAC
AFTERCOOLER CIRCUIT TYPE:	JW+OC, ATAAC
INLET MANIFOLD AIR TEMP (F):	122
JACKET WATER TEMP (F):	210.2
TURBO CONFIGURATION:	PARALLEL
TURBO QUANTITY:	4
TURBOCHARGER MODEL:	GTB4708BN-52T-0.96
CERTIFICATION YEAR:	2006
CRANKCASE BLOWBY RATE (FT3/HR):	2,203.4
FUEL RATE (RATED RPM) NO LOAD (GAL/HR):	9.8
PISTON SPD @ RATED ENG SPD (FT/MIN):	2,244.1

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

General Performance Data

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

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
1,500.0	100	2,206	307	0.332	103.2	77.5	120.9	1,145.6	74.6	756.6
1,350.0	90	1,983	276	0.336	94.0	72.2	116.1	1,102.7	68.8	727.5
1,200.0	80	1,768	246	0.343	85.5	66.9	113.2	1,069.1	63.0	713.4
1,125.0	75	1,662	232	0.346	81.0	63.4	111.5	1,052.3	59.5	706.7
1,050.0	70	1,556	217	0.348	76.4	59.7	109.8	1,035.2	55.8	700.0
900.0	60	1,349	188	0.352	67.0	51.1	107.1	1,000.5	47.6	687.3
750.0	50	1,144	159	0.355	57.3	40.6	107.5	963.6	38.4	696.7
600.0	40	940	131	0.359	47.6	30.0	108.4	921.9	29.4	702.2
450.0	30	736	103	0.368	38.1	20.9	107.1	856.0	21.9	685.3
375.0	25	632	88	0.376	33.5	16.9	106.2	809.5	18.8	664.9
300.0	20	527	73	0.388	28.8	13.3	105.2	754.5	16.0	636.4
150.0	10	312	43	0.443	19.5	7.3	103.2	609.7	11.4	540.6

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
1,500.0	100	2,206	82	449.8	4,937.2	11,734.1	21,796.5	22,529.1	4,743.3	4,317.6
1,350.0	90	1,983	77	428.8	4,734.5	10,945.3	20,885.8	21,551.9	4,532.9	4,136.4
1,200.0	80	1,768	71	409.0	4,506.7	10,265.9	19,853.4	20,459.8	4,302.7	3,938.4
1,125.0	75	1,662	68	396.6	4,371.2	9,868.8	19,223.0	19,797.6	4,160.2	3,812.8
1,050.0	70	1,556	64	382.6	4,218.1	9,442.4	18,511.1	19,053.3	4,003.2	3,672.9
900.0	60	1,349	55	350.3	3,862.4	8,508.3	16,857.2	17,332.4	3,647.3	3,352.3
750.0	50	1,144	44	309.9	3,375.7	7,435.0	14,666.1	15,072.5	3,161.3	2,907.1
600.0	40	940	33	266.6	2,868.4	6,329.0	12,406.6	12,744.3	2,678.2	2,465.5
450.0	30	736	23	224.6	2,431.9	5,278.8	10,481.3	10,752.0	2,266.9	2,093.3
375.0	25	632	19	204.3	2,243.0	4,776.5	9,654.1	9,891.7	2,088.3	1,933.3
300.0	20	527	15	184.2	2,069.9	4,283.3	8,899.4	9,103.9	1,921.3	1,784.5
150.0	10	312	9	148.8	1,782.1	3,338.5	7,648.3	7,786.4	1,641.0	1,539.0

Heat Rejection Data

PERFORMANCE DATA[EM1899]

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHAUST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
1,500.0	100	2,206	28,541	7,072	79,477	38,355	11,956	29,539	93,547	224,476	239,123
1,350.0	90	1,983	26,761	6,706	72,346	33,940	10,882	26,874	84,110	204,315	217,647
1,200.0	80	1,768	25,085	6,393	66,713	30,942	9,897	24,071	74,958	185,825	197,950
1,125.0	75	1,662	24,176	6,249	63,549	29,350	9,376	22,404	70,466	176,039	187,526
1,050.0	70	1,556	23,227	6,110	60,309	27,693	8,845	20,631	66,004	166,069	176,905
900.0	60	1,349	21,222	5,841	53,634	24,225	7,759	16,788	57,205	145,683	155,189
750.0	50	1,144	19,059	5,564	46,826	21,662	6,636	12,311	48,509	124,586	132,716
600.0	40	940	16,790	5,286	39,874	18,604	5,512	8,066	39,882	103,489	110,241
450.0	30	736	14,427	4,840	32,601	14,897	4,416	4,955	31,201	82,917	88,327
375.0	25	632	13,189	4,570	28,900	12,838	3,876	3,774	26,809	72,772	77,520
300.0	20	527	11,900	4,299	25,149	10,707	3,336	2,793	22,353	62,628	66,715
150.0	10	312	9,090	3,818	17,468	6,020	2,253	1,375	13,214	42,301	45,061

Sound Data

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

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	1,500.0	1,125.0	750.0	375.0	150.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	2,206	1,662	1,144	632	312
TOTAL NOX (AS NO2)		G/HR	14,366	7,266	4,835	3,673	2,831
TOTAL CO		G/HR	1,890	1,176	1,665	1,965	1,898
TOTAL HC		G/HR	351	381	358	283	329
PART MATTER		G/HR	97.6	99.1	150.9	184.0	112.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,848.7	1,803.1	1,671.1	2,214.1	2,967.2
TOTAL CO	(CORR 5% O2)	MG/NM3	427.2	336.3	712.5	1,486.6	2,381.4
TOTAL HC	(CORR 5% O2)	MG/NM3	68.8	95.6	123.3	175.3	360.2
PART MATTER	(CORR 5% O2)	MG/NM3	18.2	23.5	54.8	110.0	115.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,388	878	814	1,078	1,445
TOTAL CO	(CORR 5% O2)	PPM	342	269	570	1,189	1,905
TOTAL HC	(CORR 5% O2)	PPM	128	178	230	327	672
TOTAL NOX (AS NO2)		G/HP-HR	6.58	4.41	4.26	5.85	9.14
TOTAL CO		G/HP-HR	0.87	0.71	1.47	3.13	6.13
TOTAL HC		G/HP-HR	0.16	0.23	0.32	0.45	1.06
PART MATTER		G/HP-HR	0.04	0.06	0.13	0.29	0.36
TOTAL NOX (AS NO2)		LB/HR	31.67	16.02	10.66	8.10	6.24
TOTAL CO		LB/HR	4.17	2.59	3.67	4.33	4.18
TOTAL HC		LB/HR	0.77	0.84	0.79	0.62	0.73
PART MATTER		LB/HR	0.22	0.22	0.33	0.41	0.25

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	1,500.0	1,125.0	750.0	375.0	150.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	2,206	1,662	1,144	632	312
TOTAL NOX (AS NO2)		G/HR	11,972	6,055	4,029	3,061	2,359
TOTAL CO		G/HR	1,050	653	925	1,092	1,055
TOTAL HC		G/HR	264	286	269	213	248
TOTAL CO2		KG/HR	1,096	853	602	352	204
PART MATTER		G/HR	69.7	70.8	107.8	131.4	80.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,373.9	1,502.6	1,392.6	1,845.1	2,472.7
TOTAL CO	(CORR 5% O2)	MG/NM3	237.3	186.8	395.9	825.9	1,323.0
TOTAL HC	(CORR 5% O2)	MG/NM3	51.7	71.9	92.7	131.8	270.9
PART MATTER	(CORR 5% O2)	MG/NM3	13.0	16.8	39.1	78.6	82.6
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,156	732	678	899	1,204
TOTAL CO	(CORR 5% O2)	PPM	190	149	317	661	1,058

TOTAL HC	(CORR 5% O2)	PPM	97	134	173	246	506
TOTAL NOX (AS NO2)		G/HP-HR	5.48	3.68	3.55	4.87	7.62
TOTAL CO		G/HP-HR	0.48	0.40	0.81	1.74	3.40
TOTAL HC		G/HP-HR	0.12	0.17	0.24	0.34	0.80
PART MATTER		G/HP-HR	0.03	0.04	0.09	0.21	0.26
TOTAL NOX (AS NO2)		LB/HR	26.39	13.35	8.88	6.75	5.20
TOTAL CO		LB/HR	2.32	1.44	2.04	2.41	2.32
TOTAL HC		LB/HR	0.58	0.63	0.59	0.47	0.55
TOTAL CO2		LB/HR	2,417	1,881	1,327	776	449
PART MATTER		LB/HR	0.15	0.16	0.24	0.29	0.18
OXYGEN IN EXH		%	11.2	12.3	12.9	13.9	15.8
DRY SMOKE OPACITY		%	1.0	1.3	2.9	5.0	3.0
BOSCH SMOKE NUMBER			0.37	0.45	1.06	1.60	1.11

Regulatory Information

EPA EMERGENCY STATIONARY		**2011 - ----**		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE EMERGENCY STATIONARY REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 6.4 PM: 0.20

Altitude Derate Data

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	30	40	50	60	70	80	90	100	110	120	130	140	NORMAL
ALTITUDE (FT)													
0	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,096	2,206
1,000	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,162	2,074	2,206
2,000	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,176	2,118	2,007	2,206
3,000	2,206	2,206	2,206	2,206	2,206	2,206	2,206	2,173	2,135	2,098	2,052	1,919	2,206
4,000	2,201	2,201	2,201	2,201	2,201	2,171	2,132	2,094	2,057	2,021	1,963	1,831	2,201
5,000	2,129	2,129	2,129	2,129	2,129	2,092	2,054	2,017	1,982	1,947	1,875	1,743	2,129
6,000	2,059	2,059	2,059	2,059	2,053	2,015	1,978	1,943	1,909	1,876	1,765	1,677	2,059
7,000	1,992	1,992	1,992	1,992	1,976	1,940	1,904	1,870	1,838	1,787	1,677	1,588	1,992
8,000	1,927	1,927	1,927	1,927	1,902	1,867	1,833	1,800	1,769	1,699	1,610	1,522	1,927
9,000	1,865	1,865	1,865	1,865	1,831	1,797	1,764	1,733	1,699	1,610	1,522	1,412	1,865
10,000	1,805	1,805	1,805	1,795	1,761	1,729	1,697	1,667	1,610	1,522	1,368	1,279	1,805
11,000	1,522	1,522	1,522	1,522	1,522	1,522	1,522	1,522	1,434	1,324	1,213	1,125	1,522
12,000	1,478	1,478	1,478	1,478	1,478	1,478	1,478	1,390	1,279	1,169	1,081	993	1,478
13,000	1,434	1,434	1,434	1,434	1,434	1,434	1,346	1,235	1,147	1,037	971	882	1,434
14,000	1,390	1,390	1,390	1,390	1,390	1,279	1,191	1,103	1,015	927	860	794	1,390
15,000	1,346	1,346	1,346	1,346	1,235	1,147	1,059	971	882	816	772	728	1,346

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
4577180	LL1862	5084278	GS656	LS	CT200463	
4577180	LL1862	5157729	PG242	-	LYH00001	

Supplementary Data

Type	Classification	Performance Number
SOUND	SOUND PRESSURE	DM8779

Performance Parameter Reference

Parameters Reference:DM9600-12
PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%
Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.
REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 15 deg C (59 deg F), where the density is

850 G/Liter (7.0936 Lbs/Gal).
GAS
Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.
ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.
ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.
Standard temperature values versus altitude could be seen on TM2001.
When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.
Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.
Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.
REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.
Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.
EMISSION CYCLE LIMITS:
Cycle emissions Max Limits apply to cycle-weighted averages only. Emissions at individual load points may exceed the cycle-weighted limit.
EMISSIONS DEFINITIONS:
Emissions : DM1176
EMISSION CYCLE DEFINITIONS
1. For constant-speed marine engines for ship main propulsion, including,diesel-electric drive, test cycle E2 shall be applied, for controllable-pitch propeller sets
test cycle E2 shall be applied.
2. For propeller-law-operated main and propeller-law-operated auxiliary engines the test cycle E3 shall be applied.
3. For constant-speed auxiliary engines test cycle D2 shall be applied.
4. For variable-speed, variable-load auxiliary engines, not included above, test cycle C1 shall be applied.
HEAT REJECTION DEFINITIONS:
Diesel Circuit Type and HHV Balance : DM9500
HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500
RATING DEFINITIONS:
Agriculture : TM6008
Fire Pump : TM6009
Generator Set : TM6035
Generator (Gas) : TM6041
Industrial Diesel : TM6010
Industrial (Gas) : TM6040
Irrigation : TM5749
Locomotive : TM6037
Marine Auxiliary : TM6036
Marine Prop (Except 3600) : TM5747
Marine Prop (3600 only) : TM5748
MSHA : TM6042
Oil Field (Petroleum) : TM6011
Off-Highway Truck : TM6039
On-Highway Truck : TM6038
SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 07/10/19

	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY 2021 MODEL YEAR CERTIFICATE OF CONFORMITY WITH THE CLEAN AIR ACT	**OFFICE OF TRANSPORTATION AND AIR QUALITY ANN ARBOR, MICHIGAN 48105**

Certificate Issued To: Caterpillar Inc. (U.S. Manufacturer or Importer) **Certificate Number: MCPXL78.1NZS-009**	**Effective Date:** **05/07/2020** **Expiration Date:** **12/31/2021**	**Byron J. Bunker, Division Director** **Compliance Division**	**Issue Date:** **05/07/2020** **Revision Date:** **N/A**

Model Year: 2021 **Manufacturer Type:** Original Engine Manufacturer **Engine Family:** MCPXL78.1NZS	**Mobile/Stationary Indicator:** Stationary **Emissions Power Category:** kW>560 **Fuel Type:** Diesel **After Treatment Devices:** No After Treatment Devices Installed **Non-after Treatment Devices:** Electronic Control, Engine Design Modification

Pursuant to Section 111 and Section 213 of the Clean Air Act (42 U.S.C. sections 7411 and 7547) and 40 CFR Part 60, and subject to the terms and conditions prescribed in those provisions, this certificate of conformity is hereby issued with respect to the test engines which have been found to conform to applicable requirements and which represent the following engines, by engine family, more fully described in the documentation required by 40 CFR Part 60 and produced in the stated model year.

This certificate of conformity covers only those new compression-ignition engines which conform in all material respects to the design specifications that applied to those engines described in the documentation required by 40 CFR Part 60 and which are produced during the model year stated on this certificate of the said manufacturer, as defined in 40 CFR Part 60.

It is a term of this certificate that the manufacturer shall consent to all inspections described in 40 CFR 1068 and authorized in a warrant or court order. Failure to comply with the requirements of such a warrant or court order may lead to revocation or suspension of this certificate for reasons specified in 40 CFR Part 60. It is also a term of this certificate that this certificate may be revoked or suspended or rendered void *ab initio* for other reasons specified in 40 CFR Part 60.

This certificate does not cover engines sold, offered for sale, or introduced, or delivered for introduction, into commerce in the U.S. prior to the effective date of the certificate.

safety POWER

clean essential energy

Project Proposal

Safety Power ecoCUBE® SCR Emission Control System

For (4) x CAT 3512C (1,500 ekW) Diesel Generator Sets

Prepared for: NC Power Systems Co.
Arkadiy Ter-Meliksetov Ph. 425-656-4572
Proposal No: SPI 21214 Rev 1.1
Dated May 25, 2021

Prepared by:

Safety Power Inc.
Jacob Rozenblit
Senior Applications Engineer
Office (514) 927- 2898
Fax 416.477.2709
www.safetypowerinc.com

DESIGN PARAMETERS

The design of the Safety Power emissions reduction system is based on the following conditions.
Note: NOx is calculated as NO_2.

Table 1 – Engine Data

Engine Type:	CAT C9	CAT 3512C
Application	Stand-by	Stand-by
Engine Power	300 ekW	1500 ekW
Exhaust Temperature	927 °F	757 °F
Design Exhaust Flow Rate	2461 (CFM)	11734 (CFM)
Fuel Type	Diesel	Diesel

Table 2 – Emissions Data at Full Engine Load

Engine Option	Emissions	Catalyst Inlet	Emissions Requirement	Catalyst Outlet
Option 1 - CAT C9 (300 ekW)	NOx (g/HP-h)	4.27	0.50	0.50
	CO (g/HP-h)	0.45	2.60	<0.45
	VOC (g/HP-h)	0.11	0.14	<0.11
	PM (g/HP-h)	0.06	0.02	0.02
Option 2 - CAT 3512C (1500 ekW)	NOx (g/HP-h)	6.58	0.50	0.50
	CO (g/HP-h)	0.87	2.60	<0.87
	VOC (g/HP-h)	0.16	0.14	0.14
	PM (g/HP-h)	0.04	0.02	0.02

Notes: (1) The EPA does not treat methane and ethane as VOC's. Safety Power can achieve a stated reduction of VOC's based on the EPA definition assuming that the VOC's manifest themselves as propene. (2) all emissions reductions are based on an average at steady state using SCAQMD method 100.1 for NOx and SCAQMD/EPA methods 25.1/25.3 for CO and VOC's or mutually agreed test method approved in writing. (3) if NMHC/VOC data isn't provided 0.6 g/hp-hr is to be assumed (unless otherwise stated).

Table 3 – SCR System Data

Engine Model	CAT C9	CAT 3512C
Max. Ammonia Slip @ 15% O2	8 ppm	8 ppm
Urea Consumption - 32.5% solution	0.88 USG/hr Nominal (1.1 USG/hr NTE)	5.14 USG/hr Nominal (6.28 USG/hr NTE)
SCR Pressure Loss	24" W.C.	19.5" W.C.
SCR Inlet/Outlet ANSI Flange Inches	12/12	2x12/16

ecoCUBE® System Scope of Supplies and Services

Table 4 – Components Supplied for Each System

ecoCUBE System Components Description (For Each Engine)	Option 1 - CAT C9 (300 ekW)	Option 2 - CAT 3512C (1500 ekW)
1. Reactor Assembly (Part Number)	**2 Series (9520-H3C02)**	**3 Series Wide (9533-H3D20)**
1.1 ecoCUBE system configuration	SCR + DPF	SCR + DPF
1.2 ecoCUBE SCR Reactor assembly 409 s/s c/w temperature, pressure and NOx sensors	1	1
1.3 Reactor assembly weight with catalyst	4150 lbs	8500 lbs
1.4 SCR Catalyst - layers of catalyst material (each system)	3	3
1.5 DPF Filter Modules	2	20
2. Control and Dosing Assembly		
2.1 Control Panel – with embedded control, on-off switch, on-off status indicator light, and power distribution. Ability for remote monitoring and troubleshooting if Internet connection provided. Dosing System – with automatic flow rate adjustment, system purge valve, air regulator, air pressure switch, check valves, overpressure regulator and injection valves, injection pumps.	Included	Included
3. Insulation of each ecoCUBE with 4 inches MW insulation and metal cladding. Note: skin surface temperature does not exceed 70 deg C except for exhaust and access door flanges.	Included	Included

clean essential energy

EXCLUSIONS & EXCEPTIONS

1. Installation of SPI supplied equipment is by OTHERS.
2. Transition ductwork from ecoCUBE® to stack.
3. Connection from engine exhaust to ecoCUBE® inlet.
4. Gaskets used upstream of the ecoCUBE® shall not contain silica as this can harm the catalyst and will void the catalyst warranty.
5. Structural supports or anchors
6. Power supplies for SCR control panel, air compressor or urea transfer pump skid.
7. Engine on/off signal – Note: required for automatic starting of ecoCUBE® system.
8. Permits and/or certification testing, etc.
9. Emissions performance will be met provided that the actual engine emissions parameters correspond to the engine data sheet and that the fuel composition information provided corresponds to conditions at the site.
10. NOx reduction is achieved once SCR catalyst temperature exceeds 540 degF
11. Certain regulators may require the use of specific components that have been pre-certified to their standards. Unless stated otherwise in this proposal, Safety Power's guarantee is based on emissions performance of its entire system; there is no guarantee that the system contains specific internal components required by a local regulator.
12. Urea piping from urea tank(s) to the dosing panel. Urea and air piping between dosing panel and injection lances.
13. Customer to ensure that any gaskets upstream of ecoCUBE® are rated for the appropriate engine exhaust temp. Decomposition of gasket material may poison catalyst and will void catalyst warranties offered by Safety Power.
14. Air compressor connections (electrical and tubing). Note: a clean dry supply of air (as per ISO 8573.1 Class 1.4.2) 10CFM @ 80psi per system is required.
15. Safety Power has assumed the same specification as previous Microsoft project's (CYS13) as a result we have included the following almost identical clarifications & exceptions below. It's important to note that the ecoCUBE requires a minimum injection temperature of 260oC for SCR injection to occur. All exhaust piping between the engine and ecoCUBE will require at least 3" of mineral wool insulation to minimize heat loss so that SCR injection can be achieved at 10% load / provide D2 cycle compliance:
16. 2.17.A: Safety Power's system will provide Tier 4f compliant emission levels.

COMMENTS, CLARIFICATIONS & CUSTOMER REQUIREMENTS

1. This proposal is based upon full load engine data.
2. The Urea used shall be 32.5% concentration (ISO 22241 standard). The dosing panel, tanks and lines with urea must be protected from freezing e.g. by heat tracing and insulating, locating the panel, tank & lines in an area that is maintained at a temperature above the freezing temperature.
3. Systems with diesel particulate filters (DPF) must be operated with ultra-low sulfur diesel only. In order to properly regenerate the DPF canisters the temperature must be above 280°C (536°F) for 30% of the engine operating time and greater than 40% engine load.
4. Maximum number of cold starts is 12 consecutive 10 minute or less idle sessions, which must be followed by a minimum of 2-hours of regeneration at the temperature and load noted above. Depending on the number of cold starts and other items relate to use of the system, Diesel Particulate Filters may require regular cleaning. The SPI system incorporates a virtual soot sensor which indicates the number of expected Run Hours Available (RHA) so that the operator is aware of when the next cleaning cycle is required. It is important that the operator monitor RHA to avoid high engine back pressure.
5. Unless expressly included in SPI's scope of supply the responsibility for allowing for thermal expansion of the products supplied by SPI is "by others".
6. Under no circumstances should the ecoCUBE® be placed downstream of a silencer with absorptive acoustical material.
7. SCR commissioning requires a customer supplied load bank to operate the generator at various load points and establish the controls load map. The customer should allow 4 hours per machine for the SCR load map to be established, 4 hours of testing and verifying SCR system operation, and where required, 1 hour for a third party witnessing of the SCR operation and performance.
8. A 4-20mA signal proportional to engine load must be provided and connected into ecoCUBE® control panel. Customer must provide the current transducer and current transformer for 1-phase.
9. An ethernet connection with access to the internet through Port 80 is requried for each ecoCUBE® control panel; this connection is used for remote montioring, product support and client web browser access.
10. Siloxanes can't be present in the exhaust stream as they will poison the catalyst. Please note that the presence of Siloxanes in the exhaust will void Safety Power's warranty.
11. Please note that a $600/ecoCUBE® shrink wrapping fee will be charged for any unit that's being shipped more than 120 miles away on a flatbed truck, or if the project is delayed by more than 2 weeks which will result in the requirement for outside storage. Please note that storage fees may apply for projects delayed by more than 4 weeks.
12. HDPE (high-density polyethylene) urea storage tanks are designed for atmospheric pressures only. Piping to/from the tank must ensure that no static head from either the vent or fill connection can occur. HDPE tanks situated below grade and filled from a grade level fill station will require the vent to be open to the same room/level as the tank and at at a height no greater

than 10" above the top of the tank. Pressurized installations will require the use of a stainless steel tank engineered for the customer's specific site requirements.

13. Safety Power has assumed the same specification as previous Microsoft project's (CYS13) as a result we have included the following almost identical clarifications & exceptions below. It's important to note that the ecoCUBE requires a minimum injection temperature of 260oC for SCR injection to occur. All exhaust piping between the engine and ecoCUBE will require at least 3" of mineral wool insulation to minimize heat loss so that SCR injection can be achieved at 10% load / provide D2 cycle compliance:
14. 2.17.B.1: It has been assumed that the 5 load cycle is weighted as per the D2 engine cycle. See 2.17A for exception (Safety Power's system will provide Tier 4f compliant emission levels)
15. 2.17.B.2: Particulate Matter (PM) shall be measured using ISO 8178 as the engine data is measured using the ISO 8178 standard as well. If EPA Method 5/202 must be used, Safety Power will limit the guarantee to an 85% reduction in PM. As part of Safety Power's standard scope of supply we would provide NOx measurements using a Testo analyzer at 25%, 50%, 75% & 100% load; samples would be taken from the NOx sensor port located on the ecoCUBE outlet. All other emission testing would be by others (typically in owner's scope as testing is generally tied to site air permit). It's been assumed that testing will take <15 mins at each load point on the D2 cycle (loads would be tested in order of decreasing load to ensure system is at temperature).
16. 2.17.B.3: Please note that a load bank would be required to periodically regenerate the DPF filters.

    -Under ideal lab based test conditions the system can accommodate up to 24 cold starts. That being said, under real world conditions we would advise 18 cold starts before regeneration is required. The minimum regeneration temperature is 260 degC.

    - 10% Load Run Time: 180-720 minutes, depending on the available pressure drop in the exhaust system and the engine

    loading/transient heat up time performance.

    - 80% and 100% Load, Hours of Run Time: regeneration time 1- 2hrs. This varies based on soot load and if periodic load tests have been completed
17. 2.17.B.5: The ecoCUBE's control logic has built-in redundancy to ensure that emission requirements are met.
18. 2.17.B:10: Safety Power's SCR reactor housing, mixing duct are fabricated from stainless steel 409. All items that come into contact with liquid urrea (injection lance, mixers) will be made from 304 stainless steel. Safety Power assumes that seismic supports/design and analysis is conducted by others
19. 2.17.B.12: We will provide a dry contact or modbus tcp register output that the engine panel can then use for fault annunciation

20. 2.17.B.14: Safety Powers system will provide critical grade silencing, reducing the aggregate exhaust sound levels by 35 dB(A) for our SCR + DPF solution
21. 2.17.B.15: The ecoCUBE's control panel will be field certified to a standard recognized by the local AHJ.
22. 2.17.B.17: Safety Power utilizes Canbus sensors that have integral self-diagnostics. In addition, Safety Power includes a dedicated flow meter in our panel design to ensure the accuracy of the pump.
23. 2.17.B.19: The ecoCUBE's control logic has built-in redundancy to ensure that emission requirements are met.
24. 2.17.B.20: The ecoCUBE's surface temperature is designed to be at or below 140 F, with the exception of certain well-marked control surfaces. Please reference shop drawings for the ambient conditions / assumptions that are utilized to achieve 140F temperature.
25. 2.17.B.21.a: Wiring between the control panel and reactor would be in the packagers scope.
26. 2.17.B.21.b: Safety Power assumes that seismic supports/design and analysis is conducted by others.
27. Access considerations should be made for servicing of the ecoCUBE® components. If the ecoCUBE® reactor is placed on a roof or platform, either a walk way or fall arrest tie off points should be provided by others. If the site will not have safe access for work done on ecoCUBE® reactors on a roof or platform then the optional integrated fall arrest tie off points on the ecoCUBE® reactor housing must be purchased.
28. For outdoor SCR installations, shell/breakout noise of SCR reactor cannot be attenuated via downstream muffler/silencer.

Cat® C13 DIESEL GENERATOR SETS

Image shown may not reflect actual configuration

350 ekW – 400 ekW

60 Hz

Standby	Prime
350 kVA	320 kVA
400 kVA	365 kVA

DE-RATED TO 340KW FOR SITE ALTITUDE

BENEFITS & FEATURES

CAT® GENERATOR SET PACKAGE

Cat generator set packages have been fully prototype tested and certified torsional vibration analysis reports are available. The packages are designed to meet the NFPA 110 requirement for loading, conform to the ISO 8528-5 steady state and fill transient response requirements.

CAT DIESEL ENGINES

The four-cycle Cat diesel engine combines consistent performance with excellent fuel economy and transient response that meets or exceeds ISO 8528-5. The engines feature a reliable, rugged, and durable design that has been field proven in thousands of applications worldwide in emergency standby installations.

COOLING SYSTEM

The cooling system has been designed and tested to ensure proper generator set cooling, and includes the radiator, fan, belts, and all guarding installed as standard. Contact your Cat dealer for specific ambient and altitude capabilities.

GENERATORS

The generators used on Cat packages have been designed and tested to work with the Cat engine. The generators are built with robust Class H insulation and provide industry-leading motor starting capability and altitude capabilities.

EMCP CONTROL PANELS

The EMCP controller features the reliability and durability you have to come to expect from your Cat equipment. The EMCP 4 is a scalable control platform designed to ensure reliable generator set operation, providing extensive information about power output and engine operation. EMCP 4 systems can be further customized to meet your needs through programming and expansion modules.

SPECIFICATIONS

ENGINE SPECIFICATIONS

Engine Model	Cat® C13 ACERT In-line 6, 4-cycle diesel
Bore x Stroke	130mm x 157mm (5.1in x 6.2in)
Displacement	12.5 L (763 in³)
Compression Ratio	16.3:1
Aspiration	Turbocharged Air-to-Air Aftercooled
Fuel Injection System	MEUI
Governor	Electronic ADEM™ A4
Emission Certifications	EPA TIER III

GENERATOR SET SPECIFICATIONS

Alternator Design	Brushless Single Bearing, 4 Pole
Stator	2/3 Pitch
No. of Leads	12
Available Voltage Options	600V/480V/440V/240V/220V
Frequency	60Hz
Alternator Voltage	24V
Alternator Insulation & IP	Class H; IP23
Standard Temperature Rise	125/130 Deg C
Available Excitation Options	Self-Excited, PMG
Voltage Regulation, Steady State+/-	≤1%

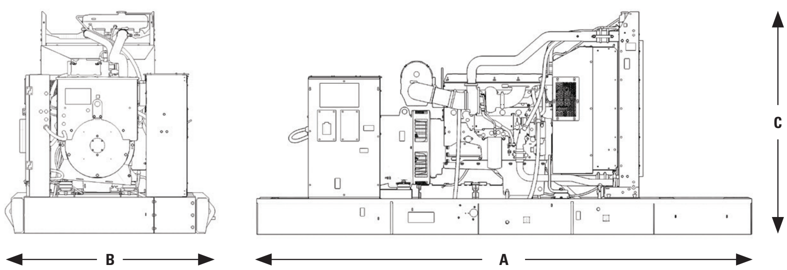
STANDARD EQUIPMENT

Air inlet system	Aftercooler core Turbocharger
Control panels	EMCP4.2 control panel
Cooling system	Coolant drain line with valve; terminated on edge of base Fan and belt guards Coolant Level Sensor Thermostats and housing, full open temperature 92 deg C (198 deg F) Coolant level sight gauge Jacket water pump, gear driven, centrifugal Caterpillar Extended Life Coolant
Exhaust system	Exhaust manifold; dry
Fuel system	Primary fuel filter w/integral water separator & secondary filter Fuel cooler Fuel priming pump Flexible fuel lines Engine fuel transfer pump
Generators and generator attachments	Brushless, self-excited 2/3 pitch, random wound IP23 Protection Insulation Class H and temperature rise Power centre, IP22 bottom cable entry Segregated low voltage wiring pane
Governing system	Cat Electronic Governor (ADEM A4)
Protection System	Safety Shutoff – High Water Temperature Safety Shutoff – Low Oil Pressure Safety Shutoff – Overspeed Coolant Level Sensor
Base/Fuel Tank	Narrow Skid Wide/Standard Sub Tank Base – UL & ULC Listed Integral Tank Base – UL & ULC Listed Spill Containment Overfill Prevention Valve
Starting/charging system	24-Volt Electric Starting Motor Charging Alternator
Certifications	EPA Stationary Emergency Use

OPTIONAL EQUIPMENT

Air inlet system	Single/Dual Element Air Cleaner Heavy Duty Air Cleaner
Control panels	EMCP 4.4 Local Annunciator Remote Annunciators Discrete I/O Module Device Server Volt Free Contact Earth (Ground) Fault Relay
Circuit Breakers	3-Pole 100% Rated – Single (Manual & Motorized) 3-Pole 100% Rated – Dual & Third (Manual) External Paralleling Auxiliary Contacts Neutral Bar
Enclosures	Sound Attenuated (SA) Weather Protective
Cooling system	Stone guards
Mufflers	Industrial grade (10 dBA) Residential and Critical grade (25 dBA)
Base/Fuel Tank	Audio & Visual Fuel Alarm
Fuel System	Integral 670 Gal Tank Base Sub Tank Bases: 660, 1000, 1900, 2200 Gal
Generators and generator attachments	Excitation – Self Excitation – Internal/AREP/PMG Oversize Coastal Protection (CIP) Space Heater Control
Starting/ charging system	Standard Battery Set Oversize Battery Set
Certifications	UL2200 Listed CSA 22.2 Certification of Compliance – IBC Seismic Certification of Compliance – IBC Seismic and OSHPD
General	Tool Set

WEIGHTS & DIMENSIONS



Standby Ratings	Dim "A" mm (in)	Dim "B" mm (in)	Dim "C" mm (in)	Generator Set Weight kg (lb)
350 ekW	3505 (138)	1652 (65)	2069 (82)	3696 (8147)
400 ekW	3505 (138)	1652 (65)	2069 (82)	3823 (8427)

Note: General configuration not to be used for installation.
See general dimension drawings for detail.

PERFORMANCE DATA[EM1692]

Performance Number: EM1692

Change Level: 02

SALES MODEL:	C13	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
ENGINE POWER (BHP):	539	**HERTZ:**	60
GEN POWER WITH FAN (EKW):	350.0	**FAN POWER (HP):**	20.1
COMPRESSION RATIO:	16.3	**ADDITIONAL PARASITICS (HP):**	9.3
RATING LEVEL:	STANDBY	**ASPIRATION:**	TA
PUMP QUANTITY:	1	**AFTERCOOLER TYPE:**	ATAAC
FUEL TYPE:	DIESEL	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
MANIFOLD TYPE:	DRY	**INLET MANIFOLD AIR TEMP (F):**	120
GOVERNOR TYPE:	ELEC	**JACKET WATER TEMP (F):**	192.2
ELECTRONICS TYPE:	ADEM4	**TURBO CONFIGURATION:**	SINGLE
CAMSHAFT TYPE:	STANDARD	**TURBO QUANTITY:**	1
IGNITION TYPE:	CI	**TURBOCHARGER MODEL:**	GTA5002BS 1.60A/R
INJECTOR TYPE:	EUI	**CERTIFICATION YEAR:**	2015
REF EXH STACK DIAMETER (IN):	5	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	1,854.3
MAX OPERATING ALTITUDE (FT):	1,640		

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR
350.0	100	539	311	0.328	24.9
315.0	90	484	279	0.337	23.0
280.0	80	431	248	0.363	22.0
262.5	75	405	234	0.374	21.4
245.0	70	380	219	0.380	20.3
210.0	60	330	190	0.389	18.1
175.0	50	281	162	0.396	15.7
140.0	40	233	134	0.397	13.0
105.0	30	184	106	0.397	10.3
87.5	25	160	92	0.398	9.0
70.0	20	134	78	0.403	7.6
35.0	10	83.0	48	0.443	5.2

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP
EKW	%	BHP	IN-HG	DEG F	DEG F	IN-HG	DEG F	IN-HG	DEG F
350.0	100	539	47.8	120.5	1,271.9	31.8	1,062.6	53	326.0
315.0	90	484	44.8	120.8	1,258.4	29.9	1,046.0	49	313.8
280.0	80	431	46.4	123.8	1,254.4	31.2	1,031.0	51	320.2
262.5	75	405	46.1	123.3	1,248.8	31.0	1,021.9	51	319.5
245.0	70	380	43.8	120.1	1,236.3	29.3	1,010.2	48	311.2
210.0	60	330	38.2	113.7	1,198.6	25.6	980.6	42	288.4
175.0	50	281	31.3	107.2	1,144.4	21.4	942.7	35	257.7
140.0	40	233	22.4	100.5	1,073.3	16.3	897.1	25	214.8
105.0	30	184	13.7	93.7	976.6	11.3	834.1	16	170.6
87.5	25	160	9.7	90.2	917.7	9.1	795.4	12	150.2
70.0	20	134	6.4	86.8	850.2	7.3	749.4	8	132.3
35.0	10	83.0	2.6	83.6	670.2	5.3	599.4	4	109.2

General Performance Data (Continued)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
350.0	100	539	881.1	2,619.7	3,862.0	4,038.9	846.1	761.4
315.0	90	484	855.8	2,508.3	3,729.7	3,893.1	819.1	739.9
280.0	80	431	878.5	2,549.2	3,839.9	3,996.2	840.8	764.1

262.5	75	405	878.6	2,530.2	3,841.4	3,992.9	839.7	765.1
245.0	70	380	857.9	2,439.7	3,742.1	3,886.3	816.0	744.9
210.0	60	330	801.9	2,220.3	3,481.1	3,609.6	758.0	694.1
175.0	50	281	727.0	1,950.9	3,138.9	3,250.2	684.0	628.2
140.0	40	233	622.6	1,616.8	2,672.7	2,765.1	585.9	540.0
105.0	30	184	517.7	1,277.3	2,206.8	2,279.9	485.4	449.0
87.5	25	160	470.9	1,117.8	1,999.7	2,063.2	437.9	405.9
70.0	20	134	431.9	973.5	1,827.1	1,881.3	395.9	367.9
35.0	10	83.0	390.5	759.0	1,643.9	1,680.7	352.4	332.1

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHAUST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
350.0	100	539	8,221	2,747	20,731	12,456	2,887	3,178	22,859	54,199	57,735
315.0	90	484	7,677	2,692	19,528	11,690	2,665	2,883	20,512	50,027	53,291
280.0	80	431	7,354	2,887	19,493	11,693	2,551	3,019	18,269	47,897	51,023
262.5	75	405	7,140	2,948	19,197	11,505	2,474	3,018	17,180	46,452	49,483
245.0	70	380	6,842	2,890	18,397	10,985	2,355	2,864	16,104	44,213	47,098
210.0	60	330	6,231	2,840	16,468	9,709	2,099	2,436	13,997	39,401	41,972
175.0	50	281	5,606	2,763	14,165	8,183	1,818	1,892	11,926	34,126	36,352
140.0	40	233	5,098	2,565	11,424	6,395	1,509	1,223	9,874	28,335	30,184
105.0	30	184	4,540	2,136	8,708	4,636	1,194	679	7,809	22,410	23,872
87.5	25	160	4,185	1,844	7,473	3,846	1,037	480	6,765	19,475	20,746
70.0	20	134	3,761	1,539	6,355	3,130	885	333	5,703	16,607	17,691
35.0	10	83.0	2,657	1,328	4,333	1,713	600	168	3,518	11,270	12,005

Emissions Data

DIESEL

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	350.0	262.5	175.0	87.5	35.0
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**539**	**405**	**281**	**160**	**83.0**
TOTAL NOX (AS NO2)		G/HR	2,428	860	482	497	337
TOTAL CO		G/HR	717	555	540	556	408
TOTAL HC		G/HR	8	15	21	25	42
TOTAL CO2		KG/HR	253	216	158	90	52
PART MATTER		G/HR	52.4	51.5	51.9	27.9	19.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,274.7	918.1	709.9	1,357.9	1,436.0
TOTAL CO	(CORR 5% O2)	MG/NM3	666.9	590.8	791.1	1,557.0	1,739.8
TOTAL HC	(CORR 5% O2)	MG/NM3	6.2	13.7	27.4	58.5	183.6
PART MATTER	(CORR 5% O2)	MG/NM3	39.4	46.6	64.9	58.9	80.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,108	447	346	661	699
TOTAL CO	(CORR 5% O2)	PPM	534	473	633	1,246	1,392
TOTAL HC	(CORR 5% O2)	PPM	12	26	51	109	343
TOTAL NOX (AS NO2)		G/HP-HR	4.58	2.14	1.73	3.13	4.07
TOTAL CO		G/HP-HR	1.35	1.38	1.93	3.50	4.93
TOTAL HC		G/HP-HR	0.01	0.04	0.08	0.16	0.50
PART MATTER		G/HP-HR	0.10	0.13	0.19	0.18	0.23
TOTAL NOX (AS NO2)		LB/HR	5.35	1.90	1.06	1.10	0.74
TOTAL CO		LB/HR	1.58	1.22	1.19	1.22	0.90
TOTAL HC		LB/HR	0.02	0.03	0.05	0.06	0.09
TOTAL CO2		LB/HR	559	476	348	198	115
PART MATTER		LB/HR	0.12	0.11	0.11	0.06	0.04
OXYGEN IN EXH		%	7.5	9.4	10.6	12.0	14.5
DRY SMOKE OPACITY		%	2.1	1.9	1.6	3.7	2.2
BOSCH SMOKE NUMBER			1.33	1.27	1.05	1.98	1.39

PERFORMANCE DATA[EM1692]

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	350.0	262.5	175.0	87.5	35.0
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**539**	**405**	**281**	**160**	**83.0**
TOTAL NOX (AS NO2)		G/HR	2,622	929	521	537	363
TOTAL CO		G/HR	1,341	1,037	1,009	1,039	764
TOTAL HC		G/HR	15	28	41	48	79
PART MATTER		G/HR	102.3	100.4	101.1	54.5	37.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,456.7	991.6	766.7	1,466.5	1,550.9
TOTAL CO	(CORR 5% O2)	MG/NM3	1,247.2	1,104.7	1,479.3	2,911.7	3,253.4
TOTAL HC	(CORR 5% O2)	MG/NM3	11.7	26.0	51.8	110.6	347.1
PART MATTER	(CORR 5% O2)	MG/NM3	76.8	90.9	126.6	114.8	157.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,197	483	373	714	755
TOTAL CO	(CORR 5% O2)	PPM	998	884	1,183	2,329	2,603
TOTAL HC	(CORR 5% O2)	PPM	22	48	97	206	648
TOTAL NOX (AS NO2)		G/HP-HR	4.95	2.31	1.86	3.38	4.39
TOTAL CO		G/HP-HR	2.53	2.58	3.61	6.54	9.23
TOTAL HC		G/HP-HR	0.03	0.07	0.15	0.30	0.95
PART MATTER		G/HP-HR	0.19	0.25	0.36	0.34	0.45
TOTAL NOX (AS NO2)		LB/HR	5.78	2.05	1.15	1.18	0.80
TOTAL CO		LB/HR	2.96	2.29	2.22	2.29	1.68
TOTAL HC		LB/HR	0.03	0.06	0.09	0.11	0.17
PART MATTER		LB/HR	0.23	0.22	0.22	0.12	0.08

Regulatory Information

EPA EMERGENCY STATIONARY		2011 - ----		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE EMERGENCY STATIONARY REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 4.0 PM: 0.20

Altitude Derate Data

STANDARD

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	30	40	50	60	70	80	90	100	110	120	130	140	NORMAL
ALTITUDE (FT)													
0	539	539	539	539	539	539	539	539	539	531	522	513	539
1,000	539	539	539	539	539	539	539	530	520	511	503	494	539
2,000	539	539	539	539	539	529	519	510	501	492	484	476	537
3,000	539	539	539	528	518	509	500	491	482	474	466	458	521
4,000	539	529	518	508	499	490	481	472	464	456	448	441	504
5,000	519	508	499	489	480	471	462	454	446	438	431	424	488
6,000	499	489	479	470	461	453	444	436	429	421	414	407	473
7,000	479	470	461	452	443	435	427	419	412	405	398	391	457
8,000	461	451	443	434	426	418	410	403	396	389	383	376	442
9,000	442	434	425	417	409	401	394	387	380	374	367	361	428
10,000	425	416	408	400	393	385	378	372	365	359	353	347	414
11,000	408	399	392	384	377	370	363	357	350	344	338	333	400
12,000	391	383	376	368	361	355	348	342	336	330	325	319	386
13,000	375	367	360	353	347	340	334	328	322	317	311	306	373
14,000	359	352	345	339	332	326	320	314	309	303	298	293	360
15,000	344	337	331	324	318	312	307	301	296	291	286	281	348

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
0K9331	PP7708	4343726	PG045	LS	PW300001	
0K9331	PP7708	5066872	PG045	LS	PW300001	

Performance Parameter Reference

Parameters Reference:DM9600-12
PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%
Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine

order or general dimension drawings for the actual stack diameter size ordered or options available.

REFERENCE FUEL

DIESEL

Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 15 deg C (59 deg F), where the density is 850 G/Liter (7.0936 Lbs/Gal).

GAS

Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.

ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD

Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.

ALTITUDE CAPABILITY

Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.
Standard temperature values versus altitude could be seen on TM2001.
When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.
Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.
Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.

REGULATIONS AND PRODUCT COMPLIANCE

TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.
Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.

EMISSION CYCLE LIMITS:

Cycle emissions Max Limits apply to cycle-weighted averages only. Emissions at individual load points may exceed the cycle-weighted limit.

EMISSIONS DEFINITIONS:

Emissions : DM1176

EMISSION CYCLE DEFINITIONS

1. For constant-speed marine engines for ship main propulsion, including,diesel-electric drive, test cycle E2 shall be applied, for controllable-pitch propeller sets test cycle E2 shall be applied.
2. For propeller-law-operated main and propeller-law-operated auxiliary engines the test cycle E3 shall be applied.
3. For constant-speed auxiliary engines test cycle D2 shall be applied.
4. For variable-speed, variable-load auxiliary engines, not included above, test cycle C1 shall be applied.

HEAT REJECTION DEFINITIONS:

Diesel Circuit Type and HHV Balance : DM9500

HIGH DISPLACEMENT (HD) DEFINITIONS:

3500: EM1500

RATING DEFINITIONS:

Agriculture : TM6008
Fire Pump : TM6009
Generator Set : TM6035
Generator (Gas) : TM6041
Industrial Diesel : TM6010
Industrial (Gas) : TM6040
Irrigation : TM5749
Locomotive : TM6037
Marine Auxiliary : TM6036
Marine Prop (Except 3600) : TM5747
Marine Prop (3600 only) : TM5748
MSHA : TM6042
Oil Field (Petroleum) : TM6011
Off-Highway Truck : TM6039
On-Highway Truck : TM6038

PERFORMANCE DATA[EM1692]

SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 07/10/19

	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY **2020 MODEL YEAR** **CERTIFICATE OF CONFORMITY** **WITH THE CLEAN AIR ACT**	**OFFICE OF TRANSPORTATION** **AND AIR QUALITY** **ANN ARBOR, MICHIGAN 48105**

Certificate Issued To: Caterpillar Inc. (U.S. Manufacturer or Importer) **Certificate Number: LCPXL12.5NYS-015**	**Effective Date:** **07/22/2019** **Expiration Date:** **12/31/2020**	**Byron J. Bunker, Division Director** **Compliance Division**	**Issue Date:** **07/22/2019** **Revision Date:** **N/A**

Model Year: 2020
Manufacturer Type: Original Engine Manufacturer
Engine Family: LCPXL12.5NYS

Mobile/Stationary Indicator: Stationary
Emissions Power Category: 225<=kW<450
Fuel Type: Diesel
After Treatment Devices: No After Treatment Devices Installed
Non-after Treatment Devices: Electronic Control, Smoke Puff Limiter, Engine Design Modification

Pursuant to Section 111 and Section 213 of the Clean Air Act (42 U.S.C. sections 7411 and 7547) and 40 CFR Part 60, and subject to the terms and conditions prescribed in those provisions, this certificate of conformity is hereby issued with respect to the test engines which have been found to conform to applicable requirements and which represent the following engines, by engine family, more fully described in the documentation required by 40 CFR Part 60 and produced in the stated model year.

This certificate of conformity covers only those new compression-ignition engines which conform in all material respects to the design specifications that applied to those engines described in the documentation required by 40 CFR Part 60 and which are produced during the model year stated on this certificate of the said manufacturer, as defined in 40 CFR Part 60.

It is a term of this certificate that the manufacturer shall consent to all inspections described in 40 CFR 1068 and authorized in a warrant or court order. Failure to comply with the requirements of such a warrant or court order may lead to revocation or suspension of this certificate for reasons specified in 40 CFR Part 60. It is also a term of this certificate that this certificate may be revoked or suspended or rendered void *ab initio* for other reasons specified in 40 CFR Part 60.

This certificate does not cover engines sold, offered for sale, or introduced, or delivered for introduction, into commerce in the U.S. prior to the effective date of the certificate.

safety POWER

clean essential energy

Project Proposal

Safety Power ecoCUBE® SCR Emission Control System

For (1) x CAT C13 (350kW) Diesel Generator Set

Prepared for: NC Power Systems Co.
Arkadiy Ter-Meliksetov Ph. 425-656-4572
Proposal No: SPI 21214 Rev 2
Dated June 30, 2021

Prepared by:

Safety Power Inc.
Jacob Rozenblit
Senior Applications Engineer
Office (514) 927-2898
Fax 416.477.2709
www.safetypowerinc.com

safety POWER

clean essential energy

DESIGN PARAMETERS

The design of the Safety Power emissions reduction system is based on the following conditions.
Note: NOx is calculated as NO_2.

Table 1 – Engine Data

Engine Type:	CAT C13
Application	Stand-by
Engine Power	350 ekW
Exhaust Temperature	1063 °F
Design Exhaust Flow Rate	2620 (CFM)
Fuel Type	Diesel

Table 2 – Emissions Data at Full Engine Load

Engine Option	Emissions	Catalyst Inlet	Emissions Requirement	Catalyst Outlet
CAT C13	NOx (g/HP-h)	4.95	0.50	0.50
	CO (g/HP-h)	2.53	2.60	<2.53
	VOC (g/HP-h)	0.03	0.14	<0.03
	PM (g/HP-h)	0.19	0.020	0.020

Notes: (1) The EPA does not treat methane and ethane as VOC's. Safety Power can achieve a stated reduction of VOC's based on the EPA definition assuming that the VOC's manifest themselves as propene. (2) all emissions reductions are based on an average at steady state using SCAQMD method 100.1 for NOx and SCAQMD/EPA methods 25.1/25.3 for CO and VOC's or mutually agreed test method approved in writing. (3) if NMHC/VOC data isn't provided 0.6 g/hp-hr is to be assumed (unless otherwise stated).

Table 3 – SCR System Data

Engine Option	CAT C13
Max. Ammonia Slip @ 15% O2	10 ppm
Urea Consumption - 32.5% solution (+/- 15%)	1.2 USG/hr Nominal (1.3 USG/hr NTE)
SCR Pressure Loss	24.0" WC
SCR Inlet/Outlet ANSI Flange Inches	12/12

ecoCUBE® System Scope of Supplies and Services

Table 4 – Components Supplied for Each System

ecoCUBE System Components Description (For Each Engine)	CAT C13
1. Reactor Assembly (Part Number)	**2 Series (9523-H3C04)**
1.1 ecoCUBE system configuration	SCR + DPF
1.2 ecoCUBE SCR Reactor assembly 409 s/s c/w temperature, pressure and NOx sensors	1
1.3 Reactor assembly weight with catalyst	4,850 lbs
1.4 SCR Catalyst - layers of catalyst material (each system)	3
1.5 DPF Filter Modules	4
2. Control and Dosing Assembly	
2.1 Control Panel – with embedded control, on-off switch, on-off status indicator light, and power distribution. Ability for remote monitoring and troubleshooting if Internet connection provided. Dosing System – with automatic flow rate adjustment, system purge valve, air regulator, air pressure switch, check valves, overpressure regulator and injection valves, injection pumps.	Included
3. Insulation of each ecoCUBE with 4 inches MW insulation and metal cladding. Note: skin surface temperature does not exceed 70 deg C except for exhaust and access door flanges.	Included

EXCLUSIONS & EXCEPTIONS

1. Installation of SPI supplied equipment is by OTHERS.
2. Transition ductwork from ecoCUBE® to stack.
3. Connection from engine exhaust to ecoCUBE® inlet.
4. Gaskets used upstream of the ecoCUBE® shall not contain silica as this can harm the catalyst and will void the catalyst warranty.
5. Structural supports or anchors
6. Power supplies for SCR control panel, air compressor or urea transfer pump skid.
7. Engine on/off signal – Note: required for automatic starting of ecoCUBE® system.
8. Permits and/or certification testing, etc.
9. Emissions performance will be met provided that the actual engine emissions parameters correspond to the engine data sheet and that the fuel composition information provided corresponds to conditions at the site.
10. NOx reduction is achieved once SCR catalyst temperature exceeds 540 degF
11. Certain regulators may require the use of specific components that have been pre-certified to their standards. Unless stated otherwise in this proposal, Safety Power's guarantee is based on emissions performance of its entire system; there is no guarantee that the system contains specific internal components required by a local regulator.
12. Urea piping from urea tank(s) to the dosing panel. Urea and air piping between dosing panel and injection lances.
13. Customer to ensure that any gaskets upstream of ecoCUBE® are rated for the appropriate engine exhaust temp. Decomposition of gasket material may poison catalyst and will void catalyst warranties offered by Safety Power.
14. Air compressor connections (electrical and tubing). Note: a clean dry supply of air (as per ISO 8573.1 Class 1.4.2) 10CFM @ 80psi per system is required.
15. Safety Power has assumed the same specification as previous Microsoft project's (CYS13) as a result we have included the following almost identical clarifications & exceptions below. It's important to note that the ecoCUBE requires a minimum injection temperature of 260oC for SCR injection to occur. All exhaust piping between the engine and ecoCUBE will require at least 3" of mineral wool insulation to minimize heat loss so that SCR injection can be achieved at 10% load / provide D2 cycle compliance:
16. 2.17.A: Safety Power's system will provide Tier 4f compliant emission levels.

COMMENTS, CLARIFICATIONS & CUSTOMER REQUIREMENTS

1. This proposal is based upon full load engine data.
2. The Urea used shall be 32.5% concentration (ISO 22241 standard). The dosing panel, tanks and lines with urea must be protected from freezing e.g. by heat tracing and insulating, locating the panel, tank & lines in an area that is maintained at a temperature above the freezing temperature.
3. Systems with diesel particulate filters (DPF) must be operated with ultra-low sulfur diesel only. In order to properly regenerate the DPF canisters the temperature must be above 280°C (536°F) for 30% of the engine operating time and greater than 40% engine load.
4. Maximum number of cold starts is 12 consecutive 10 minute or less idle sessions, which must be followed by a minimum of 2-hours of regeneration at the temperature and load noted above. Depending on the number of cold starts and other items relate to use of the system, Diesel Particulate Filters may require regular cleaning. The SPI system incorporates a virtual soot sensor which indicates the number of expected Run Hours Available (RHA) so that the operator is aware of when the next cleaning cycle is required. It is important that the operator monitor RHA to avoid high engine back pressure.
5. Unless expressly included in SPI's scope of supply the responsibility for allowing for thermal expansion of the products supplied by SPI is "by others".
6. Under no circumstances should the ecoCUBE® be placed downstream of a silencer with absorptive acoustical material.
7. SCR commissioning requires a customer supplied load bank to operate the generator at various load points and establish the controls load map. The customer should allow 4 hours per machine for the SCR load map to be established, 4 hours of testing and verifying SCR system operation, and where required, 1 hour for a third party witnessing of the SCR operation and performance.
8. A 4-20mA signal proportional to engine load must be provided and connected into ecoCUBE® control panel. Customer must provide the current transducer and current transformer for 1-phase.
9. An ethernet connection with access to the internet through Port 80 is requried for each ecoCUBE® control panel; this connection is used for remote montioring, product support and client web browser access.
10. Siloxanes can't be present in the exhaust stream as they will poison the catalyst. Please note that the presence of Siloxanes in the exhaust will void Safety Power's warranty.
11. Please note that a $600/ecoCUBE® shrink wrapping fee will be charged for any unit that's being shipped more than 120 miles away on a flatbed truck, or if the project is delayed by more than 2 weeks which will result in the requirement for outside storage. Please note that storage fees may apply for projects delayed by more than 4 weeks.
12. HDPE (high-density polyethylene) urea storage tanks are designed for atmospheric pressures only. Piping to/from the tank must ensure that no static head from either the vent or fill connection can occur. HDPE tanks situated below grade and filled from a grade level fill station will require the vent to be open to the same room/level as the tank and at at a height no greater

than 10“ above the top of the tank. Pressurized installations will require the use of a stainless steel tank engineered for the customer’s specific site requirements.

13. Safety Power has assumed the same specification as previous Microsoft project’s (CYS13) as a result we have included the following almost identical clarifications & exceptions below. It’s important to note that the ecoCUBE requires a minimum injection temperature of 260oC for SCR injection to occur. All exhaust piping between the engine and ecoCUBE will require at least 3“ of mineral wool insulation to minimize heat loss so that SCR injection can be achieved at 10% load / provide D2 cycle compliance:
14. 2.17.B.1: It has been assumed that the 5 load cycle is weighted as per the D2 engine cycle. See 2.17A for exception (Safety Power's system will provide Tier 4f compliant emission levels)
15. 2.17.B.2: Particulate Matter (PM) shall be measured using ISO 8178 as the engine data is measured using the ISO 8178 standard as well. If EPA Method 5/202 must be used, Safety Power will limit the guarantee to an 85% reduction in PM. As part of Safety Power's standard scope of supply we would provide NOx measurements using a Testo analyzer at 25%, 50%, 75% & 100% load; samples would be taken from the NOx sensor port located on the ecoCUBE outlet. All other emission testing would be by others (typically in owner's scope as testing is generally tied to site air permit). It’s been assumed that testing will take <15 mins at each load point on the D2 cycle (loads would be tested in order of decreasing load to ensure system is at temperature).
16. 2.17.B.3: Please note that a load bank would be required to periodically regenerate the DPF filters.

    -Under ideal lab based test conditions the system can accommodate up to 24 cold starts. That being said, under real world conditions we would advise 18 cold starts before regeneration is required. The minimum regeneration temperature is 260 degC.

    - 10% Load Run Time: 180-720 minutes, depending on the available pressure drop in the exhaust system and the engine

    loading/transient heat up time performance.

    - 80% and 100% Load, Hours of Run Time: regeneration time 1- 2hrs. This varies based on soot load and if periodic load tests have been completed
17. 2.17.B.5: The ecoCUBE's control logic has built-in redundancy to ensure that emission requirements are met.
18. 2.17.B:10: Safety Power's SCR reactor housing, mixing duct are fabricated from stainless steel 409. All items that come into contact with liquid urrea (injection lance, mixers) will be made from 304 stainless steel. Safety Power assumes that seismic supports/design and analysis is conducted by others
19. 2.17.B.12: We will provide a dry contact or modbus tcp register output that the engine panel can then use for fault annunciation

20. 2.17.B.14: Safety Powers system will provide critical grade silencing, reducing the aggregate exhaust sound levels by 35 dB(A) for our SCR + DPF solution
21. 2.17.B.15: The ecoCUBE's control panel will be field certified to a standard recognized by the local AHJ.
22. 2.17.B.17: Safety Power utilizes Canbus sensors that have integral self-diagnostics. In addition, Safety Power includes a dedicated flow meter in our panel design to ensure the accuracy of the pump.
23. 2.17.B.19: The ecoCUBE's control logic has built-in redundancy to ensure that emission requirements are met.
24. 2.17.B.20: The ecoCUBE's surface temperature is designed to be at or below 140 F, with the exception of certain well-marked control surfaces. Please reference shop drawings for the ambient conditions / assumptions that are utilized to achieve 140F temperature.
25. 2.17.B.21.a: Wiring between the control panel and reactor would be in the packagers scope.
26. 2.17.B.21.b: Safety Power assumes that seismic supports/design and analysis is conducted by others.
27. Access considerations should be made for servicing of the ecoCUBE® components. If the ecoCUBE® reactor is placed on a roof or platform, either a walk way or fall arrest tie off points should be provided by others. If the site will not have safe access for work done on ecoCUBE® reactors on a roof or platform then the optional integrated fall arrest tie off points on the ecoCUBE® reactor housing must be purchased.
28. For outdoor SCR installations, shell/breakout noise of SCR reactor cannot be attenuated via downstream muffler/silencer.

APPENDIX F – RENEWABLE DIESEL FUEL TEST DATA

Renewable Hydrocarbon Diesel Certificate of Analysis

202009256022 COA

Lot Number:	750-200925-T6022	Product Type:	Renewable Hydrocarbon Diesel

Analysis of REG-9000/RHD

Property	Value	ASTM D975 No. 2-D Limit	REG-9000® Limit*	Units	Test Method (current revision)
Cloud point:	-11	Report	Report	**°C**	D5771
Water & Sediment:	<0.05	0.05, max	0.05, max	**% volume**	D2709
Conductivity:	60	25, min	25, min	**pS/m**	D2624
Appearance:	Clear & Bright	Clear & Bright	Clear & Bright	**N/A**	D4176, Procedure 1
API Gravity @ 60°F:	49.3	N/A	Report	**N/A**	D4052
Specific gravity @ 60°F:	0.7827	N/A	Report	**N/A**	D4052
Flash point:	65.1	52, min	52, min	**°C**	D93A
Total Sulfur:	<1	15, max	2, max	**ppm (mg/kg)**	D5453
Ramsbottom Carbon:	0.05	0.35, max	0.35, max	**% mass**	D524
Ash:	<0.001	0.01	0.01	**% mass**	D482
Kinematic Viscosity at 40 °C:	3.2	1.9 – 4.1	1.9 – 4.1	**mm^2/sec**	D445
Copper Corrosion (3 hrs at 50 °C):	1a	No. 3	No. 1b	**N/A**	D130
Distillation Temperature, at 90%:	301	282 – 338	282 – 338	**°C**	D86
Cetane Index:	94	40, min	65, min	**N/A**	D4737, Procedure A

Notes:

1. ASTM D1319 test detection limits for Aromatics is 5-99 % volume, since REG Geismar's renewable diesel is lower than 5 % volume, this testing was discontinued in the REG Geismar lab
2. Based on a customer's purchase requirements, an optional lubricity additive may be injected into the RHD at the time of shipment to bring the lubricity to < 520 microns
3. This product conforms to the most recent version of ASTM D975

Prepared by: Keith Gill (Name) — Lab Supervisor (Title) — Geismar, LA (Location) — 09/25/2020 (Date)

Please contact Inside Sales at Renewable Energy Group, Inc. at (888)734-8686 with any questions or comments about this product.

CATERPILLAR®

Electric Power Division
P.O. Box 610- AC6109
Mossville, IL 61552

6/28/2021

Mycah Gambrell-Ermak
Energy & Sustainability Division,

RE: **Regarding Caterpillar engine emissions from renewable/alternative fuels**

Ms. Gambrell-Ermak,

This letter conveys our emissions experience with Hydrotreated Vegetable Oil (HVO) renewable fuel. Based on our scientific judgment, the chemical attributes of HVO as a fuel, general experience, and available test data, emissions from Caterpillar engines running on a HVO fuel should be comparable, if not lower, to that of the same engine model running on a petroleum diesel. Any given HVO fuel would be expected to meet the fuel specifications prescribed in Caterpillar Commercial Engine Fluid Recommendations (SEBU6251).

Based on the above, HVO fuel-fired Caterpillar engine emissions are expected to be the same or lower than diesel fuel-fired Caterpillar engine emissions provided in Caterpillar's "rated speed potential site variation emissions data (PSV)." PSV data should be used for onsite performance testing validation.

Sincerely,

Evan K. Hodgen

Evan Hodgen
Electric Power Technical Sales Support Manager
Caterpillar Inc.
(765)448-2645
Hodgen_Evan@cat.com

CATERPILLAR®

HVO RD99 Testing on Caterpillar C175-16

HVO (RD99) fuel testing on Caterpillar C175-16 Operational and Performance Test

Engine Emissions and Load Comparisons

Test Date: November 5 & 6, 2020
Type of Test: Transient Response Test / Load Test / Emissions Testing

Project Number: EP03524
Engine Serial Number: TB800180
Generator Serial Number: G7J06324

Engine Model: C175-16
Max Power: 3140 KW
Voltage: 480 Volts
Current: 3975 Amps

CATERPILLAR®

Summary of Test Results for Diesel vs. RD99 Fuel

The following report encompasses results from a series of tests used for evaluation of exhaust emissions and performance of HVO C175-16 Generator Set using #2 Diesel and Alternative RD99 Fuel. The transient response test results demonstrate that the Genset is able to pick up the 0 to100% block load and stabilize voltage and frequency in 6.54 seconds on #2 ULSD Fuel and 7.67 Seconds on RD99 Fuel.

Transient response and Emissions load test were conducted on a C175-16 genset rated at 480V 60Hz 0.95pf 3100kW without fan, 3000kW with engine mounted fan. The testing was conducted in a test cell in Griffin, GA at the YES facility, overseen by Caterpillar, with the purpose of comparing genset perform during transient load application and emissions on both diesel and RD99 fuel. The full set of test data was provided to the client for their records. Below is a high-level summary of the results including a reduced data set. The requirements for the RD99 fuel specification were determined during meetings between Caterpillar, client, and the fuel vendor and is documented outside of this summary of results.

Transient Response

Testing indicated that there was not a significant difference in genset transient response performance between the two fuels. Despite RD99 having a lower energy content, the engine fuel system was capable of dynamically adjusting flow rates to provide a similar transient performance. Operation on RD99 should not negatively impact operation during load acceptance. A table with the comparison at each load step is provided in Appendix A.

Emissions Data

Testing was conducted on both fuels for one hour at each 25%, 50% and 75% load and for 3 hours at 100% load. RD99 did show a reduction in PM and CO across all load steps. A reduction of NOx was experienced at part load steps, but the 100% load point was essentially the same between both fuels. A table with the comparison at each load point is provided in Appendix B.

Engine Oil Sample Analysis

Engine oil sample analysis were performed before and after testing on both fuels. The results of wear metals were consistent with a new engine moving through its break in cycle and did not indicate any areas for concern.

Fuel Sample Analysis

Fuel samples were taken for both fuels and have been provide outside of this summary to document the fuel characteristics.

Appendix C – Test Procedure

Test Details
November 4, 2020 – Yancy CAT test facility

4 hour load run on Diesel
20 hour load run on R99
Transient on both fuels

Emissions data

Analytes	EPA Method	Run Duration	Number of runs per test
Oxygen (O2)	3A	60 Min	1
Nitrogen oxides (NOx)	7E	60 Min	1
Carbon monoxide (CO)	10	60 Min	1
Visual emissions (opacity)	9	60 Min	1

Test Procedure:

The tests, as specified in test procedure provided to the customer, are conducted at Yancey Engineered Solutions Test Laboratory. The Genset is set up in Test Cell 2 with the following temporary connections; 24v Battery, 240 VAC Shore Power, Fuel supply and return.

1. Perform Pretest activities for Testing with #2 Diesel Fuel. Obtain Engine Oil and #2 Diesel Fuel Samples for Analysis.
2. Perform Transient Tests with #2 Diesel Fuel as per Test procedure. Load Percentages 0-75-0-50-100-50-75-100-75-50-0-100-0.
3. Operate the Genset on #2 Diesel Fuel at load percentages 25-50-75-100 for Emissions sampling and data collection.
4. Perform Pretest activities for Testing with RD99 Fuel. Obtain Engine Oil Sample for Analysis. Top off Oil Level and Record quantity as necessary.
5. Operate the Genset on RD99 Fuel for 14 Hours Continuously at 100 percent load and collect operating data.
6. Operate the Genset on RD99 Fuel at load percentages 25-50-75-100 for Emissions sampling and data collection.
7. Perform Transient Tests with RD99 Fuel as per Test procedure. Load Percentages 0-75-0-50-100-50-75-100-75-50-0-100-0.
8. Operate the Genset on RD99 Fuel for 3 Hours Continuously at 100 percent load and collect operating data.
9. Obtain Oil Sample for analysis.

Test Instrumentation:

Load bank	Creschic 6.25 Mva Resistive/Reactive.
Computer Software	Caterpillar- Electronic Technician
	Dran View 6 Enterprise
Data Recorder	Dranetz PX5, calibration date: 1/20/2020

Test Fuel:

#2 ULSD Fuel- Test Lab Analysis
RD99 Fuel- Test Lab Analysis

Advanced Industrial Resources, Inc.

Test Results

Yancy

Griffin, GA

Generator #2 Diesel

		Units	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Averages
Genset Load		% of full load	25	50	75	100	100	100	**100**
Test Date			05-Nov-20	05-Nov-20	05-Nov-20	05-Nov-20	05-Nov-20	05-Nov-20	**05-Nov-20**
Start Time			9:10	10:48	12:10	13:35	14:50	16:10	**Runs**
End Time			10:16	11:52	13:14	14:40	15:54	17:15	**4, 5, 6**
P_m	Pressure of meter gases	inches Hg	30.27	30.30	30.27	30.24	30.21	30.20	**30.22**
P_s	Pressure of stack gases	inches Hg	30.18	30.20	30.18	30.14	30.11	30.10	**30.12**
$V_{m(std)}$	Volume of gas sample	dscf	37.35	39.54	36.09	37.10	36.31	39.26	**37.56**
$V_{w(std),meas}$	Meas. volume of water vapor	scf	2.26	2.40	2.17	2.54	2.64	2.59	**2.59**
$B_{ws,meas}$	Measured moisture	dimensionless	0.057	0.057	0.057	0.064	0.068	0.062	**0.065**
$B_{ws,theo}$	Theoretical max. moisture	dimensionless	1.000	1.000	1.000	1.000	1.000	1.000	**1.000**
$B_{ws,act}$	Actual moisture	dimensionless	0.057	0.057	0.057	0.064	0.068	0.062	**0.065**
M_d	Mol. Wt. Of gas at DGM	lb./lb.-mole	29.48	29.50	29.59	29.66	29.66	29.65	**29.66**
M_s	Mol. Wt. Of gas at stack	lb./lb.-mole	28.83	28.85	28.93	28.92	28.87	28.93	**28.91**
v_s	Velocity of stack gas	ft./sec	42.42	85.13	96.59	119.90	120.96	121.60	**120.82**
A_n	Area of nozzle	ft^2	0.000491	0.000289	0.000241	0.000218	0.000218	0.000218	**0.000218**
A_s	Area of stack	ft^2	3.14	3.14	3.14	3.14	3.14	3.14	**3.14**
Gas Stream Flow Rates									
Q_a	Vol. Flow rate of actual gas	cfm	7,996	16,046	18,207	22,601	22,800	22,921	**22,774**
Q_w	Vol. Flow rate of wet gas	scfm	4,124	7,502	8,328	9,908	9,878	9,989	**9,925**
Q_w	Vol. Flow rate of wet gas	scfh	247,424	450,104	499,686	594,472	592,702	599,366	**595,513**
Q_{sd}	Vol. Flow rate of dry gas	dscfm	3,889	7,072	7,857	9,273	9,210	9,371	**9,285**
I	Isokinetic sampling ratio	percent	102.5	101.5	100.0	96.1	94.7	100.6	**97.1**
Process Data									
$P_{(product\ input)}$	Process	HP	1,126	2,148	3,151	4,159	4,160	4,166	**4,162**
$P_{(heat\ input)}$	Fuel firing rate	MMBtu/hr	9.8	18.0	23.8	31.3	31.1	31.0	**31.1**
Gas Stream Particulate Concentrations Method 5									
c_{PM}	Conc. Of PM in dry stack gas	mg/dscm	54.99	5.16	7.02	8.93	12.91	2.66	**8.17**
c_{PM}	Conc. Of PM in dry stack gas	gr/dscf	0.02402	0.00225	0.00307	0.00390	0.00564	0.00116	**0.00357**
Particulate Matter Mass Rates Method 5									
E_{PM}	Emission rate of PM	lb/hour	0.801	0.137	0.207	0.310	0.445	0.093	**0.283**
E_{PM}	Emission rate of PM	g/HP-hr	0.323	0.029	0.030	0.034	0.049	0.010	**0.031**
E_{PM}	Emission rate of PM	lb / MMBtu	0.0820	0.0076	0.0087	0.0099	0.0143	0.0030	**0.0091**
Gas Stream Particulate Concentrations Method 202									
c_{PM}	Conc. Of PM in dry stack gas	mg/dscm	17.06	21.35	18.15	24.04	18.67	9.04	**17.25**
c_{PM}	Conc. Of PM in dry stack gas	gr/dscf	0.00745	0.00932	0.00793	0.01050	0.00816	0.00395	**0.00753**
Particulate Matter Mass Rates Method 202									
E_{PM}	Emission rate of PM	lb/hour	0.249	0.565	0.534	0.835	0.644	0.317	**0.599**
E_{PM}	Emission rate of PM	g/HP-hr	0.100	0.119	0.077	0.091	0.070	0.035	**0.065**
E_{PM}	Emission rate of PM	lb / MMBtu	0.025	0.031	0.022	0.027	0.021	0.010	**0.0192**
Gas Stream Particulate Concentrations Methods 5 & 202									
c_{PM}	Conc. Of PM in dry stack gas	mg/dscm	72.06	26.50	25.17	32.96	31.59	11.70	**25.42**
c_{PM}	Conc. Of PM in dry stack gas	gr/dscf	0.0315	0.0116	0.0110	0.0144	0.0138	0.0051	**0.0111**
Particulate Matter Mass Rates Methods 5 & 202									
E_{PM}	Emission rate of PM	lb/hour	1.05	0.70	0.74	1.14	1.09	0.41	**0.88**
E_{PM}	Emission rate of PM	g/HP-hr	0.423	0.148	0.107	0.125	0.119	0.045	**0.096**
E_{PM}	Emission rate of PM	lb / MMBtu	0.1075	0.0389	0.0311	0.0366	0.0350	0.0132	**0.0283**
Sulfur Dioxide Concentrations Method 6C									
c_{SO2}	Conc. of SO_2 in dry stack gas	ppm	9.48	3.4	3.78	5.31	5.38	5.07	**5.25**
c_{SO2}	Conc. of SO_2 in dry stack gas	ppm @ 15% O_2	6.96	2.43	2.30	2.90	2.94	2.82	**2.89**
c_{SO2}	Conc. of SO_2 in dry stack gas	mg/dscm	25.23	8.96	10.07	14.13	14.31	13.48	**13.98**
c_{SO2}	Conc. of SO_2 in dry stack gas	gr/dscf	0.01102	0.00391	0.00440	0.00617	0.00625	0.00589	**0.00610**
Sulfur Dioxide Mass Rates Method 6C									
E_{SO2}	Emission rate of SO_2	lb/hour	0.37	0.24	0.30	0.49	0.49	0.47	**0.49**
E_{SO2}	Emission rate of SO_2	g/HP-hr	0.148	0.050	0.043	0.054	0.054	0.052	**0.053**
E_{SO2}	Emission rate of SO_2	lb / MMBtu	0.0376	0.0132	0.0124	0.0157	0.0159	0.0153	**0.0156**

Advanced Industrial Resources, Inc.

Test Results

Yancy

Griffin, GA

Generator #2 Diesel

		Units	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Averages
Genset Load		% of full load	25	50	75	100	100	100	**100**
Test Date			05-Nov-20	05-Nov-20	05-Nov-20	05-Nov-20	05-Nov-20	05-Nov-20	**05-Nov-20**
Start Time			9:10	10:48	12:10	13:35	14:50	16:10	**Runs**
End Time			10:16	11:52	13:14	14:40	15:54	17:15	**4, 5, 6**
Nitrogen Oxides Concentrations Method 7E									
c_{NOx}	Conc. of NO_x in dry stack gas	ppm	510.5	270.6	620.9	890.0	874.2	855.4	**873.2**
c_{NOx}	Conc. of NO_x in dry stack gas	ppm @ 15% O_2	374.6	195.4	377.7	486.6	477.1	476.1	**480.0**
c_{NOx}	Conc. of NO_x in dry stack gas	mg/dscm	976.4	517.6	1187.6	1702.3	1672.0	1636.0	**1670.1**
c_{NOx}	Conc. of NO_x in dry stack gas	gr/dscf	0.426	0.226	0.519	0.743	0.730	0.715	**0.729**
Nitrogen Oxides Mass Rates Method 7E									
E_{NOx}	Emission rate of NO_x	lb/hour	14.2	13.7	35.0	59.1	57.7	57.4	**58.1**
E_{NOx}	Emission rate of NO_x	g/HP-hr	5.73	2.90	5.03	6.33	6.29	6.25	**6.29**
E_{NOx}	Emission rate of NO_x	lb / MMBtu	1.46	0.76	1.47	1.89	1.85	1.85	**1.87**
Carbon Monoxide Concentrations Method 10									
c_{CO}	Conc. of CO in dry stack gas	ppm	360.4	89.2	116.1	78.6	74.6	65.3	**72.8**
c_{CO}	Conc. of CO in dry stack gas	ppm @ 15% O_2	264.5	64.4	70.6	43.0	40.7	36.3	**40.0**
c_{CO}	Conc. of CO in dry stack gas	mg/dscm	419.6	103.8	135.2	91.5	86.8	76.0	**84.8**
c_{CO}	Conc. of CO in dry stack gas	gr/dscf	0.1833	0.0454	0.0590	0.0399	0.0379	0.0332	**0.0370**
Carbon Monoxide Mass Rates Method 10									
E_{CO}	Emission rate of CO	lb/hour	6.11	2.75	3.98	3.18	3.00	2.67	**2.95**
E_{CO}	Emission rate of CO	g/HP-hr	2.46	0.58	0.57	0.35	0.33	0.29	**0.32**
E_{CO}	Emission rate of CO	lb / MMBtu	0.626	0.152	0.167	0.102	0.096	0.086	**0.095**
Total Hydrocarbon Concentrations (including methane) Method 25A									
c_{THC}	THC concentration (as methane)	ppm	12.20	5.63	2.04	2.48	2.15	3.15	**2.59**
c_{THC}	THC concentration (as methane)	ppm @ 15% O_2	8.95	4.06	1.24	1.35	1.17	1.75	**1.43**
c_{THC}	THC concentration (as methane)	mg/dscm	8.11	3.74	1.36	1.65	1.43	2.09	**1.72**
c_{THC}	THC concentration (as methane)	gr/dscf	0.00354	0.00164	0.00059	0.00072	0.00062	0.00091	**0.00075**
Total Hydrocarbon Mass Rates (including methane) Method 25A									
E_{THC}	THC emission rate (as methane)	lb/hour	0.1182	0.0992	0.0400	0.0572	0.0493	0.0735	**0.0600**
E_{THC}	THC emission rate (as carbon)	lb/hour	0.0886	0.0744	0.0300	0.0429	0.0370	0.0551	**0.0450**
E_{THC}	THC emission rate (as carbon)	lb / MMBtu	0.0121	0.0055	0.0017	0.0018	0.0016	0.0024	**0.0019**
Methane Concentrations Method 25A									
$c_{Methane}$	CH_4 concentration (as methane)	ppm	1.57	0.87	1.02	0.77	0.71	0.72	**0.73**
$c_{Methane}$	CH_4 concentration (as methane)	ppm @ 15% O_2	1.15	0.63	0.62	0.42	0.39	0.40	**0.40**
$c_{Methane}$	CH_4 concentration (as methane)	mg/dscm	1.04	0.58	0.68	0.51	0.47	0.48	**0.49**
$c_{Methane}$	CH_4 concentration (as methane)	gr/dscf	0.00046	0.00025	0.00030	0.00022	0.00021	0.00021	**0.00021**
Methane Mass Rates Method 25A									
$E_{Methane}$	CH_4 emission rate (as methane)	lb/hour	0.0152	0.0153	0.0199	0.0178	0.0163	0.0167	**0.0169**
$E_{Methane}$	CH_4 emission rate (as carbon)	lb/hour	0.0114	0.0115	0.0149	0.0134	0.0122	0.0125	**0.0127**
$E_{methane}$	CH_4 emission rate (as carbon)	lb / MMBtu	0.001168	0.000848	0.000836	0.000570	0.000525	0.000538	**0.000544**
Ethane Concentrations Method 25A									
c_{Ethane}	C_2H_6 concentration (as Ethane)	ppm	< 0.0502	< 0.0502	< 0.0501	< 0.0505	< 0.0507	< 0.0504	**< 0.0506**
c_{Ethane}	C_2H_6 concentration (as Ethane)	ppm @ 15% O_2	< 0.0368	< 0.0362	< 0.0305	< 0.0276	< 0.0277	< 0.0281	**< 0.0278**
c_{Ethane}	C_2H_6 concentration (as Ethane)	mg/dscm	< 0.0627	< 0.0627	< 0.0627	< 0.0632	< 0.0634	< 0.0630	**< 0.0632**
c_{Ethane}	C_2H_6 concentration (as Ethane)	gr/dscf	< 0.000027	< 0.000027	< 0.000027	< 0.000028	< 0.000028	< 0.000028	**< 0.000028**
Ethane Mass Rates Method 25A									
c_{Ethane}	C_2H_6 emission rate (as Ethane)	lb/hour	< 0.00091	< 0.00166	< 0.00184	< 0.00219	< 0.00219	< 0.00221	**< 0.00220**
c_{Ethane}	C_2H_6 emission rate (as carbon)	lb/hour	< 0.00073	< 0.00133	< 0.00147	< 0.00175	< 0.00175	< 0.00177	**< 0.00175**
c_{Ethane}	C_2H_6 emission rate (as carbon)	lb / MMBtu	< 0.00007	< 0.00009	< 0.00008	< 0.00007	< 0.00007	< 0.00007	**< 0.00007**
Total Hydrocarbon Mass Rates (excluding methane and ethane) Method 25A									
E_{THC}	THC emission rate (as carbon)	lb/hour	0.0765	0.0616	0.0136	0.0278	0.0230	0.0408	**0.0306**
E_{THC}	THC emission rate (as carbon)	g/HP-hr	0.0308	0.0130	0.0020	0.0030	0.0025	0.0044	**0.0033**

Notes:

1) lb/MMBtu results based on Method 19 Fd factor of 9190 for diesel oil combustion.

2) (<) indicates the result were below the detection limit and value used is the mininally detected value.

Advanced Industrial Resources, Inc.

Test Results

Yancy

Griffin, GA

Generator RD99 Diesel

		Units	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Averages
Genset Load		% of full load	25	50	75	100	100	100	**100**
Test Date			06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	**06-Nov-20**
Start Time			7:55	9:28	10:43	11:58	13:12	14:25	**Runs**
End Time			9:00	10:31	11:47	13:04	14:17	15:30	**4, 5, 6**
P_m	Pressure of meter gases	inches Hg	30.26	30.20	30.18	30.17	30.15	30.11	**30.14**
P_s	Pressure of stack gases	inches Hg	30.16	30.09	30.09	30.07	30.05	30.01	**30.04**
$V_{m(std)}$	Volume of gas sample	dscf	38.26	39.85	36.47	40.85	40.46	38.16	**39.82**
$V_{w(std),meas}$	Meas. volume of water vapor	scf	2.21	2.54	2.73	2.68	2.92	2.45	**2.68**
$B_{ws,meas}$	Measured moisture	dimensionless	0.055	0.060	0.070	0.062	0.067	0.060	**0.063**
$B_{ws,theo}$	Theoretical max. moisture	dimensionless	1.000	1.000	1.000	1.000	1.000	1.000	**1.000**
$B_{ws,act}$	Actual moisture	dimensionless	0.055	0.060	0.070	0.062	0.067	0.060	**0.063**
M_d	Mol. Wt. Of gas at DGM	lb./lb.-mole	29.44	29.36	29.46	29.54	29.58	29.64	**29.59**
M_s	Mol. Wt. Of gas at stack	lb./lb.-mole	28.82	28.68	28.66	28.83	28.80	28.94	**28.86**
v_s	Velocity of stack gas	ft./sec	45.33	85.70	95.71	121.65	121.50	121.94	**121.70**
A_n	Area of nozzle	ft^2	0.000491	0.000289	0.000241	0.000218	0.000218	0.000218	**0.000218**
A_s	Area of stack	ft^2	3.14	3.14	3.14	3.14	3.14	3.14	**3.14**
Gas Stream Flow Rates									
Q_a	Vol. Flow rate of actual gas	cfm	8,544	16,154	18,041	22,931	22,902	22,986	**22,939**
Q_w	Vol. Flow rate of wet gas	scfm	4,386	7,597	8,294	10,167	10,086	10,041	**10,098**
Q_w	Vol. Flow rate of wet gas	scfh	263,182	455,846	497,638	610,029	605,151	602,478	**605,886**
Q_{sd}	Vol. Flow rate of dry gas	dscfm	4,147	7,142	7,716	9,541	9,407	9,436	**9,461**
I	Isokinetic sampling ratio	percent	98.5	101.3	102.9	102.8	103.3	97.1	**101.1**
Process Data									
$P_{(product\ input)}$	Process	HP	1,126	2,148	3,133	4,166	4,165	4,166	**4,166**
$P_{(heat\ input)}$	Fuel firing rate	MMBtu/hr	10.9	20.9	25.0	33.2	32.7	31.7	**32.5**
Gas Stream Particulate Concentrations Method 5									
c_{PM}	Conc. Of PM in dry stack gas	mg/dscm	43.01	2.85	4.77	3.42	3.48	2.51	**3.14**
c_{PM}	Conc. Of PM in dry stack gas	gr/dscf	0.01879	0.00125	0.00208	0.00150	0.00152	0.00110	**0.00137**
Particulate Matter Mass Rates Method 5									
E_{PM}	Emission rate of PM	lb/hour	0.668	0.076	0.138	0.122	0.122	0.089	**0.111**
E_{PM}	Emission rate of PM	g/HP-hr	0.269	0.016	0.020	0.013	0.013	0.010	**0.012**
E_{PM}	Emission rate of PM	lb / MMBtu	0.0615	0.0036	0.0055	0.0037	0.0037	0.0028	**0.0034**
Gas Stream Particulate Concentrations Method 202									
c_{PM}	Conc. Of PM in dry stack gas	mg/dscm	9.88	10.68	15.15	8.34	11.00	12.96	**10.77**
c_{PM}	Conc. Of PM in dry stack gas	gr/dscf	0.00431	0.00466	0.00662	0.00364	0.00480	0.00566	**0.00470**
Particulate Matter Mass Rates Method 202									
E_{PM}	Emission rate of PM	lb/hour	0.153	0.286	0.438	0.298	0.388	0.458	**0.381**
E_{PM}	Emission rate of PM	g/HP-hr	0.062	0.060	0.063	0.032	0.042	0.050	**0.042**
E_{PM}	Emission rate of PM	lb / MMBtu	0.014	0.014	0.018	0.009	0.012	0.014	**0.0118**
Gas Stream Particulate Concentrations Methods 5 & 202									
c_{PM}	Conc. Of PM in dry stack gas	mg/dscm	52.89	13.53	19.92	11.77	14.47	15.46	**13.90**
c_{PM}	Conc. Of PM in dry stack gas	gr/dscf	0.0231	0.0059	0.0087	0.0051	0.0063	0.0068	**0.0061**
Particulate Matter Mass Rates Methods 5 & 202									
E_{PM}	Emission rate of PM	lb/hour	0.82	0.36	0.58	0.42	0.51	0.55	**0.49**
E_{PM}	Emission rate of PM	g/HP-hr	0.331	0.076	0.083	0.046	0.056	0.060	**0.054**
E_{PM}	Emission rate of PM	lb / MMBtu	0.0757	0.0173	0.0230	0.0127	0.0156	0.0172	**0.0152**
Sulfur Dioxide Concentrations Method 6C									
c_{SO2}	Conc. of SO_2 in dry stack gas	ppm	3.38	2.3	4.40	5.67	6.44	6.20	**6.10**
c_{SO2}	Conc. of SO_2 in dry stack gas	ppm @ 15% O_2	2.38	1.46	2.50	3.00	3.42	3.40	**3.27**
c_{SO2}	Conc. of SO_2 in dry stack gas	mg/dscm	8.99	6.19	11.71	15.08	17.15	16.50	**16.24**
c_{SO2}	Conc. of SO_2 in dry stack gas	gr/dscf	0.00393	0.00270	0.00511	0.00658	0.00749	0.00721	**0.00709**
Sulfur Dioxide Mass Rates Method 6C									
E_{SO2}	Emission rate of SO_2	lb/hour	0.14	0.17	0.34	0.54	0.60	0.58	**0.58**
E_{SO2}	Emission rate of SO_2	g/HP-hr	0.056	0.035	0.049	0.059	0.066	0.064	**0.063**
E_{SO2}	Emission rate of SO_2	lb / MMBtu	0.0129	0.0079	0.0135	0.0162	0.0185	0.0184	**0.0177**

Advanced Industrial Resources, Inc.

Test Results

Yancy

Griffin, GA

Generator RD99 Diesel

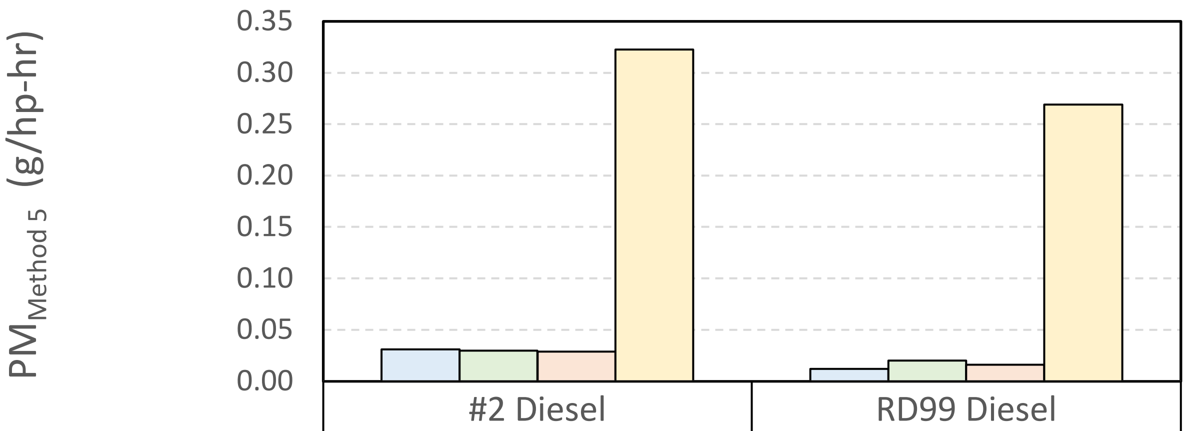
		Units	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Averages
Genset Load		% of full load	25	50	75	100	100	100	**100**
Test Date			06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	06-Nov-20	**06-Nov-20**
Start Time			7:55	9:28	10:43	11:58	13:12	14:25	**Runs**
End Time			9:00	10:31	11:47	13:04	14:17	15:30	**4, 5, 6**
Nitrogen Oxides Concentrations Method 7E									
c_{NOx}	Conc. of NO_x in dry stack gas	ppm	516.4	236.9	555.0	812.5	823.6	859.7	**831.9**
c_{NOx}	Conc. of NO_x in dry stack gas	ppm @ 15% O_2	363.6	148.9	315.4	430.7	437.0	470.9	**446.2**
c_{NOx}	Conc. of NO_x in dry stack gas	mg/dscm	987.7	453.1	1061.5	1554.0	1575.3	1644.3	**1591.2**
c_{NOx}	Conc. of NO_x in dry stack gas	gr/dscf	0.431	0.198	0.464	0.679	0.688	0.718	**0.695**
Nitrogen Oxides Mass Rates Method 7E									
E_{NOx}	Emission rate of NO_x	lb/hour	15.3	12.1	30.7	55.5	55.5	58.1	**56.4**
E_{NOx}	Emission rate of NO_x	g/HP-hr	6.18	2.56	4.44	6.05	6.05	6.33	**6.14**
E_{NOx}	Emission rate of NO_x	lb / MMBtu	1.41	0.58	1.23	1.67	1.70	1.83	**1.73**
Carbon Monoxide Concentrations Method 10									
c_{CO}	Conc. of CO in dry stack gas	ppm	294.0	52.5	90.5	57.1	61.2	63.3	**60.6**
c_{CO}	Conc. of CO in dry stack gas	ppm @ 15% O_2	207.0	33.0	51.4	30.3	32.5	34.7	**32.5**
c_{CO}	Conc. of CO in dry stack gas	mg/dscm	342.3	61.1	105.3	66.5	71.3	73.8	**70.5**
c_{CO}	Conc. of CO in dry stack gas	gr/dscf	0.1495	0.0267	0.0460	0.0290	0.0311	0.0322	**0.0308**
Carbon Monoxide Mass Rates Method 10									
E_{CO}	Emission rate of CO	lb/hour	5.32	1.63	3.04	2.38	2.51	2.61	**2.50**
E_{CO}	Emission rate of CO	g/HP-hr	2.14	0.35	0.44	0.26	0.27	0.28	**0.27**
E_{CO}	Emission rate of CO	lb / MMBtu	0.490	0.078	0.122	0.072	0.077	0.082	**0.077**
Total Hydrocarbon Concentrations (including methane) Method 25A									
c_{THC}	THC concentration (as methane)	ppm	5.56	2.98	1.87	2.03	2.10	2.18	**2.10**
c_{THC}	THC concentration (as methane)	ppm @ 15% O_2	3.91	1.88	1.06	1.08	1.12	1.19	**1.13**
c_{THC}	THC concentration (as methane)	mg/dscm	3.70	1.99	1.24	1.35	1.40	1.45	**1.40**
c_{THC}	THC concentration (as methane)	gr/dscf	0.00162	0.00087	0.00054	0.00059	0.00061	0.00063	**0.00061**
Total Hydrocarbon Mass Rates (including methane) Method 25A									
E_{THC}	THC emission rate (as methane)	lb/hour	0.0575	0.0531	0.0359	0.0484	0.0493	0.0511	**0.0496**
E_{THC}	THC emission rate (as carbon)	lb/hour	0.0431	0.0398	0.0270	0.0363	0.0370	0.0384	**0.0372**
E_{THC}	THC emission rate (as carbon)	lb / MMBtu	0.0053	0.0025	0.0014	0.0015	0.0015	0.0016	**0.0015**
Methane Concentrations Method 25A									
$c_{Methane}$	CH_4 concentration (as methane)	ppm	1.62	0.79	< 0.49	< 0.48	< 0.45	< 0.45	**0.46**
$c_{Methane}$	CH_4 concentration (as methane)	ppm @ 15% O_2	1.14	0.50	< 0.28	< 0.26	< 0.24	< 0.25	**0.25**
$c_{Methane}$	CH_4 concentration (as methane)	mg/dscm	1.08	0.53	< 0.32	< 0.32	< 0.30	< 0.30	**0.31**
$c_{Methane}$	CH_4 concentration (as methane)	gr/dscf	0.00047	0.00023	< 0.00014	< 0.00014	< 0.00013	< 0.00013	**0.00013**
Methane Mass Rates Method 25A									
$E_{Methane}$	CH_4 emission rate (as methane)	lb/hour	0.0167	0.0141	< 0.0094	< 0.0115	< 0.0106	< 0.0107	**0.0109**
$E_{Methane}$	CH_4 emission rate (as carbon)	lb/hour	0.0125	0.0106	< 0.0070	< 0.0086	< 0.0080	< 0.0080	**0.0082**
$E_{methane}$	CH_4 emission rate (as carbon)	lb / MMBtu	0.001156	0.000675	< 0.000374	< 0.000346	< 0.000325	< 0.000336	**0.000335**
Ethane Concentrations Method 25A									
c_{Ethane}	C_2H_6 concentration (as Ethane)	ppm	< 0.0514	< 0.0491	< 0.0497	< 0.0492	< 0.0495	< 0.0492	**< 0.0493**
c_{Ethane}	C_2H_6 concentration (as Ethane)	ppm @ 15% O_2	< 0.0362	< 0.0309	< 0.0282	< 0.0261	< 0.0263	< 0.0269	**< 0.0264**
c_{Ethane}	C_2H_6 concentration (as Ethane)	mg/dscm	< 0.0643	< 0.0614	< 0.0621	< 0.0616	< 0.0619	< 0.0615	**< 0.0617**
c_{Ethane}	C_2H_6 concentration (as Ethane)	gr/dscf	< 0.000028	< 0.000027	< 0.000027	< 0.000027	< 0.000027	< 0.000027	**< 0.000027**
Ethane Mass Rates Method 25A									
c_{Ethane}	C_2H_6 emission rate (as Ethane)	lb/hour	< 0.00100	< 0.00164	< 0.00179	< 0.00220	< 0.00218	< 0.00217	**< 0.00218**
c_{Ethane}	C_2H_6 emission rate (as carbon)	lb/hour	< 0.00080	< 0.00131	< 0.00143	< 0.00176	< 0.00174	< 0.00173	**< 0.00174**
c_{Ethane}	C_2H_6 emission rate (as carbon)	lb / MMBtu	< 0.00007	< 0.00008	< 0.00007	< 0.00007	< 0.00007	< 0.00007	**< 0.00007**
Total Hydrocarbon Mass Rates (excluding methane and ethane) Method 25A									
E_{THC}	THC emission rate (as carbon)	lb/hour	0.0297	0.0279	0.0185	0.0259	0.0273	0.0286	**0.0273**
E_{THC}	THC emission rate (as carbon)	g/HP-hr	0.0120	0.0059	0.0027	0.0028	0.0030	0.0031	**0.0030**

Notes:

1) lb/MMBtu results based on Method 19 Fd factor of 9190 for diesel oil combustion.

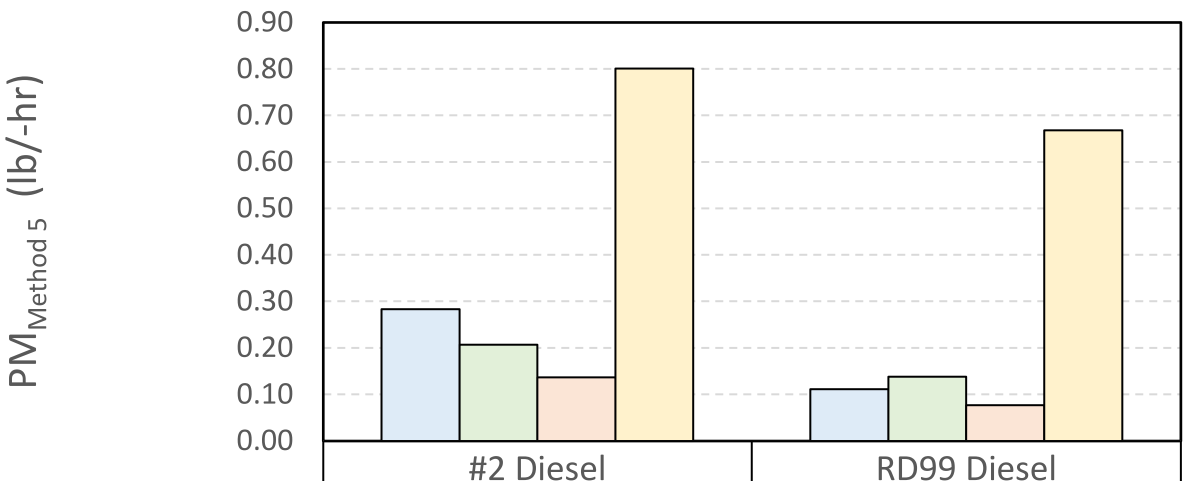
2) (<) indicates the result were below the detection limit and value used is the mininally detected value.

Emissions Test Comparisons - $PM_{Method\ 5}$ (g/hp-hr)



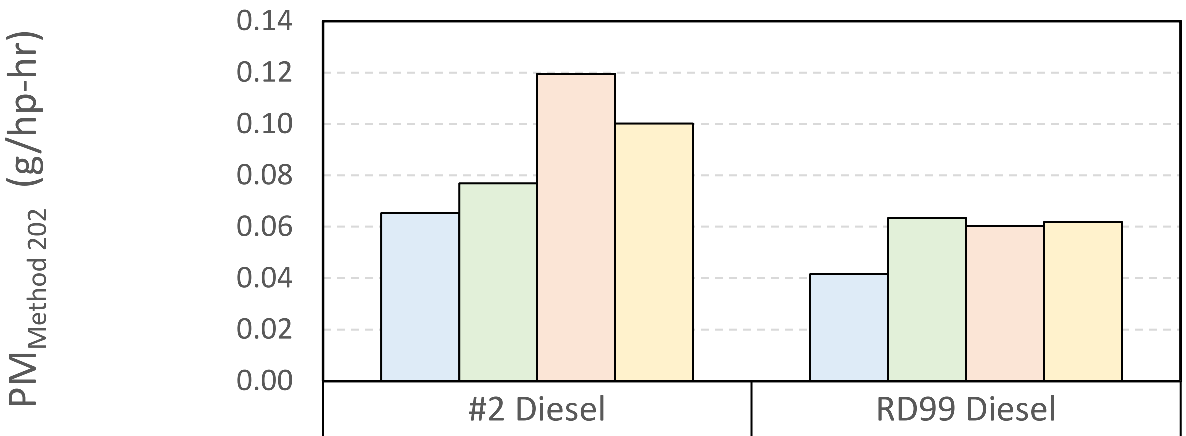
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0308	0.0121
75% of Full Load	0.0297	0.0199
50% of Full Load	0.0288	0.0161
25% of Full Load	0.3227	0.2691

Emissions Test Comparisons - $PM_{Method\ 5}$ (lb/hr)



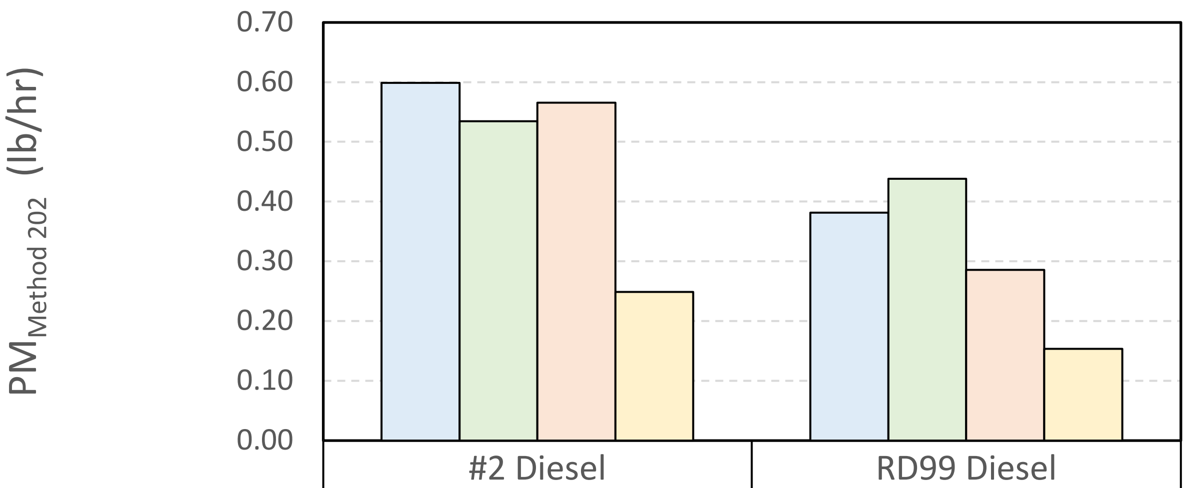
	#2 Diesel	RD99 Diesel
100% of Full Load	0.2829	0.1112
75% of Full Load	0.2066	0.1378
50% of Full Load	0.1366	0.0763
25% of Full Load	0.8010	0.6681

Emissions Test Comparisons - $PM_{Method\ 202}$ (g/hp-hr)



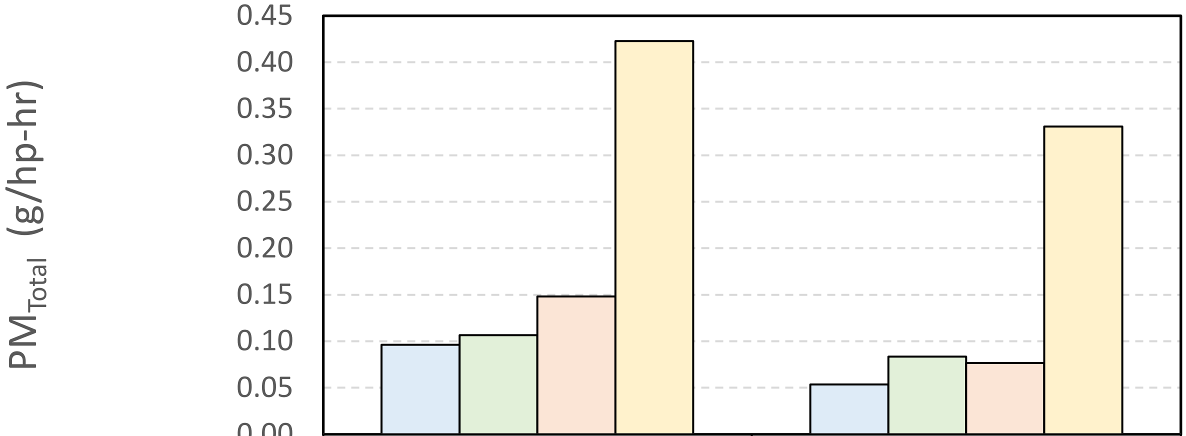
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0653	0.0415
75% of Full Load	0.0769	0.0634
50% of Full Load	0.1194	0.0603
25% of Full Load	0.1001	0.0618

Emissions Test Comparisons - $PM_{Method\ 202}$ (lb/hr)



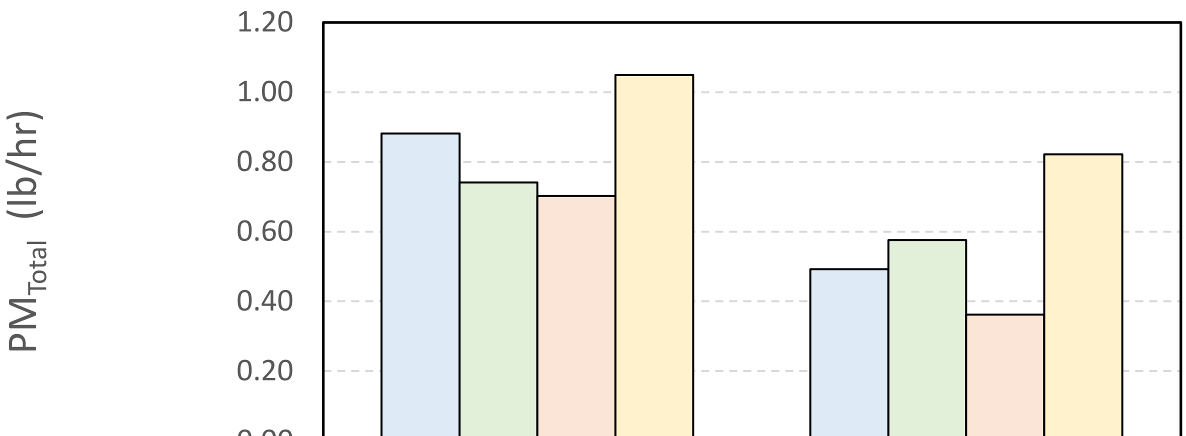
	#2 Diesel	RD99 Diesel
100% of Full Load	0.5988	0.3812
75% of Full Load	0.5342	0.4380
50% of Full Load	0.5654	0.2857
25% of Full Load	0.2486	0.1534

Emissions Test Comparisons - PM_{Total} (g/hp-hr)



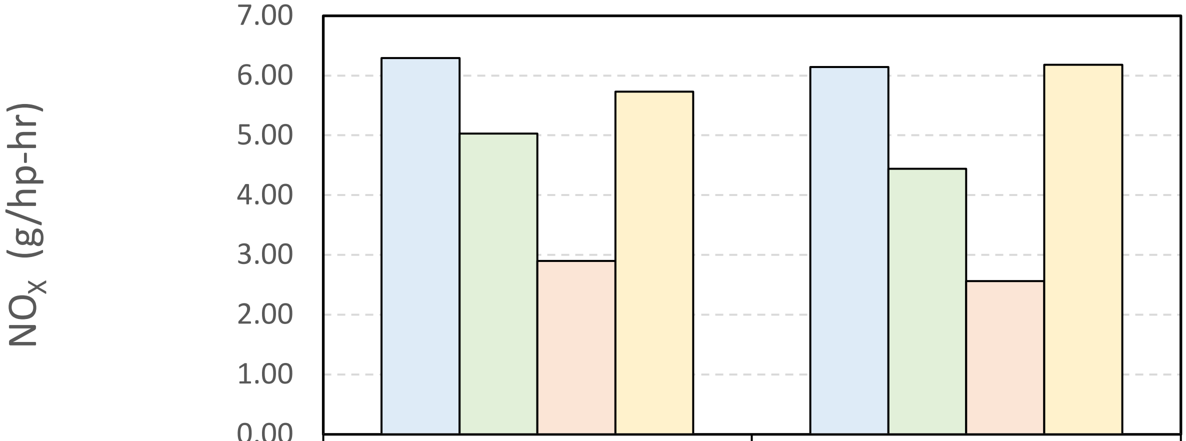
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0961	0.0536
75% of Full Load	0.1066	0.0834
50% of Full Load	0.1483	0.0764
25% of Full Load	0.4228	0.3309

Emissions Test Comparisons - PM_{Total} (lb/hr)



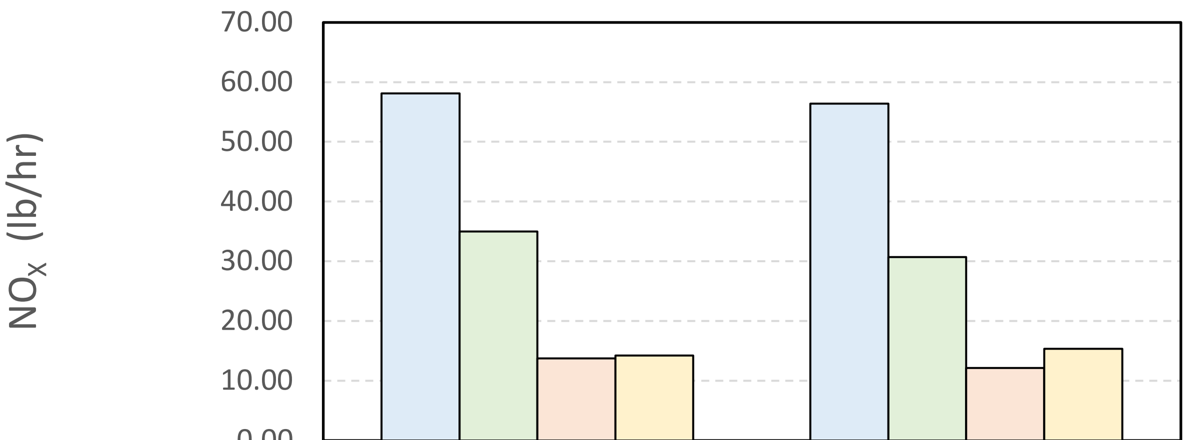
	#2 Diesel	RD99 Diesel
100% of Full Load	0.8817	0.4924
75% of Full Load	0.7409	0.5757
50% of Full Load	0.7021	0.3620
25% of Full Load	1.0495	0.8214

Emissions Test Comparisons - NO_X (g/hp-hr)

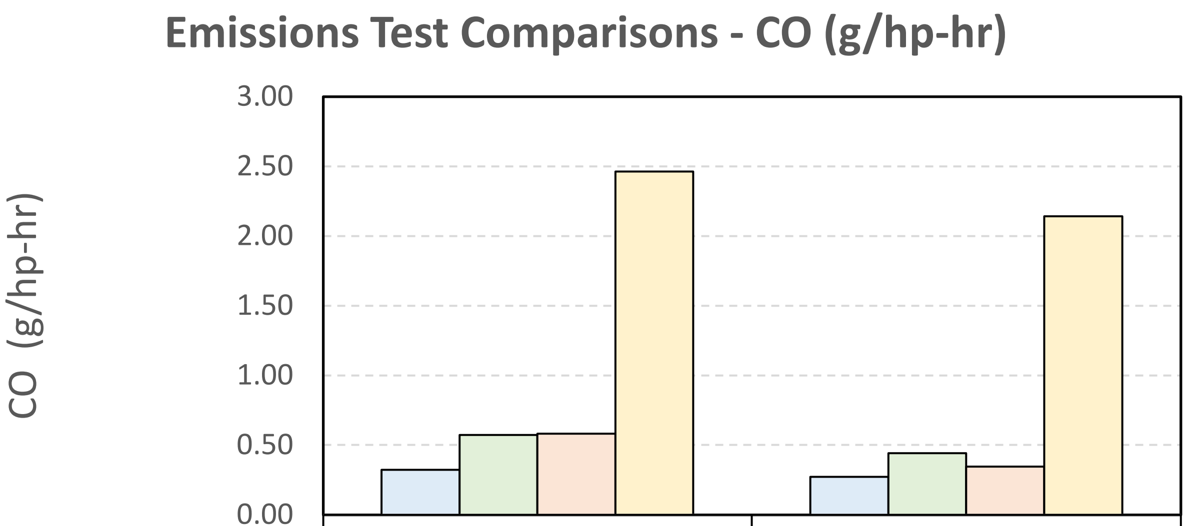


	#2 Diesel	RD99 Diesel
100% of Full Load	6.2908	6.1399
75% of Full Load	5.0312	4.4419
50% of Full Load	2.8958	2.5598
25% of Full Load	5.7292	6.1802

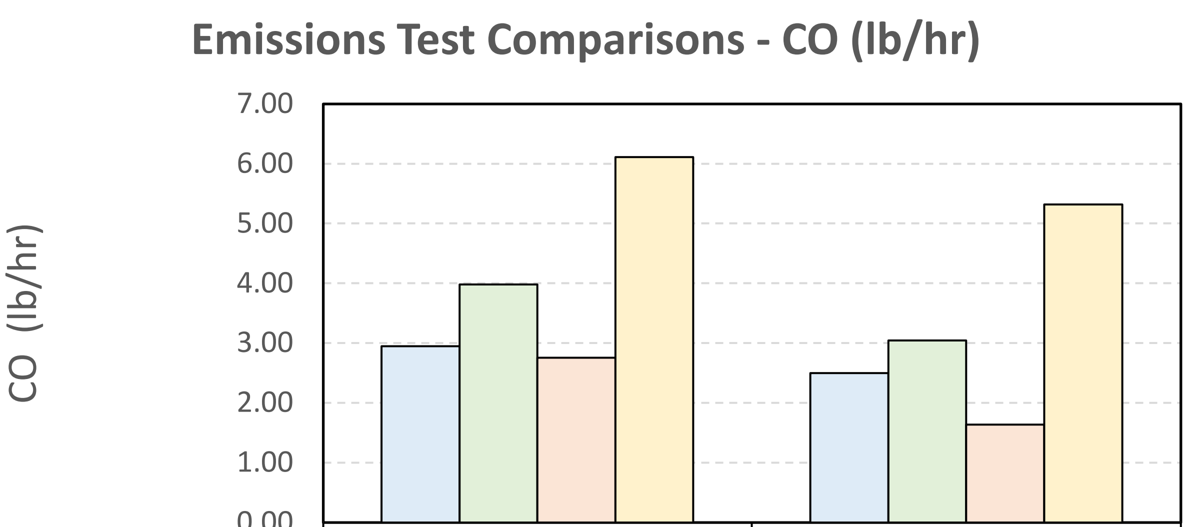
Emissions Test Comparisons - NO_X (lb/hr)



	#2 Diesel	RD99 Diesel
100% of Full Load	58.0785	56.3874
75% of Full Load	34.9503	30.6804
50% of Full Load	13.7131	12.1221
25% of Full Load	14.2221	15.3419

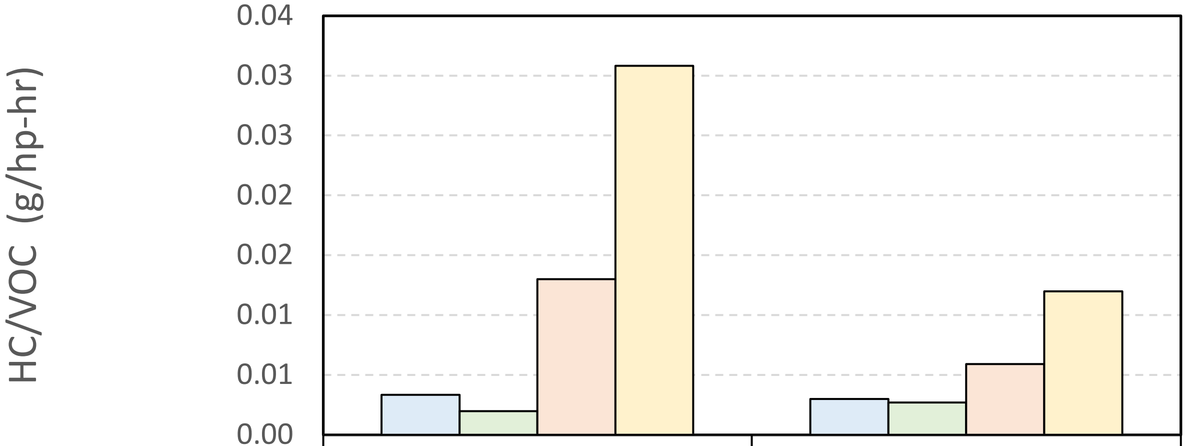


	#2 Diesel	RD99 Diesel
100% of Full Load	0.3212	0.2721
75% of Full Load	0.5726	0.4408
50% of Full Load	0.5809	0.3450
25% of Full Load	2.4619	2.1417



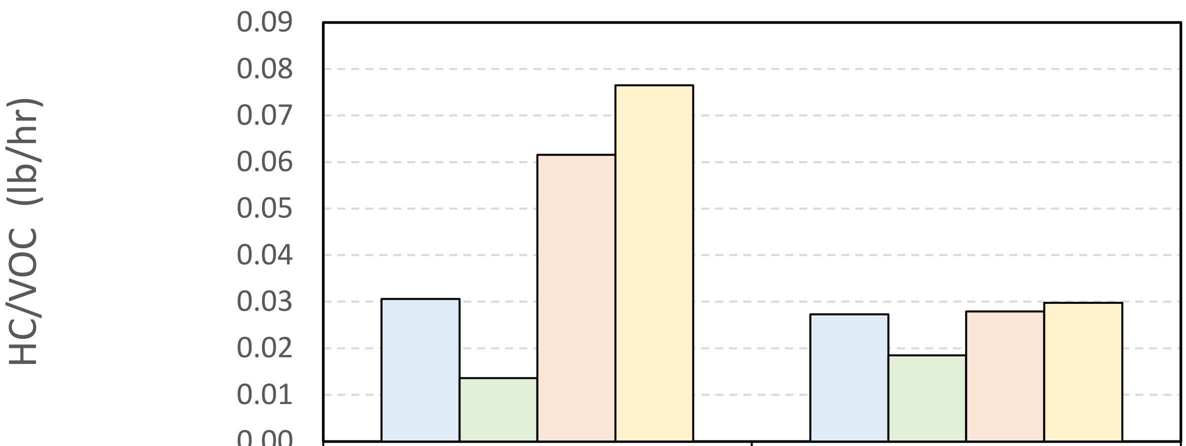
	#2 Diesel	RD99 Diesel
100% of Full Load	2.9471	2.4987
75% of Full Load	3.9776	3.0445
50% of Full Load	2.7510	1.6339
25% of Full Load	6.1115	5.3166

Emissions Test Comparisons - HC/VOC (g/hp-hr)



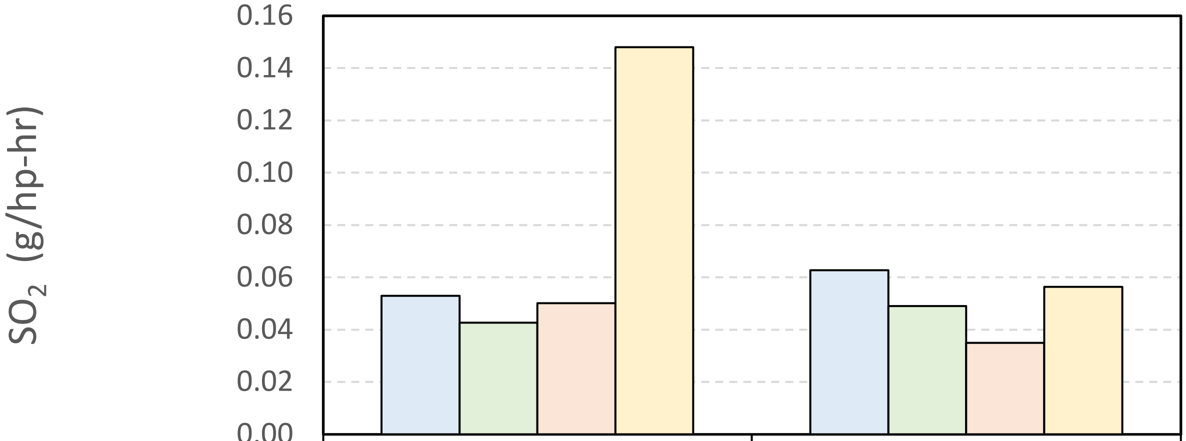
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0033	0.0030
75% of Full Load	0.0020	0.0027
50% of Full Load	0.0130	0.0059
25% of Full Load	0.0308	0.0120

Emissions Test Comparisons - HC/VOC (lb/hr)



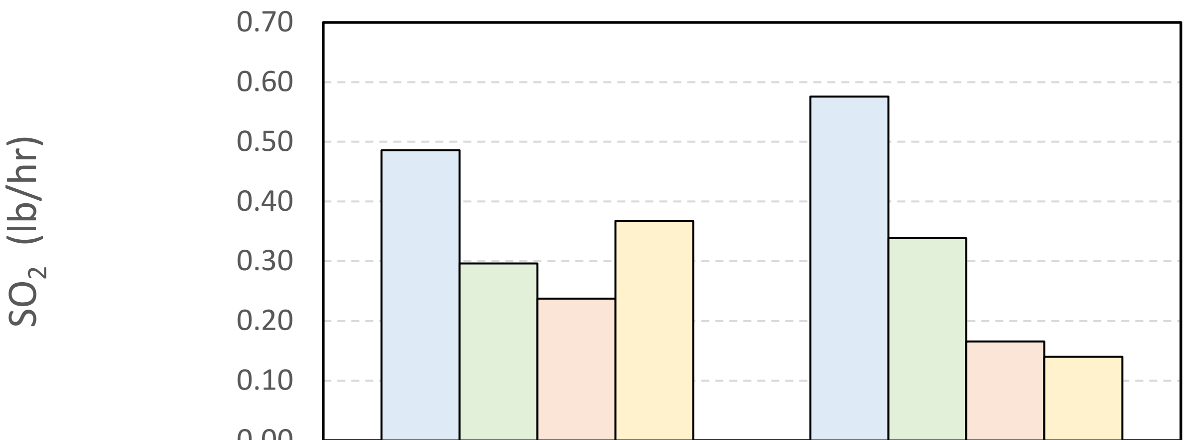
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0306	0.0273
75% of Full Load	0.0136	0.0185
50% of Full Load	0.0616	0.0279
25% of Full Load	0.0765	0.0297

Emissions Test Comparisons - SO_2 (g/hp-hr)



	#2 Diesel	RD99 Diesel
100% of Full Load	0.0530	0.0627
75% of Full Load	0.0426	0.0490
50% of Full Load	0.0501	0.0350
25% of Full Load	0.1480	0.0563

Emissions Test Comparisons - SO_2 (lb/hr)



	#2 Diesel	RD99 Diesel
100% of Full Load	0.4860	0.5754
75% of Full Load	0.2963	0.3384
50% of Full Load	0.2374	0.1657
25% of Full Load	0.3675	0.1397

APPENDIX G – SEPA CHECKLIST AND DETERMINATION

SEPA ENVIRONMENTAL CHECKLIST

Purpose of checklist:

Governmental agencies use this checklist to help determine whether the environmental impacts of your proposal are significant. This information is also helpful to determine if available avoidance, minimization or compensatory mitigation measures will address the probable significant impacts or if an environmental impact statement will be prepared to further analyze the proposal.

Instructions for applicants:

This environmental checklist asks you to describe some basic information about your proposal. Please answer each question accurately and carefully, to the best of your knowledge. You may need to consult with an agency specialist or private consultant for some questions. You may use “not applicable” or "does not apply" only when you can explain why it does not apply and not when the answer is unknown. You may also attach or incorporate by reference additional studies reports. Complete and accurate answers to these questions often avoid delays with the SEPA process as well as later in the decision-making process.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Instructions for Lead Agencies:

Please adjust the format of this template as needed. Additional information may be necessary to evaluate the existing environment, all interrelated aspects of the proposal and an analysis of adverse impacts. The checklist is considered the first but not necessarily the only source of information needed to make an adequate threshold determination. Once a threshold determination is made, the lead agency is responsible for the completeness and accuracy of the checklist and other supporting documents.

Use of checklist for nonproject proposals:

For nonproject proposals (such as ordinances, regulations, plans and programs), complete the applicable parts of sections A and B plus the SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS (part D). Please completely answer all questions that apply and note that the words "project," "applicant," and "property or site" should be read as "proposal," "proponent," and "affected geographic area," respectively. The lead agency may exclude (for non-projects) questions in Part B - Environmental Elements –that do not contribute meaningfully to the analysis of the proposal.

A. Background [HELP]

1. Name of proposed project, if applicable: **CO7/CO8 Site**

2. Name of applicant: **Microsoft Corporation**

3. Address and phone number of applicant and contact person:

Adam McKnight
425-703-6526
1515 Port Industrial Parkway
Quincy, Washington 98848

4. Date checklist prepared: **July 26, 2021**

5. Agency requesting checklist: **City of Quincy Building Department**

6. Proposed timing or schedule (including phasing, if applicable):

Construction Start: September 2021

- **CO7 Substantial Complete: January 2023**
- **CO8 Substantial Complete: January 2023**

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

Additions, expansion, or further activity are not currently planned in connection with this proposal.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

- **Stormwater Pollution Prevention Plan**
- **Air Quality Notice of Construction Permit**
- **Noise Limitations and Mitigation Plan**

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

No applications are pending for governmental approvals directly affecting the property covered by the proposal.

10. List any government approvals or permits that will be needed for your proposal, if known.

- **Stormwater Pollution Prevention Plan**
- **Air Quality Notice of Construction Permit**
- **City of Quincy Building Permit**

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

Microsoft is proposing to construct two buildings in its existing data center facility in Quincy, Washington. Both building will be utilized as data centers and exactly 7,800SF. The total area of the site is 67.15 acres, expected ground disturbances total 5.35 acres.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The proposal is located in Quincy, Grant County, Washington in the Section 7 of Township 20N and Range 24E. The address is 501 Port Industrial Way Quincy, Washington 98848.

B. Environmental Elements [HELP]

1. *Earth* [help]

a. General description of the site: **Flat**

(circle one): Flat, rolling, hilly, steep slopes, mountainous, other.

b. What is the steepest slope on the site (approximate percent slope)?

The slopes on site are less than 1%.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

Based on the NRCS, general types of soils include Warden silt loam, 0 to 2 percent slopes, however all soils are currently paved over.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.

Two buildings will be built to house data centers that will be 7,800SF. Ground disturbance activities will total 5.35 acres. Approximately 1,200CY of soil will be brought in for building and pad preparation.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Yes, but is unlikely as the slope of the area is less than 1% and the existing area is currently permanently stabilized as a gravel laydown area. A Storm Water Pollution Protection Plan and an Erosion Control Plan will be implemented for the site.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

The current impervious covering of the site surface is 80.99%. After construction, the impervious covering of the surface will be 81.09%.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

A Storm Water Pollution Protection Plan and an Erosion Control Plan will be implemented for the site.

2. Air [help]

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

Emissions during construction include dust and emission generated from construction equipment. Proposed diesel fuel tanks, emergency generators, and cooling towers will generate emissions during operation and maintenance.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

There are no off-site sources of emissions or odor that would affect the proposal.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

An Air Permit Analysis determined that an Air Quality Notice of Construction will be required to reduce or control emissions.

3. Water [help]

a. Surface Water: [help]

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

There are no surface water bodies on or in the immediate vicinity of the site.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

The project will not require any work over, in, or adjacent to any surface water bodies.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

Not Applicable

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

The proposal does not require surface water withdrawals or diversions.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

No. The project is within FEMA Zone 'X', which is defined as "Area of Minimal Flood Hazard".

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

The project does not involve any discharges of waste materials to surface waters.

b. Ground Water: [help]

1) Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

Groundwater will not be withdrawn for this project.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals. . . ; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

No waste material will be discharged into the ground.

c. Water runoff (including stormwater):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Stormwater runoff from the project site will be collected in stormwater retention ponds. All stormwater infiltrated or evaporated onsite.

2) Could waste materials enter ground or surface waters? If so, generally describe.

No. Full compliance with all applicable stormwater regulations will ensure that waste material will not enter ground or surface waters.

3) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.

The project does not alter or affect drainage patterns in the vicinity of the site.

d. Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, if any:

No measures to reduce or control surface, ground, and runoff water and drainage pattern impacts are applicable for this project.

4. Plants [help]

a. Check the types of vegetation found on the site: **N/A**

____deciduous tree: alder, maple, aspen, other
____evergreen tree: fir, cedar, pine, other
_____shrubs
_____grass
____pasture
____crop or grain
____ Orchards, vineyards or other permanent crops.
____ wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other
____water plants: water lily, eelgrass, milfoil, other
____other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

Only gravel laydown yards will be impacted.

c. List threatened and endangered species known to be on or near the site.

There are no threatened or endangered species known to be on or near the site.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

The project site will be landscaped in accordance with City of Quincy requirements; however, no vegetation will be disturbed as a result of this project.

e. List all noxious weeds and invasive species known to be on or near the site.

Noxious weeds and invasive species are not present on the site.

5. Animals [help]

a. List any birds and other animals which have been observed on or near the site or are known to be on or near the site.

Examples include:

birds: **hawk, heron, eagle, songbirds**, other:
mammals: deer, bear, elk, beaver, other:
fish: bass, salmon, trout, herring, shellfish, other ________

b. List any threatened and endangered species known to be on or near the site.

None

c. Is the site part of a migration route? If so, explain.

The site, as is the entire west coast of the US, is located within the Pacific Flyway. This flyway is the general migration route for various species of ducks, geese and other migratory waterfowl. The flyway stretches from Alaska to Mexico and from the Pacific Ocean to the Rocky Mountains.

d. Proposed measures to preserve or enhance wildlife, if any:

There are no proposed measures to preserve or enhance wildlife.

e. List any invasive animal species known to be on or near the site.

No invasive animals' species are known to be on or near the site.

6. Energy and Natural Resources [help]

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Electricity will be needed and is being secured to power the data center.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

The project will not affect the potential use of solar energy by adjacent properties.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

The project will meet the requirements for LEED Gold certification.

7. Environmental Health [help]

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

The proposal includes on-site storage of approximately 26,714 gallons of fuel in double wall belly tanks associated with the backup generators. While the risk is low, it increases the chance of exposure to health hazards. The project will require to prepare a Spill Prevention Control and Countermeasure Plan for the storage tank. Electrical issues can occur with the data center buildings and increase the risk of a fire.

1) Describe any known or possible contamination at the site from present or past uses.

There is no known or possible contamination at the site from present or past issues.

2) Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity.

There are no known existing hazardous chemical/conditions that might affect project development.

3) Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.

Toxic or hazardous chemicals during construction would be confined to staging areas, covered, and monitored. Secondary containment will be utilized as necessary.

4) Describe special emergency services that might be required.

Fire and/or EMS services may be needed if accidents occur on the project site.

5) Proposed measures to reduce or control environmental health hazards, if any:

A Spill Prevention Control and Countermeasure Plan will be used to reduce and control environmental health hazards. A Notice of Construction permit will be

required to regulate air emissions from diesel fuel tanks, diesel-fueled emergency stationary reciprocating internal combustion engines.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

Existing sound sources in the ambient environment consist of industrial facilities, truck traffic, local traffic, and wildlife. Measurements were taken during daytime hours at four measurement locations surrounding the Project. Measured sound levels ranged from 46 to 51 dBA and are not expected to significantly impact the Project.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

Major environmental noise sources at the Project site are expected to include emergency stationary reciprocating internal combustion engines and heating, ventilation, and air conditioning equipment. WAC Section 173-60-040 provides a maximum permissible sound level at residential property to be 50 dBA during daytime hours and 60 dBA during nighttime hours. The Project sound sources were developed to not exceed 50 dBA during emergency operation when all HVAC and select generators are operating. Emergency Operation is expected to be the loudest scenario and is not expected to regularly occur. Normal Operation and Generator Testing scenarios were also modeled to be below the WAC sound level restrictions.

3) Proposed measures to reduce or control noise impacts, if any:

To meet local noise regulations, mitigation measures implemented include exhaust silencers on generators and enclosures for generators. Upon implementation of these mitigation measures, the Project is expected to comply with applicable regulations.

8. Land and Shoreline Use [help]

a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.

The site is currently located within Microsoft's existing facility. The current use of adjacent properties is a mixture of industrial, agricultural, commercial, and residential uses. The proposal will not affect land use of nearby property.

b. Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?

Farmland previously present at this location was previously converted for industrial purposes.

1) Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? If so, how:

   No

c. Describe any structures on the site.

   There are no existing structures within the construction footprint, however the site is located within Microsoft's existing campus.

d. Will any structures be demolished? If so, what?

   No

e. What is the current zoning classification of the site?

   General Industrial (I-G)

f. What is the current comprehensive plan designation of the site?

   Industrial

g. If applicable, what is the current shoreline master program designation of the site?

   Not Applicable

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.

   No part of the site has been classified as critical.

i. Approximately how many people would reside or work in the completed project?

   Up to 14 people in each building.

j. Approximately how many people would the completed project displace?

   None

k. Proposed measures to avoid or reduce displacement impacts, if any:

   Not Applicable

L. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The proposed activity is consistent with permitted use within the General Industrial Zone.

m. Proposed measures to reduce or control impacts to agricultural and forest lands of long-term commercial significance, if any:

Not Applicable

9. Housing [help]

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

Not Applicable

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

Not Applicable

c. Proposed measures to reduce or control housing impacts, if any:

Not Applicable

10. Aesthetics [help]

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The generator stacks are the tallest structure on the Project site at 71'8" tall and the top of the exhaust pipe is 72' above grade.

b. What views in the immediate vicinity would be altered or obstructed?

There will be minimal impacts to views since these buildings are located within the existing facility and the surrounding buildings are taller than the proposed structures.

c. Proposed measures to reduce or control aesthetic impacts, if any:

Not Applicable

11. Light and Glare [help]

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Parking lots, buildings, and vehicles will produce light and glare when it is dark and indoor light from buildings.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

Light or glare is not expected to be a safety hazard and interfere with views.

c. What existing off-site sources of light or glare may affect your proposal?

No existing off-site sources of light or glare are expected to affect the proposal.

d. Proposed measures to reduce or control light and glare impacts, if any:

The project lighting will be designed to provide a safe level of lighting in the parking areas and around the buildings. Light fixtures and pole spacing will be designed to minimize light encroachment on adjacent properties.

12. Recreation [help]

a. What designated and informal recreational opportunities are in the immediate vicinity?

There are no recreation areas adjacent to or in the immediate vicinity of the site.

b. Would the proposed project displace any existing recreational uses? If so, describe.

The proposed project will not displace any existing recreational uses.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

Not Applicable

13. Historic and cultural preservation [help]

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers? If so, specifically describe.

No buildings, structures, or sites are listed in or eligible for listing in national, state, or local preservation registers.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.

None are present. The Project will be completed entirely within an existing developed site.

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.

Not Applicable

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.

No impacts are anticipated; therefore, no measures are proposed. If previously unidentified cultural resources are encountered during construction, work will cease in the vicinity and consultation with the project environmental team and county will be initiated.

14. Transportation [help]

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

The site is accessed by 501 Port Industrial Way.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?

No

c. How many additional parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate?

The project will not add additional parking spaces as there is currently sufficient parking at the campus to support parking needs.

d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).

No

e. Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

The project will not use water, rail, or air transportation in the immediate vicinity.

f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and nonpassenger vehicles). What data or transportation models were used to make these estimates?

The first phase is expected to create approximately 56 daily vehicular trips, with a peak PM trip count of approximately 28 trips. The majority of trips generated after construction will be passenger vehicles and small trucks.

g. Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.

No

h. Proposed measures to reduce or control transportation impacts, if any:

Not Applicable

15. Public Services [help]

a. Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.

No

b. Proposed measures to reduce or control direct impacts on public services, if any.

Proposed measures to reduce or control direct impacts include OSHA regulations and BMPs will be followed during construction. The site is design with a focus on long-term safety which reduces the potential to need emergency services.

16. Utilities [help]

a. Circle utilities currently available at the site:
electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other ___________

Electricity, sanitary sewer, and water are currently available at the site.

d. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

Domestic Water – City of Quincy
Sanitary Sewer – City of Quincy
Storm Water – City of Quincy
Industrially Treated Water – City of Quincy
Industrial Wastewater – City of Quincy
Refuse Service – Consolidated Disposal Services Inc or TBD
Electricity – Grand County PUD

C. Signature [HELP]

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Adam McKnight Digitally signed by Adam McKnight DN: CN=Adam McKnight, OU=MSE, OU=Users, OU=CoreIdentity, DC=redmond, DC=corp, DC=microsoft, DC=com Date: 2021.07.30 09:11:50-07'00'

Name of signee: Adam McKnight

Position and Agency/Organization Principal Design Manager/ Microsoft Corporation

Date Submitted: 07/30/2021

City Hall / City Clerk
(509) 787-3523
Fax (509) 787-1284
Public Services Building
(509) 787-3523
Fax (509) 787-2212

CITY OF QUINCY

104 B Street SW
P.O. Box 338
Quincy, Washington 98848

Notice of Application

Optional DNS Process

August 27, 2021

The City of Quincy has received a permit application for the following project.

Date of permit application: July 26, 2021

Date of determination of completeness: August 26, 2021

Date of notice of application: September 1, 2021

Comment due date: September 15, 2021

Agency Contact: *Carl Worley, Municipal Services Director*
cworley@quincywashington.us
P.O. Box 338/115 1st Avenue SW, Quincy, WA 98848
(509) 787-3523

Project Description: Microsoft is proposing to construct two buildings in its existing, 67.15-acre data center facility. Both buildings will be utilized as data centers and are 7,800 square feet in size. Construction of the two buildings is expected to disturb an estimated 5.35 acres within the existing 67.15-acre data center facility. There is existing parking available within the campus and all landscaping with comply with the City's landscaping municipal code. The current zoning classification of the site is general industrial. The comprehensive plan designation of the site is industrial.

Location of proposal: *501 Port Industrial Way, Quincy, WA 98848*

Project Applicant: Aaron McKnight
1515 Port Industrial Way
Quincy, WA 98848
(509) 289-0376

SEPA Environmental Review: The City of Quincy has reviewed the proposed project for probable adverse environmental impacts and expects to issue a Determination of Nonsignificance (DNS). This determination is based on the following findings and conclusions:

This determination is based on the following considerations:

City Hall / City Clerk
(509) 787-3523
Fax (509) 787-1284
Public Services Building
(509) 787-3523
Fax (509) 787-2212

104 B Street SW
P.O. Box 338
Quincy, Washington 98848

- The proposed, 5.35-acre project is within an existing 67.15-acre data center facility that has already been disturbed.
- Stormwater will be captured using on-site stormwater retention ponds in compliance with the Washington State Department of Ecology's Construction Stormwater Permit.
- The proposed project is consistent with the zoning classification of the site (general industrial).
- The proposed project is consistent with the comprehensive plan designation of the site (industrial).
- An estimated 14 additional employee vehicles are estimated per day when the project is complete. It is not anticipated that the addition of 14 employee vehicles will have a detectable impact to the existing traffic baseline.

The optional DNS process in WAC 197-11-355 is being used. **This may be your only opportunity to comment on the environmental impacts of the proposed project.**

Agencies, tribes, and the public are encouraged to review and comment on the proposed project and its probable environmental impacts. **Comments must be submitted by the date noted above to Carl Worley, Municipal Services Director, SEPA Responsible Official, P.O. Box 338/115 1st Avenue SW Quincy, WA 98848.**

The following conditions have been identified that may be used to mitigate the adverse environmental impacts of the proposal:

- Washington State Department of Ecology Emergency Spill Kit is required to be on-site during grading and construction
- To reduce unnecessary emissions, all vehicles and equipment is required to be turned off when not in use.
- Compliance with required permits listed below is required, including adherence to the Stormwater Pollution Prevention Plan and Noise Limitations and Mitigation Plan.

Required Permits: The following local, state, and federal permits/approvals are needed for the proposed project: Building Permit, Washington State Stormwater Construction Permit, Stormwater Pollution Prevention Plan, Air Quality Notice of Construction Permit, and Noise Limitations and Mitigation Plan.

Required Studies: N/A.

Existing Environmental Documents: N/A.

City Hall / City Clerk
(509) 787-3523
Fax (509) 787-1284
Public Services Building
(509) 787-3523
Fax (509) 787-2212

CITY OF QUINCY

104 B Street SW
P.O. Box 338
Quincy, Washington 98848

The following Quincy Municipal Code development regulations apply to this project and the project has been determined to be consistent:

City of Quincy Zoning Code, City of Quincy Standards for Roads and Sewer Construction, City of Quincy Building Permit Guidelines, and City of Quincy Stormwater Management are the primary regulations applicable to the site.

Public Hearing – NA.

Review Authority:

Carl Worley
115 1st Ave SW
Quincy, WA 98848

Date Issued: 8/31/2021 Signature Carl Worley

You May Appeal this Determination:

Carl Worley
115 1st Ave SW
Quincy, WA 98848

Date: Pursuant to RCW 43.12.C.075 and Quincy City Code 17.09.035, a project denial based upon environmental information, and a conditioned or mitigated Determination of Nonsignificance (DNS) may be appealed by any agency or aggrieved person. A notice of appeal shall be filed with the City of Quincy Finance Officer/Clerk within ten (10) days after the decision requested to be reviewed has been transmitted to the appealing party. The appellant shall have the burden of proof in all appeals.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

September 14, 2021

Carl Worley
Municipal Service Director
SEPA Responsible Official
City of Quincy Building Department
PO Box 338
115 1st Avenue SW
Quincy, WA 98848

Re: Microsoft Corporation Buildings CO7 and CO8, File: SEPA 2021-012

Dear Carl Worley:

Thank you for the opportunity to comment on the Notice of Application and anticipated Determination of Nonsignificance regarding the construction of two buildings, parking and landscaping on the existing 67.15-acre data center facility (Proponent: Microsoft Corporation). After reviewing the documents, the Department of Ecology (Ecology) submits the following comments:

Hazardous Waste and Toxics Reduction Program-Andrew Maher (509) 329-3612

Please keep in mind that during the construction activities associated with the Microsoft Corporation Buildings CO7 and CO8 project, some construction-related wastes produced may qualify as dangerous wastes in Washington State. Some of these wastes include:

- Absorbent material
- Aerosol cans
- Asbestos-containing materials
- Lead-containing materials
- PCB-containing light ballasts
- Waste paint
- Waste paint thinner
- Sanding dust
- Treated wood

You may find a more comprehensive list, as well as a link to identify and designate your wastes on the Common Construction and Demolition Wastes website at https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Dangerous-waste-guidance/Common-dangerous-waste/Construction-and-demolition.

The applicant, as the facility generating the waste, bears the responsibility for all construction waste.

In order to adequately identify some of your construction and remodel debris, you may need to sample and test the wastes generated to determine whether they are dangerous waste.

For more information and technical assistance, contact Andy Maher at (509) 329-3612 or andy.maher@ecy.wa.gov.

Water Quality Program-Shannon Adams (509) 329-3610

This project may need a Construction Stormwater General Permit unless it is in the footprint of an existing permit.

For more information or technical assistance in obtaining a Construction Stormwater General Permit, please contact Shannon Adams at (509) 329-3610 or via email at Shannon.Adams@ecy.wa.gov.

Water Resources Program-Dam Safety-Charlotte Lattimore (360) 407-6066

Under RCW 90.03.350, a Dam Safety construction permit is required for those dams or ponds which can impound a volume of 10 acre-feet or more of water or other liquids above ground level. The Microsoft Corporation Buildings CO7 and CO8 project references stormwater ponds as part of the project. To determine if a Dam Safety construction permit is required for your project, the applicant must submit a set of construction plans to:

WA Department of Ecology
Dam Safety Office
P.O. Box 47600
Olympia, WA 98504-7600

For more information, please contact Charlotte Lattimore at (360) 407-6066 or via email at Charlotte.Lattimore@ecy.wa.gov.

Water Resources Program-Herm Spangle (509) 329-3488

The water purveyor is responsible for ensuring that the proposed use(s) are within the limitations of its water rights. If the proposal's actions are different than the existing water right (source, purpose, the place of use, or period of use), then it is subject to approval from the Department of Ecology pursuant to Sections 90.03.380 RCW and 90.44.100 RCW.

For more information or technical assistance please contact Herm Spangle at (509) 329-3488 or via email at Herm.Spangle@ecy.wa.gov.

State Environmental Policy Act (SEPA)

Ecology bases comments upon information submitted for review. As such, comments made do not constitute an exhaustive list of the various authorizations you may need to obtain, nor legal requirements you may need to fulfill in order to carry out the proposed action. Applicants should remain in touch with their Local Responsible Officials or Planners for additional guidance.

To receive more guidance on or to respond to the comments made by Ecology, please contact the appropriate staff listed above at the phone number or email provided.

Department of Ecology
Eastern Regional Office
(Ecology File: 202104739)

Smith, Teleri A

From: Marla Roduner <mroduner@quincywashington.us>
Sent: Wednesday, October 6, 2021 4:54 PM
To: Smith, Teleri A
Cc: Linstead, Carson; Dyke, Michael C (Mike)
Subject: Re: SEPA ODNS

Follow Up Flag: Follow up
Flag Status: Completed

Good afternoon Teleri,

Since the comment period has ended the SEPA process is deemed completed and the City will take no further action.

Thank you!

From: Smith, Teleri A <tasmith@burnsmcd.com>
Sent: Wednesday, October 6, 2021 2:21 PM
To: Marla Roduner <mroduner@quincywashington.us>
Cc: Linstead, Carson <clinstead@burnsmcd.com>; Dyke, Michael C (Mike) <mcdyke@burnsmcd.com>
Subject: RE: SEPA ODNS

[External Email]

Thank you Marla!

It looks like this has completed its public notice period (ending Sept 15th). Do you know what, if any, steps remain for the City of Quincy to issue the final Determination of Non-significance?

Thanks again!

Teleri Smith \ Burns & McDonnell
Assistant Environmental Scientist
O 682-382-0472 \ **M** 817-944-5848
tasmith@burnsmcd.com \ burnsmcd.com
100 Energy Way, Suite 1700 \ Fort Worth, TX 76102

From: Marla Roduner <mroduner@quincywashington.us>
Sent: Tuesday, October 5, 2021 12:57 PM
To: Smith, Teleri A <tasmith@burnsmcd.com>
Subject: SEPA ODNS

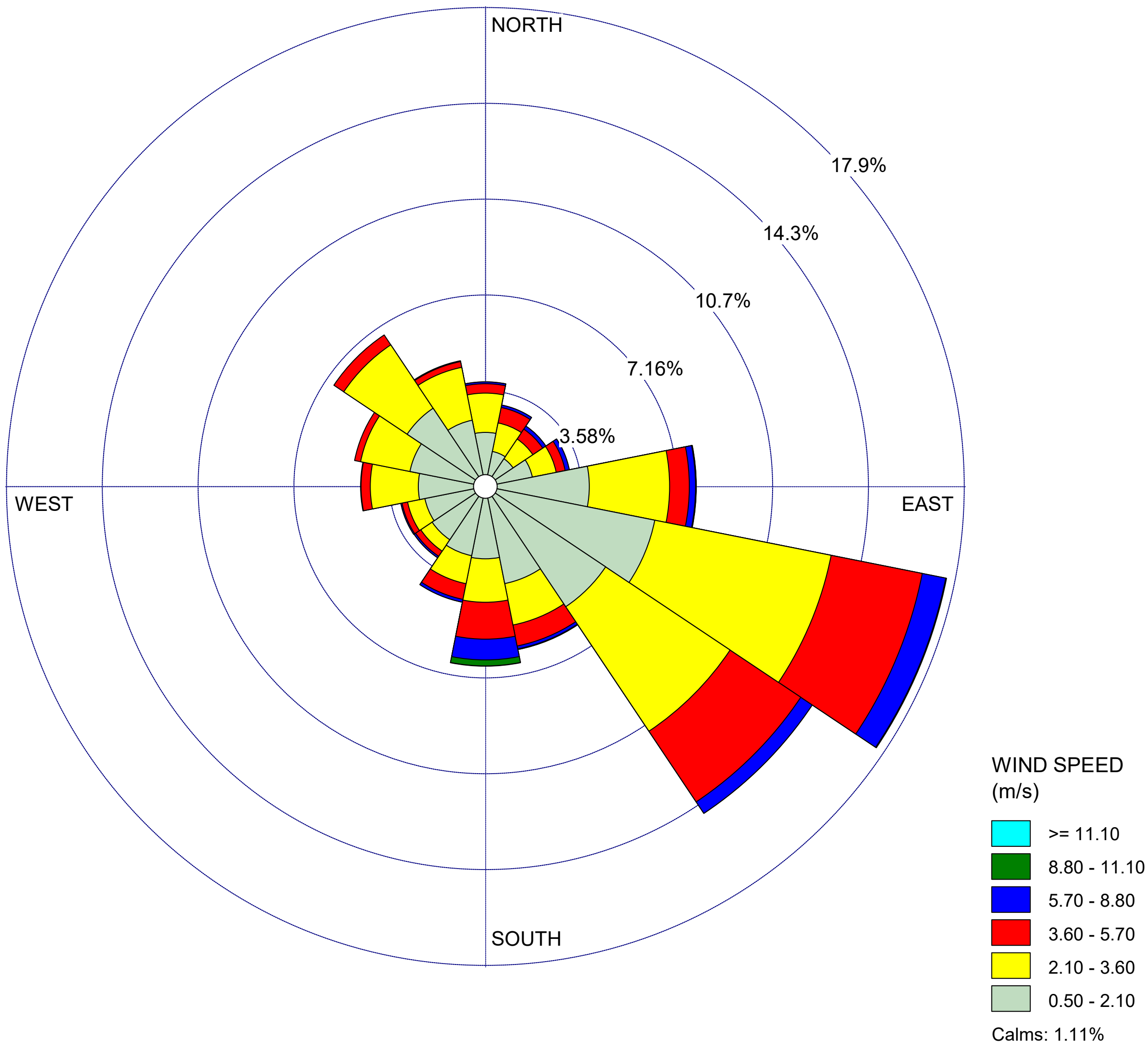
Marla D. Roduner
Public Services Secretary/Receptionist

APPENDIX H – MODELING FIGURES

Figure H-1 - Wind Speed and Direction Frequency Distribution

WIND ROSE PLOT:
Quincy Onsite and Grant County International Airport (WBAN 24110)

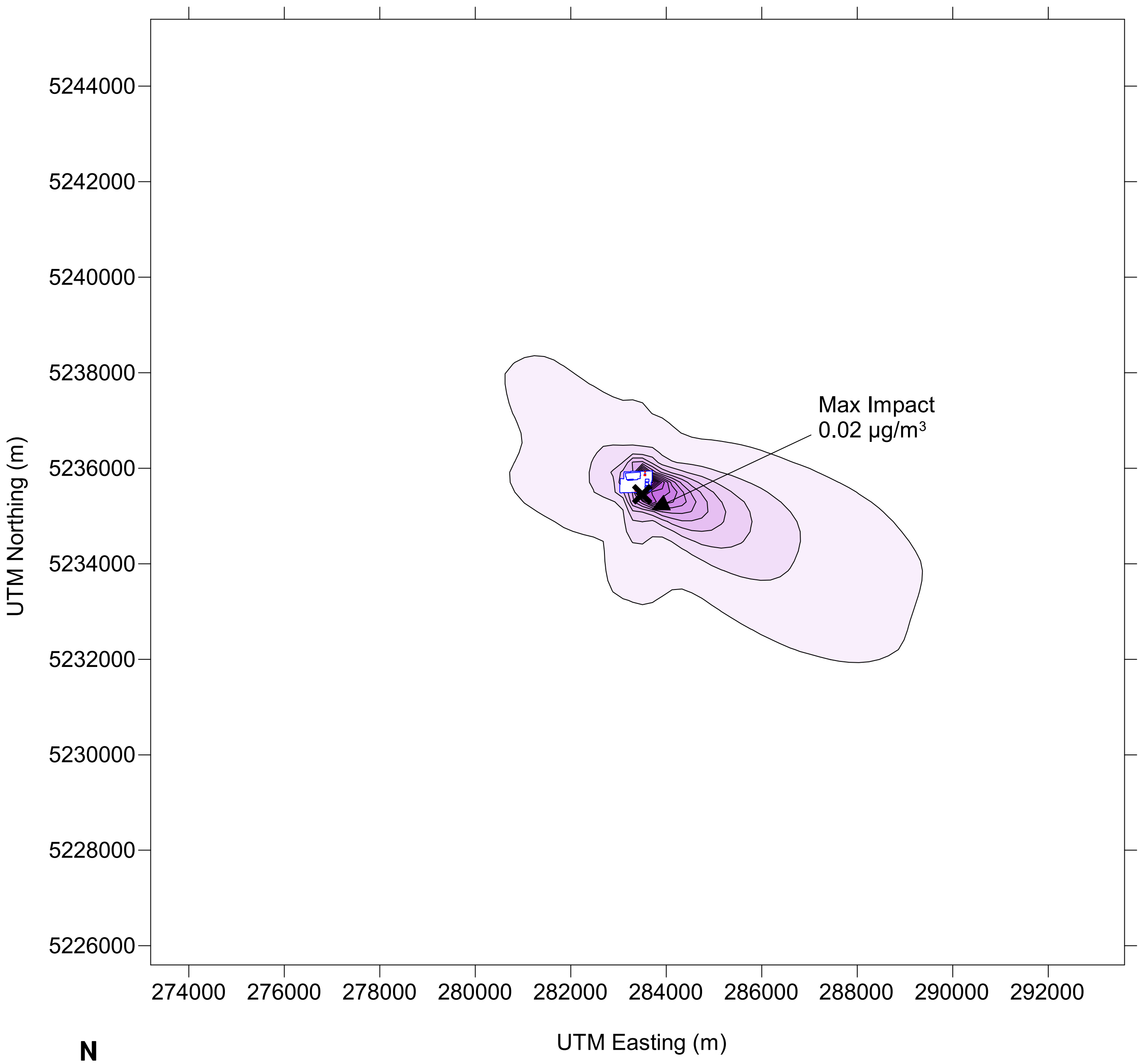
DISPLAY:
Wind Speed
Flow Vector (blowing to)



COMMENTS:	DATA PERIOD: **Start Date: 1/1/2018 - 00:00** **End Date: 12/31/2020 - 23:59**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **1.11%**	TOTAL COUNT: **52097 hrs.**	
	AVG. WIND SPEED: **2.41 m/s**	DATE: **3/11/2022**	PROJECT NO.:

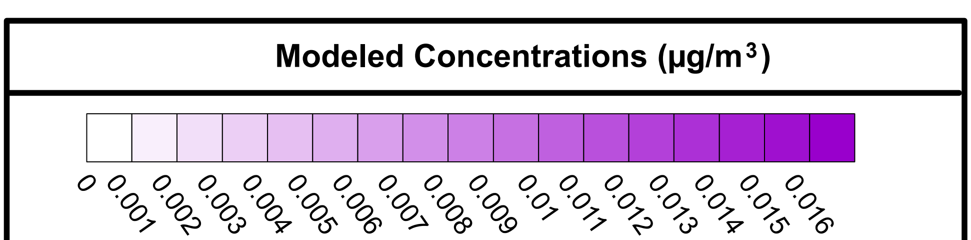
WRPLOT View - Lakes Environmental Software

Figure H-2: NO$_2$ Annual Significance Primary 10% Load (3 years)



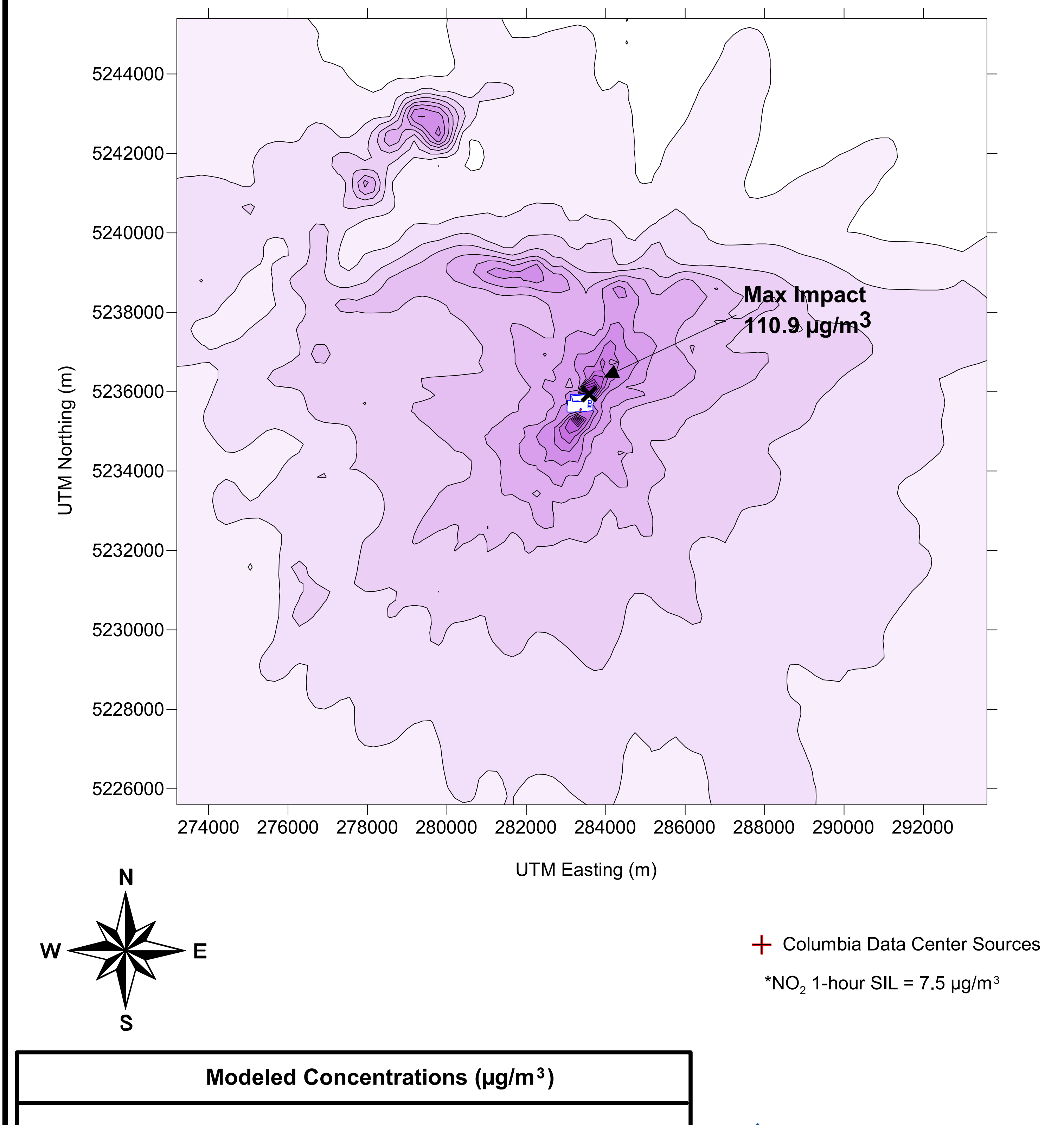
Columbia Data Center Sources

*NO$_2$ Annual SIL = 1 µg/m^3



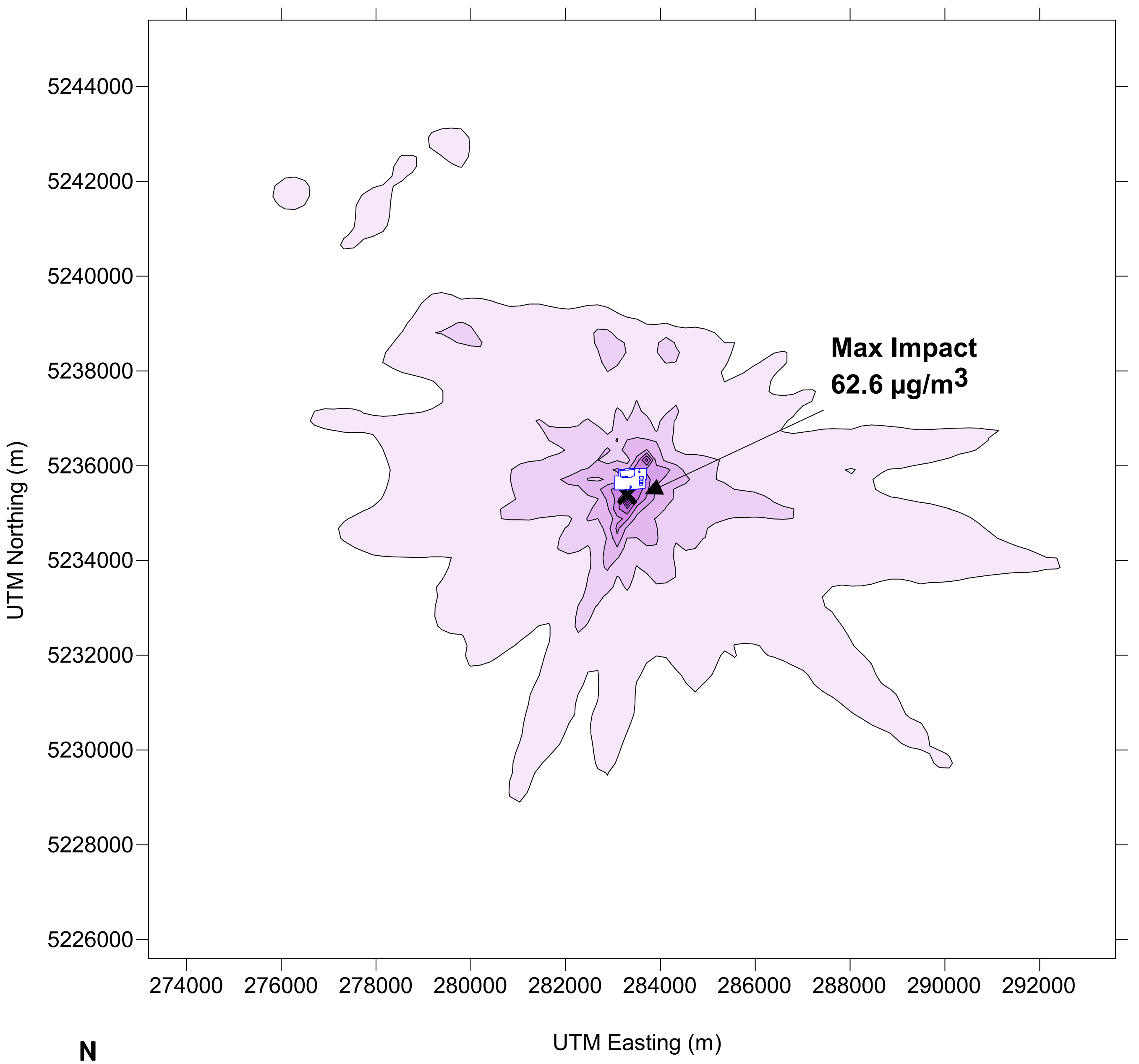
BURNS McDONNELL

Figure H-3: NO_2 1-hour Significance
Reserve 10% Load (3 years)



BURNS McDONNELL

Figure H-4: CO 8-hour Significance
Reserve 10% Load (2019)



N
W E
S

+ Columbia Data Center Sources

*CO 8-hour SIL = 500 µg/m³

Modeled Concentrations (µg/m³)

0 5 10 15 20 25 30 35 40 45 50

BURNS McDONNELL

Figure H-5: CO 1-hour Significance
Reserve 10% Load (2019)

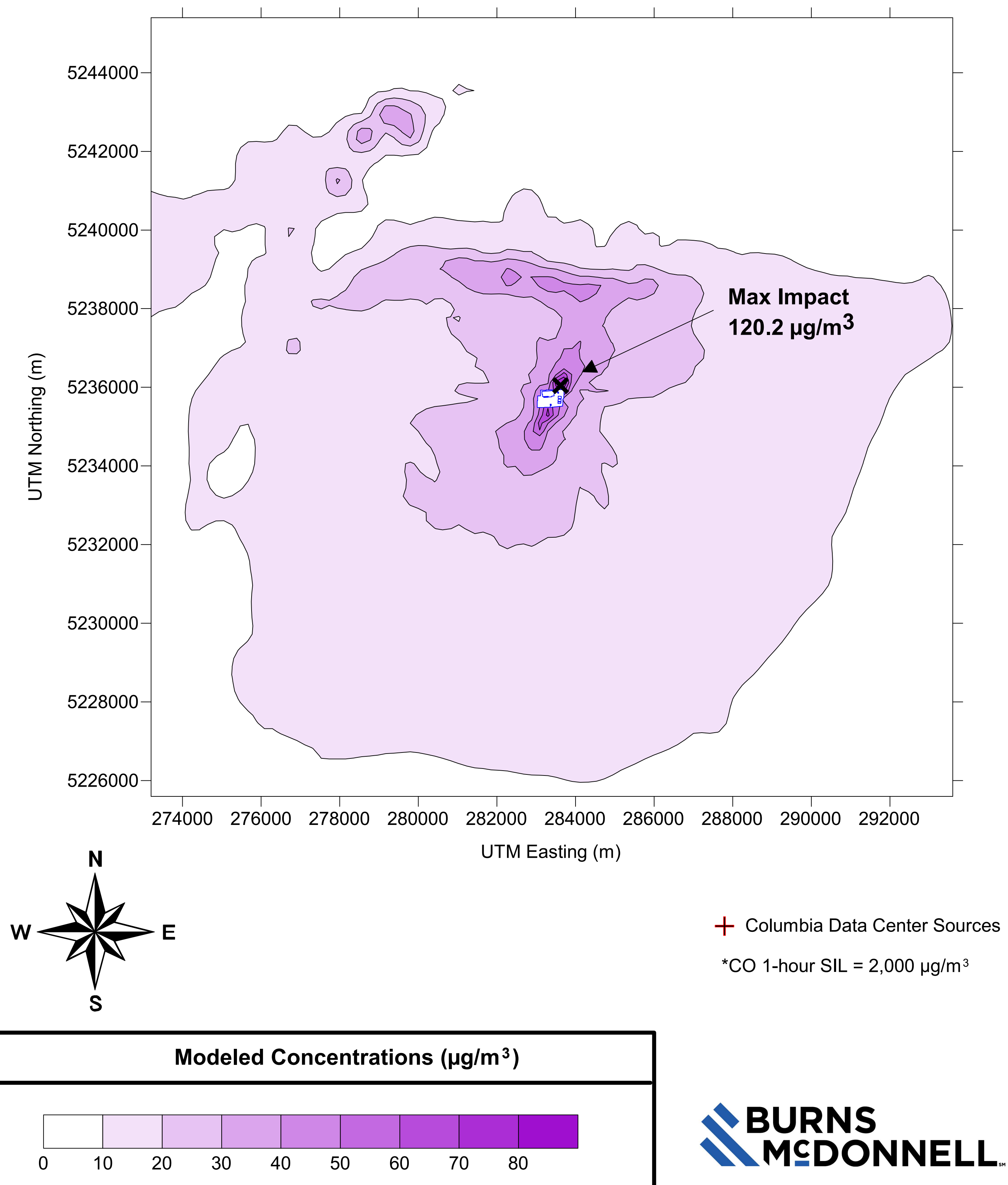


Figure H-6: PM_{10} 24-Hour Significance Reserve 10% Load (2020)

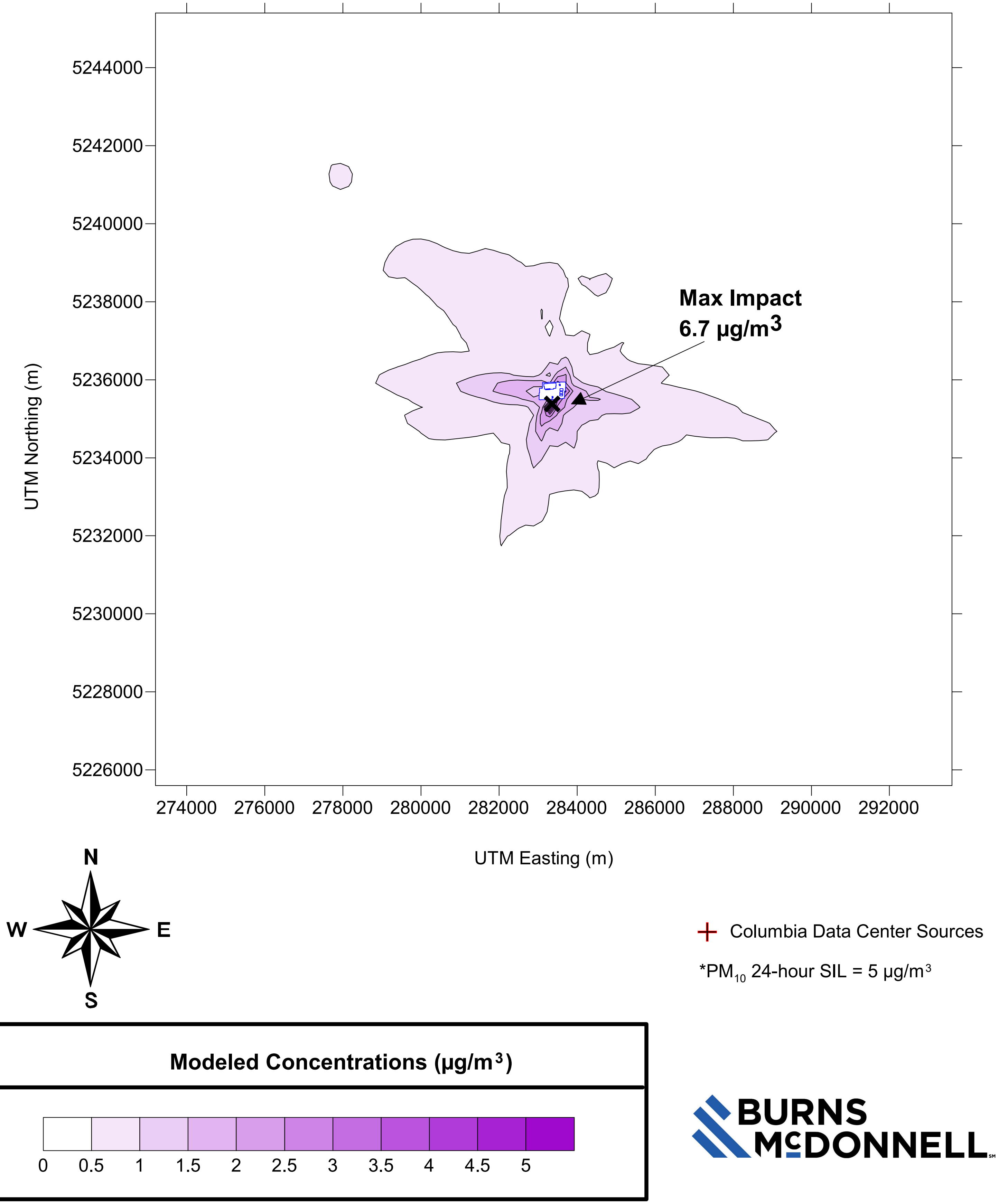
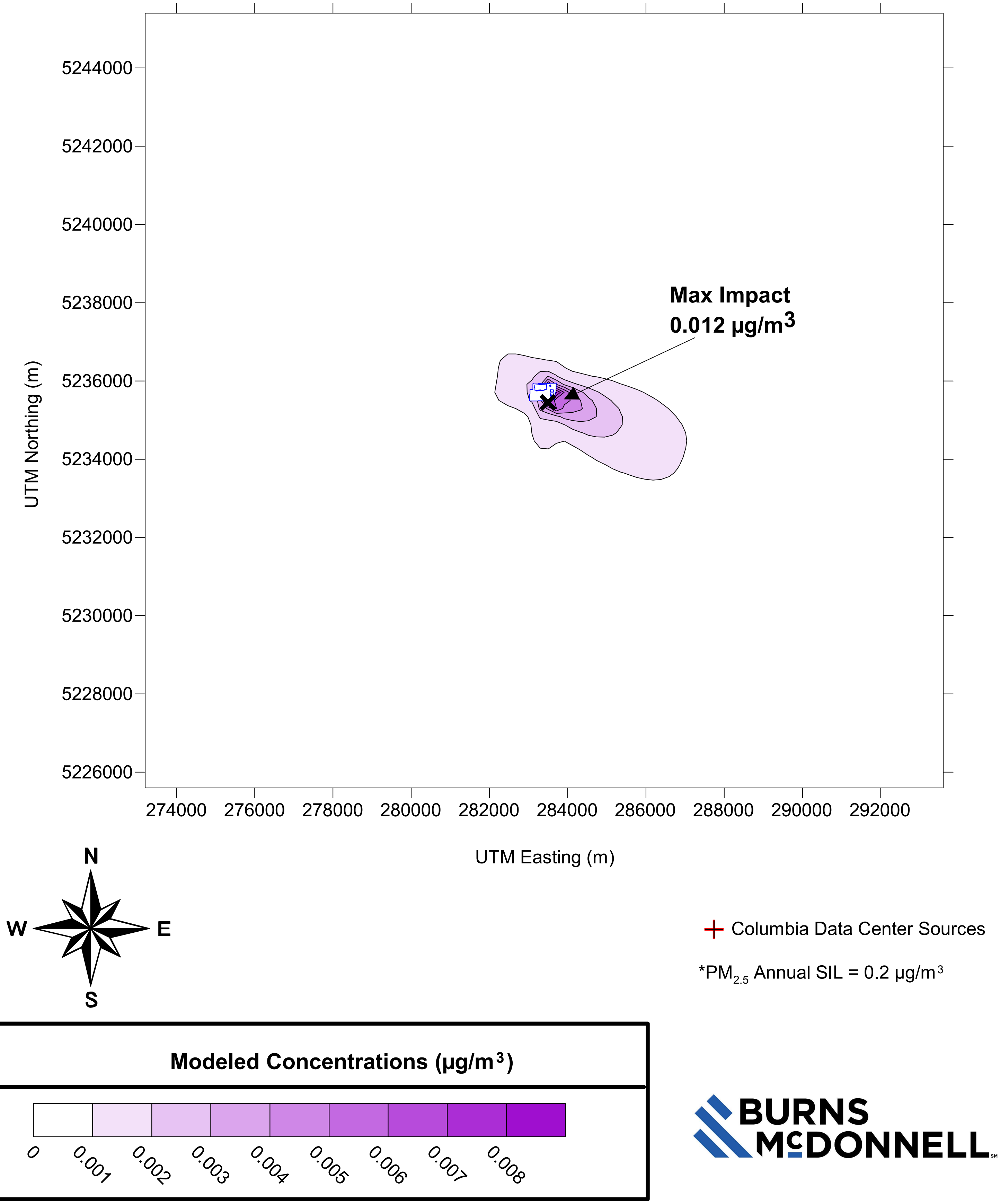
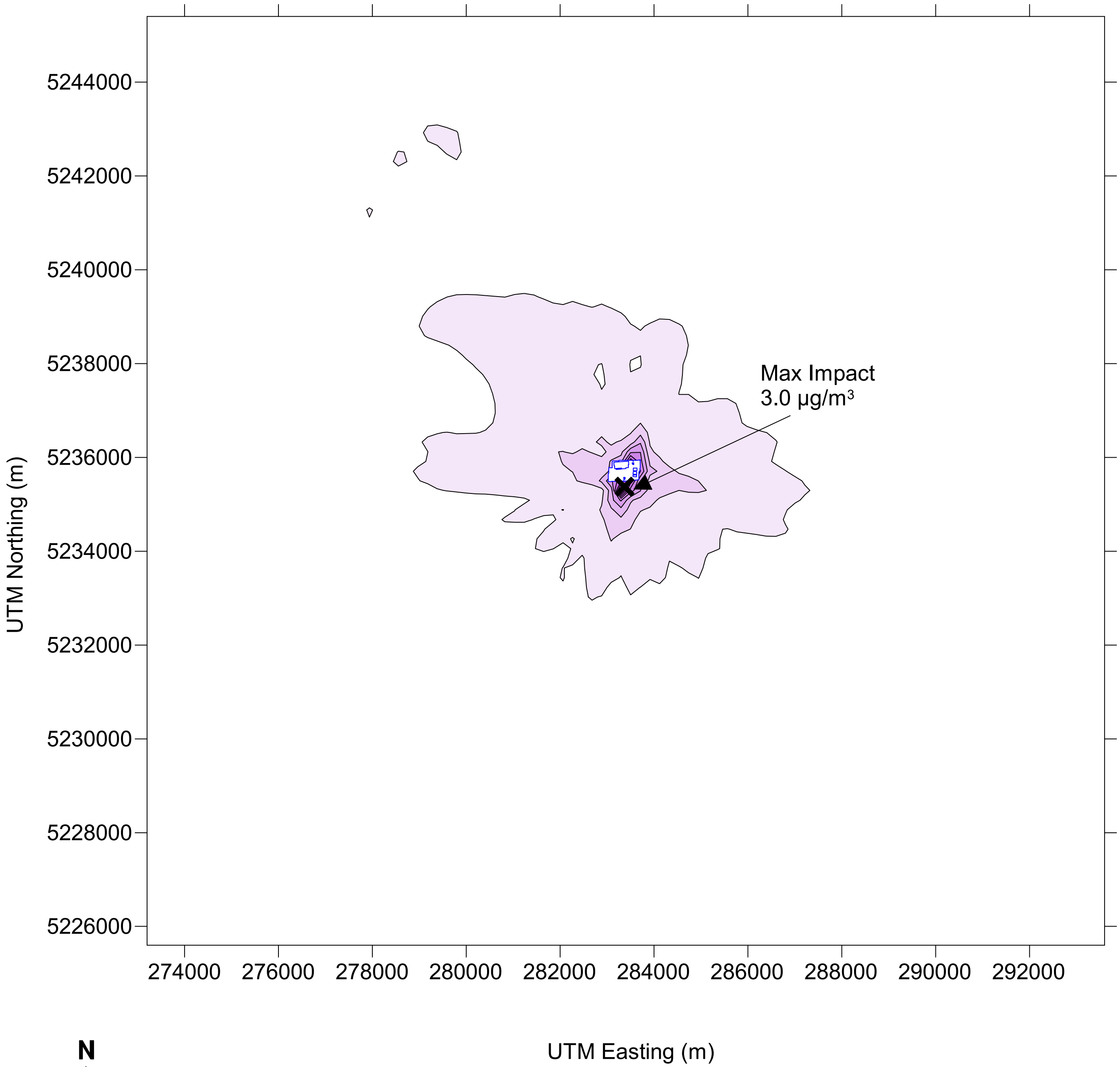


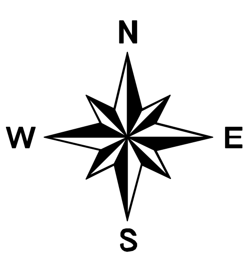
Figure H-7: $PM_{2.5}$ Annual Significance Primary 10% Load (3 Years)



*$PM_{2.5}$ Annual SIL = 0.2 µg/m³

Figure H-8: $PM_{2.5}$ 24-Hour Significance Reserve 10% Load (3 Years)





+ Columbia Data Center Sources

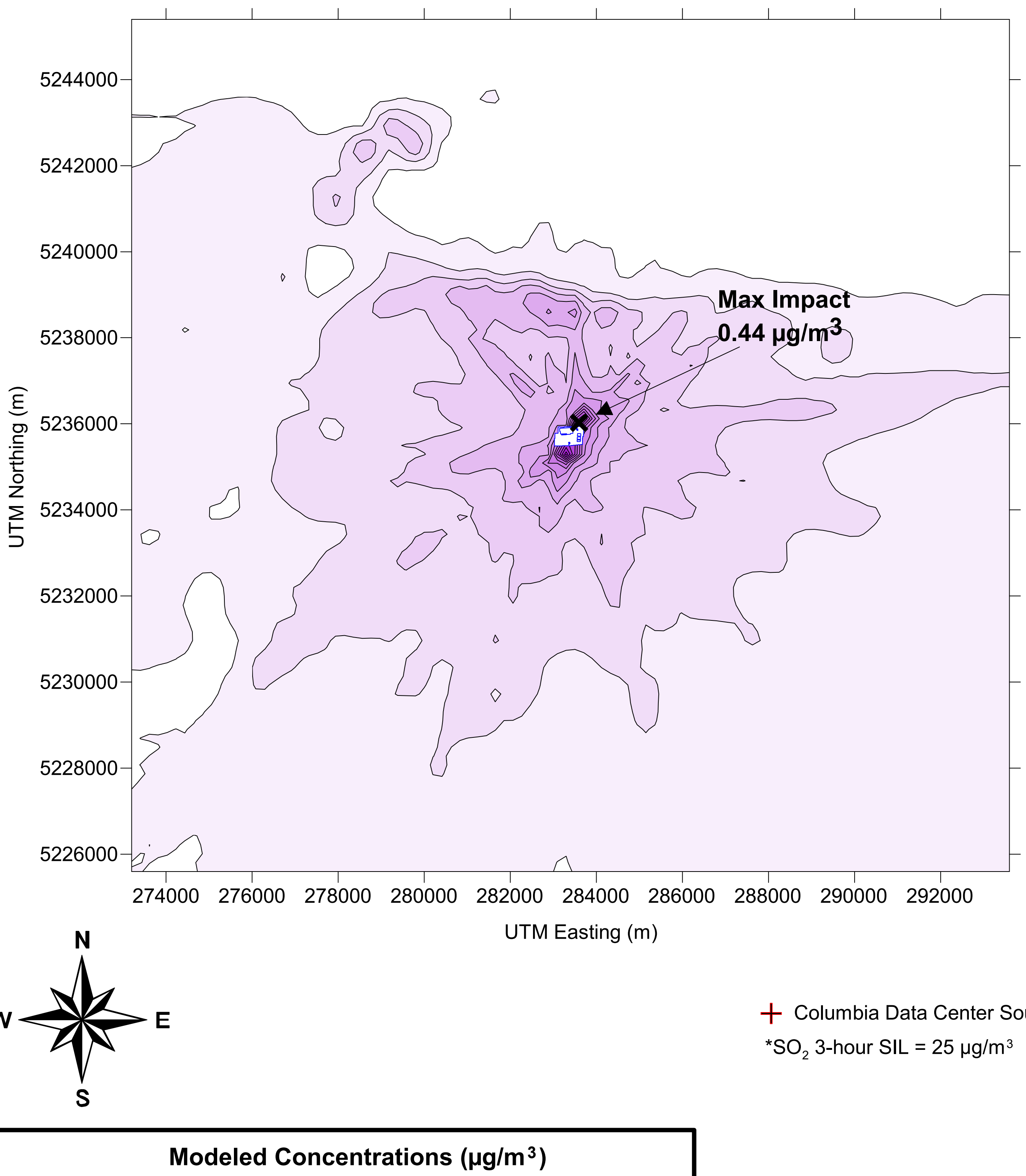
*$PM_{2.5}$ 24-hour SIL = 1.2 µg/m³

Modeled Concentrations (µg/m³)

0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

BURNS McDONNELL

Figure H-9: SO_2 3-hour Significance
Reserve 10% Load (2019)



Columbia Data Center Sources

*SO_2 3-hour SIL = 25 µg/m³

Modeled Concentrations (µg/m³)

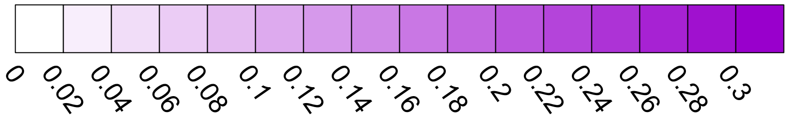


Figure H-10: SO_2 1-hour Significance Reserve 10% Load (3 years)

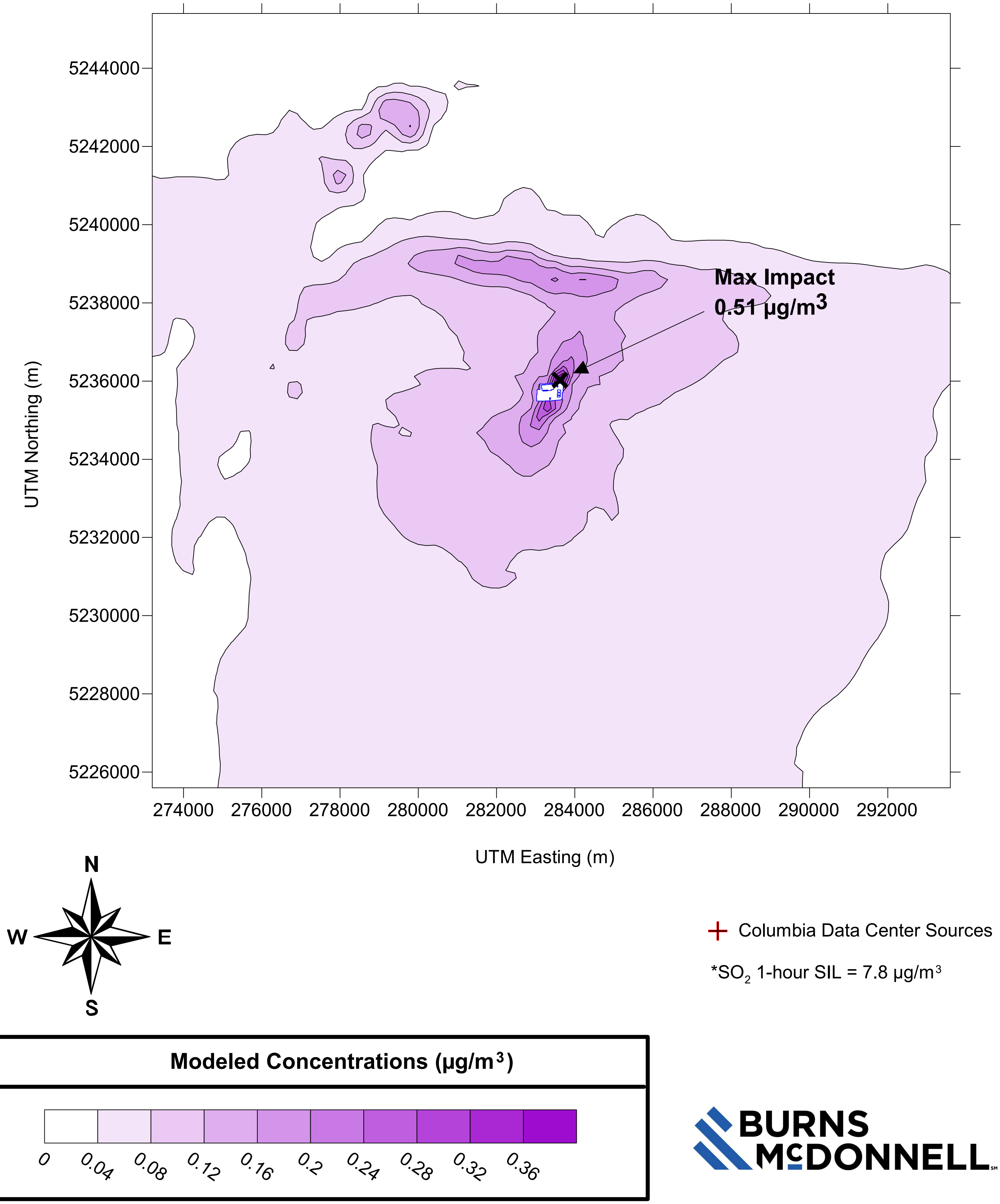
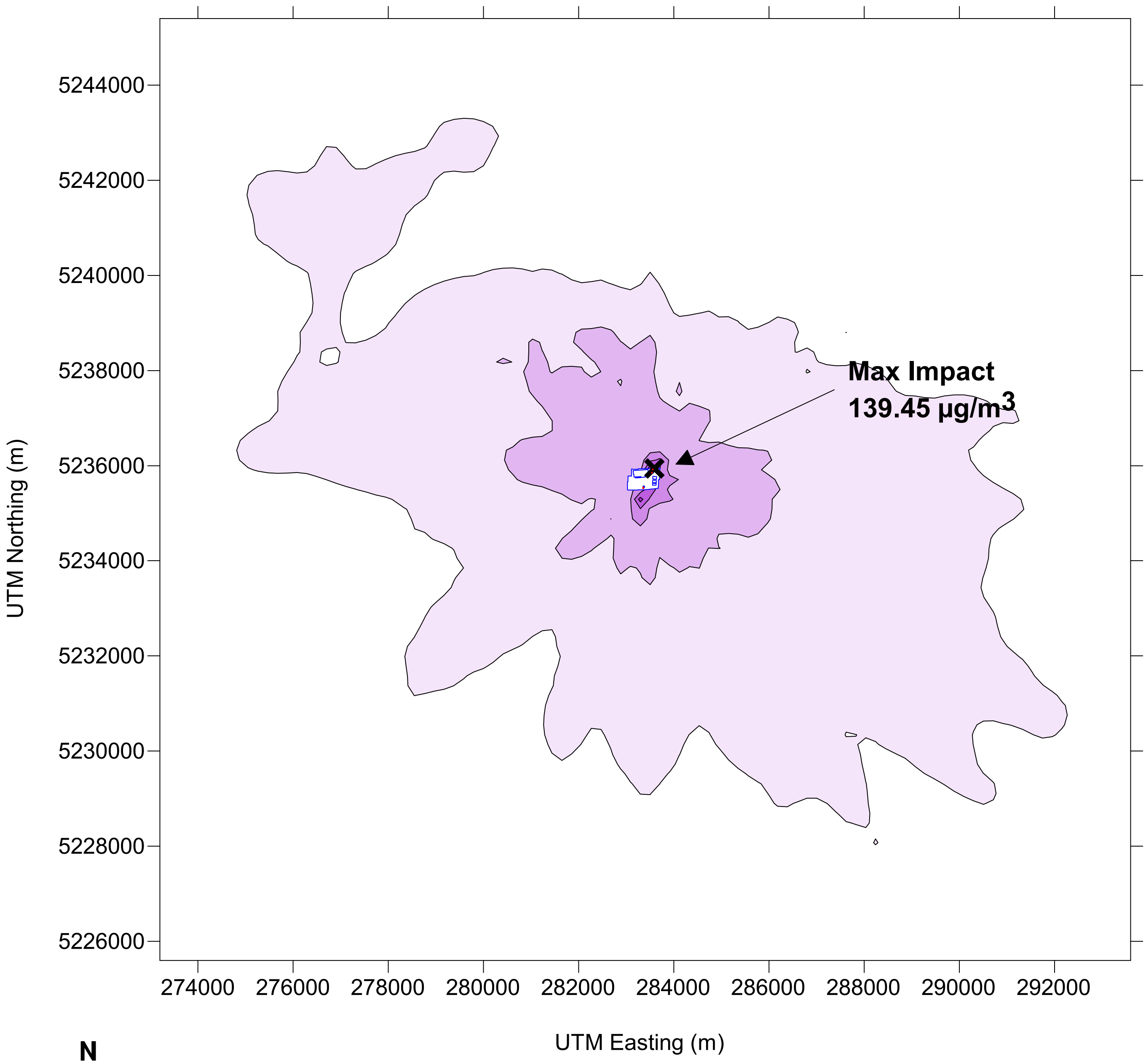


Figure H-11: NO_2 1-hour NAAQS
Reserve 10% Load (3 years)



+ Columbia Data Center Sources

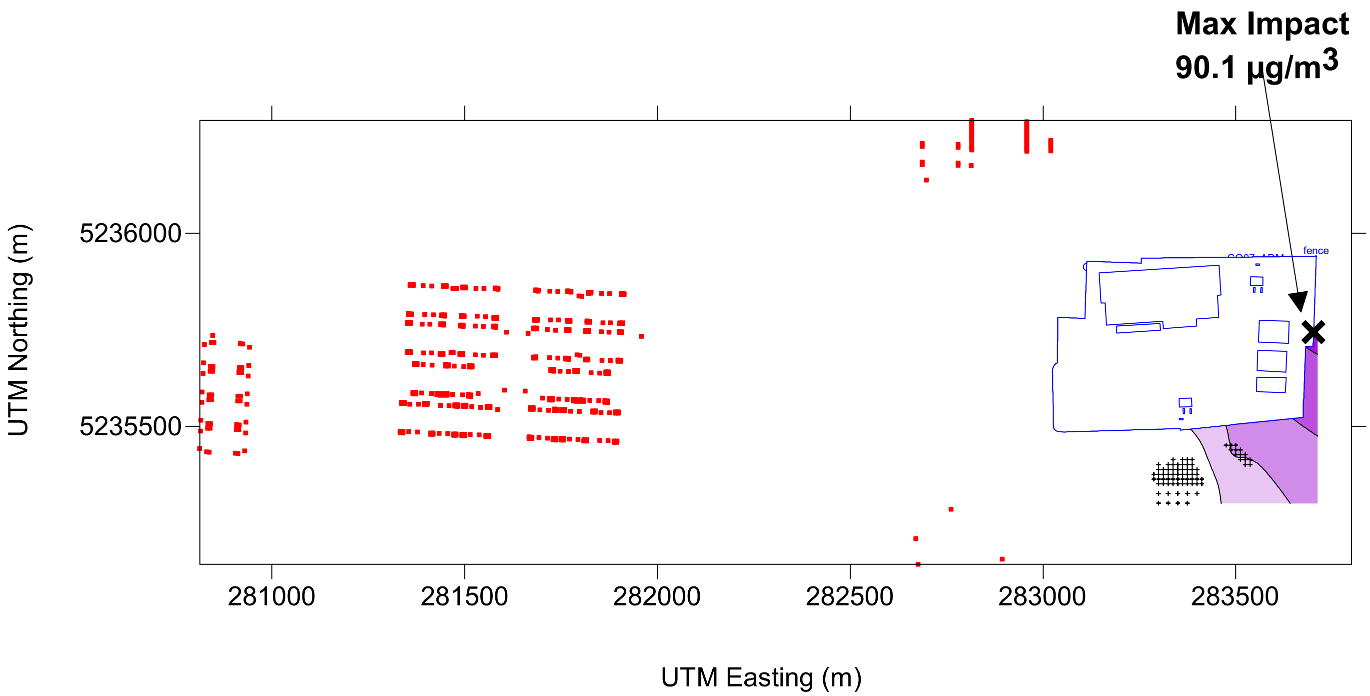
*Plot includes background concentration (58.75 µg/m³)

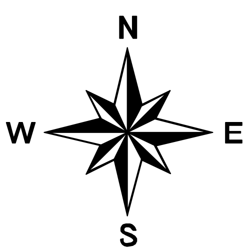
*NO_2 1-hour NAAQS = 188 µg/m³

Modeled Concentrations (µg/m³)

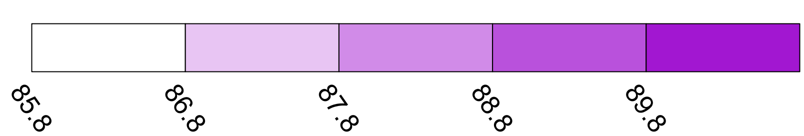
55 | 65 | 75 | 85 | 95 | 105 | 115

Figure H-12: PM_{10} 24-Hour NAAQS
Primary 10% Load (2020)





Modeled Concentrations (µg/m³)



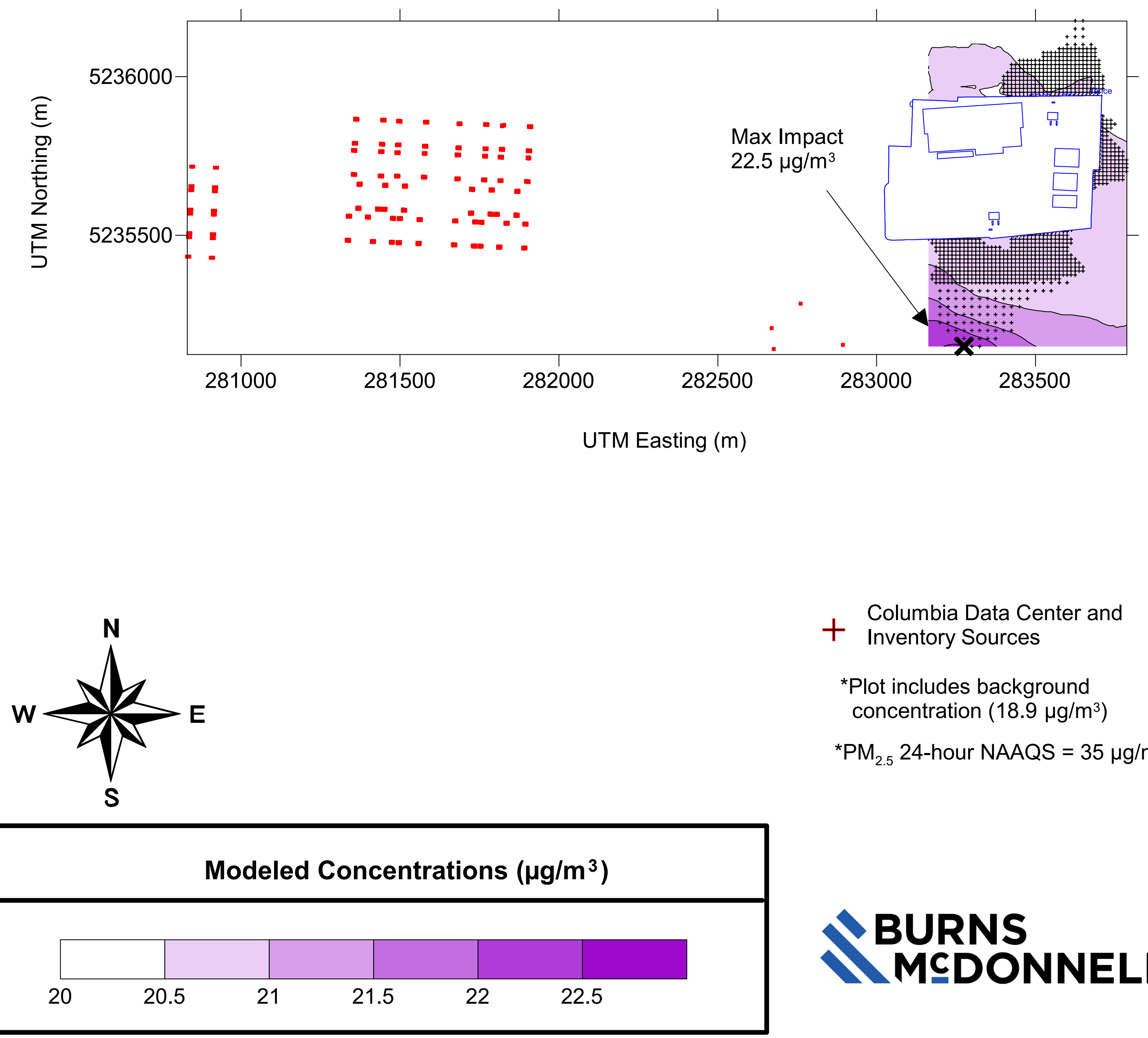
+ Columbia Data Center and Inventory Sources

*Plot includes background concentration (77.6 µg/m³)

*PM_{10} 24-hour NAAQS = 150 µg/m³

BURNS McDONNELL

Figure H-13: $PM_{2.5}$ 24-Hour NAAQS
Reserve 10% Load (3 years)



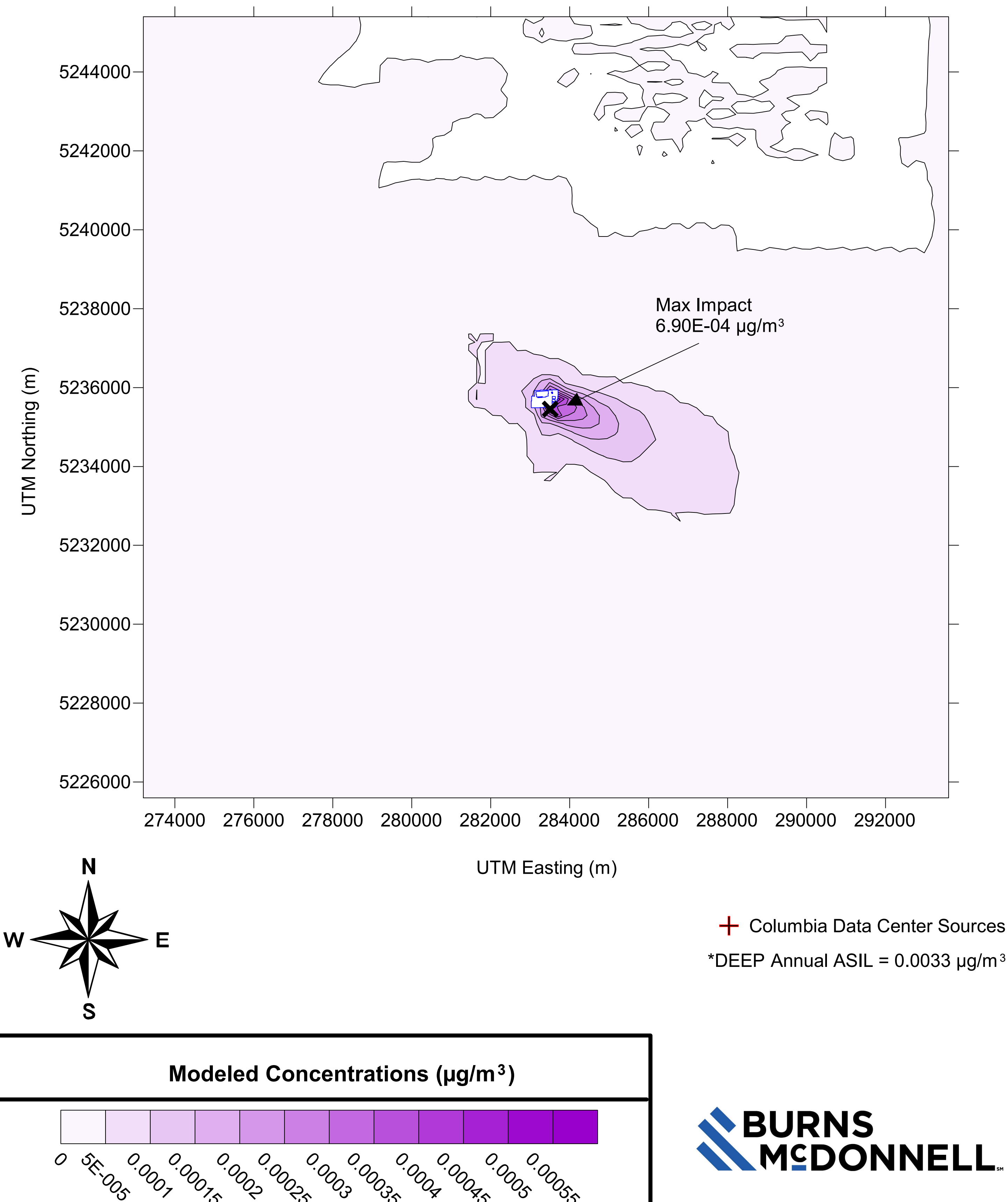
Columbia Data Center and Inventory Sources

*Plot includes background concentration (18.9 µg/m³)

*$PM_{2.5}$ 24-hour NAAQS = 35 µg/m³

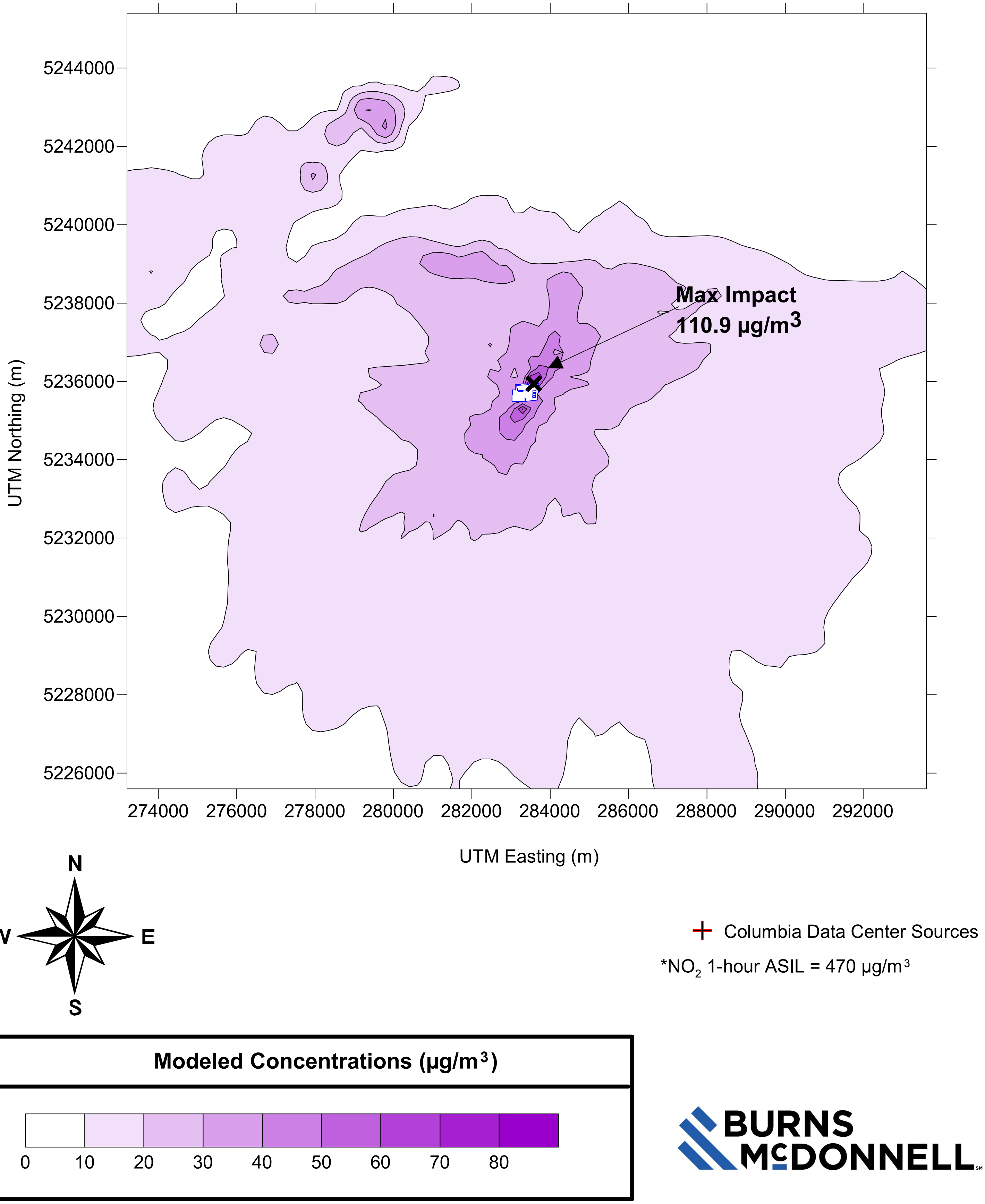
BURNS McDONNELL

Figure H-14: DEEP ASIL
Primary 25% Load (3 years)



BURNS McDONNELL

Figure H-15: NO_2 1-hour ASIL
Reserve 10% Load (3 years)



BURNS McDONNELL

CREATE AMAZING.

Burns & McDonnell World Headquarters
9400 Ward Parkway
Kansas City, MO 64114
O 816-333-9400
F 816-333-3690
www.burnsmcd.com