BURNS & McDONNELL

October 1, 2024

Jenny Filipy
Environmental Engineer, Air Quality Program
Washington State Department of Ecology
Eastern Regional Offices
4601 N Monroe
Spokane, WA 99205-1295

Re: Notice of Construction (NOC) Modification Application, Columbia Data Center, July 2024 Revision (with October 2024 Updates)

Dear Ms. Filipy:

On June 6, 2023, Burns & McDonnell submitted an application to modify Notice of Construction (NOC) Approval Order No. 22AQ-E006. As described in the application, Microsoft proposed to update equipment nomenclature and verbiage of permit conditions for the operation of emission units at the Columbia Data Center, located at 501 Port Industrial Parkway, Quincy, Washington in Grant County (Project). More specifically, the objectives of this application were to:

- Update nomenclature of generator engines due to facility upgrades and related changes to building nomenclature and generator assignments;
- Amend the timeline for developing O&M manuals for new engines;
- Make administrative corrections; and
- Edit verbiage of specific permit conditions to:
  - Provide clarifying verbiage surrounding annual operating hour and load conditions for operating designated groupings of emergency generator engines for specific uses; and
  - Adjust short-term limitations and emissions for electrical bypass operations.

The application did NOT seek authorization to add a "new source" of emissions or to "modify" an existing stationary source at the facility; however, adjustments to short-term emissions for electrical bypass operations were proposed, with associated emission estimates and modeling results.

A revised version of the application was submitted in September 2023 to update the toxic air pollutant emission factors based on additional information supplied August 25, 2023 by the Washington State Department of Ecology (Ecology). Revisions included updates to Parts 2, 3, and 4 and to the calculations at Appendix F. Also, 24-hour air dispersion modeling results were provided for two additional toxic air pollutants – acrolein and mercury, with related modeling plots added in Appendix G.

During October 2023, Ecology was advised of a project to store and maintain nonroad engines at an offsite location to be temporarily deployed at the Columbia Data Center to provide emergency backup power while a stationary emergency engine is being repaired. Ecology paused agency review of the application until revisions might be incorporated to include information, emissions, and modeling results associated with the nonroad engines.

A revision submitted on July 1, 2024 provided updates to the following portions of the permit amendment application, with modified verbiage in the narrative portions underlined:

- Executive Summary
- Part 1 – Project Description
- Part 2 – Emissions Estimates
- Part 3 – Regulatory Review
- Part 4 – Air Dispersion Modeling Analysis
- Part 5 – References
- Appendices A, C, F, G, and H

Additional air dispersion modeling was conducted to incorporate the nonroad engine emissions. The revised modeling files were submitted in conjunction with the revised application.

On August 26, 2024, Ecology requested that the air dispersion modeling be revised again to include nonroad engine operations at 10% engine load and no electrical load, with emissions adjusted for the anticipated operating durations during monthly maintenance testing. Therefore, this update to the latest the July 2024 revision includes revised modeling files and provides appropriate edits to the following portions of the application:

- description of nonroad engine emission calculations in Chapter 2;
- inputs, descriptions, and results for air dispersion modeling in Chapter 4;
- nonroad engine emissions calculations at Appendix F; and
- modeling figures at Appendix G.

If we can be of any assistance to facilitate your staff's efforts, please do not hesitate to contact Minda Nelson (816-601-4311, mnelson@burnsmcd.com), Teleri Smith (682-382-0472, tasmith@burnsmcd.com), or me (682-291-9341, mkcook@burnsmcd.com).

Thank you so much for your time and efforts on this project.

Sincerely,

Michael K. Cook

Michael Cook
Senior Environmental Engineer
Burns & McDonnell

Attachment: Columbia Data Center NOC Modification Application, July 2024 Revision (with October 2024 Updates)

cc: Beth Friedman, Washington State Department of Ecology, Air Quality Program
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MICROSOFT CORPORATION

COLUMBIA DATA CENTER NOC MODIFICATION APPLICATION

APPROVAL ORDER UPDATE PROJECT

COLUMBIA DATA CENTER, QUINCY, WA

JULY 2024 REVISION (WITH OCTOBER 2024 UPDATES)

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FIGURES

TABLES

List of Abbreviations

Abbreviation	Term/Phrase/Name
°F	degrees Fahrenheit
µg/m³	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
bhp	brake horsepower
BPIP-PRIME	Building Profile Input Program - Plume Rise Model Enhancements
Btu	British thermal units
CAQT	critical air quality threshold
CEC	California Energy Commission
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPM	condensable particulate matter
DEEP	diesel engine exhaust particulate matter
DNS	Determination of Nonsignificance
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particulate Filter
DOC	Diesel Oxidation Catalyst
DPM	Diesel Particulate Matter
dscfm	dry standard cubic feet per minute
Ecology	State of Washington Department of Ecology
EMISFACT	emission factor
EP	emission point
EPA	U.S. Environmental Protection Agency
EU	emission unit

Abbreviation	Term/Phrase/Name
ft	feet
g/bhp-hr	grams per brake horsepower hour
g/kWm-hr	grams per kilowatt-meter 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
HAP	hazardous air pollutant
HC	hydrocarbon
HIA	Health Impact Assessment
hp	horsepower
hr	hours
hr/yr	hours per year
HVO	hydrogenated vegetable oil
in	inches
ISR	In-Stack Radio
kW	kilowatts
kWe	kilowatts of electrical power
kWm	kilowatts of mechanical power
lb/hr	pounds per hour
lb/MMBtu	pounds per million British Thermal Units
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
N/A	Not Applicable
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAD83	North American Datum of 1983

Abbreviation	Term/Phrase/Name
NED	National Elevation Dataset
NESHAP	National Emission Standards for Hazardous Air Pollutants
NLCD	National Land Cover Database
NMHC	non-methane hydrocarbons
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NSPS	New Source Performance Standard
NSR	New Source Review
NTP	Non-thermal Plasma
OLM	Ozone Limiting Method
PAH	polycyclic aromatic hydrocarbons
PBL	Planetary Boundary Layers
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
$PM_{Filterable}$	Filterable portion of particulate matter
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
RPM	revolutions per minute
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 fuel
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	volatile organic compound
WAC	Washington Administrative Code
WBAN	Weather Bureau Army Navy

Executive Summary

Microsoft Corporation (Microsoft) is proposing to update equipment nomenclature and verbiage of permit conditions within Approval Order No. 20AQ-E006 for the operation of emission units at the Columbia Data Center (Facility), located at 501 Port Industrial Parkway, Quincy, Washington in Grant County (Project). Additionally, to maintain continuous operation of critical infrastructure in the event of an engine failure or prolonged maintenance of an engine, Microsoft seeks concurrence to temporarily deploy non-road engines to provide emergency backup power while the stationary emergency engine is repaired. More specifically, the objectives of this application are to:

- Update nomenclature of generator engines due to facility upgrades and related changes to building nomenclature and generator assignments;
- Amend the timeline for developing O&M manuals for new engines;
- Make administrative corrections;
- Edit verbiage of specific permit conditions to:
    - Provide clarifying verbiage surrounding annual operating hour and load conditions for operating designated groupings of emergency generator engines for specific uses; and
- Adjust short-term limitations and emissions for electrical bypass operations.
- Acquire concurrence for the use of two nonroad engine emergency generator sets, which will be stored and maintained at an offsite location for temporary delivery to the Columbia Data Center, providing emergency backup power while one or more stationary emergency engines are being repaired.

This application does NOT seek authorization to add a "new source" of emissions or to "modify" an existing stationary source at the Facility, but this application does propose adjustments to short-term emissions for electrical bypass operations and includes associated emission estimates and modeling results.

The facility emissions will continue to be limited to less than 100 tons per year (tpy) for each applicable regulated criteria pollutant and will continue to be an area (minor) source of hazardous air pollutants (HAPs). As such, the Facility will continue to be classified as a minor source for both Prevention of Significant Deterioration (PSD) and Title V.

This permit amendment application is divided into the following sections:

- Chapter 1 – Project Description
- Chapter 2 – Emissions Estimates
- Chapter 3 – Regulatory Review
- Chapter 4 – Air Dispersion Modeling Analysis
- Chapter 5 – References

The application form, required by the State of Washington Department of Ecology (Ecology), is included at Appendix B of this application. Plan view site maps, a markup copy of the existing approval order, facility upgrade correspondence, emission calculations, equipment information, renewable diesel fuel test data, and modeling figures are in Appendix A and Appendices C through I.

1.0 Project Description

The Microsoft Columbia Data Center is located at 501 Port Industrial Parkway in Quincy, Washington (Grant County), as is depicted in the plan view site maps at Appendix A.

1.1 Background

1.1.1 Facility Upgrades

Of the 46 emergency diesel generator engines authorized in Approval Order No. 20AQ-E006, 35 have been designated to support operations associated with Buildings CO1, CO2, CO3.1, CO3.2, and CO3.3. Facility upgrades are nearing completion for which the following activities were included:

(1) Reconstruct and add a second level to Building CO3.1 to accommodate specific Microsoft telecommunications objectives.

(2) Reconfigure and upgrade the electrical power monitoring system for eleven (11) emergency generators associated with Buildings CO3.1, CO3.2, and CO3.3.

(3) Install stack extensions of twenty-five feet (25-ft) for the northernmost nine (9) of the 11 emergency generators to accommodate the architectural changes to Building CO3.1.

(4) Conduct post-project generator engine testing to verify proper operation of the upgraded electrical power monitoring system.

Although the facility upgrades did not constitute a "modification" to existing emission sources or result in a "new source" of emissions at the Facility, Microsoft provided information on the upgrades to Ecology for review. Upon Ecology's request, Microsoft conducted modeling screening analysis for the changes and published notices in the Quincy Valley Post-Register to inform the local community. Accordingly, Ecology signaled no objection to the upgrades moving forward (refer to facility upgrade correspondence at Appendix D).

1.1.2 Requirement for Nonroad Engines

To maintain continuous operation of critical infrastructure in the event of an engine failure or prolonged maintenance of an engine, Microsoft seeks concurrence to temporarily deploy non-road engines to provide emergency backup power while one or more stationary emergency engines are being repaired. More specifically, Microsoft seeks concurrence in accordance with WAC 173-400-035 for the use of two generator sets, consisting of three nonroad engines, on as needed basis for temporary replacements. The rationale for including these engines in this NSR application is provided in Section 3.3.2. Both nonroad engine generator sets will be stored and maintained offsite until they are required for use at the Facility.

1.2 Nomenclature Updates

As a result of the facility upgrades described above, Microsoft has renamed Building CO3.1 as Building C09 and has assigned ten (10) of the 11 emergency generators, previously assigned to Buildings CO3.1, CO3.2, and CO3.3, for use in support of Building CO9 operations. Therefore, Microsoft is seeking to update generator engine nomenclature as follows (refer to approval order markup at Appendix C):

- Edits to Phase column in Table 1.a, page 2.
- Edits to Location column in Table 2, page 4.
- Edits to generator identifiers in Permit Conditions 3.b, 3.c, 3.d, and 3.f, pages 4 and 5.
- Edits to the title of Table 4, page 9.

1.3 O&M Manual Development

Microsoft requests edits for the timeline on availability of O&M manuals for new engines, as referenced in Permit Condition 9.b.ii, page 11 (refer to approval order markup at Appendix C).

Per contractual timelines, O&M manuals may not be available within 60 days after the issuance of an approval order, especially if supply schedules result in generator engines being delivered to the Facility several months after an approval order is issued. Additionally, operation of the engines during the construction phase of a project is limited primarily to testing, which is overseen by the engine manufacturer and the general contractor. Therefore, Microsoft requests edits in this permit condition to specify that the O&M manuals for new generator engines must be developed prior to the transfer of the engines to the permittee for operational use.

1.4 Administrative Corrections

Microsoft also seeks edits which corrects outdated or inaccurate references, to include the following (refer to approval order markup at Appendix C):

- Updates to regulatory citations for engine test requirements at Permit Conditions 2.a, 4.b, 4.d.ii, and 5.a, pages 3 through 8.
- Correction of a reference to Table 4 at Permit Condition 5.b, page 9.

1.5 Nonroad Engines

One of the two nonroad engine generator sets consists of one enclosed trailer, which houses two nonroad engines with generators, each with a capacity of 500 kilowatts of electrical power (500-kWe). The other unit consists of an enclosed trailer, which houses one nonroad engine and generator, having a capacity of 1,825 kilowatts of electrical power (1,825-kWe). These are Tier 4 certified engines, with emission controls to reduce emissions, as described more fully in Section 2.5. Microsoft proposes to operate each nonroad engine for up to 100 operating hours annually as required for temporary engine repair or replacement needs at the Columbia Data Center.

The nonroad engines will be operated for required reliability testing, maintenance, emergency use, or other non-emergency purposes in lieu of one or more existing emergency generator engines which are being repaired. Microsoft proposes that annual fuel usage, based on 100 operating hours at full standby load for each nonroad engine, will serve as a surrogate parameter for annual emissions from these engines.

1.6 Ultra-Low Sulfur and Renewable Diesel Fuels

In the same manner as for the existing generator engines, Microsoft intends that requests Ecology's concurrence for the use of ultra-low sulfur diesel (ULSD) fuels, renewable diesel fuels, or a blend of both fuels in the nonroad engines. The sulfur content of ULSD has an upper limit of 15 parts per million (ppm). As shown in the certificate of analysis in Appendix I, 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*. The use of renewable diesel fuel for these engines, with its significantly reduced lifecycle carbon footprint, will support Microsoft's goal of becoming carbon negative by 2030 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 as the surrogate parameter for tracking emissions, which are calculated based on annual engine operating hours. Based on the projected 100 annual operating hours for each nonroad engine, the estimated annual fuel usage for the nonroad engines is 19,620 gallons per year (gal/yr), including 3,650 gal/yr for each of the two 500-kWe engines and 12,320 gal/yr for the 1,825-kWe engine.

Combined with the annual fuel usage of 460,213 gal/yr for the existing permitted engines, estimated total fuel usage for the Facility will be 479,833 gal/yr.

2.0 Emission Estimates

Air emissions from the Facility result from diesel-fuel powered internal combustion engines. As referenced in Chapter 1, 35 of the 46 permitted emergency diesel generator engines at the facility have been designated to support operations for Buildings CO1, CO2, CO3.2, and CO9 according to the building nomenclature changes requested in Section 1.2. Microsoft requests updates of three permit conditions associated with these engines.

2.1 Clarifying Verbiage for Operations of the 35 Engines

As described by Permit Condition 3.b on page 4 (refer to approval order markup at Appendix C), the 35 emergency diesel generator engines which support Buildings CO1, CO2, CO9, and CO3.2 are permitted to operate for up to 100 hours per year per engine at an average load of 53 percent of full standby capacity. The permit condition also states that individual units may be operated at higher loads as long as no emission limit is exceeded. The permit condition makes clear that annual operating hours may be averaged for all 35 generators – that is, individual units may operate for more than 100 hours per year.

In other words, this permit condition limits the operations of these 35 generator engines to average operations of 100 hours per year at an operating load of 53 percent of standby capacity for the purpose of limiting annual emissions from the operation of these generator engines.

Microsoft requests specific edits, as shown below, which will clarify that generator operations may deviate from the 53 percent load requirement as long as emissions represented by 100 average annual operating hours at 53 percent of standby capacity are not exceeded:

b. The 35 CO1, CO2, CO9, and CO3.2 generators must not operate more than 100 hours per year per engine at an average capacity of 53 percent of full standby capacity. ~~Individual units~~ Generator operations may ~~be operated at a higher load than~~ deviate form 53 percent of full standby capacity as long as ~~no emission limit is exceeded~~ emissions do not exceed emissions represented by 100 average operating hours at 53 percent of full standby capacity. Annual operating hours may be averaged over all 35 CO1, CO2, CO9, and CO3.2 generators.

2.2 Explanatory Edits for Emergency Operations

As described in Permit Condition 3.f on page 5 (refer to approval order markup at Appendix C), the 11 emergency diesel generator engines which support Buildings CO9 and CO3.2 are permitted to operate during power outage emergencies for a maximum of 48 hours per year per engine at a maximum average electrical load of 85 percent.

Similar to the limitations in Permit Condition 3.b, this condition limits the operations of these 11 generator engines during power outage emergencies to an average of 48 hours per year at an average load of 85 percent of full standby capacity for the purpose of limiting annual emissions during power outage emergencies from these 11 generator engines.

Microsoft requests specific edits, as shown below, to explain that individual generator operations during power outage emergencies for these engines may exceed 48 hours per year for individual engines and may deviate from the 85 percent maximum load requirement as long as emissions represented by 48 average annual operating hours at 85 percent of standby capacity are not exceeded:

f. Operation of the 11 CO9 and CO3.2 generators for power outage emergencies must be limited to a maximum of 48 hours per engine per calendar year at a maximum average electrical load of 85 percent. Annual operating hours for power outage emergencies may be averaged over the 11 generators. Operations for power outage emergencies may deviate from 85 percent of full standby capacity as long as emissions do not exceed emissions represented by 48 average annual operating hours at 85 percent of full standby capacity.

2.3 Clarifications for Electrical Bypass Operations

As described in Permit Condition 3.c on page 5 (refer to approval order markup at Appendix C), the 11 emergency diesel generator engines which support Buildings CO9 and CO3.2 are permitted to conduct electrical bypass operations for a maximum of 44 hours per year per engine at a maximum average electrical load of 40 percent.

Similar to the limitations in Permit Conditions 3.b and 3.f, this condition limits the operations of these 11 generator engines during electrical bypass operations to an average of 44 hours per year at an average load of 40 percent of full standby capacity for the purpose of limiting annual emissions during power outage emergencies from these 11 generator engines.

Microsoft requests specific edits, as shown below, to clarify that generator operations during power outage emergencies for these engines may exceed 44 hours per year for individual engines and may deviate from the 40 percent load requirement as long as emissions represented by 44 average annual operating hours at 44 percent of standby capacity are not exceeded:

c. Operation of the 11 ~~CO3.2,~~ CO9 and CO3.2~~, and CO3.3~~ generators for electrical bypass must be limited to approximately 44 hours per year each at an average electrical load of 40 percent of the standby rating. Annual operating hours for electrical bypasses may be averaged over the 11 generators. Operations for electrical bypasses may deviate from 40 percent of full standby capacity as long as emissions do not exceed emissions represented by 44 average annual operating hours at 40 percent of full standby capacity. No more than ~~two~~ five engines will operate at the same time during any electrical bypass operation.

2.4 Adjustment to Number of Generators for Electrical Bypasses

As described in the last sentence of Permit Condition 3.c on page 5 (refer to approval order markup at Appendix C), the 11 emergency diesel generator engines which support Buildings CO9 and CO3.2 are limited to the use of two of the 11 generator engines operating simultaneously during each electrical bypass operation.

It should be noted that the emission calculations which established this limitation were based on the operation of 2 generator engines at an average electrical load of 40 percent for a full

24-hour period. These parameters represent a limitation on short-term emissions from this set of generator engines electrical bypass operations.

Based on changes in requirements for such operations, Microsoft requests that the short-term limitation on these operations be adjusted so that the permit condition is edited as follows:

> No more than five engines will operate at the same time during any electrical bypass operation.

New 24-hour emission calculations have been prepared for these events (refer to revised bypass emission calculations at Appendix F) and modeling, for short-term averaging periods (up to 24 hours), has been performed as described in Chapter 4. The calculations and the modeling utilize emissions generated at an average electrical load of 75 percent for the simultaneous operation of five generator engines for four hours of a 24-hour day. Previously calculated hourly emissions and the revised hourly emissions estimate are compared in Table 2-1. As shown, hourly emissions for the revised scenario, with 5 generator engines operating at an electrical load of 75 percent, are greater than emissions for the previous scenario, represented by 2 generator engines operating at an electrical load of 40%.

Table 2-1: Comparison of Previous and Revised Hourly Emissions for Bypass Operations

Pollutant	Previous Electrical Bypass Emissions Rate Estimate (lb/hr)[a]	Revised Electrical Bypass Emissions Rate Estimate (lb/hr)[b]	Difference between Previous and Revised Emissions (lb/hr)
NO_X[c]	31.13	156.68	125.55
CO[d]	17.80	15.58	(2.22)
$PM/PM_{10}/PM_{2.5}$[e]	1.02	7.19	6.17
SO_2[f]	0.06	0.18	0.12
VOC[g]	1.43	5.63	4.20

(a) The previous emissions rate estimate, in pounds per hour (lb/hr), is based on two (2) engines operating simultaneously at an average electrical load of 40%.
(b) The revised emissions rate estimate (lb/hr) is based on five (5) engines operating simultaneously at an average electrical load of 75%.
(c) NO_X = nitrogen oxides.
(d) CO = carbon monoxide.
(e) Particulate matter (PM) emissions include filterable plus condensable particulate matter. PM emissions are considered to be a surrogate for emissions of particulate matter less than 10 microns in diameter (PM10) and particulate matter less than 2.5 microns in diameter (PM2.5).
(f) SO_2 = sulfur dioxide.
(g) VOC = volatile organic compounds.

In Table 2-2, daily emissions are contrasted. The revised daily emissions are lower for four of the five criteria pollutants than for the previous scenario because electrical bypasses were calculated based on 4 hours per day rather than 24 hours per day.

Table 2-2: Comparison of Previous and Revised Daily Emissions for Bypass Operations

Pollutant	Previous Electrical Bypass Emissions Rate Estimate (lb/day)[a]	Revised Electrical Bypass Emissions Rate Estimate (lb/day)[b]	Difference between Previous and Revised Emissions (lb/day)
NO_X	747.12	626.73	(120.39)
CO	427.27	62.31	(364.96)
$PM/PM_{10}/PM_{2.5}$	24.42	28.75	4.33
SO_2	1.47	0.71	(0.76)
VOC	34.43	22.50	(11.93)

(a) The previous emissions rate estimate (lb/day) is based on two (2) engines operating simultaneously at an average electrical load of 40% for a 24-hour period.
(b) The revised emissions rate estimate (lb/day is based on five (5) engines operating simultaneously at an average electrical load of 75% for a 4-hour period.

The emission adjustments also included new factors for toxic air pollutant (TAP) emissions. The factors specified by Ecology (in pounds per thousand gallons of diesel fuel) were obtained from Ventura County (VC, 2001) and California Air Toxics (CARB, 1996) emission factor tables. These factors were multiplied by fuel usage rates at the 75% load condition to derive lb/hr emission rates, as shown in the calculations at Appendix F and as incorporated into the air dispersion modeling in Chapter 4. The lb/hr emission rates also incorporated appropriate adjustments applicable to VOC or PM emissions for cold starts.

2.5 Nonroad Engine Emissions

The two nonroad engine generator sets, to be stored and maintained offsite for potential use at the Columbia Data Center, consist of two 500-kWe generator engines and one 1,825-kWe generator engine. Microsoft proposes to operate each nonroad engine for up to 100 operating hours annually as required for temporary engine repair or replacement needs at the Columbia Data Center, as reflected in the emission calculations at Appendix F and as represented in the air dispersion modeling of Chapter 4.0. As described in Sectoin 1.6, Microsoft proposes that annual fuel usage, based on 100 operating hours at full standby load for each nonroad engine, will serve as a surrogate parameter for annual emissions from these engines, which are calculated based on 100 annual operating hours for each nonroad engine.

Vendor-supplied emissions data were incorporated into emissions estimates from each nonroad engine, at varying load conditions (refer to Appendix H). The hourly emission rates were calculated based on the following approaches:

- The nonroad engines are Tier 4 certified, with selective catalytic reduction (SCR) systems to reduce NO_X emissions and catalyzed diesel particulate filter (DPF) systems to reduce PM, CO, and VOC emissions.
- Hourly emission rates, representing the Tier 4 controlled emissions, were acquired from the manufacturer "Emissions Data" tables labeled, "Rated Speed Potential Site Variation" for each nonroad engine.
    - Maximum performance data across all loads from the emissions data performance tables were used to determine maximum hourly emission rates

  - for NO_X, CO, and the filterable portion of particulate matter ($PM_{Filterable}$) emission rates.
  - Maximum performance data for hydrocarbons (HC) across all loads were used to determine the hourly VOC emission rates. The VOC emission rates were also conservatively assumed to be equivalent to condensable particulate matter (CPM) emissions.
  - Emission rates of PM, representing PM_{10} and $PM_{2.5}$ emission rates, were conservatively considered to be equivalent to the sum of $PM_{Filterable}$ and CPM (or VOC) emissions.
  - For rates showing values as 0.00 lb/hr in the tables, a rate of 0.005 was used.
  - An upper limit of 15 ppm sulfur content was used to determine maximum 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* (EPA, 1996).
  - NO_X emission factors at the 10% load condition were acquired from manufacturer data of like engines without NO_X controls and converted to lb/hr uncontrolled emission rates using performance data from the generator sets with Tier 4 levels emission controls. Because engine operation at the 10% load condition is limited to a 10-minute period for monthly reliability testing and maintenance, with no electrical load being produced, hourly emissions were appropriately adjusted (e.g., hourly rate multiplied by 10 minutes and divided by 60 minutes/hr).
- Cold-start emissions, occurring during the first minute of engine start-up were calculated for NO_X, CO, VOC, $PM_{Filterable}$ and, by extension, PM_{10} and $PM_{2.5}$ based on the data from *Air Quality Implications of Backup Generators in California; Volume Two: Emission Measurements from Controlled and Uncontrolled Backup Generators* (UCR, 2005).
  - Emission rate calculations conservatively assumed 12 cold-start events per year of up to one hour each for monthly reliability testing and maintenance. 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 operating hours. This resulted in estimates of 30 cold-start events annually for each nonroad engine. 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 F.
  - Cold-start adjustments were also applied to NO_X reductions acquired from the SCR systems. Emissions reductions cannot occur until exhaust temperatures during a cold start exceed injection and catalyst temperatures in the range of 500 °F. To provide time for these temperature conditions to be achieved, an estimated warm-up period of approximately 10 minutes at high load conditions and 15 minutes at idle loads are needed. As a conservative measure, the emissions calculations at Appendix F assume that NO_X emissions will not be reduced during warm-up periods consisting of the first 15 minutes of each cold-start event.

2.6 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 for the nonroad engines, 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 I.

2.7 Diesel Storage Tank Emissions

As described in Section 1.7, the nonroad engines have two diesel storage tanks, each with an estimated 630-gallon capacity, and one diesel storage tank with an estimated 1,050-gallon capacity. Due to the low vapor pressure of diesel (<0.01 psia), the VOC emissions from the diesel storage tanks (working and standing losses) are expected to be minimal (< 1 tpy). Therefore, these tanks meet an emissions-based exemption from permitting, as described in Section 3.3.2.

3.0 Regulatory Review

The Project is subject to various Federal and State air regulations. Below is a discussion of applicable Federal and 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.

3.1 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.

3.1.1 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. The diesel storage tanks associated with the nonroad engines will have capacities less than 75 cubic meters (19,812 gallons); therefore, the two 630-gallon storage tanks and the 1,050-gallon storage tank will not be subject to Subpart Kb.

3.1.2 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. The stationary emergency generator engines at the Facility meet the definition of "emergency stationary internal combustion engine" under this subpart. The generator engines are operated for the purposes of reliability testing, maintenance, emergency use, or other non-emergency uses.

The emergency diesel generator engines at the Facility are certified in accordance with the appropriate limits referenced in 40 CFR §60.4202(a)(2) and (b)(2), which refer to the Tier 2 emission standards at Tables 2 and 3 of 40 CFR §1039, Appendix I. NSPS Subpart IIII does not apply to the nonroad engines because they are not stationary engines.

3.2 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 requires the maximum degree of emission reduction of certain HAP emissions that EPA determines to be achievable. These Maximum Achievable Control Technology (MACT) standards are contained in 40 CFR Part 63. One MACT standard is applicable to the Project.

3.2.1 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 stationary emergency generator engines at the Facility are affected sources under Subpart ZZZZ (§63.6580 et seq.). The engines are 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). NESHAP Subpart ZZZZ does not apply to the nonroad engines because they are not stationary engines.

3.3 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).

3.3.1 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. The emergency diesel generator engines at the facility comply with these limits. Table 4-3 demonstrates that the nonroad engines, under any operating load condition, will comply with this limit.

Table 3-1: State Particulate Emission Standard Compliance

Emission Unit	Maximum $PM_{Filterable}$ Emission Rate[a] (lb/hr)	Minimum Flow Rate[b] (dscf/min)	Maximum PM Emission Rate[c] (gr/dscf)	PM Emission Limit (gr/dscf)	In Compliance?
500-kWe Generator Engines	0.042	655	0.007	0.1	Yes
1,825-kWe Generator Engine	0.090	1,273	0.004	0.1	Yes

(a) Maximum $PM_{Filterable}$, including cold-start emissions, for a single nonroad engine across all loads.
(b) Minimum flow rate across all loads for a single nonroad engine.
(c) gr/dscf = lb/hr x 7000 grains/lb ÷ (dscf/min x 60 min/hr).

3.3.2 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(1)(b), (4), (5), or (6). The Project involves operational updates to the 11 engines located associated with Buildings CO9 and CO3.2 at the Columbia facility. Therefore, these emission units do not meet any of the exemption criteria under WAC 173-400-110; therefore, these operational updates require NOC approval.

According to WAC 173-400-110(1)(b) and WAC 173-400-035(2)(a), the New Source Review (NSR) permitting requirements are not applicable to nonroad engines. Nevertheless, WAC 173-400-035(6) requires integrated review of the operation of nonroad engines if the applicant is also seeking approval to modify a stationary source requiring review. Additionally, WAC 173-400-035(9) states that the permitting authority may set specific conditions for operation as necessary to ensure that the nonroad engines do not cause or contribute to a violation of the NAAQS. For these reasons, the nonroad engines have been included in this application as part of an integrated review and to address evaluate the emissions from these nonroad engines against the NAAQS requirements.

As described in Section 2.7, the emission estimates for diesel storage tanks are expected to have minimal VOC emissions, 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.

3.3.3 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 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 described in the Executive Summary, the potential to emit for the Facility 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.

3.3.4 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

[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.

HAP emissions, whereas sources with emissions below these levels are known as area sources of HAP emissions.[1]

Major sources are required to obtain Title V operating permits. As described in the Executive Summary, the potential to emit for the Facility is well below the major source thresholds. Therefore, the Columbia Data Center will remain a minor source under the Title V program.

3.3.5 Best Available Control Technology

As required in WAC 173-400-113, a new or modified 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 toxic air pollutants (TAP) showing increases above de minimis levels found in WAC 173-460-150. As described in the Executive Summary, the operational updates to the 11 engines located associated with Buildings CO9 and CO3.2 do NOT represent seeking authorization to add a "new source" of emissions or to "modify" an existing stationary source at the Facility. Therefore, analysis for BACT and tBACT controls is not applicable to the Buildings CO9 and CO3.2 engines.

And according to WAC 173-400-035(2), nonroad engines are not subject to control technology determinations. Therefore, analysis for BACT and tBACT controls is not applicable to the nonroad engines.

3.3.6 Ambient Air Quality Standards and Toxic Air Pollutants

According to WAC 173-400-113(3), projects requiring NOC approval may not cause or contribute to a violation of any ambient air quality standard. Also, new or modified sources emitting TAPs are required to show compliance with the Washington TAP program pursuant to WAC 173-460. Air dispersion modeling for criteria pollutants and TAPs was accomplished for the Buildings CO9 and CO3.2 emergency generator emissions to show that the operational updates will not exceed the National Ambient Air Quality Standards (NAAQS) for criteria or the limits established for TAPs, as described below.

One notable exception to the TAPs requirements is nonroad engines. According to WAC 173-460-040(1), sources for which the new source review requirements are applicable are the sources which must adhere to the toxic air pollutants requirements. According to WAC 173-400-035(2), nonroad engines are not subject to new source review. Therefore, WAC 173-460 does not apply to nonroad engines. Nevertheless, WAC 173-400-035(9) states that the permitting authority may establish conditions for compliance with the NAAQS for nonroad engines with an aggregate power rating of greater than 2,000 brake horsepower. Therefore, air dispersion modeling of the nonroad engine emissions was accomplished for criteria pollutants but not for TAPs.

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. As described in the Executive Summary, this application does NOT seek authorization to add a "new source" of

[1] Refer to definition of "major source" in WAC 173-401-200.

emissions or to “modify” an existing stationary source at the Facility. Nevertheless, the Project analysis has determined whether modeling is needed for short-term TAP emission increases associated with the project.

If the short-term project-related TAP emissions increase exceeds the de minimis level for a pollutant, the increase is evaluated against the SQER. If the respective SQER is exceeded, further determination of compliance with the ASIL is conducted.

Table 3-2 summarizes the short-term TAP emissions increases being reviewed and illustrates a comparison of the emissions, on a lb/hr averaging period basis, with the de minimis and SQER levels. Emission increases for a 24-hour period are relevant to this Project based on the proposed adjustment to the number of generators operated for electrical bypasses, as described in Section 2.4. Project emissions are represented as “N/A” if the averaging period is greater than 24 hours. TAPs showing rates that exceed the de minimis levels for averaging periods up to 24 hours include CO, NO_2, acrolein, ammonia, hydrogen chloride, manganese and manganese compounds, and elemental mercury. TAPs showing rates that exceed the SQER levels for averaging periods up to 24 hours include NO_2, acrolein, and elemental mercury. Therefore, NO_2, acrolein, and elemental mercury emissions are included in the air dispersion modeling, described in Chapter 4. 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 F.

Table 3-2: Project TAP Emission Summary

TAP	Averaging Period[a]	Project Emissions	De Minimis[a]	SQER[a]	Evaluated vs. SQER	Modeling Required?
		(lb/averaging period)[b]				
CO	1-hour	15.58	1.10	43.00	Yes	No
DEEP	1-year	N/A	2.7E-02	N/A	No	No
SO_2	1-hour	0.18	0.46	N/A	No	No
NO_2	1-hour	15.67	0.46	0.87	Yes	Yes
Acetaldehyde	1-year	N/A	3.00	N/A	No	No
Acrolein	24-hour	9.40E-02	1.3E-03	2.6E-02	Yes	Yes
Ammonia	24-hour	13.07	1.90	37.00	Yes	No
Arsenic & Compounds	1-year	N/A	2.5E-03	N/A	No	No
Benz(a)anthracene	1-year	N/A	4.5E-02	N/A	No	No
Benzene	1-year	N/A	1.00	N/A	No	No
Benzo(a)pyrene	1-year	N/A	8.2E-03	N/A	No	No
Benzo(b)fluoranthene	1-year	N/A	4.5E-02	N/A	No	No
Benzo(k)fluoranthene	1-year	N/A	4.5E-02	N/A	No	No
1,3-Butadiene	1-year	N/A	0.27	N/A	No	No
Cadmium & Compounds	1-year	N/A	1.9E-03	N/A	No	No
Chlorobenzene	24-hour	5.54E-04	3.70	N/A	No	No
Chromium VI & Compounds	1-year	N/A	3.3E-05	N/A	No	No
Chrysene	1-year	N/A	0.45	N/A	No	No
Copper & Compounds	1-year	N/A	9.3E-03	N/A	No	No
Dibenz(a,h)anthracene	1-year	N/A	4.1E-03	N/A	No	No
Ethyl benzene	1-year	N/A	3.20	N/A	No	No
Formaldehyde	1-year	N/A	1.40	N/A	No	No
n-Hexane	24-hour	7.46E-02	2.60	N/A	No	No
Hydrogen Chloride	24-hour	0.52	3.3E-02	0.67	Yes	No
Indeno(1,2,3-cd)pyrene	1-year	N/A	4.5E-02	N/A	No	No
Lead & Compounds	1-year	N/A	10.00	N/A	No	No
Manganese & Compounds	24-hour	8.59E-03	1.1E-03	2.2E-02	Yes	No
Mercury, elemental	24-hour	5.54E-03	1.1E-04	2.2E-03	Yes	Yes
Naphthalene	1-year	N/A	0.24	N/A	No	No
Nickel & Compounds	1-year	N/A	3.1 E-02	N/A	No	No
Propylene	24-hour	1.29	11.00	N/A	No	No
Selenium & Compounds	24-hour	6.10E-03	7.4 E-02	N/A	No	No
Toluene	24-hour	0.29	19.00	N/A	No	No
Xylenes	24-hour	0.12	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 and are represented as "N/A" if Project emissions were below de minimis thresholds. Project Emissions are represented as "N/A" if the averaging period is greater than 24 hours.
(b) lb/averaging period estimated by multiplying lb/hr estimates by 1 and 24 for the 1-hr and 24-hr averaging periods.

3.3.7 Health Impact Assessments

If air dispersion modeling, referenced in Section 3.3.6 and described in Chapter 4, shows that an ASIL for a TAP is exceeded, second-tier review of the potential impact from TAP emissions is triggered.[1] If this were to occur, a health impact assessment (HIA) protocol would be developed, and an HIA would be 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.

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.[2] 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 Chapter 4, there are no TAPs with emissions which exceed their ASIL. Therefore, a second-tier HIA is not triggered by this Project.

[1] Refer to WAC 173-460-090.
[2] Refer to WAC 173-460-100.

3.3.8 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.[1] 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.[2]

3.3.9 State Environmental Policy Act Checklist Review

An update of the previously completed State Environmental Policy Act (SEPA) checklist is generally required for permit approvals. However, this Project does NOT seek authorization to add a "new source" of emissions or to "modify" an existing stationary source at the Facility. Therefore, an update to the SEPA checklist is not applicable for this application.

[1] Refer to WAC 173-400-171.

[2] As noted in Section 3.3.7, a second-tier HIA is not triggered by this Project; therefore, it follows that a third-tier HIA will not apply.

4.0 Air Dispersion Modeling

Air dispersion modeling was performed for the Facility upgrades (electrical bypass operation) and potential operation of nonroad engines.

- Due to adjustments to the number of generators and maximum load conditions to be operated during electrical bypass operations for the Buildings CO9 and CO3.2 emergency generator engines, air dispersion modeling was performed to demonstrate compliance with the short-term NAAQS for criteria pollutants and the applicable ASILs that trigger an air dispersion modeling analysis. The adjustment to the electrical bypass operation condition only affects the hourly emissions. No modifications are being made to the Building C09 units on an annual basis for the electrical bypass condition; therefore, the electrical bypass condition is not included in the ~~no~~ annual modeling ~~is~~ being performed for this analysis.

- For the nonroad engines, air dispersion modeling was performed for criteria pollutants to demonstrate compliance with the NAAQS, but modeling was not conducted for TAPs for the emergency generator engines, as described in Section 3.3.6. Short-term and annual NAAQS modeling was performed for the nonroad engines.

A summary of the models, the modeling techniques, and modeling results for the Project are discussed in the following sections.

4.1 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 23132). 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 *User's Guide for the AMS/EPA Regulatory Model (AERMOD)* (EPA, 2023). The regulatory default option was selected for this analysis since it met the EPA and Ecology guidance requirements.

The following default model options were used:
- Elevated Terrain Algorithms
- Stack-tip Downwash
- Gradual Plume Rise
- Buoyancy-induced Dispersion
- Calms and Missing Data Processing Routine
- Calculated Wind Profiles
- Default Vertical Potential Temperature Gradient
- Rural Dispersion

4.2 Model Parameters

Modeling runs were conducted to represent the proposed electrical bypass operational condition, which allows five of the Buildings CO9 and CO3.2 generator engines to run simultaneously at no more than 75 percent capacity. The modeling parameters and the emission rate parameters for the Buildings CO9 and CO3.2 emergency generator engines are shown in Table 4-1 and Table 4-2, respectively.

Table 4-1: Buildings C09 and C03.2 Generator Engine Modeling Parameters for Electrical Bypasses

Source ID	Stack Height (feet)	Design Temperature (°F)	Modeled Temperature[a] (°F)	Design Exit Velocity (meters/second)	Modeled Exit Velocity[b] (meters/second)	Stack Diameter (inches)
C3Y10G25	56	864.0	820.8	47.61	45.23	18
C3Y10G26	56	864.0	820.8	47.61	45.23	18
C3Y10G27	56	864.0	820.8	47.61	45.23	18
C3Y10G28	56	864.0	820.8	47.61	45.23	18
C3Y10G29	56	864.0	820.8	47.61	45.23	18
C3Y10G30	56	864.0	820.8	47.61	45.23	18
C3Y10G31	56	864.0	820.8	47.61	45.23	18
C3Y10G32	56	864.0	820.8	47.61	45.23	18
C3Y10G33	56	864.0	820.8	47.61	45.23	18
C3Y10G34	31	864.0	820.8	47.61	45.23	18
C3Y10G35	31	864.0	820.8	47.61	45.23	18

(a) A safety factor was applied, which reduced the stack temperature by five percent to account for variations in onsite environmental conditions.
(b) 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.

Maximum hourly emissions at 75% load were modeled for CO, NO_2, and SO_2. The 24-hour PM_{10} and $PM_{2.5}$ modeling emission rates were adjusted to represent the engine operating for the electrical bypass scenario for four (4) hours out of a 24-hour period. Table 4-2 shows the maximum hourly PM_{10} and $PM_{2.5}$ emission rate for the 2,500-kWe generator engine at 75% load operation and the modeled 24-hour average emissions.

Table 4-2: Buildings C09 and C03.2 Generator Engine Criteria Pollutant Emission Rate Parameters (Single Engine)

Pollutant	75% Load (lb/hr)	Adjusted 75% Load[a] (lb/hr)
$PM_{2.5}$	1.44	0.24
PM_{10}	1.44	0.24
CO	3.12	--
NO_2	31.34	--
SO_2	0.036	--

(a) Maximum hourly emission rate (lb/hr) value * 4 hour/24 hours

The modeling parameters and the emission rate parameters for the nonroad engines are shown in Table 4-3 and Table 4-4, respectively. Because engine operation at the 10% load condition is limited to a 10-minute duration for monthly reliability testing and maintenance, with no electrical load being produced, hourly emissions were appropriately adjusted for that load condition (e.g., hourly rate multiplied by 10 minutes and divided by 60 minutes/hr). Also, for the purpose of the modeling, the nonroad engines were placed in the southeastern quadrant of the Facility, as shown in the area maps in Appendix A. The southeastern quadrant served as a worst-case modeling scenario due to the southeasterly flow direction of prevailing winds.

4.3 Modeling Methodology

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

4.3.1 Source Groups

For the operating updates on Buildings CO9 and CO3.2 emergency generator engines, only five of the 11 engines will operate in an electrical bypass scenario; therefore, the engine groupings were modeled to demonstrate compliance with the bypass condition.

Electrical Bypass Scenarios

- Operating Scenario A – Five Buildings CO9 and CO3.2 engines - C3Y10G25, C3Y10G26, C3Y10G27, C3Y10G28, C3Y10G29.
- Operating Scenario B – Five Buildings CO9 and CO3.2 engines - C3Y10G28, C3Y10G29, C3Y10G30, C3Y10G31, C3Y10G32.
- Operating Scenario C – Five Buildings CO9 and CO3.2 engines - C3Y10G31, C3Y10G32, C3Y10G33, C3Y10G34, C3Y10G35.

The nonroad engines will not be tested during the electrical bypass scenario and the nonroad engines will be tested one at a time; therefore, the nonroad engine groupings are as follows:

- P1_1_100
- P1_1_75
- P1_1_50
- P1_1_25
- P1_1_10
- P1_2_100
- P1_2_75
- P1_2_50
- P1_2_25
- P1_2_10
- P2_A_100 and P2_B_100
- P2_A_75 and P2_B_75
- P2_A_50 and P2_B_50
- P2_A_25 and P2_B_25
- P2_A-10 and P2_B_10

For the PM_{25} and NO_2 annual averaging period runs, all nonroad and five Buildings CO9 and CO3.2 engines were run as one combined group for each engine load group.

4.3.2 Emission Factors

Emission factors (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.

Table 4-3: Nonroad Engine Modeling Parameters (each stack)

Source ID[a]	Load	Stack Height (feet)	Design Temperature (°F)[b]	Modeled Temperature (°F)[c]	Design Exit Velocity (meters/second)[b]	Modeled Exit Velocity (meters/second)[c,d]	Stack Diameter (inches)[e]
P1_1 and P1_2 (each stack)	100%	11.97	836.8	795.0	91.85	87.25	5.0
	75%		744.2	707.0	80.32	76.31	
	50%		659.8	626.8	67.13	63.78	
	25%		551.4	523.8	50.44	47.92	
	10%		456.8	434.0	42.34	40.22	
P2_A and P2_B (each stack)	100%	13.39	876.9	833.1	48.75	46.32	12.00
	75%		843.7	801.5	39.95	37.96	
	50%		790.0	750.5	30.63	29.10	
	25%		659.1	626.1	21.10	20.05	
	10%		506.3	481.0	15.06	10.54	14.34

(a) Source IDs represent two 500-kWe nonroad engines (P1_1 & P1_2) and two exhaust stacks from one 1,825-kWe nonroad engine (P2_A and P2_B). Each of the two exhaust stacks for the 1,825-kWe generator engine account for half of the engine's exhaust flows and emissions.
(b) Design exhaust temperatures and flow rates (from which exit velocities were derived) were acquired from post-treatment manufacturer data, with no adjustments necessary due to routing of exhaust gases through the treatment systems.
(c) Safety factors were applied to design exhaust temperatures and design exit velocities, which reduced the exhaust temperatures and exit velocities by five percent to account for variations in onsite environmental conditions.
(d) For the 10% load condition, the exit velocity was reduced by 30% rather than the 5% reduction as described in Note (c) for the 1,825-kWe nonroad engine to account for a vertical stack with a rain cap that has an angle of 45 degrees. This adjustment was not applied to the 500-kWe nonroad engines due to the horizontal nature of the exhaust flow, as discussed in Section 4.3.3.
(e) For the 10% load condition, an effective stack diameter was derived for the 1,825-kWe nonroad engine to simulate the widening of the plume due to the effect on exit velocity of the lowered rain cap. This diameter was calculated by dividing the actual flow rate by the adjusted exit velocity. This adjustment was not applied to the 500-kWe nonroad engines due to the horizontal nature of the exhaust flow, as discussed in Section 4.3.3.

Table 4-4: Nonroad Engine Criteria Pollutant Emission Rate Parameters (each stack)

Source ID[a]	Pollutant	Units[b]	100% Load	75% Load	50% Load	25% Load	10% Load[c]
P1_1 and P1_2 (each stack)	$PM_{2.5}$	lb/hr	0.084	0.045	0.020	0.020	0.0072
		tpy	0.0041	0.0027	0.0020	0.0020	0.0013
	PM_{10}	lb/hr	0.084	0.045	0.020	0.020	0.0072
	CO	lb/hr	0.0057	0.0057	0.0057	0.0057	0.0015
	NO_2	lb/hr	2.63	1.40	0.81	0.99	0.42
		tpy	0.057	0.057	0.045	0.041	0.054
	SO_2	lb/hr	0.0090	0.0069	0.0047	0.0026	0.00022
P2_A and P2_B (each stack)	$PM_{2.5}$	lb/hr	0.21	0.21	0.19	0.16	0.034
		tpy	0.0099	0.0091	0.0083	0.0079	0.0034
	PM_{10}	lb/hr	0.21	0.21	0.19	0.16	0.034
	CO	lb/hr	0.40	0.30	0.22	0.16	0.066
	NO_2	lb/hr	6.19	3.54	2.08	1.51	0.56
		tpy	0.15	0.13	0.12	0.11	0.11
	SO_2	lb/hr	0.016	0.013	0.0087	0.0050	0.00044

(a) Source IDs represent two 500-kWe nonroad engines (P1_1 and P1_2) and two exhaust stacks from one 1,825-kWe nonroad engine (P2_A and P2_B). Each of the two exhaust stacks for the 1,825-kWe generator engine account for half of the engine's emissions.
(b) Maximum tpy values for each engine are based on 100 operating hours per year.
(c) Because engine operation at the 10% load condition is limited to a 10-minute period for monthly reliability testing and maintenance, with no electrical load being produced, hourly emissions were appropriately adjusted (e.g., hourly rate multiplied by 10 minutes and divided by 60 minutes/hr). Annual emissions were similarly adjusted.

The following EMISFACT was applied to the modeling runs:

- Time-of-day factors for Electrical Bypass Operating Scenarios A, B, and C were applied from 9 A.M. to 4 P.M. (7 hours each day).
- Time-of-day factors for nonroad engines were applied from 7 A.M. to 5 P.M. (10 hours each day).
- For NO_2 (annual averaging period) and $PM_{2.5}$ (annual averaging period) – No EMISFACT was applied.

4.3.3 Rain Caps and 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 POINTHOR keyword was applied to the two 500-kWe nonroad engines.

For all load conditions, safety factors were applied, which reduced the exhaust temperatures and exit velocities by five percent to account for variations in onsite environmental conditions. For the 10% load condition, the exit velocity was reduced by 30% rather than the 5% reduction for the 1,825-kWe nonroad engine to account for a vertical stack with a rain cap that has an angle of 45 degrees; also, an effective stack diameter was derived to simulate the widening of the plume due to the effect on exit velocity of the lowered rain cap (calculated by dividing the actual flow rate by the adjusted exit velocity. These adjustments at the 10% load condition were not applied to the 500-kWe nonroad engines due to the horizontal nature of the exhaust flow.

4.3.4 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 Ecology.

4.3.5 Receptor Grid

The overall purpose of the modeling analysis is to demonstrate that the 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 4-5. Receptors were also 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 human breathing zone was used for all receptors.

Table 4-5: Receptor Spacing from Property 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

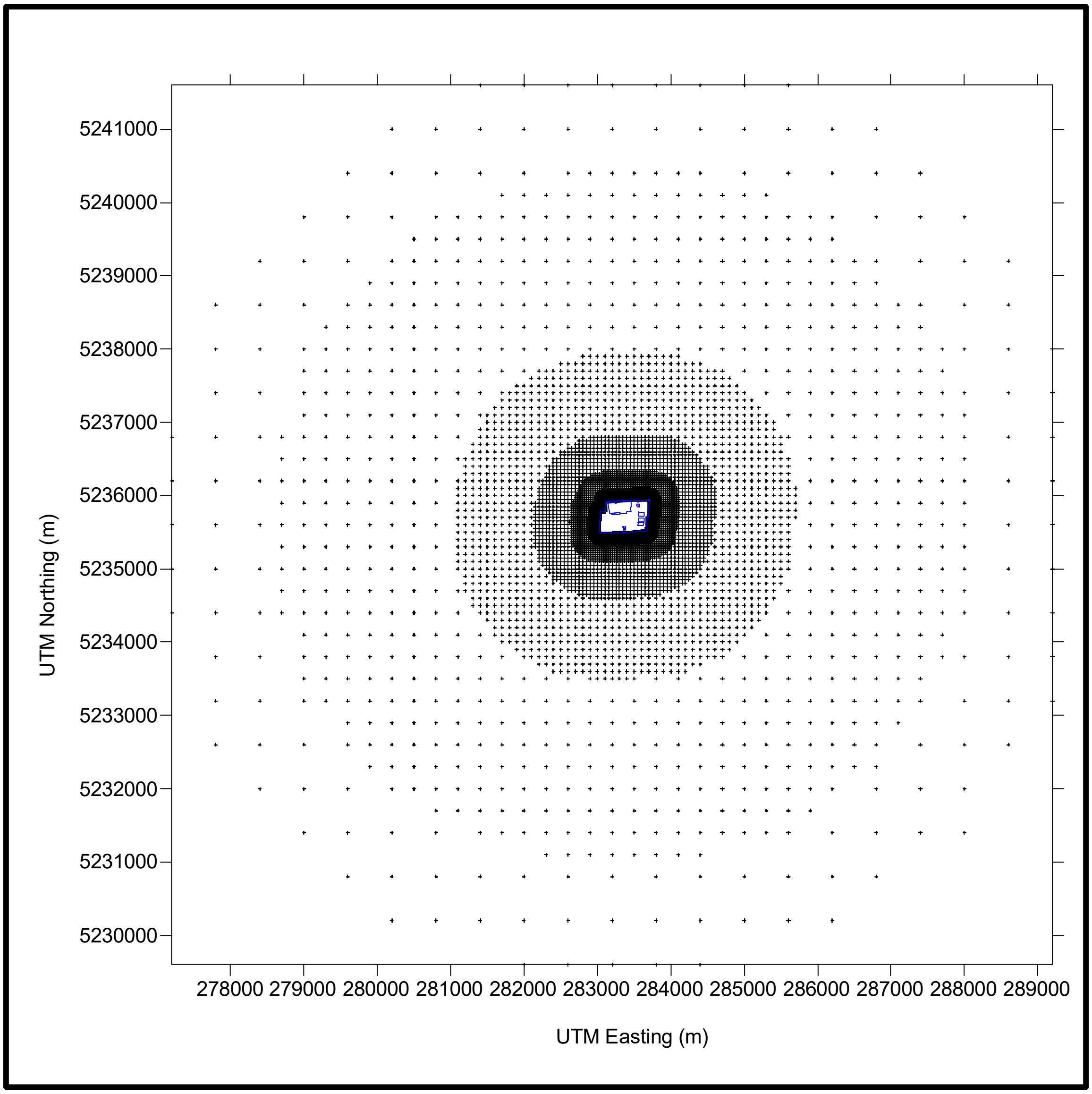
Source: Ecology, Air Quality Program Guidance, August 2019 (Ecology, 2019)

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 pre-processor (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 4-1 on the following page.

Figure 4-1: Receptor Grid



4.3.6 Meteorological Data

AERMOD requires a pre-processor called AERMET (Version 22112) 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.

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 G-1 in Appendix G 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 G-1, the prevailing winds are blowing to the southeast.

4.3.7 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.

Table 4-6: 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

The inputs used in the AERSURFACE analysis are listed in Table 4-6. 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.

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.

4.3.8 Modeling Thresholds

The NAAQS and modeling significance levels for the modeled pollutants are shown in Table 4-7.

Table 4-7: 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	0.13[c]	9[c]
	24-hour	1.2[c]	35
SO_2	3-hour	25	1,300
	1-hour	7.8	196

(a) Title 40 CFR §51.165(b)(2)
(b) WAC 173-476, Ambient Air Quality Standards.
(c) EPA Memorandums, 2024, "Updates to the Guidance for Ozone and Fine Particulate Matter Permit Modeling" and 2022, "Guidance for Ozone and Fine Particulate Matter Permit Modeling." (EPA, 2024).

The modeled values were modeled using the appropriate form of the standard for each pollutant and averaging period. For significance modeling, all short-term averaging periods were modeled with the impact shown in Table 4-8. Where applicable, the NAAQS thresholds were modeled using the highs shown in Table 4-8 for each averaging period.

Table 4-8: Modeled Highs

Pollutant	Averaging Period	Significant Impact Level[a]	NAAQS Modeled High[b]
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

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

4.3.9 NAAQS Analysis

When the maximum impacts exceed the significant impact level for any pollutant and averaging time, then a comprehensive analysis is required. The comprehensive analysis includes the facility sources, all other existing sources at the Facility, and nearby facilities. For this analysis, only facility sources were modeled, and no nearby facilities were included.

Background air quality concentrations (as described in Section 4.3.10) 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.

4.3.10 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. The regional background value for $PM_{2.5}$ was obtained from the Idaho Department of Environmental Quality's database. 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 4-9 were used as background levels and added to the modeled impacts.

Table 4-9: Background Concentrations

Pollutant	Averaging Period	Background Concentration ($\mu g/m^3$)[a]
NO_2	1-hour	58.75[b]
$PM_{2.5}$	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, 2023)
(c) Idaho Department of Environmental Quality, https://arcg.is/1jXmHH, accessed April 2023 (Idaho, 2023).

4.3.11 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, 2023). The background ozone value was 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.

4.4 SIL Modeling Results

Significance modeling was performed for NO_2, CO, PM_{10}, $PM_{2.5}$, and SO_2 short-term averaging periods for the operational updates to the Buildings C09 and CO3.2 emergency generator engines and for short-term and annual averaging periods for the operation of the nonroad engines. The modeled impacts are shown in Table 4-10 below. Isopleths of the maximum impact concentrations for each pollutant and averaging period are shown in Figures G-2 to G-10 in Appendix G.

Table 4-10: Maximum Modeled Concentrations for Significance Modeling

Pollutant	Averaging Period	UTM Coordinates[a]		Year	Predicted Concentration	Modeling Significance Level[b]
		Easting (meters)	Northing (meters)		micrograms per cubic meter ($\mu g/m^3$)	
NO_2	Annual	283,503.48	5,235,505.00	3 years	0.16	1
	1-hour	281,600.00	5,243,600.00	3 years	184.6[C]	7.5
CO	8-hour	283,681.17	5,235,706.55	2019	57.1	500
	1-hour	283,681.17	5,235,706.55	2018	80.7	2,000
PM_{10}	24-hour	283,369.11	5,235,490.97	2019	1.9	5
$PM_{2.5}$	Annual	283,515.70	5,235,506.28	3 years	0.007	0.13[d]
	24-hour	283,355.73	5,235,493.81	3 years	1.7	1.2[d]
SO_2	3-hour	283,681.17	5,235,706.55	2019	0.73	25
	1-hour	283,479.05	5,235,502.45	3 years	1.5	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) EPA Memorandums, 2024, "Updates to the Guidance for Ozone and Fine Particulate Matter Permit Modeling" and 2022, "Guidance for Ozone and Fine Particulate Matter Permit Modeling."

After examining the modeling results at all load levels, it was determined that exceedances of the NO_2 (1-hour) and $PM_{2.5}$ (24-hour) modeling significance levels occurred, and refined modeling was 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.

4.5 NAAQS Modeling Results

Refined modeling for the operational updates to the Buildings CO9 and CO3.2 emergency generator engines and for the operation of the nonroad engines was performed for 1-hour NO_2 and 24-hour $PM_{2.5}$. Inventories were incorporated into the $PM_{2.5}$ 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 4-11. Isopleths of the maximum impact concentration for the NO_2 1-hour averaging period and $PM_{2.5}$ 24-hour averaging period are shown in Figure G-11 and G-12, respectively, in Appendix G.

Table 4-11: Maximum Modeled Concentrations for NAAQS Modeling

Pollutant	Averaging Period	UTM Coordinates[a]		Year	Predicted Concentration	Background Concentration	Total Concentration	NAAQS[b]
		Easting (meters)	Northing (meters)		micrograms per cubic meter ($\mu g/m^3$)			
NO_2	1-hour	283,681.17	5,235,706.55	3 years	127.8[c]	58.75	186.52	188
$PM_{2.5}$	24-hour	283,681.17	5,235,706.55	3 years	12.1	18.9	31.0	35

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

4.6 Toxic Air Pollutant Analysis

All new or modified sources that emit TAPs are required to show compliance with the TAP program, which establishes emission limits for certain air pollutants which are particularly harmful to the surrounding environment and people. As described in Section 3.3.6 above, the TAPs requirements do not apply to the nonroad engine emissions. Therefore, this analysis was limited to the emissions associated with operational updates for the Buildings CO9 and CO3.2 emergency generator engines.

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.

As shown in the Project TAP Emissions Summary at Table 3-2, NO_2, acrolein, and elemental mercury exceed the SQER and require modeling.

A first tier TAP analysis using AERMOD is to be conducted to compare the impacts of NO_2, acrolein, and elemental mercury to their respective ASILs as shown in Table 4-12.

Table 4-12: ASIL Thresholds

TAP	Averaging Period	ASIL Threshold[a] (μg/m3)
NO_2	1-hour	470
Acrolein	24-hour	0.35
Mercury, elemental	24-hour	0.03

(a) Source: WAC 173-460-150.

An ASIL modeling analysis was performed using the stack parameters shown in Table 4-1 and emissions parameters in Table 4-2. The following engine groupings were modeled.

- Operating Scenario A – Five Buildings CO9 and CO3.2 engines - C3Y10G25, C3Y10G26, C3Y10G27, C3Y10G28, C3Y10G29.
- Operating Scenario B – Five Buildings CO9 and CO3.2 engines - C3Y10G28, C3Y10G29, C3Y10G30, C3Y10G31, C3Y10G32.
- Operating Scenario C – Five Buildings CO9 and CO3.2 engines - C3Y10G31, C3Y10G32, C3Y10G33, C3Y10G34, C3Y10G35.

The modeling analysis determined that all modeled TAPs comply with their respective ASILs as shown in Table 4-13 and no further modeling will be required. Isopleths of the maximum impact concentrations for each pollutant and averaging period are shown in Figures G-13 to G-15 in Appendix G.

Table 4-13: Maximum Modeled Concentrations for ASIL Modeling

Pollutant	Averaging Period	UTM Coordinates[a]		Year	Predicted Concentration	ASIL Threshold[b]
		Easting (meters)	Northing (meters)		micrograms per cubic meter (µg/m3)	
NO_2	1-hour	281,600.00	5,243,600.00	3 years	184.6[C]	470
Acrolein	24-hour	283,681.17	5,235,706.55	2019	0.03	0.35
Mercury, elemental	24-hour	283,681.17	5,235,706.55	2019	0.002	0.03

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

4.7 Dispersion Modeling Conclusion

The modeling results shown in Table 4-10 demonstrate that no exceedances of the modeling significance levels are predicted for NO_2 (annual averaging period), CO (1- and 8-hour averaging periods), PM_{10} (24-hour averaging period), $PM_{2.5}$ (annual averaging period), and SO_2 (1- and 3-hour averaging periods); consequently, no further modeling is required for these pollutants and averaging periods. A refined modeling analysis was conducted, with results as shown in Table 4-11, to demonstrate compliance with the NAAQS for the NO_2 1-hour and $PM_{2.5}$ 24-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 4-13, 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}, $PM_{2.5}$, and SO_2 have been fulfilled, and no further modeling is required.

5.0 References

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APPENDIX A – PLAN VIEW SITE MAPS

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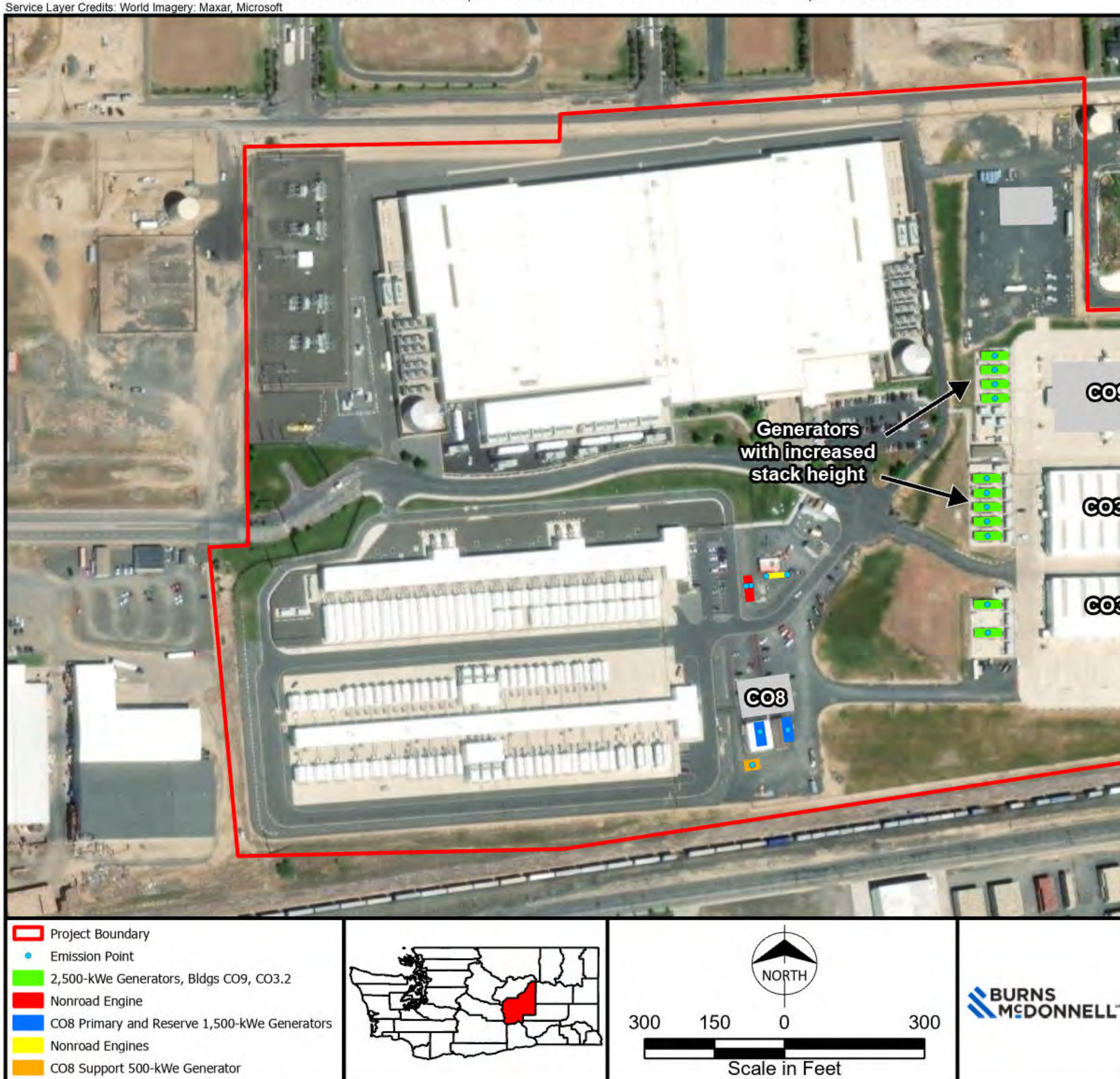

Appendix A.1 - Area Map
Columbia Data Center
Microsoft Corporation
Grant County, Washington

Source: ESRI; Microsoft Corporation; Burns & McDonnell

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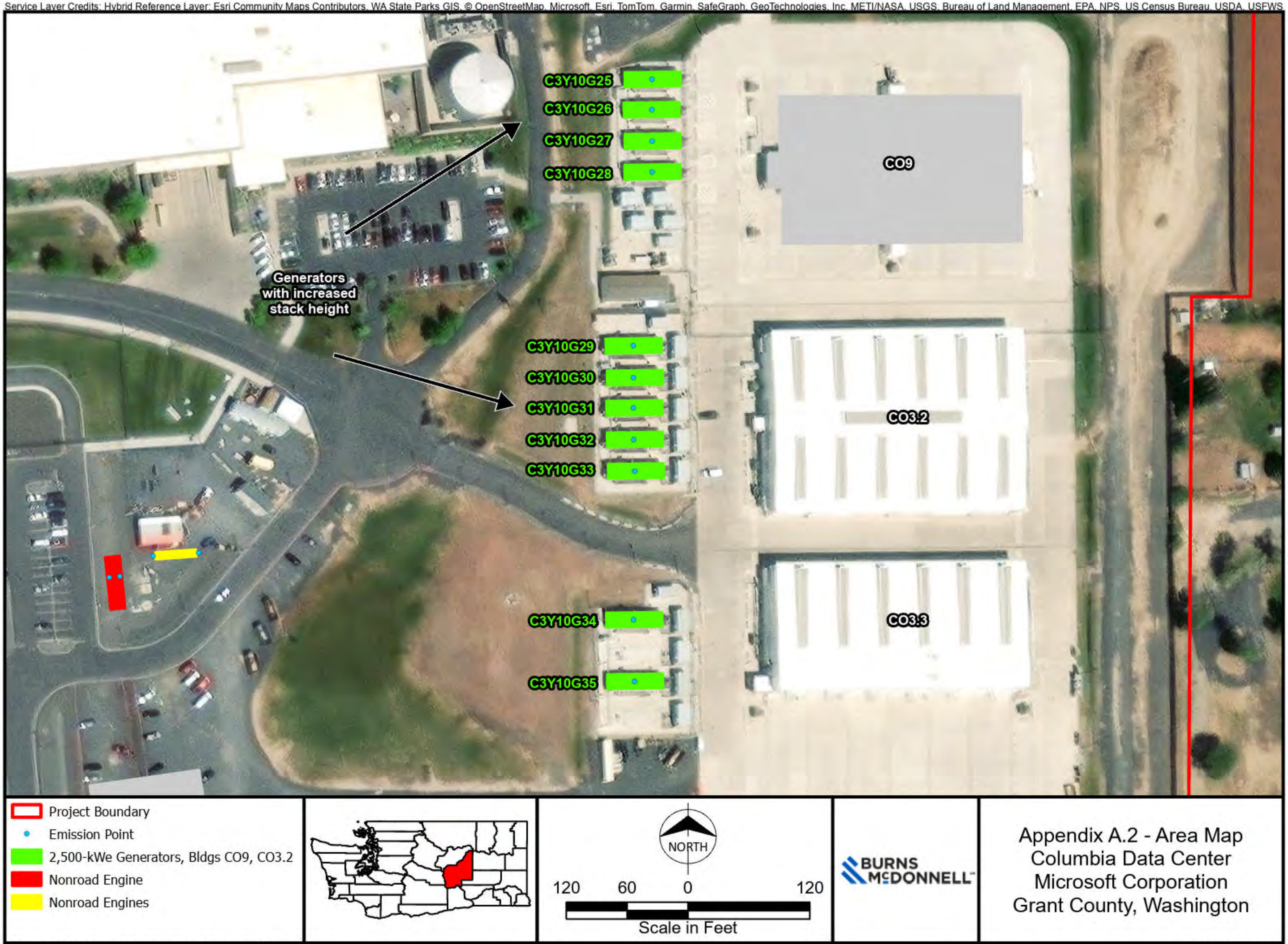

Appendix A.2 - Area Map
Columbia Data Center
Microsoft Corporation
Grant County, Washington

Source: ESRI; Microsoft Corporation; Burns & McDonnell

Issued: 6/24/2024

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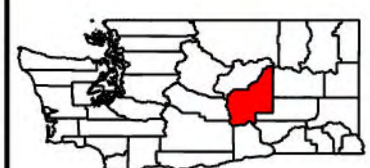
Service Layer Credits: Hybrid Reference Layer: Esri Community Maps Contributors, WA State Parks GIS, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS

- Project Boundary
- Emission Point
- 2,500-kWe Generators, Bldgs CO9, CO3.2
- Nonroad Engine
- CO8 Primary and Reserve 1,500-kWe Generators
- Nonroad Engines
- CO8 Support 500-kWe Generator



NORTH

150 75 0 150

Scale in Feet

BURNS McDONNELL

Appendix A.3 - Area Map
Columbia Data Center
Microsoft Corporation
Grant County, Washington

Source: ESRI; Microsoft Corporation; Burns & McDonnell

Issued: 6/24/2024

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.

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

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 Approval Order Update Project	
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) Brian Logan	
2. Facility Contact Mailing Address (if different than Company Mailing Address) 501 Port Industrial Parkway, Quincy, Washington 98848	
3. Facility Contact Phone Number +1 (425) 706-8468	4. Facility Contact E-mail brianlogan@microsoft.com
5. Billing Contact Name (who should receive billing information) Teleri Smith	
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 (682) 382-0472	8. Billing Contact E-mail tasmith@burnsmcd.com
9. Consultant Name (optional – if 3rd party hired to complete application elements) Alicia Beasley	
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 (817) 570-0013	13.Consultant E-mail abeasley@burnsmcd.com
14. Responsible Official Name and Title (who is responsible for project policy or decision-making) Hichem Garnaoui, Campus Director (or designee: Shirazeh Entezari, CE Operations Manager)	
16. Responsible Official Phone +1 (425) 538-3684 / +1 (509) 794-6233	17. Responsible Official E-mail hichem.garnaoui@microsoft.com shirazeh.entezari@microsoft.com
18. Responsible Official Certification and Signature I certify that the information on this application is accurate and complete. Signature [signature] Date 05/04/2023	

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:

____

☐ 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

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

Notice of Construction Application

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 – APPROVAL ORDER MARKUP

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Eastern Region Office

4601North Monroe St., Spokane, WA 99205-1295 • 509-329-3400

September 27, 2022

Hichem Garnaoui
Campus Director
Microsoft Corporation
Columbia Data Center
501 Port Industrial Parkway,
Quincy, WA 98848

Re: Microsoft Columbia Data Center
Approval Order No. 22AQ-E006
AQPID No. A0250278

Dear Hichem Garnaoui:

The Department of Ecology's Air Quality Program (Ecology) approves the installation of six new emergency backup engines at Microsoft Columbia Data Center. The Data Center is located at 501 Port Industrial Parkway, Quincy, Washington in Grant County.

Ecology's approval is based on the Notice of Construction application and supplemental information submitted on October 7, 2021through April 8, 2022. The 30-day comment period required per Washington Administrative Code (WAC) 173-400-171, was completed. Comments were received and are included in Appendix B of the Technical Support Document.

Enclosed is Approval Order No. 22AQ-E006 for Microsoft Columbia Data Center.

Thank you for your patience while we processed your application. If you have any questions, please contact me at jenny.filipy@ecy.wa.gov or 509-405-2487.

Sincerely,

Commercial/Industrial Unit
Regional Air Quality Program

JF:sg

Enclosures: Approval Order No. 22AQ-E006
Technical Support Document

Certified Mail: 7019 0140 0000 6495 6453

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

In the matter of approving a new AIR CONTAMINANT SOURCE for **MICROSOFT CORPORATION** **COLUMBIA DATA CENTER**	))))	**Approval Order No. 22AQ-E006** AQPID No. A0250278

Project Summary

Microsoft Corporation – Columbia Data Center, herein referred to as the Permittee, is an existing data center located at 501 Port Industrial Parkway, Quincy, Washington, in Grant County.

The Permittee is classified as a Synthetic Minor source.

Equipment

1. A list of equipment that was evaluated for this order of approval is contained in Tables 1.a through 1.c.

Table 1.a: Engine & Generator Serial Numbers

Phase	Unit ID	Engine SN	Generator SN	Build date
CO1/1	1	SBK000170	G4B00130	8/14/2006
"	2	SBK000179	G4B00132	8/25/2006
"	3	SBK000169	G4B00128	8/10/2006
"	4	SBK000181	G4B00133	8/28/2006
"	5	SBK000176	G4B00131	8/25/2006
"	6	SBK000168	G4B00129	8/10/2006
"	7	SBK000160	G4B00125	7/21/2006
"	8	SBK000159	G4B00127	7/19/2006
"	9	SBK000162	G4B00126	7/24/2006
"	10	SBK000158	G4B00124	7/19/2006
"	11	SBK000172	G4B00113	8/18/2006
"	12	SBK00990	KHD00231	8/15/2010
CO1/2	1	SBK000208	G4B00173	11/1/2006
"	2	SBK000214	G4B00171	11/6/2006
"	3	SBK000211	G4B00176	11/3/2006
"	4	SBK000213	G4B00177	11/6/2006
"	5	SBK000201	G4B00178	10/20/2006
"	6	SBK000171	G4B00112	8/17/2006
"	7	SBK000212	G4B00175	11/6/2006
"	8	SBK000205	G4B00170	10/30/2006
"	9	SBK000210	G4B00172	11/3/2006
"	10	SBK000200	G4B00179	10/20/2006
"	11	SBK000209	G4B00174	11/2/2006
"	12	SBK00989	KHD00230	8/14/2010

Phase	Unit ID	Engine SN	Generator SN	Build date
~~CO3.2~~CO9	25	SBK00949	G8D00117	7/25/2010
~~“~~CO3.2	26	SBK00947	G8D00116	7/16/2010
~~“~~CO9	27	SBK00945	G8D00115	7/15/2010
“	28	SBK00953	G8D00119	7/28/2010
“	29	SBK00951	G8D00118	7/28/2010
~~CO3.1~~ “	30	SBK01014	G8D00142	10/6/2010
“	31	SBK01012	G8D00141	10/5/2010
“	32	SBK01030	G8D00146	10/14/2010
“	33	SBK01027	G8D00145	10/13/2010
~~CO3.3~~“	34	SBK01013	G8D00140	9/30/2010
“	35	SBK01015	G8D00144	10/7/2010
CO6	1	LYM00715	G7J06261	5/27/2020
“	2	LYM01199	G7J06262	5/27/2020
“	3	LYM00713	G7J06249	5/27/2020
“	4	LYM01195	G7J06263	5/27/2020
“	5	LYM01200	G7J06260	5/27/2020
CO7	1			
“	2			
“	3			
CO8	1			
“	2			
“	3			

Table 1.b: Fire Pump Engine Serial Number

Unit ID	Engine SN	Engine Size	Build Year
CO1	Pe6068t602182	149 bhp	2006
CO2	Pe6068t679482	149 bhp	2007

Table 1.c: Cooling Towers

Unit ID	# Cooling Tower Banks	# Cooling Tower Units per Bank	Total # Cooling Tower Units
CO1	1	18	18
CO2	1	18	18
Total	2	na	36

Legal Authority

The emissions from the proposed project have been reviewed under the legal authority of RCW 70A.15.2210 and the applicable rules and regulations adopted thereunder. The proposed project, if operated as specified, will be in accordance with applicable rules and regulations, as set forth in Chapters 173-400 WAC and 173-460 WAC and the operation thereof, at the location proposed, will not result in ambient air quality standards being exceeded.

This Notice of Construction (NOC) Approval Order rescinds and replaces NOC Approval Order No. 20AQ-E002; NOC Approval Order No. 20AQ-E002 is no longer in effect.

Therefore, it is ordered that the project as described in the NOC application and more specifically detailed in plans, specifications, and other information submitted to the Washington State Department of Ecology, (Ecology) is approved for construction and operation, provided the following conditions are satisfied:

Approval Conditions

1. **Administrative Conditions**

a. The emergency engine generators approved for operation by this Order are to be used solely for those purposes authorized for emergency generators under 40 C.F.R. 60, Subpart IIII. This includes the hourly operation requirements described in 40 C.F.R. 60.4211(f), except that there must be no operation of this equipment to produce power for demand-response arrangements, peak shaving arrangements, nor to provide power as part of a financial arrangement with another entity, nor to supply power to the grid.

b. Mountain View Elementary School administrators must be provided a maintenance testing schedule as contained in the permit, and the Permittee must update the school whenever Ecology-approved changes occur in the maintenance testing schedule. As decided by the school administrators and the Permittee, an ongoing relationship between the school and the Permittee should be established.

2. **Equipment Restrictions**

a. All engines identified in Tables 1.a and 2 used to power the electrical generators must be operated in accordance with applicable 40 C.F.R. 60, Subpart IIII requirements including but not limited to: certification by the manufacturer to meet the 40 C.F.R. ~~89~~ 1039, Appendix I EPA Tier 2 or Tier 3 (for support engines) emissions levels as required by 40 C.F.R. 60.4202; and installed and operated as emergency engines, as defined in 40 C.F.R. 60.4219.

   i. At the time of the effective date of this permit, Tier 4 interim and Tier 4 final certified engines (as specified in 40 C.F.R. 1039.102 Table 7 and 40 C.F.R. 1039.101 Table 1, respectively), are not required for 2.5 MWe (3633 bhp), 1.5 MWe (2,206 bhp), 350 kWe (539 bhp) electrical generators used for emergency purposes as defined in 40 C.F.R. 60.4219 in attainment areas in Washington State. Any engines installed at the facility after Tier 4 or other limits are implemented by EPA for emergency generators, must meet the applicable specifications as required by EPA at the time the emergency engines are installed.

b. Only Caterpillar Model 3516C 2.5 MWe (3633 bhp), Model 3512C 1.5 MWe (2,206 bhp), and Model C13 350 kWe (539 bhp) engines and electrical generating units are approved for operation at the facility and are listed in Table 1.a above.

c. Manufacture and installation of the CO7 and CO8 engine generator sets identified in Table 1.a must take place by January 30, 2024. If the manufacture and installation of these engines has not been completed by January 30, 2024, a NOC application may be required prior to installation.

d. Engines associated with buildings CO7 and CO8 must be equipped with Selective Catalytic Reduction (SCR) and Diesel Particulate Filter (DPF) controls to meet emission limits listed in Condition 5, Table 3.

e. The installation of any new or replacement engines 18 months after issuance of this Approval Order, will require notification to Ecology that includes engine manufacturer's specification sheets. Ecology will decide whether new source review is required based on various factors including whether the new engines will have either an increased emission rate, or result in an emission concentration that may increase community impacts over those evaluated for this Approval Order, or if an update to Best Available Control Technology, analysis is necessary.

Table 2 – Emergency Generator Exhaust Stack Height Requirements

Quantity	Location	Minimum Height (feet)	Stack Diameter (inches)	Height Above Roof (feet)
20	CO1 and CO2 Building	38'	18"	8'
4	CO1 and CO2 Ground Level	20'	18"	
11	~~CO3.1,~~ CO9 and CO3.2~~, CO3.3~~ Ground Level	31'	18"	
5	CO6 Building	38'	24"	12.5'
4	CO7 and CO8 Buildings 1.5 MWe (2,206 bhp)	46	16"	20.5'
2	CO7 and CO8 Buildings 350 kWe (539 bhp)	46	12"	20.5'

3. **Operating Limitations**

a. Facility fuel consumption must be limited to a combined total of 467,485 gallons per year and 95,016 gallons per day of renewable diesel (including renewable hydrocarbon diesel and hydro-treated vegetable oil) and/or on-road specification No. 2 distillate fuel oil. All fuels used must be less than 0.00150 weight percent sulfur.

b. The 35 CO1, CO2, CO9, and CO3.2 generators must not operate more than 100 hours per year per engine at an average capacity of 53 percent of full standby capacity. ~~Individual units~~ Generator operations may ~~be operated at a higher load than~~ deviate from 53 percent of full standby capacity as long as ~~no emission limit is exceeded~~ emissions do not exceed emissions represented by 100 average annual operating hours at 53 percent of full standby capacity. Annual operating hours may be averaged over all 35 CO1, CO2, CO9, and CO3.2 generators.

c. Operation of the 11 ~~CO3.1,~~ CO9 and CO3.2~~, and CO3.3~~ generators for electrical bypass must be limited to approximately 44 hours per year each at an average electrical load of 40 percent of the standby rating. Annual operating hours for electrical bypasses may be averaged over the 11 generators. Operations for electrical bypasses may deviate from 40 percent of full standby capacity as long as emissions do not exceed emissions represented by 44 average annual operating hours at 40 percent of full standby capacity. No more than ~~two~~ five engines will operate at the same time during any electrical bypass operation.

d. Each of the 35 CO1, CO2, CO9, and CO3.2 generator engines require maintenance and testing for approximately one hour per month. To mitigate engine emission impacts, the Permittee will perform at least 80 percent of all maintenance testing from 7:00 AM until 5:00 PM on Monday through Friday with no more than three engines tested concurrently. Engine maintenance and testing may take place outside of these restrictions upon coordination by the Permittee with the other data centers in Quincy to minimize engine emission impacts to the community. The Permittee must maintain records of the coordination communications with the other data centers, and those communications must be available for review by Ecology. This schedule can be re-negotiated at any time as approved in writing by Ecology, and will not trigger revision or amendment of this Order.

e. CO1 and CO2 each have one bank of six cooling units with a total of 18 cooling towers, for a facility total of 36 cooling towers. Each individual unit must have a mist eliminator that will maintain the maximum drift rate to no more than 0.0005 percent of the circulating water rate.

f. Operation of the 11 CO9 and CO3.2 generators for power outage emergencies must be limited to a maximum of 48 hours per engine per calendar year at a maximum average electrical load of 85 percent. Annual operating hours for power outage emergencies may be averaged over the 11 generators. Operations for power outage emergencies may deviate from 85 percent of full standby capacity as long as emissions do not exceed emissions represented by 48 average annual operating hours at 85 percent of full standby capacity.

g. The five CO6 generators must not operate more than 80 hours per year per engine. Annual operating hours may be averaged over all CO6 generators in service. The five CO6 generators must not operate more than 94 hours per engine for the first year of operation to include commissioning.

h. Operation of more than one CO6 generator for more than 15 hours per generator in any 24-hour period must not occur more than three times in any three calendar year period.

i. The operation of more than one CO6 generator, operating concurrently at any one time, must not occur on more than 21 calendar days in any three calendar year period.

j. There is no limit on the number of days that operation of one CO6 generator at a time can occur, but operation under this scenario is limited to daytime hours only (7:00 am to 7:00 pm).

k. The four 1.5 MWe (2,206 bhp) generators located at buildings CO7 and CO8 must not operate more than a combined total 220 hours per year.

l. The two 350 kWe (539 bhp) generators located at building CO7 and CO8 must not operate more than a combined total of 200 hours per year.

4. General Testing and Maintenance Requirements

a. The Permittee will follow engine-manufacturer's recommended diagnostic testing and maintenance procedures to ensure that each of the 40 2.5 MWe (3633 bhp) engines, four 1.5 MWe (2,206 bhp) engines, and two 350 kWe (539 bhp) engines will conform to applicable engine specifications in Conditions 2.a, 2.b, and applicable emission specifications in Condition 5, Table 3 throughout the life of each engine.

b. Following installation and commissioning, or concurrent with commissioning, of the first generator, but prior to the transfer of a batch of engines to the Permittee's ownership, one of each of the 2.5 MWe (3,633 bhp) and 1.5 MWe (2,206 bhp) engines must be source tested. To demonstrate the engines are commissioned and programmed to run within the emission limits in Condition 5, Table 3, for Particulate Matter (PM) (filterable only), Nitrogen Oxides (NOx), Non-Methane Hydrocarbons (NMHC), and Carbon Monoxide (CO) emissions measurement must be conducted for one engine from each batch or control generation. Testing must be conducted at the loads of 100 percent, 75 percent, 50 percent, 25 percent and 10 percent using weighted averaging according to ~~Table 2 of~~ Appendix ~~B~~ II to ~~Subpart E of~~ 40 C.F.R. ~~89~~1039. Testing may be conducted using 40 C.F.R. 1065.

c. Within 60 months of the first engine installation of each phase of installation, and every 60 months thereafter, the Permittee must measure emissions of PM (filterable), NMHC, NOx, CO, and oxygen (O_2) from at least one representative engine from each batch of engines installed, in accordance with Condition 4.d. This testing will serve to demonstrate compliance with the emission limits contained in Condition 5, Table 3; and as an indicator of proper operation of the engines. The selection of the engine(s) to be tested must be subject to prior approval by Ecology and must be defined in the source test protocol submitted to Ecology no less than 30 days in advance of any compliance-related stack sampling conducted by the Permittee. The representative engine to be tested from each batch of engines installed must have the most operating hours since an engine of that batch was last tested.

d. The following procedures must be used for each test for the engines required by Condition 4.b and 4.c unless an alternate method is proposed by the Permittee and approved in writing by Ecology prior to the test:

i. Periodic emissions testing should be combined with pre-scheduled maintenance testing and annual load bank testing. Additional operation of the engines for the purpose of emissions testing beyond the operating hour and fuel consumptions limits authorized by this Order may be allowed by Ecology upon request.

ii. For the five load tests, testing must be performed at each of the five engine torque load levels described in ~~Table 2 of~~ Appendix ~~B~~ II to ~~Subpart E of~~ 40 C.F.R. Part 1039 ~~89~~, and data must be reduced to a single-weighted average value using the weighting factors specified in ~~Table 2~~Appendix II. The Permittee may replace the dynamometer requirement in Subpart ~~E~~ F of 40 C.F.R. Part ~~89~~ 1039 with corresponding measurement of gen-set electrical output to derive torque output.

iii. For all tests, the F-factor described in Method 19 must be used to calculate exhaust flow rate through the exhaust stack, except that EPA Method 2 must be used to calculate the flow rate for purposes of particulate testing (Method 2 is not required if 40 C.F.R. 1065 is used). Fuel meter data measured according to Condition 4.f must be included in the test report, along with the emissions calculations.

iv. Three test runs must be conducted for each engine, except as allowed by the sampling protocol from 40 C.F.R. 1065. Each run must last at least 60 minutes except as allowed by the sampling protocol from 40 C.F.R. 1065. Source test analyzers and engine control unit data must be recorded at least once every minute during the test. Engine run time and torque output (measured kWe to convert to torque) and fuel usage must be recorded during each test run for each load and must be included in the test report.

v. In the event that any stack test indicates non-compliance with the emission limits in Condition 5, Table 3 the Permittee must repair or replace the engine and repeat the test on the same engine plus two additional engines from the same phase of installation as the engine showing non-compliance. Test reports must be submitted to Ecology within 60 days of the final day of testing. Test reports must be submitted to the address in Condition 7.

vi. For the gaseous pollutants (NO_x, CO, and NMHC), the Permittee may propose using a portable emissions instrument analyzer for subsequent rounds of periodic source testing if initial testing of engines show compliance with each of the emission limits referenced in Condition 5, Table 3. The use of an analyzer and the analyzer model must be approved in writing by Ecology prior to testing. The analyzer must be calibrated using EPA Protocol 1 gases according to the procedures for drift and bias limits outlined in EPA Methods 7E and Method 10. Alternate calibration procedures may be approved in advance by Ecology.

e. Each engine must be equipped with a properly installed and maintained non-resettable meter that records total operating hours.

f. Each engine must be connected to a properly installed and maintained fuel flow monitoring system that records the amount of fuel consumed by the engine during each operation.

5. Emission Limits

The 40 2.5 MWe (3633 bhp) engines, four 1.5 MWe (2,206 bhp) engines, and two 350 kWe (539 bhp) engines must meet the follow emission rate limitations:

a. To demonstrate compliance with the following emission limits through stack testing, the Permittee must conduct exhaust stack testing and averaging of emission rates for five individual operating loads (10 percent, 25 percent, 50 percent, 75 percent, and 100 percent) according to 40 C.F.R. §~~89.410~~1039, ~~Table 2 of~~ Appendix ~~B~~II, 40 C.F.R. Part ~~89~~ 1039, Subpart ~~E~~ F, and/or 40 C.F.R. Part 60, Subpart IIII, or any other applicable EPA requirement in effect at the time the engines are installed.

Table 3: Emission Limitations and Testing Requirements

Generator Engines	Pollutant	Test Method*	Emission Limits
2.5 MWe (2.709 MWm; 3,633 bhp)	PM (filterable)	EPA Method 5 or alternative method from 40 C.F.R. 1065	0.20 g/kWm-hr
2.5 MWe (2.709 MWm; 3,633 bhp)	NMHC and NOx	EPA Method 7E, 25A and 18 or alternative method from 40 C.F.R 1065	6.4 g/kWm-hr
2.5 MWe (2.709 MWm; 3,633 bhp)	CO	EPA Method 10, or alternative method from 40 C.F.R. 1065	3.5 g/kWm-hr
1.5 MWe (1.645 MWm; 2,206 bhp); **350 kWe** (402 kWm; 539 bhp)	PM (filterable)	EPA Method 5 or alternative method from 40 C.F.R. 1065	0.03 g/kWm-hr
1.5 MWe (1.645 MWm; 2,206 bhp); **350 kWe** (402 kWm; 539 bhp)	NOx	EPA Method 7E or alternative method from 40 C.F.R 1065	0.67 g/kWm-hr
1.5 MWe (1.645 MWm; 2,206 bhp); **350 kWe** (402 kWm; 539 bhp)	NMHC	EPA Method 25A and 18 or alternative method from 40 C.F.R 1065	0.70 g/kWm-hr
1.5 MWe (1.645 MWm; 2,206 bhp); **350 kWe** (402 kWm; 539 bhp)	CO	EPA Method 10, or alternative method from 40 C.F.R. 1065	3.5 g/kWm-hr
1.5 MWe (1.645 MWm; 2,206 bhp)	Ammonia	BAAQMD Method ST-1B or EPA CTM-027; or alternative method suitable for use with 40 C.F.R. 1065 (100% -load +/- 2%)	0.17 lb/hr

Generator Engines	Pollutant	Test Method*	Emission Limits
350 kWe (402 kWm; 539 bhp)	Ammonia	BAAQMD Method ST-1B or EPA CTM-027; or alternative method suitable for use with 40 C.F.R. 1065 (100% -load +/- 2%)	0.05 lb/hr

*In lieu of these requirements, the Permittee may propose an alternative test protocol to Ecology in writing for approval.

b. Total annual facility-wide emissions must not exceed the 12-month rolling average emissions for PM_{10}, $PM_{2.5}$, CO, NO_X, NMHC, SO_2, DEEP, and NO_2 as listed in Table 4 3.

Table 4: Criteria Pollutant and Toxic Air Pollutant Emission Limits for Total Facility CO1, CO2, CO9, CO3.2, CO6, CO7, CO8 (Tons/Year)

Pollutant	Annual Emissions
PM smaller than 10 microns in diameter (PM_{10})	14.29
PM smaller than 2.5 microns in diameter ($PM_{2.5}$)(a)	6.49
PM2.5/PM10 (Gens Only)	2.99
Carbon monoxide (CO)	6.49
Nitrogen oxides (NO_X)	37.60
NMHC, Volatile organic compound (VOC)	2.42
Sulfur dioxide (SO_2)	0.05
Diesel Engine Exhaust Particulate (DEEP)*	0.61
Nitrogen Dioxide (NO_2)**	3.76
Ammonia	0.023

*All PM emissions from the generator engines are $PM_{2.5}$, and all filterable $PM_{2.5}$ from the generator engines is considered Diesel Engine Exhaust Particulate (DEEP).
** NO_2 is assumed to be equal to 10 percent of the total NOx emitted.

c. Visual emissions from each diesel electric generator exhaust stack must be no more than ten percent, with the exception of a 10 minute period after unit start-up. Visual emissions must be measured by using the procedures contained in 40 C.F.R. 60, Appendix A, Method 9.

6. Operation and Maintenance (O&M) Manuals

A site-specific O&M manual for the facility equipment must be developed and followed. Manufacturers' operating instructions and design specifications for the engines, generators, cooling towers, and associated equipment must be included in the manual. The O&M manual must be reviewed annually and be updated to reflect any modifications of the equipment or its operating procedures. Emissions that result from failure to follow the operating procedures contained in the O&M manual or manufacturer's operating instructions may be considered proof that the equipment was not properly installed, operated, and/or maintained. The O&M manual for the diesel engines and associated equipment must at a minimum include:

a. Manufacturer's testing and maintenance procedures that will ensure that each individual engine will conform to the EPA Tiered Emission Standards appropriate for that engine throughout the life of the engine.

b. Normal operating parameters and design specifications.

c. Operating maintenance schedule.

7. **Submittals**

All notifications, reports, and other submittals must be sent to:

Washington State Department of Ecology
Air Quality Program
4601 N. Monroe Street
Spokane, WA 99205-1295

Annual reports may also be submitted electronically to: emissions.inventory@ecy.wa.gov

OR AS DIRECTED.

8. **Recordkeeping**

All records, O&M Manual, and procedures developed under this Order must be organized in a readily accessible manner and cover a minimum of the most recent 60-month period. The following records are required to be collected and maintained.

a. Fuel receipts with amount of diesel and sulfur content for each delivery to the facility.

b. Annual hours of operation for each diesel engine.

c. Annual number of start-ups for each diesel engine.

d. Annual gross power generated by facility-wide operation of the emergency backup electrical generators.

e. Upset condition log for each engine and generator that includes date, time, duration of upset, cause, and corrective action.

f. Recordkeeping required by 40 C.F.R. Part 60 Subpart IIII.

g. Air quality complaints received from the public or other entity, and the affected emissions units.

9. Reporting

a. The serial number, manufacturer make and model, and standby capacity for each engine and the generator, and the engine build date must be submitted prior to installation of each engine.

b. The following information will be submitted to Ecology at the address in Condition 7 above by January 31 of each calendar year.

i. Monthly rolling annual total summary of air contaminant emissions, monthly rolling hours of operation with annual total, and monthly rolling gross power generation with annual total.

ii. Written notification that the O&M manual has been developed and updated ~~within 60 days after the issuance of this Order~~. For new generator engines being installed, the O&M manual must be developed prior to the transfer of the engines to the Permittee for operational use.

c. Any air quality complaints resulting from operation of the emissions units or activities must be promptly assessed and addressed. A record must be maintained of the Permittee's action to investigate the validity of the complaint and what, if any, corrective action was taken in response to the complaint. Ecology must be notified within three days of receipt of any such complaint.

10. Stack Testing

Any emission testing performed to verify conditions of this Approval Order or for submittal to Ecology in support of this facility's operations must be conducted as follows:

a. At least 30 days in advance of such testing, the Permittee must submit a testing protocol for Ecology approval that includes the following information:

i. The location and Unit ID of the equipment proposed to be tested.

ii. The operating parameters to be monitored during the test and the personnel assigned to monitor the parameters during the test.

iii. A description of the source including manufacturer, model number and design capacity of the equipment, and the location of the sample ports or test locations.

iv. Time and date of the test and identification and qualifications of the personnel involved.

v. A description of the test methods or procedures to be used.

b. Test Reporting: test reports must be submitted to Ecology within 60 days of completion of the test and must include, at a minimum, the following information:

i. A description of the source including manufacturer, model number and design capacity of the equipment, and the location of the sample ports or test locations.

ii. Time and date of the test and identification and qualifications of the personnel involved.

iii. A summary of results, reported in units and averaging periods consistent with the applicable emission standard or limit.

iv. A summary of control system or equipment operating conditions.

v. A summary of production related parameters.

vi. A description of the test methods or procedures used including all field data, quality assurance/quality control procedures and documentation.

vii. A description of the analytical procedures used including all laboratory data, quality assurance/quality control procedures and documentation.

viii. Copies of field data and example calculations.

ix. Chain of custody information.

x. Calibration documentation.

xi. Discussion of any abnormalities associated with the results.

xii. A statement signed by the senior management official of the testing firm certifying the validity of the source test report.

11. **General Conditions**

a. **Activities Inconsistent with this Order** – Any activity undertaken by the Permittee, or others, in a manner that is inconsistent with the data and specifications submitted as part of the NOC application or this NOC Approval Order, must be subject to Ecology enforcement under applicable regulations.

b. **Availability of Order** – Legible copies of this NOC Approval Order and any O&M manual(s) must be available to employees in direct operation of the equipment described in the NOC application and must be available for review upon request by Ecology.

c. **Compliance Assurance Access** – Access to the source by representatives of Ecology or the United States Environmental Protection Agency (EPA) must be permitted upon request. Failure to allow access is grounds for enforcement action under the federal Clean Air Act or the Washington State Clean Air Act, and may result in revocation of this NOC Approval Order.

d. **Discontinuing Construction or Operation** – This NOC Approval Order will become invalid if construction of the equipment described in the NOC application and this NOC Approval Order does not commence within 18 months after receipt of this NOC Approval Order.

   If construction or operation is discontinued for 18 months or longer on a portion or all of the equipment described in the NOC application and this NOC Approval Order, the portion of the NOC Approval Order regulating the inactive equipment will become invalid. Ecology may extend the 18 month period upon request by the Permittee and a satisfactory showing that an extension is justified.

e. **Equipment Operation –** Operation of the facility must be conducted in compliance with all data and specifications submitted as part of the NOC application and in accordance with O&M manuals, unless otherwise approved in writing by Ecology.

f. **Registration** – Periodic emissions inventory and other information may be requested by Ecology. The requested information must be submitted within 30 days of receiving the request, unless otherwise specified. All fees must be paid by the date specified.

g. **Testing** – When information obtained by Ecology indicates the need to quantify emissions, Ecology may require the Permittee to conduct material analysis or air emissions testing under WAC 173-400-105. This testing requirements is in addition to any testing required by Ecology in this Order, other permits, or other state or federal requirements.

h. **Violation Duration** – If the Permittee violates a condition in this NOC Approval Order, testing, recordkeeping, monitoring, or credible evidence will be used to establish the starting date of the violation. The violation will be presumed to continue until testing, recordkeeping, monitoring, or other credible evidence indicates compliance. A violation of a condition includes, but is not limited to, failure of air pollution control equipment, failure of other equipment resulting in increased emissions, or a failed source test indicating an exceedance of an emission limit.

i. **Obligations Under Other Laws or Regulations** – Nothing in this NOC Approval Order will be construed so as to relieve the Permittee of its obligations under any state, local, or federal laws or regulations.

j. **Maintaining Compliance** – It must not be a defense for the Permittee in an enforcement action that it would have been necessary to halt or reduce the operation in order to maintain compliance with the conditions of this NOC Approval Order.

k. **Visible Emissions** – No visible emissions from the source are allowed beyond the property line, as determined by 40 C.F.R. Part 60, Appendix A, Test Method 22.

l. **Changes in Operations** – Any changes in operation contrary to information submitted in the NOC application must be reported to Ecology at least 60 days before the changes are implemented. Such changes in operation may require a new or amended NOC Approval Order.

Authorization may be modified, suspended, or revoked in whole or part for cause, including, but not limited to, the following:

- Violation of any terms or conditions of this authorization.
- Obtaining this authorization by misrepresentation or failure to disclose full all relevant facts.

The provisions of this authorization are severable and, if any provision of this authorization or application of any provision to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this authorization, must not be affected thereby.

Your Right to Appeal

You have a right to appeal this Approval Order to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of this Approval Order. The appeal process is governed by Chapter 43.21B RCW and Chapter 371-08 WAC. "Date of receipt" is defined in RCW 43.21B.001(2).

To appeal you must do the following within 30 days of the date of receipt of this Approval Order:

- File your appeal and a copy of this Approval Order with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.
- Serve a copy of your appeal and this Approval Order on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in Chapter 43.21B RCW and Chapter 371-08 WAC.

Address and Location Information

Street Addresses	Mailing Addresses
Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive SE Lacey, WA 98503	**Department of Ecology** Attn: Appeals Processing Desk PO Box 47608 Olympia, WA 98504-7608
Pollution Control Hearings Board 1111 Israel RD SW Ste 301 Tumwater, WA 98501	**Pollution Control Hearings Board** PO Box 40903 Olympia, WA 98504-0903

Americans with Disabilities Act Information

Accommodation Requests
To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 360-407-7668 or visit https://ecology.wa.gov/accessibility. People with impaired hearing may call Washington Relay Service at 711. People with speech disability may call TTY at 877-833-6341.

Dated this 27th day of September, 2022, at Spokane, Washington.

Prepared By:

Jenny Filipy, P.E.
Eastern Regional Office
Department of Ecology
State of Washington

David Knight, Section Supervisor
Eastern Regional Office
Department of Ecology
State of Washington

APPENDIX D – FACILITY UPGRADE CORRESPONDENCE

Cook, Michael K

From:	Filipy, Jenny (ECY) <JFIL461@ECY.WA.GOV>
Sent:	Friday, July 29, 2022 9:53 AM
To:	Nelson, Minda; Cook, Michael K
Cc:	Hichem Garnaoui; Shirazeh Entezari; Ashley Kangas; zawash@microsoft.com; Dale Stansbury; Morgan Ireland; Sid Janga; Lara Pollitt; Wood, Christine B; Breitling, Amanda K; Smith, Teleri A; Baldwin, Karin K. (ECY)
Subject:	RE: Description and Request for “No Objection” to Facility Upgrades at the Columbia Data Center, Addendum 1

Hello Everyone,

Thank you Minda for supplying some modeling files for my review. Ecology has no objection to the project moving forward. Please let Karin and I, know of any community outreach for this project.

Thank you.

Jenny Filipy, PE
Environmental Engineer - Air Quality
Washington State Department of Ecology
(509) 405-2487 (mobile)
jenny.filipy@ecy.wa.gov

From: Nelson, Minda <mnelson@burnsmcd.com>
Sent: Thursday, July 28, 2022 12:38 PM
To: Filipy, Jenny (ECY) <JFIL461@ECY.WA.GOV>; Cook, Michael K <mkcook@burnsmcd.com>
Cc: Hichem Garnaoui <hichem.garnaoui@microsoft.com>; Shirazeh Entezari <Shirazeh.Entezari@microsoft.com>; Ashley Kangas <ashleykangas@microsoft.com>; zawash@microsoft.com; Dale Stansbury <ristansb@microsoft.com>; Morgan Ireland <mireland@microsoft.com>; Sid Janga <sidjanga@microsoft.com>; Lara Pollitt <lara.pollitt@microsoft.com>; Wood, Christine B <cbwood@burnsmcd.com>; Breitling, Amanda K <akbreitling@burnsmcd.com>; Smith, Teleri A <tasmith@burnsmcd.com>; Baldwin, Karin K. (ECY) <KBAL461@ECY.WA.GOV>
Subject: RE: Description and Request for “No Objection” to Facility Upgrades at the Columbia Data Center, Addendum 1

Jenny,
Attached are the model input and output files that provide the below requested information. The comparative analysis was run using 1 g/s for all emission units. Let me know if you have any questions or if you need additional information.

Thanks,
Minda

Minda Nelson, PE \ Burns & McDonnell
Associate Environmental Engineer
o 816-601-4311

mnelson@burnsmcd.com \ burnsmcd.com
9400 Ward Parkway \ Kansas City, MO 64114

*Registered in: KS, IA

From: Filipy, Jenny (ECY) <JFIL461@ECY.WA.GOV>
Sent: Wednesday, July 27, 2022 3:18 PM
To: Cook, Michael K <mkcook@burnsmcd.com>
Cc: Hichem Garnaoui <hichem.garnaoui@microsoft.com>; Shirazeh Entezari <Shirazeh.Entezari@microsoft.com>; Ashley Kangas <ashleykangas@microsoft.com>; zawash@microsoft.com; Dale Stansbury <ristansb@microsoft.com>; Morgan Ireland <mireland@microsoft.com>; Sid Janga <sidjanga@microsoft.com>; Lara Pollitt <lara.pollitt@microsoft.com>; Wood, Christine B <cbwood@burnsmcd.com>; Breitling, Amanda K <akbreitling@burnsmcd.com>; Nelson, Minda <mnelson@burnsmcd.com>; Smith, Teleri A <tasmith@burnsmcd.com>; Baldwin, Karin K. (ECY) <KBAL461@ECY.WA.GOV>
Subject: RE: Description and Request for “No Objection” to Facility Upgrades at the Columbia Data Center, Addendum 1

Hello Mike,

Thank you for the follow up letter and modeling impact reduction percentage. Could you please provide the inputs and outputs of the modeling evaluation to demonstrate the 40% reduction of impacts?

Input and Output Summary:
Emission input (g/s)
Stack heights
Stack diameter
Stack temperature
Stack flowrate
Property line impacts

Thank you.

Jenny Filipy, PE
Environmental Engineer - Air Quality
Washington State Department of Ecology
(509) 405-2487 (mobile)
jenny.filipy@ecy.wa.gov

From: Cook, Michael K <mkcook@burnsmcd.com>
Sent: Friday, July 22, 2022 12:04 PM
To: Filipy, Jenny (ECY) <JFIL461@ECY.WA.GOV>
Cc: Hichem Garnaoui <hichem.garnaoui@microsoft.com>; Shirazeh Entezari <Shirazeh.Entezari@microsoft.com>; Ashley Kangas <ashleykangas@microsoft.com>; zawash@microsoft.com; Dale Stansbury <ristansb@microsoft.com>; Morgan Ireland <mireland@microsoft.com>; Sid Janga <sidjanga@microsoft.com>; Lara Pollitt <lara.pollitt@microsoft.com>; Wood, Christine B <cbwood@burnsmcd.com>; Breitling, Amanda K <akbreitling@burnsmcd.com>; Nelson, Minda <mnelson@burnsmcd.com>; Smith, Teleri A <tasmith@burnsmcd.com>
Subject: Description and Request for “No Objection” to Facility Upgrades at the Columbia Data Center, Addendum 1

THIS EMAIL ORIGINATED FROM OUTSIDE THE WASHINGTON STATE EMAIL SYSTEM - Take caution not to open attachments or links unless you know the sender AND were expecting the attachment or the link

Ms. Filipy,

Attached is Addendum 1 to a letter submitted to your office on July 1, 2022 on behalf of the Microsoft Corporation.

The letter described various activities of a facility upgrade project at the Columbia Data Center and requested a "no objection" response.

This addendum provides the results from comparative modeling analysis conducted for the project and provides an update on an effort to distribute information to interested parties about the project.

Michael (Mike) K. Cook, PE, BCEE, MEng, LEED® AP BD+C
Burns & McDonnell \ Senior Environmental Engineer
O/M 682-291-9341 \ mkcook@burnsmcd.com
100 Energy Way, Suite 1700 \ Fort Worth, TX 76102
DESIGNED **TO BUILD.**
#DesignedToBuild

July 1, 2022

Ms. Jenny Filipy
Environmental Engineer, Air Quality Program
Washington State Department of Ecology
Eastern Regional Offices
4601 N Monroe
Spokane, WA 99205-1295

Re: Description and Request for "No Objection" to Facility Upgrades at the Columbia Data Center

Dear Ms. Filipy:

The Microsoft Corporation (MSFT) is initiating a facility upgrade project at the Columbia Data Center, located at 501 Port Industrial Parkway, Quincy, Washington (Grant County). Permitted air emissions at the Columbia Data Center are currently authorized under Approval Order No. 20AQ-E002. The facility upgrades includes the following activities:

1. Reconstruct the CO3.1 data center building to accommodate specific MSFT telecommunications objectives.
2. Reconfigure and upgrade the electrical power monitoring system associated with eleven (11) existing emergency generators associated with Buildings CO3.1, CO3.2, and CO3.3 buildings.
3. Install stack extensions of twenty-five feet (25-ft) on the northernmost nine (9) of the 11 emergency generators to accommodate Building CO3.1 architectural changes.
4. Conduct post-project generator engine testing to verify proper operation of the upgraded electrical power monitoring system.

Each of the above activities is discussed in further detail below.

1. **Reconstruct Building CO3.1**: Building CO3.1 is being reconstructed to accommodate specific MSFT telecommunications objectives. A second level is being added, but the overhead view will essentially remain unchanged (refer to Attachment 1). This does not include or constitute a "modification" to an existing emission source or result in a "new source" of emissions at the facility. Therefore, MSFT anticipates that Ecology will have "no objection" to this activity, as described herein.

2. **Upgrade Electrical Power Monitoring System for 11 Emergency Generators**: The electrical power monitoring system facilitates the combined operation of the 11 emergency generators in the vicinity of Buildings CO3.1, CO3.2, and CO3.3 for delivery

of backup electrical power in the event of a power outage. The upgrades to this system will improve the availability of key monitoring data and will enable optimized use of these generators when needed. These improvements will not result in increased emissions and will not constitute a modification of the emission units. Additionally, these upgrades will not affect how each individual generator engine and its related equipment is to be operated in accordance with the O&M manual or as represented in the existing approval order or the previously submitted NOC applications. For these reasons, MSFT anticipates that Ecology will have no objection to this activity, as described herein.

3. **Install 25-ft Stack Extensions on 9 Emergency Generators**: Due to the increase in the CO3.1 building height, MSFT will proactively install stack extensions on 9 of the 11 emergency generator engines in closest proximity to the building. The extensions will allow for improved dispersion from the generator stacks, but they will not result in increased emissions nor constitute a modification to the emission units. Also, these upgrades will not affect how each individual generator engine and its related equipment are to be operated in accordance with the O&M manual or as represented in the existing approval order or the previously submitted NOC applications. Additionally, Table 2 of Approval Order No. 20AQ-E002 lists the engine exhaust stack height requirements, including the minimum heights and stack diameters. Because the stack extensions will not reduce these minimum heights nor alter the diameters, the information contained in Table 2 will continue to be valid. Consequently, MSFT anticipates that Ecology will have “no objection” to this activity, as described herein.

4. **Conduct Post-Upgrade Generator Engine Testing**: As a result of the electrical power monitoring system upgrades, the 11 affected generator engines will undergo testing to verify proper operation of the upgraded system. The testing will comply with the operating limitations included in Approval Order Condition 3. As a result, MSFT anticipates that Ecology will have “no objection” to this activity, as described herein.

In summary, the proposed acility upgrades will result in operational improvements at the Columbia Data Center, and MSFT is requesting Ecology’s review and a response of “no objection” to the activities described above. If we can be of any assistance to facilitate your efforts, please do not hesitate to contact me at 682-291-9341 or mkcook@burnsmcd.com. Thank you so much for your time in reviewing and responding to this request.

Sincerely,

Michael K. Cook

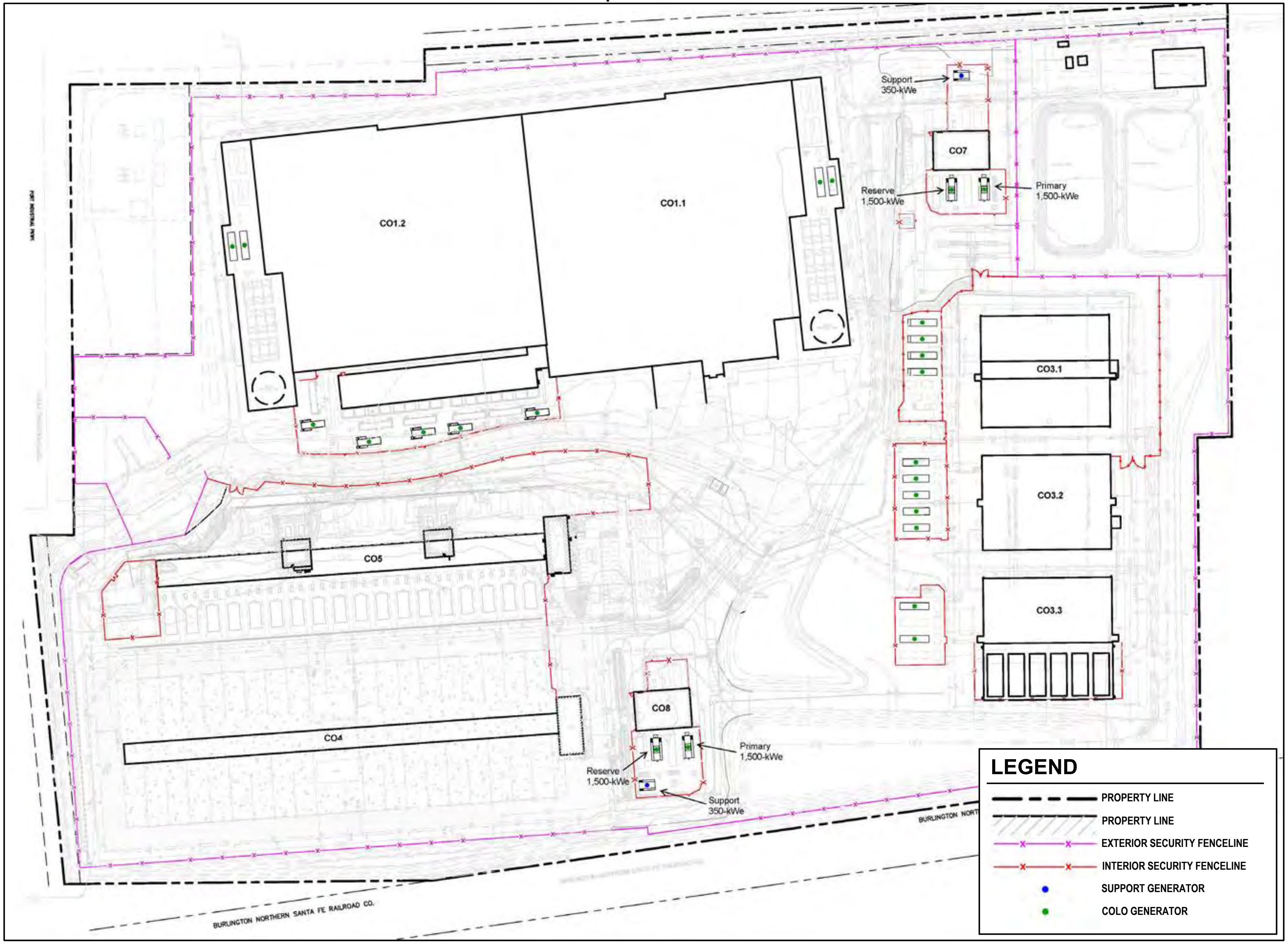
Michael K. Cook, P.E.
Senior Environmental Engineer
Burns & McDonnell

Attachment 1: Plan View Site Map – Columbia Data Center

cc: Hichem Garnaoui, Microsoft Corporation, Quincy Metro Campus Director
Shirazeh Entezari, Microsoft Corporation, Critical Environment Operations Manager
Ashley Kangas, Microsoft Corporation, Principal Construction Mgr, Datacenter Engineering
Zach Washington, Microsoft Corporation, Ops Mechanical Engineer, Quincy Datacenters
Dale Stansbury, Microsoft Corporation, Mechanical Engineer, Quincy Datacenters
Morgan Ireland, Microsoft Corporation, Regional Permitting/Environmental Program Mgr
Sid Janga, Microsoft Corporation, Americas Environmental Permitting Lead, Datacenter
Lara Pollitt, Microsoft Corporation, Principal Engineer, Due Diligence & Permitting Lead
Christine Wood, Burns & McDonnell, Regional Global Practice Manager, Global Facilities
Amanda Breitling, Burns & McDonnell, Regional Global Practice Manager, Environ. Svc
Carson Linstead, Burns & McDonnell, Department Manager, Global Facilities
Minda Nelson, Burns & McDonnell, Associate Environmental Engineer
Teleri Smith, Burns & McDonnell, Assistant Environmental Scientist

Attachment 1

Plan View Site Map, Columbia Data Center



BURNS McDONNELL

July 22, 2022

Ms. Jenny Filipy
Environmental Engineer, Air Quality Program
Washington State Department of Ecology
Eastern Regional Offices
4601 N Monroe
Spokane, WA 99205-1295

Re: Description and Request for “No Objection” to Facility Upgrades at the Columbia Data Center, Addendum 1

Dear Ms. Filipy:

On July 1, 2022, Burns & McDonnell submitted a letter to your office, on behalf of the Microsoft Corporation (MSFT), describing a facility upgrade project at the Columbia Data Center, located at 501 Port Industrial Parkway, Quincy, Washington (Grant County). The letter requested that the Department of Ecology (Ecology) review and provide a response of “no objection” to the upgrade activities. Two project activities described in the letter included the following:

1. Reconstruct the CO3.1 data center building to accommodate specific telecommunications objectives. A second level is being added, but the overhead view will essentially remain unchanged.
2. Install stack extensions of twenty-five feet (25-ft) for the northernmost nine (9) of the 11 existing emergency generators associated with Buildings CO3.1, CO3., and CO3.3.

On July 13, MSFT and Ecology staff met to discuss the MSFT request. During the meeting, Ecology requested that comparison screening modeling be conducted to show that the above-described activities will not negatively impact pollutant concentrations at or beyond the property boundary. Ecology also expressed an interest in a pursuit by MSFT of an appropriate means of providing information on this project to interested parties within the Quincy community. MSFT is currently considering various approaches for developing an optimal method to distribute project information. MSFT will include Ecology in the dissemination of the project message.

For the screening analysis, the modeled impacts from the 9 emergency generators of the current design (base model) were compared to the modeled impacts after the facility upgrades are completed (facility upgrade model). Using the EPA-approved American Meteorological Society/EPA Regulatory Model (AERMOD), maximum concentrations from the facility upgrade model were shown to decrease by 40 percent in comparison with results from the base model. Therefore, the screening analysis confirmed that the facility upgrades will not result in a negative impact to pollutant concentrations at or beyond the property boundary.

The above-described analysis supports a conclusion that the facility upgrades will result in operational improvements which have a net positive impact on pollutant concentrations. This analysis further supports the MSFT request for Ecology's review and a response of "no objection" to the facility upgrades.

If we can be of any assistance to facilitate your efforts, please do not hesitate to contact me at 682-291-9341 or mkcook@burnsmcd.com. Thank you so much for your time in reviewing and responding to this request.

Sincerely,

Michael K. Cook

Michael K. Cook, P.E.
Senior Environmental Engineer
Burns & McDonnell

cc: Hichem Garnaoui, Microsoft Corporation, Quincy Metro Campus Director
Shirazeh Entezari, Microsoft Corporation, Critical Environment Operations Manager
Ashley Kangas, Microsoft Corporation, Principal Construction Mgr, Datacenter Engineering
Zach Washington, Microsoft Corporation, Ops Mechanical Engineer, Quincy Datacenters
Dale Stansbury, Microsoft Corporation, Mechanical Engineer, Quincy Datacenters
Morgan Ireland, Microsoft Corporation, Regional Permitting/Environmental Program Mgr
Sid Janga, Microsoft Corporation, Americas Environmental Permitting Lead, Datacenter
Lara Pollitt, Microsoft Corporation, Principal Engineer, Due Diligence & Permitting Lead
Christine Wood, Burns & McDonnell, Regional Global Practice Manager, Global Facilities
Amanda Breitling, Burns & McDonnell, Regional Global Practice Manager, Environ. Svc
Minda Nelson, Burns & McDonnell, Associate Environmental Engineer
Teleri Smith, Burns & McDonnell, Assistant Environmental Scientist

Quincy officials hear more objections to design of B Street Northeast being built

BY DAVE BURGESS
burgess@qvpr.com

Like the previous meeting of the Quincy City Council, the Aug. 16 meeting was dominated by objections from residents over the city's design for the reconstruction of B Street NE.

More members of the public attended the meeting than were at the Aug. 2 meeting. Three council members, Josey Ferguson, Tom Harris and Andrew Royer, were absent.

All of the residents who stood to speak to the council had concerns about the design and how it affects them.

Rob Sole began by saying he appreciated the willingness of the city to address his concerns about the project affecting a business of his, Blue Skies Storage, located in the commercial area of B Street NE.

He had stood in the previous meeting and stated his concerns about the lack of notification and the design. The design of the street – narrowing to 20 feet wide for the two eastern-most blocks, from Fourth to Sixth Avenue NE, where Sole's storage property is – has made entering and exiting the business very difficult. The city has had the contractor widen the opening in the curb for the driveway into Sole's business, but the narrowness of the road remains problematic.

Sole said he was not the only one on the street who

Dave Burgess/Post-Register

was not notified about the project.

He pointed out the city's own designation of half of the six-block-long street as "major arterial" and asked why the city didn't question the project on that point. Two of those three blocks of the street are being narrowed to 20 feet wide, drastically smaller than the 45-foot apparent minimum allowed in the city code.

An intention to change the comprehensive plan and code in the future cannot alter what is allowable today, Sole said.

He objected to the narrowness also on the basis of restricting fire truck access.

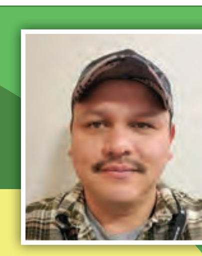
He objected also to the new curb blocking neighboring properties' access to B Street NE.

"I'm just real curious as to how the thought process worked, how we got to where we are at," he said.

Municipal Services Direc-

See **District**, page 3

City of Quincy Code Corner



BUILDINGS MAINTENANCE STANDARDS

Windows and Doors. All windows and doors shall be secured from illegal entry. Broken glass in windows or doors must be repaired, replaced, or covered immediately upon discovery of the breakage or upon notification by the City. Siding and Paint. Siding must be in good repair with no loose or missing boards; Building paint must be in good repair with less than 10 percent of the exterior wall surface displaying faded, chipped, or peeling paint. Roofing. Roofing must be kept in good repair with no roofing element missing or loose. Landscaping. Vegetation on premises shall be maintained at all times; No noxious weeds shall be allowed to grow on premises.

Sergio Castillo/ Code Enforcement Officer

NORMAS DE MANTENIMIENTO EN LOS EDIFICIOS

Ventanas y puertas. Todas las ventanas y puertas deberán tener un mecanismo de seguridad por dentro. Los vidrios rotos en ventanas o puertas deben repararse, reemplazarse o cubrirse inmediatamente al descubrirse la rotura o al ser notificado por la Ciudad. Revestimiento y pintura. El revestimiento debe estar en buen estado, sin tablas sueltas o faltantes; La pintura del edificio debe estar en buen estado, con menos del 10 por ciento de la superficie de la pared exterior con pintura descolorida, astillada o descascarada. Techos. El techo debe mantenerse en buen estado, sin elementos faltantes o sueltos. Jardines y áreas verdes. La vegetación en las instalaciones debe mantenerse en todo momento; No se permitirá que crezcan malezas nocivas en las instalaciones.

Sergio Castillo / Oficial de aplicación del código

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Quincy School District ready for start of classes; rolls out new school bus

BY DAVE BURGESS
burgess@qvpr.com

Dave Burgess/Post-Register

This new bus bought by Quincy School District features air-conditioning.

Rob Henne had a new school bus for show-and-tell at the Aug. 23 meeting of the Quincy School Board.

Henne, director of transportation for Quincy School District, gave his annual report to the board. But first, during the meeting's public comment opportunity 10 people stood, and four of them addressed the board, keeping to the three-minute time limit for each speaker.

Carol Van Dyke went first, saying the group standing with her were in solidarity with her subject on potentially conflicting policies involving gender-inclusiveness, sexual harassment and indecent exposure, and she referred to Policy 3211.

Jennifer Safe gave the most pointed remarks on the subject, suggesting the school board had taken state money tied to certain policies that run contrary to local parents' values, and asking the board to reverse course.

Ryan Van Dyke also referred to Policy 3211 and was concerned about the health and safety of local children. He asked school board members to talk about the group's concerns and explain how policies work with state law.

Policy 3211 itself was not up for a vote on the agenda.

Beginning his report, Henne offered board members a tour of a new bus, which features air-conditioning and gets a little better miles per gallon, about 1 to 1.5 miles per gallon of diesel. The district's buses get 5-7.5 miles per gallon, he said.

Looking ahead, Henne is interesting in trying an electric bus.

"There's a huge electric bus grant that's going to be going for the next four years," he said,

School districts can apply for the $350,000 grant program for an electric bus, and $20,000 for charging equipment, he explained.

"I plan on applying the next four years for an electric bus, and hopefully it won't be much cost to the district," he said.

Board member Heather Folks-Lambert asked about expected fuel savings with an electric model. Henne said there would be savings, but did not have forecast numbers.

With fuel costs higher in the past year, his department's fuel expense last year we went over the $100,000 budget by $71,000.

The department is also working on increasing par-

See **Schools**, page 3

Chief's Corner

Kieth Siebert, Quincy Chief of Police

I recently heard a complaint about a community member's behavior and when asked if it was reported to law enforcement, I was told no because this community member knows me. Quincy is better than that. No one in this community is above the law, this includes friends, family and even me. Just because someone knows me, one of our officers or another city official doesn't mean they can do what they want. As I wrote in a Chief's Corner in 2018, "….I demand our officers treat everyone equally, regardless of the last name, socio-economic standing or reputation." I still stand by this statement although I also expect all community members to treat each other equally and respectfully.

Hace poco escuché una queja sobre el comportamiento de un miembro de la comunidad y cuando me preguntaron si se informó a las fuerzas del orden público, me dijeron que no porque este miembro de la comunidad me conoce. Quincy es mejor que eso. Nadie en esta comunidad está por encima de la ley, esto incluye a amigos, familiares e incluso a mí. El hecho de que alguien me conozca, a uno de nuestros oficiales o conozca a otro funcionario de la ciudad no significa que puedan hacer lo que quieran. Como escribí en un Rincón del Jefe en 2018, "… exijo que nuestros oficiales traten a todos por igual, independientemente del apellido, la posición socioeconómica o la reputación". Todavía mantengo esta declaración, aunque también espero que todos los miembros de la comunidad se traten entre sí por igual y con respeto.

FOR EMERGENCIES, CALL 911 • OFFICE PHONE: 787-4718 • FOLLOW US ON
PARA EMERGENCIAS, LLAME AL 911 • OFICINA : 787-4718 • SIGUENOS EN

APPENDIX E - PREVIOUS BYPASS EMISSION CALCULATIONS

Chapter 3

Description of CO-3, CO-4 and CO-5 Expansion

3.1 Data Center Expansion

3.1.1 Additional Computer Servers and Backup Generators

Figure 1-1 shows the layout of the proposed Phase CO-3, CO-4, and CO-5 expansion. The initial phases of the Columbia Data Center (Phases CO-1 and CO-2) were permitted in 2007, and were constructed in 2008–2010. Phases CO-1 and CO-2 include 24 backup diesel generators, two small fire pump backup engines, and a small emergency generator at the facility's water treatment plant. Twenty of the generator stacks for CO-1 and CO-2 were installed at the roof of the main data center building, while four of the CO-1 and CO-2 engines are inside their own ground-level enclosures.

The computer servers for Phases CO-3, CO-4, and CO-5 will be inside dedicated buildings (25 feet tall) as shown on Figure 1-1. There will be no wet mechanical-draft cooling towers used for the expansion. The proposed expansion will add the following backup generators:

- Phase CO-3, which will be installed in 2010, will add five generators plus a small fire pump backup engine. Each generator will be a 2,500 kilowatt-electric (kWe) Caterpillar generator. Specifications are provided in Appendix A. The backup fire pump will use a 149 horsepower engine.
- Phases CO-4 and CO-5, which will be installed in 2011 or 2012, will install a total of eight Caterpillar 2,500 kWe generators.
- Each generator will be inside its own acoustical enclosure at ground level. Each generator will use its own stack, with a stack height 3114 feet above ground. This stack height is considerably higher than the originally assumed 14-foot stacks. As a result, the downwind ambient air pollutant concentrations are modeled to be considerably lower.

3.1.2 Runtime Regimes for Expansion Engines and Currently-Permitted Engines

Table 3-1 lists the requested potential-to-emit generator runtime for the CO-3, CO-4, and CO-5 backup generators. All generators (the existing CO-1 and CO-2 generators plus the proposed new expansion generators) will have three operating modes. The operating parameters for the CO-3, CO-4, and CO-5 generators will be as follows:

- 12 hours per year pre-scheduled monthly diagnostic testing, when only a few engines at a time will operate at any one time;
- Two full days per year (48 hours/year) of power outage when the generators would operate at their rated design load. This assumption of 2 days per year of power outage is designed to demonstrate compliance with the second highest 24-hour ambient standard for particulate matter less than 10 microns in size (PM10).
- 44 hours per year of non-emergency "storm avoidance" engine operation, when Microsoft would operate some of the generators for limited periods to provide localized electrical power during occasional maintenance or repair of electrical systems at the facility.
- These forecast engine runtime regimes are equivalent to annual runtime of 104 hours per year per expansion engine.

The currently-permitted CO-1 and CO-2 engines are subject to facility-wide fuel usage limits that correspond to an allowable annual runtime of roughly 359 hours per year. During the past 2 years of operation the CO-1 and CO-2 engines have actually operated for less than 120 hours per engine per year.

3.1.3 Ambient Air Quality Compliance Boundary

The ambient air quality compliance boundary for the Columbia Data Center is defined as all locations beyond the project boundary. All people within the Columbia Data Center are Microsoft employees or contractors. Therefore, occupied spaces within the project boundary are excluded from consideration.

Table 3-1. CO-3, CO-4, and CO-5 Generator Run-Time Regimes

Generator Number			Scheduled Testing				Power Outages			Storm Avoidance + Electrical Bypass		
Gen #	Gen Area	Engine Size	Monthly Tests				Average Load During Outage	Unplanned Outage hours	Average Load Outage	Engine Load	Duration	Engine Usage
		kWm	% Load	hrs/test	Tests/yr	kWm-hr/yr	%	hours/yr	kWm-hr/yr	%	Hours/Yr	kWm-Hrs/Yr
CO3-1	CO-3	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO3-2	CO-3	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO3-3	CO-3	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO3-4	CO-3	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO3-5	CO-3	2740	10%	1	12	3288	10%	**48**	13152	40%	44	48224
CO4-1	CO-4	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO4-2	CO-4	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO4-3	CO-4	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO4-4	CO-4	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO5-1	CO-5	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO5-2	CO-5	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO5-3	CO-5	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
CO5-4	CO-5	2740	10%	1	12	3288	85%	**48**	111792	40%	44	48224
FP-3	CO3,4,5	111	10%	1	12	133	80%	**48**	4262	0%	0	0
Combined Kwm-hrs/Yr									3,462,125			2,836,448

Note – kWm is mechanical kilowatt output of the diesel engine

3.2 Backup Generator Emissions

This section describes the estimated emission rates from the generators.

3.2.1 Screening-Level Tier-2 Generator Emission Factors

Table 3-2 lists the emission factors used for this analysis. The methods used to derive the emission factors are described below.

Table 3-2. Assumed Diesel Generator Emission Factors

	Emission Factor		
Pollutant	**Factor**	**Units**	**Source**
NO_X	6.12	g/kWm-hr	Tier-2 Average Limit
PM2.5	0.200	g/kWm-hr	Tier-2 Average Limit
Annual PM2.5/DPM		See "Unit Rates" worksheet	
CO	3.50	g/kWm-hr	Tier-2 Average Limit
VOC	0.282	g/kWm-hr	Tier-2 Average Limit
SO_2		Fuel sulfur mass balance	
Primary Nitrogen Dioxide (NO_2)	0.612 ~~0.31~~	g/kwm-hr	10% ~~5%~~ of NOx
Benzene	7.92E-04	lbs/MMBTU	AP-42 Sec 3.4
Toluene	2.87E-04	lbs/MMBTU	AP-42 Sec 3.4
Xylenes	1.97E-04	lbs/MMBTU	AP-42 Sec 3.4
1,3-Butadiene	1.99E-05	lbs/MMBTU	AP-42 Sec 3.3
Formaldehyde	8.05E-05	lbs/MMBTU	AP-42 Sec 3.4
Acetaldehyde	2.57E-05	lbs/MMBTU	AP-42 Sec 3.4
Acrolein	8.04E-06	lbs/MMBTU	AP-42 Sec 3.4
Benzo(a)pyrene	1.31E-07	lbs/MMBTU	AP-42 Sec 3.4
Total PAHs (simple sum, no TEFs)	3.96E-06	lbs/MMBTU	AP-42 Sec 3.4
Total PAHs (Applying TEFs)	5.08E-07	lbs/MMBTU	AP-42 Sec 3.4

For any given pollutant, the emission factors for a diesel engine, expressed as grams per kilowatt-hour (g/kWm-hr), depend on the engine load. NO_x emission factors generally increase with higher engine load, while the emission factors for products of incomplete combustion (particulate matter, carbon monoxide, hydrocarbons, and organic toxic air pollutants) generally decrease with higher engine load. EPA's Tier-2 certification program was originally intended to quantify emissions from mobile sources (on-road vehicles and mobile construction equipment) which routinely operate under a wide range of engine loads. The Tier-2 certification requires each engine to be tested over a duty cycle ranging from 10% load to 100% load, and the Tier-2 emission limit for each pollutant applies to the weighted average of the emission factors for the range of loads. For most engines the weighted-average Tier-2 value is dominated by the values for low loads (25% load and 10% load).

However, because most backup generator engines are designed to run at much higher loads, the actual emission factors for backup engines running at their design loads will be considerably lower than the weighted-average Tier-2 limits. Therefore, assuming a constant emission factor equal to the Tier-2 limit generally results conservatively over-estimates emission rate for backup generators at data centers.

For this analysis, the instantaneous emissions from an engine were calculated as follows:

$$E_i = EF \times \text{Engine Rating} \times \text{Load}_i$$

Where

E_i is the instantaneous emission rate (grams/hour) at condition "i"
EF is the constant emission factor, equal to the EPA Tier-2 certification limit (g/kWm-hour)
Engine Rating is the full-load brake power of the engine (kWm)
Load_i is the fractional engine load

Emission factors for toxic air pollutants were derived from AP-42. The emission rate for primary nitrogen dioxide (NO_2) assumed primary NO_2 is 5% by mass of the primary oxides of nitrogen.

3.2.2 Generator Emission Rates

Annual average emission rates for the combined expansion generators are listed in Table 3-3. Detailed information on the emission calculations is provided in Appendix B.

3.2.3 Voluntary Limitation on Facility-Wide Fuel Usage (To Be Retained at Current Limit)

Microsoft proposes to retain the currently permitted facility-wide fuel usage limit of 890,021 gallons per year, which is robust enough to allow engine runtime for the Phase CO-3, CO-4, and CO-5 generators at the values listed in Table 3-1. These engine runtimes listed in Table 3-1 correspond to an expansion generator fuel usage of 139,493 gallons per year. Calculations for the fuel usage are provided in Appendix B.

The forecast potential-to-emit NO_X emission for the proposed expansion is 13.7 tons per year. Microsoft requests federally-enforceable operational limits to maintain the facility-wide NOx emission rate at the currently-permitted 89.4 tons per year, to ensure the facility is not subject to Title V permitting. To do so, the potential-to-emit NO_X emissions from the proposed expansion and the currently-permitted generators must be kept below the following values:

Currently-Permitted Facility Wide NOx Limit	89.4 tons/year
PTE for Phases CO-3, CO-4, CO-5	13.7 tons/year
Adjusted Allowable PTE for Existing CO-1 and CO-2	75.7 tons/year

The currently-permitted generators for CO-1 and CO-2 are currently subject to a federally enforceable facility-wide fuel usage of 890,021 gallons per year, which corresponds to a facility-wide NOx emission limit of 89.4 tons/year. To maintain the current facility-wide NO_X limit while adding the new expansion generators, the facility-wide fuel usage limit must be maintained at its currently-permitted 890,021 gallons per year. To do so, the allowable fuel usages for the proposed new expansion generators and the currently-permitted generators are as follows:

Facility-Wide Fuel Limit (To Be Maintained)	890,021 gallons/year
PTE Fuel Usage for CO-3, CO-4, CO-5	139,493 gallons/year
Adjusted Fuel usage for Existing CO-1 and CO-2	750,528 gallon/year

The adjusted facility-wide fuel usage limits correspond to the following equivalent engine runtimes:

CO-3, CO-4, CO-5 Expansion Engines	104 hours/year/engine
Adjusted Existing CO-1 and CO-2 Engines	303 hours/year/engine

Table 3-3. Backup Generator Emission Rates (Includes 2.5-MWe Generators and 750-kWe Generator)

	Emission Rates (tons/Year)			
Pollutant	Testing	Power Outages	Storm Avoidance	Total
NOX	0.3	9.2	4.2	13.7
Uncontrolled DPM/PM2.5 (Worst single year), 48 hours outage	0.322	0.7852	0.3	1.4
CO	0.2	5.2	2.4	7.8
VOC	0.013	0.42	0.2	0.6
SO_2	0.001	0.009	0.005	0.015
Primary Nitrogen Dioxide (NO_2), 10% ~~5%~~ of NO_X	0.02 ~~0.01~~	0.92 ~~0.46~~	0.4 ~~0.2~~	1.3 ~~0.7~~
Benzene	2.7E-04	4.7E-03	2.6E-03	7.6E-03
Toluene	9.6E-05	1.7E-03	9.3E-04	2.7E-03
Xylenes	6.6E-05	1.2E-03	6.4E-04	1.9E-03
1,3-Butadiene	6.7E-06	1.2E-04	6.5E-05	1.9E-04
Formaldehyde	2.7E-05	4.8E-04	2.6E-04	7.7E-04
Acetaldehyde	8.6E-06	1.5E-04	8.3E-05	2.5E-04
Acrolein	2.7E-06	4.8E-05	2.6E-05	7.7E-05
Benzo(a)Pyrene	4.4E-08	7.9E-07	4.3E-07	1.3E-06
Total PAHs (simple sum, no TEFs)	1.3E-06	2.4E-05	1.3E-05	3.8E-05
Total PAHs (Applying TEFs)	1.7E-07	3.0E-06	1.6E-06	4.9E-06

PAHs = polycyclic aromatic hydrocarbons; TEF = toxicity equivalency factor.

1-Hour No ssions During Electrical Bypass Maintenance

7th-Highest / PVMRM Using NOx Emissions

TIER-2 SCREENII

Stack No.	Descr	Stack Ht (m)	Stack Dia (m)	Engine Load	Exit Temp (K)	Exit Velocity (m/sec)	1-hr NOX Rate (g/sec)	
Electrical Bypass Maintenance								
CO3-1	CO-3		0.457	85%	744	48.5	-	
CO3-2	CO-3		0.457	85%	744	48.5	-	
CO3-3	CO-3		0.457	85%	744	48.5	-	
CO3-4	CO-3		0.457	85%	744	48.5	-	
CO3-5	CO-3		0.457	10%	613	13.5	-	
CO4-1	CO-4		0.457	85%	744	48.5	-	
CO4-2	CO-4		0.457	40%	726	30.0	1.96	
CO4-3	CO-4		0.457	40%	744	30.0	1.96	
CO4-4	CO-4		0.457	85%	744	48.5	-	
CO5-1	CO-5		0.457	85%	744	48.5	-	
CO5-2	CO-5		0.457	85%	744	48.5	-	
CO5-3	CO-5		0.457	85%	744	48.5	-	
CO5-4	CO-5		0.457	85%	744	48.5	-	
FP-3	CO3,4,5		0.152	80%	910	17.3	-	

Site-wide g/sec 3.92

Stack data for 250 : Caterpillar 3516C

Load	ACFM	Temp F	Dia Inches	Area ft2	Velicty fps	Rated kWm	Load	Actual Kwm	NOx EF	Run Hours		
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
10%	4693	644	18	1.76625	44.28402925	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
40%	10439	848	18	1.76625	98.50436424	2740	40%	1152	6.118	1		
40%	10439	880	18	1.76625	98.50436424	2740	40%	1152	6.118	1		
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
80%	667	1178	6	0.19625	56.64543524	2740	0%					

ACFM 194658

24-hr PM2.5 Emissions During Electrical Bypass Maintenance

7th-Highest 24-hr PM2.5

TIER-2 SCREENII

Stack No.	Descr	Stack Ht (m)	Stack Dia (m)	Engine Load	Exit Temp (K)	Exit Velocity (m/sec)	24-hr PM2.5 Rate (g/sec)	
Electrical Bypass Maintenance								
CO3-1	CO-3		0.457	85%	744	48.5	-	
CO3-2	CO-3		0.457	85%	744	48.5	-	
CO3-3	CO-3		0.457	85%	744	48.5	-	
CO3-4	CO-3		0.457	85%	744	48.5	-	
CO3-5	CO-3		0.457	10%	613	13.5	-	
CO4-1	CO-4		0.457	85%	744	48.5	-	
CO4-2	CO-4		0.457	40%	726	30.0	0.0160	
CO4-3	CO-4		0.457	40%	744	30.0	0.0160	
CO4-4	CO-4		0.457	85%	744	48.5	-	
CO5-1	CO-5		0.457	85%	744	48.5	-	
CO5-2	CO-5		0.457	85%	744	48.5	-	
CO5-3	CO-5		0.457	85%	744	48.5	-	
CO5-4	CO-5		0.457	85%	744	48.5	-	
FP-3	CO3,4,5		0.152	80%	910	17.3	-	

Site-wide g/sec 0.032

Stack data for 2500 kWe: Caterpillar 3516C

Load	ACFM	Temp F	Dia Inches	Area ft2	Velicty fps	Rated kWm	Load	Actual Kwm	PM2.5 EF	Run Hours		
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
10%	4693	644	18	1.76625	44.28402925	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
40%	10439	848	18	1.76625	98.50436424	2740	40%	1152	0.2	6		
40%	10439	880	18	1.76625	98.50436424	2740	40%	1152	0.2	6		
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
85%	16842	880	18	1.76625	158.9242746	2740	0%					
80%	667	1178	6	0.19625	56.64543524	2740	0%					

ACFM 194658

FIGURE A
GENERATOR PARAMETERS DURING
ELECTRICAL SYSTEM BYPASS
MAINTENANCE

Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO9 2010 Application - Recreated Short-Term Electrical Bypass Calculations
Microsoft Corporation

Description	Emergency Generators		Source
Engine Rating	1,000	kWe	Manufacturer Data
	1,154	kWm	Manufacturer Data
	1,547	bhp	Manufacturer Data
Operating Hours	44	hr/yr	--
Tier	2		Manufacturer Data
Full Load Consumption Rate	243.8689	gal/hr	Manufacturer Data
Diesel HHV	0.1384	MMBtu/gal	Engineering Basis
Heat Value	33.75	MMBtu/hr	
Sulfur Content	15	ppmw	
	0.0015	wt%	
No. of Units	2	Engine	
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	

Emission Calculations
Emergency Generator Diesel Engine Emissions Calculations
CO9 2010 Application - Recreated Short-Term Electrical Bypass Calculations
Microsoft Corporation

Pollutant	Emission Factor & Units [1, 2, 3, 4, 5, 6]		Emissions [7, 8, 9, 10]
			lb/hr
PM/PM10/PM2.5	0.200	g/KWm-hr	1.02
NO_x	6.12	g/KWm-hr	31.13
VOC	0.282	g/KWm-hr	1.43
DEEP	0.200	g/KWm-hr	1.02
SO_2	1.25E-04	lb/gal	0.06106
NO_2	N/A	N/A	3.113
CO	3.50	g/KWm-hr	17.80
Acetaldehyde	2.57E-05	lb/MMBtu	0.00173
Acrolein	8.04E-06	lb/MMBtu	0.00054
Benz(a)anthracene	6.22E-07	lb/MMBtu	0.00004
Benzene	7.92E-04	lb/MMBtu	0.05347
Benzo(a)pyrene	1.31E-07	lb/MMBtu	0.00001
Benzo(b)fluoranthene	1.11E-06	lb/MMBtu	0.00007
Benzo(k)fluoranthene	2.18E-07	lb/MMBtu	0.00001
1,3-Butadiene	1.99E-05	lb/MMBtu	0.00134
Chrysene	1.53E-06	lb/MMBtu	0.00010
Dibenz(a,h)anthracene	3.46E-07	lb/MMBtu	0.00002
Formaldehyde	8.05E-05	lb/MMBtu	0.00543
Indeno(1,2,3-cd)pyrene	4.14E-07	lb/MMBtu	0.00003
Naphthalene	1.30E-04	lb/MMBtu	0.0088
Propylene	2.79E-03	lb/MMBtu	0.1883
Toluene	2.87E-04	lb/MMBtu	0.0194
Xylenes	1.97E-04	lb/MMBtu	0.0133
Total HAP	N/A	N/A	1.721
CO_2	73.96	kg/MMBtu	11,008
CH_4	0.003	kg/MMBtu	0.45
N_2O	0.0006	kg/MMBtu	0.089
CO_2e	--	--	11,045

APPENDIX F – REVISED BYPASS AND PORTABLE ENGINE EMISSIONS CALCULATIONS

Table EC - 1a: Total Facility Emissions
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Pollutant	PTE from Existing Permitted Sources	Project Emissions	Existing + Project Emissions
	Annual (tpy)	Annual (tpy)	Annual (tpy)
NO_X	37.60	0.42	38.02
CO	6.49	0.037	6.53
VOC	2.42	0.016	2.44
DEEP	0.61	0.0127	0.62
PM_{10}	14.29	0.028	14.32
$PM_{2.5}$	6.49	0.028	6.52
$PM_{2.5}$ (Gens Only)	2.99	0.028	3.02
SO_2	0.05	0.0025	0.06
NO_2	3.71	0.042	3.75
Acetaldehyde	0.0011	0.0040	0.0050
Acrolein	0.0024	0.00017	0.0026
Acenaphthylene	0.000016	—	0.000016
Acenaphthene	0.0000079	—	0.0000079
Ammonia	0.023	0.059	0.082
Anthracene	0.0000026	—	0.0000026
Arsenic	—	0.0000024	0.0000024
Benz(a)anthracene	0.000020	0.0000055	0.000026
Benzene	0.025	0.00094	0.026
Benzo(a)pyrene	0.0000080	0.0000045	0.000012
Benzo(b)fluoranthene	0.000035	0.0000089	0.000044
Benzo(g,h,l)perylene	0.0000011	—	0.0000011
Benzo(k)fluoranthene	0.0000069	0.0000087	0.000016
Bromodichloromethane	0.00018	—	0.00018
Bromoform	0.0046	—	0.0046
1,3-Butadiene	0.0012	0.00110	0.0023
Cadmium	—	0.0000023	0.0000023
Chlorobenzene	—	0.00000101	0.00000101
Chloroform	0.00018	—	0.00018
Chromium VI, Hexavalent	—	0.00000015	0.00000015
Chrysene	0.000048	0.0000049	0.000053
Copper	0.00018	0.0000062	0.00019
Dibenz(a,h)anthracene	0.000011	0.0000047	0.000016
Ethyl benzene	—	0.000055	0.000055
Fluoranthene	0.0000090	—	0.0000090
Fluorene	0.000030	—	0.000030
Fluoride	0.0055	—	0.0055
Formaldehyde	0.0029	0.0087	0.0116
n-Hexane	—	0.000136	0.000136
Hydrogen Chloride	—	0.0019	0.0019
Indeno(1,2,3-cd)pyrene	0.000013	0.000005	0.000018
Lead	—	0.000013	0.000013

Table EC - 1a: Total Facility Emissions
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Pollutant	PTE from Existing Permitted Sources	Project Emissions	Existing + Project Emissions
	Annual (tpy)	Annual (tpy)	Annual (tpy)
Manganese	0.00054	0.0000047	0.00054
Mercury	—	0.0000030	0.0000030
Naphthalene	0.0041	0.00018	0.0043
Nickel	—	0.0000059	0.0000059
Phenanthrene	0.000075	—	0.000075
Propylene	0.087	0.0024	0.090
Pyrene	0.0000076	—	0.0000076
Selenium	—	0.0000033	0.0000033
Toluene	0.0089	0.00053	0.0094
Vanadium	0.00036	—	0.00036
Xylenes	0.0061	0.00021	0.0064
CO_2e	8,889	224.8	9,114

Note:
CH_4 - Methane
CO - Carbon monoxide
CO_2 - Carbon dioxide
CO_2e - Carbon dioxide equivalents
DEEP - Diesel engine exhaust particulate matter
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 - 1b: Nonroad Engine Emissions
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Pollutant	Emissions for Nonroad Engines	
	lb/hr	Annual (tpy)
NO_X	17.62	0.42
CO	0.80	0.037
VOC	0.34	0.016
DEEP	0.26	0.0127
PM_{10}	0.58	0.028
$PM_{2.5}$	0.58	0.028
$PM_{2.5}$ (Gens Only)	0.58	0.028
SO_2	0.051	0.0025
NO_2	1.76	0.042
Acetaldehyde	0.079	0.0040
Acrolein	0.0034	0.00017
Ammonia	1.17	0.059
Arsenic	0.000049	0.0000024
Benz(a)anthracene	0.00011	0.0000055
Benzene	0.019	0.0009
Benzo(a)pyrene	0.000089	0.0000045
Benzo(b)fluoranthene	0.00018	0.0000089
Benzo(k)fluoranthene	0.00017	0.0000087
1,3-Butadiene	0.022	0.00110
Cadmium	0.000046	0.0000023
Chlorobenzene	0.000020	0.00000101
Chromium VI, Hexavalent	0.0000030	0.00000015
Chrysene	0.00010	0.0000049
Copper	0.00012	0.0000062
Dibenz(a,h)anthracene	0.00009	0.0000047
Ethyl benzene	0.0011	0.000055
Formaldehyde	0.17	0.0087
n-Hexane	0.0027	0.000136
Hydrogen Chloride	0.037	0.0019
Indeno(1,2,3-cd)pyrene	0.00009	0.0000047
Lead	0.00025	0.000013
Manganese	0.00009	0.0000047
Mercury	0.000061	0.0000030
Naphthalene	0.0036	0.00018
Nickel	0.00012	0.0000059
Propylene	0.047	0.0024
Selenium	0.000067	0.0000033
Toluene	0.011	0.00053
Xylenes	0.0043	0.00021
CO_2e	4,496	224.78

Table EC - 1b: Nonroad Engine Emissions
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Note:

CH_4 - Methane
CO - Carbon monoxide
CO_2 - Carbon dioxide
CO_2e - Carbon dioxide equivalents
DEEP - Diesel engine exhaust particulate matter
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 - 1c: Total Electrical Bypass Operations
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Pollutant	Emissions for Generator Engine Bypass Operations
	lb/hr
NO_X	156.68
CO	15.58
VOC	5.63
DEEP	1.56
PM_{10}	7.19
$PM_{2.5}$	7.19
SO_2	0.18
NO_2	15.67
Acetaldehyde	5.43E-01
Acrolein	2.35E-02
Ammonia	3.27
Arsenic	1.11E-03
Benz(a)anthracene	7.50E-04
Benzene	0.13
Benzo(a)pyrene	6.11E-04
Benzo(b)fluoranthene	1.21E-03
Benzo(k)fluoranthene	1.19E-03
1,3-Butadiene	0.15
Cadmium	1.04E-03
Chlorobenzene	1.39E-04
Chromium VI, Hexavalent	6.93E-05
Chrysene	6.74E-04
Copper	2.84E-03
Dibenz(a,h)anthracene	6.43E-04
Ethyl benzene	7.55E-03
Formaldehyde	1.20
n-Hexane	1.86E-02
Hydrogen Chloride	0.13
Indeno(1,2,3-cd)pyrene	6.37E-04
Lead	5.75E-03
Manganese	2.15E-03
Mercury	1.39E-03
Naphthalene	2.47E-02
Nickel	2.70E-03
Propylene	0.32
Selenium	1.52E-03
Toluene	7.30E-02
Xylenes, Total	2.94E-02
CO_2	20,481
CH_4	0.83
N_2O	0.17
CO_2e	20,551

Table EC - 1c: Total Electrical Bypass Operations
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Note:

CH_4 - Methane
CO - Carbon monoxide
CO_2 - Carbon dioxide
CO_2e - Carbon dioxide equivalents
DEEP - Diesel engine exhaust particulate matter
NO_X - Nitrogen oxides
NO_2 - Nitrogen dioxide
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

Table EC - 2a: Electrical Bypass Operational Update
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Parameter	Units	Primary Engines
Annual Hours of Operation (per engine)	Hours	4
Number of Cold-Startup Events per year (per engine) [1]	Events	2
Duration of Each Cold-Startup Event	Hours/Event	0.017
Total Duration of Cold Conditions (per engine)	Hours	0.03

Estimate of hourly emissions from each engine 80%

Pollutant	Primary Generator Engines		Average Emission Factor
	Warm Emissions	Cold-Start emissions	Cold and Warm Average
	lb/hr/engine	lb/hr/engine	lb/hr/engine
NO_X	31.34	31.34	31.34
CO	2.92	3.31	3.12
VOC	1.10	1.15	1.13
DEEP	0.30	0.32	0.31
PM_{10}	1.40	1.48	1.44
$PM_{2.5}$	1.40	1.48	1.44
SO_2	0.04	0.04	0.04
NO_2	3.13	3.13	3.13

Estimate of hourly emissions from each engine 40%

Pollutant	Primary Generator Engines		Average Emission Factor
	Warm Emissions	Cold-Start emissions	Cold and Warm Average
	lb/hr/engine	lb/hr/engine	lb/hr/engine
NO_X	7.82	7.82	15.64
CO	2.85	3.23	3.04
VOC	0.83	0.88	0.86
DEEP	0.28	0.29	0.29
PM_{10}	1.11	1.17	1.14
$PM_{2.5}$	0.00	1.17	0.59
SO_2	0.04	0.04	0.04
NO_2	0.78	0.78	0.78

Notes:

1) See explanation in Section 2.1 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 - 2b: Nonroad Engine Emissions
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Parameter	Units	Nonroad Engine 1	Nonroad Engine 2
Annual Hours of Operation (per engine)	Hours	100	100
Number of Cold-Startup Events per year (per engine) [1]	Events	30	30

Estimate of warm and cold start hourly emissions from each engine or each stack

Pollutant	Nonroad Engine 1 (Each Engine)		Nonroad Engine 2 (Each Stack)	
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions
	lb/hr/engine	lb/hr/engine	lb/hr/engine	lb/hr/engine
NO_X	0.51	2.63	1.76	6.19
CO	0.005	0.0057	0.35	0.40
VOC	0.04	0.042	0.12	0.13
DEEP	0.04	0.042	0.085	0.090
PM_{10}	0.08	0.084	0.20	0.21
$PM_{2.5}$	0.08	0.08	0.20	0.21
SO_2	0.0090	0.0090	0.016	0.016
NO_2	0.051	0.263	0.18	0.62
Ammonia Slip	0.054	—	0.094	—

Annual Emissions from each engine engine or each stack

Pollutant	Nonroad Engine 1 (Each Engine)		Nonroad Engine 2 (Each Stack)	
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions
	tpy/engine	tpy/engine	tpy/engine	tpy/engine
NO_X	0.018	0.039	0.062	0.093
CO	0.00018	0.000085	0.012	0.0060
VOC	0.0014	0.00063	0.0042	0.0019
DEEP	0.0014	0.00063	0.0030	0.0013
PM_{10}	0.0028	0.0013	0.0068	0.0031
$PM_{2.5}$	0.0028	0.0013	0.0068	0.0031
SO_2	0.00032	0.00014	0.00057	0.00025
NO_2	0.0018	0.0039	0.0062	0.0093
Ammonia Slip	0.0019	—	0.0033	—

Total Annual Warm and Cold Start Emissions

Pollutant	Nonroad Engine 1 x 2 engines		Nonroad Engine 2 x 2 stacks	
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions
	tpy	tpy	tpy	tpy
NO_X	0.036	0.079	0.12	0.19
CO	0.00035	0.00017	0.025	0.012
VOC	0.0028	0.0013	0.0084	0.0038
DEEP	0.0028	0.0013	0.0060	0.0027
PM_{10}	0.0056	0.0025	0.014	0.0062
$PM_{2.5}$	0.0056	0.0025	0.014	0.0062
SO_2	0.00063	0.00027	0.0011	0.00049
NO_2	0.0036	0.0079	0.012	0.019
Ammonia Slip	0.0038	—	0.0066	—

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 - 3a: Generator Parameters - Electrical Bypass Operational Update
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Parameters for One Engine

Description	Support Emergency Generator Engines		Source
Engine Rating	2,000	kWe	Manufacturer Data
	2,189	kWm	Manufacturer Data
	2,935	bhp	Manufacturer Data
Operating Hours	4	hr/day	--
Tier	2		Manufacturer Data
Fuel Type	ULSD or Renewable Diesel		Fuel Specification
Full Load Consumption Rate	142.3	gal/hr	Manufacturer Data
	569	gal/day	--
Diesel HHV	0.1384	MMBtu/gal	Engineering Basis
Heat Value	19.70	MMBtu/hr	--
Sulfur Content	15	ppmw	Fuel Specification
	0.0015	wt%	--

Total Daily Fuel Consumption from 5 Engines

Description	Support Emergency Generator Engines
Number of Engines	5
Daily Fuel Use	2,846

Table EC - 3b: Nonroad Engine Parameters
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Parameters for One Engine

Description	Nonroad Engine 1		Source	Nonroad Engine 2		Source
Engine Rating	500	kWe	Manufacturer Data	1,825	kWe	Manufacturer Data
	555	kWm	Manufacturer Data	2,007	kWm	Manufacturer Data
	744	bhp	Manufacturer Data	2,692	bhp	Manufacturer Data
Operating Hours	100	hr/yr	--	100	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	36.5	gal/hr	Manufacturer Data	123.2	gal/hr	Manufacturer Data
	3,650	gal/yr	--	12,320	gal/yr	--
Diesel HHV	0.1384	MMBtu/gal	Engineering Basis	0.1384	MMBtu/gal	Engineering Basis
Heat Value	5.05	MMBtu/hr	--	17.05	MMBtu/hr	--
Sulfur Content	15	ppmw	Fuel Specification	15	ppmw	Fuel Specification
	0.0015	wt%	--	0.0015	wt%	--

Total Annual Fuel Consumption from Nonroad Engines

Description	Nonroad Engine 1	Nonroad Engine 2	Totals
Number of Engines	2	1	3
Annual Fuel Use (gal/yr)	7,300	12,320	19,620

Table EC - 4a: lb/hr - Electrical Bypass Operational Update
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Description	Emergency Generators		Source
Engine Rating	1,500	kWe	Manufacturer Data
	1,645	kWm	Manufacturer Data
	2,206	bhp	Manufacturer Data
Operating Hours	4	hr/day	--
Tier	2		Manufacturer Data
Full Load Consumption Rate	134.9	gal/hr	Manufacturer Data
Diesel HHV	0.1384	MMBtu/gal	Engineering Basis
Heat Value	18.67	MMBtu/hr	--
Sulfur Content	15	ppmw	
	0.0015	wt%	
No. of Units	5	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[1,2,3]	Emission Factor & Units [1,2,3]		Calcualted Emissions [4,5]
			lb/hr
Acetaldehyde[1]	7.83E-01	lb/Mgal	5.28E-01
Acrolein[1]	3.39E-02	lb/Mgal	2.29E-02
Ammonia[2]	4.85E+00	lb/Mgal	3.27E+00
Arsenic[1]	1.60E-03	lb/Mgal	1.08E-03
Benz(a)anthracene[2]	1.08E-03	lb/Mgal	7.30E-04
Benzene[1]	1.86E-01	lb/Mgal	1.26E-01
Benzo(a)pyrene[2]	8.82E-04	lb/Mgal	5.95E-04
Benzo(b)fluoranthene[2]	1.75E-03	lb/Mgal	1.18E-03
Benzo(k)fluoranthene[2]	1.72E-03	lb/Mgal	1.16E-03
1,3-Butadiene[1]	2.17E-01	lb/Mgal	1.47E-01
Cadmium[1]	1.50E-03	lb/Mgal	1.01E-03
Chlorobenzene[1]	2.00E-04	lb/Mgal	1.35E-04
Chromium VI, Hexavalent[1]	1.00E-04	lb/Mgal	6.75E-05
Chrysene[2]	9.73E-04	lb/Mgal	6.56E-04
Copper[1]	4.10E-03	lb/Mgal	2.77E-03
Dibenz(a,h)anthracene[2]	9.28E-04	lb/Mgal	6.26E-04
Ethyl benzene[1]	1.09E-02	lb/Mgal	7.35E-03
Formaldehyde[1]	1.73E+00	lb/Mgal	1.16E+00
n-Hexane[1]	2.69E-02	lb/Mgal	1.81E-02
Hydrogen Chloride[1]	1.86E-01	lb/Mgal	1.26E-01
Indeno(1,2,3-cd)pyrene[2]	9.19E-04	lb/Mgal	6.20E-04

Table EC - 4a: lb/hr - Electrical Bypass Operational Update
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Pollutant[1,2,3]	Emission Factor & Units [1,2,3]		Calcualted Emissions [4,5]
			lb/hr
Lead[1]	8.30E-03	lb/Mgal	5.60E-03
Manganese[1]	3.10E-03	lb/Mgal	2.09E-03
Mercury[1]	2.00E-03	lb/Mgal	1.35E-03
Naphthalene[2]	3.57E-02	lb/Mgal	2.41E-02
Nickel[1]	3.90E-03	lb/Mgal	2.63E-03
Propylene[1]	4.67E-01	lb/Mgal	3.15E-01
Selenium[1]	2.20E-03	lb/Mgal	1.48E-03
Toluene[1]	1.05E-01	lb/Mgal	7.11E-02
Xylenes, Total[1]	4.24E-02	lb/Mgal	2.86E-02
CO_2	73.96	kg/MMBtu	15,223
CH_4	0.003	kg/MMBtu	0.62
N_2O	0.0006	kg/MMBtu	1.23E-01
CO_2e	--	--	15,275

Notes:

1) Emission factors for some Toxc Air Pollutants (TAP), as denoted, were derived from Ventura County Pollution Controll District AB 2588 Combustion Emission Factors, Diesel Combustion Factors Table, dated May 17, 2001,accessed at: http://vcapcd.org/pubs/Engineering/AirToxics/combem.pdf

2) Emission factors for some TAPs, as denoted were derived from California Air Toxics Emission Factors accessed at: https://ww2.arb.ca.gov/california-air-toxics-emission-factor. The lb/Mgal factors were calculated as the average values of the mean lb/Mgal factors derived from the various test data sets for diesel-fired intermal combustion engines.

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

4) Example Calculations (Acetaldehyde):
Hourly Acetaldehyde Emissions = 134.90 gal/hr * 0.7833 lb/Mgal * 5 engines / 1000 gal/Mgal = 0.528 lb/hr

5) Example Calculations (CO_2e):
(i) Hourly CO2 Emissions = 18.67 MMBtu/hr * 73.96 kg/MMBtu / 453.5924 g/lb * 1,000 kg/g * 5 engine = 15,223 lb/hr
Therefore, CO_2e Emissions = CO_2 Emissions + (CH_4 Emissions * GWP of CH_4) + (N_2O Emissions * GWP of N_2O)
(ii) Hourly CO2e Emissions = 15,222.53 lb/hr + (0.62 * 25) + (0.12 * 298) = 15,275 lb/hr

Table EC - 4b: lb/hr - Nonroad Engine 1
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Description	Nonroad Engines	Source
Engine Rating	500 kWe	Manufacturer Data
	555 kWm	Manufacturer Data
	744 bhp	Manufacturer Data
Operating Hours	100 hr/yr	--
Tier	2	Manufacturer Data
Full Load Consumption Rate	36.5 gal/hr	Manufacturer Data
Diesel HHV	0.1384 MMBtu/gal	Engineering Basis
Heat Value	5.05 MMBtu/hr	--
Sulfur Content	15 ppmw	
	0.0015 wt%	
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[(1,2,3)]	Emission Factor & Units [(1,2,3)]		Calcualted Emissions [(4,5)]
			lb/hr
Acetaldehyde[(1)]	7.83E-01	lb/Mgal	2.86E-02
Acrolein[(1)]	3.39E-02	lb/Mgal	1.24E-03
Ammonia[(2)]	4.85E+00	lb/Mgal	3.54E-01
Arsenic[(1)]	1.60E-03	lb/Mgal	1.75E-05
Benz(a)anthracene[(2)]	1.08E-03	lb/Mgal	3.95E-05
Benzene[(1)]	1.86E-01	lb/Mgal	6.80E-03
Benzo(a)pyrene[(2)]	8.82E-04	lb/Mgal	3.22E-05
Benzo(b)fluoranthene[(2)]	1.75E-03	lb/Mgal	6.40E-05
Benzo(k)fluoranthene[(2)]	1.72E-03	lb/Mgal	6.28E-05
1,3-Butadiene[(1)]	2.17E-01	lb/Mgal	7.94E-03
Cadmium[(1)]	1.50E-03	lb/Mgal	1.64E-05
Chlorobenzene[(1)]	2.00E-04	lb/Mgal	7.30E-06
Chromium VI, Hexavalent[(1)]	1.00E-04	lb/Mgal	1.10E-06
Chrysene[(2)]	9.73E-04	lb/Mgal	3.55E-05
Copper[(1)]	4.10E-03	lb/Mgal	4.49E-05
Dibenz(a,h)anthracene[(2)]	9.28E-04	lb/Mgal	3.39E-05
Ethyl benzene[(1)]	1.09E-02	lb/Mgal	3.98E-04
Formaldehyde[(1)]	1.73E+00	lb/Mgal	6.30E-02
n-Hexane[(1)]	2.69E-02	lb/Mgal	9.82E-04
Hydrogen Chloride[(1)]	1.86E-01	lb/Mgal	1.36E-02
Indeno(1,2,3-cd)pyrene[(2)]	9.19E-04	lb/Mgal	3.36E-05

Table EC - 4b: lb/hr - Nonroad Engine 1
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Pollutant[1,2,3]	Emission Factor & Units [1,2,3]		Calcualted Emissions [4,5]
			lb/hr
Lead[1]	8.30E-03	lb/Mgal	9.09E-05
Manganese[1]	3.10E-03	lb/Mgal	3.39E-05
Mercury[1]	2.00E-03	lb/Mgal	2.19E-05
Naphthalene[2]	3.57E-02	lb/Mgal	1.30E-03
Nickel[1]	3.90E-03	lb/Mgal	4.27E-05
Propylene[1]	4.67E-01	lb/Mgal	1.70E-02
Selenium[1]	2.20E-03	lb/Mgal	2.41E-05
Toluene[1]	1.05E-01	lb/Mgal	3.85E-03
Xylenes, Total[1]	4.24E-02	lb/Mgal	1.55E-03
CO_2	73.96	kg/MMBtu	1,648
CH_4	0.003	kg/MMBtu	0.07
N_2O	0.0006	kg/MMBtu	1.34E-02
CO_2e	--	--	1,653

Notes:

1) Emission factors for some Toxc Air Pollutants (TAP), as denoted, were derived from Ventura County Pollution Controll District AB 2588 Combustion Emission Factors, Diesel Combustion Factors Table, dated May 17, 2001,accessed at: http://vcapcd.org/pubs/Engineering/AirToxics/combem.pdf

2) Emission factors for some TAPs, as denoted were derived from California Air Toxics Emission Factors accessed at: https://ww2.arb.ca.gov/california-air-toxics-emission-factor. The lb/Mgal factors were calculated as the average values of the mean lb/Mgal factors derived from the various test data sets for diesel-fired intermal combustion engines.

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

4) Example Calculations (Acetaldehyde):
Hourly Acetaldehyde Emissions = 36.50 gal/hr * 0.7833 lb/Mgal * 2 engines / 1000 gal/Mgal = 0.057 lb/hr
Annual Acetaldehyde Emissions = 0.029 lb/hr * 100 hr/yr / 2,000 lb/tons = 0.00143 tpy

5) Example Calculations (CO_2e):
(i) Hourly CO2 Emissions = 5.05 MMBtu/hr * 73.96 kg/MMBtu / 453.5924 g/lb * 1,000 kg/g * 2 engine = 1,648 lb/hr
(ii) Annual CO2 Emissions = 1,647.51 lb/hr * 100 hr/yr / 2,000 lb/tons = 82.38 tpy
Therefore, CO_2e Emissions = CO_2 Emissions + (CH_4 Emissions * GWP of CH_4) + (N_2O Emissions * GWP of N_2O)
(ii) Hourly CO2e Emissions = 1,647.51 lb/hr + (0.07 * 25) + (0.01 * 298) = 1,653 lb/hr
(iv) Annual CO2e Emissions = 1,653.16 lb/hr * 100 hr/yr / 2,000 lb/tons = 82.66 tpy

Table EC - 4c: lb/hr - Nonroad Engine 2
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Description	Nonroad Engine	Source
Engine Rating	1,825 kWe	Manufacturer Data
	2,007 kWm	Manufacturer Data
	2,692 bhp	Manufacturer Data
Operating Hours	100 hr/yr	--
Tier	2	Manufacturer Data
Full Load Consumption Rate	126.2 gal/hr	Manufacturer Data
Diesel HHV	0.1384 MMBtu/gal	Engineering Basis
Heat Value	17.47 MMBtu/hr	--
Sulfur Content	15 ppmw	
	0.0015 wt%	
No. of Units	1 Engine	--
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[1,2,3]	Emission Factor & Units [1,2,3]		Calcualted Emissions [4,5]
			lb/hr
Acetaldehyde[1]	7.83E-01	lb/Mgal	4.94E-02
Acrolein[1]	3.39E-02	lb/Mgal	2.14E-03
Ammonia[2]	4.85E+00	lb/Mgal	6.12E-01
Arsenic[1]	1.60E-03	lb/Mgal	3.03E-05
Benz(a)anthracene[2]	1.08E-03	lb/Mgal	6.83E-05
Benzene[1]	1.86E-01	lb/Mgal	1.18E-02
Benzo(a)pyrene[2]	8.82E-04	lb/Mgal	5.56E-05
Benzo(b)fluoranthene[2]	1.75E-03	lb/Mgal	1.11E-04
Benzo(k)fluoranthene[2]	1.72E-03	lb/Mgal	1.09E-04
1,3-Butadiene[1]	2.17E-01	lb/Mgal	1.37E-02
Cadmium[1]	1.50E-03	lb/Mgal	2.84E-05
Chlorobenzene[1]	2.00E-04	lb/Mgal	1.26E-05
Chromium VI, Hexavalent[1]	1.00E-04	lb/Mgal	1.89E-06
Chrysene[2]	9.73E-04	lb/Mgal	6.14E-05
Copper[1]	4.10E-03	lb/Mgal	7.76E-05
Dibenz(a,h)anthracene[2]	9.28E-04	lb/Mgal	5.85E-05
Ethyl benzene[1]	1.09E-02	lb/Mgal	6.88E-04
Formaldehyde[1]	1.73E+00	lb/Mgal	1.09E-01
n-Hexane[1]	2.69E-02	lb/Mgal	1.70E-03
Hydrogen Chloride[1]	1.86E-01	lb/Mgal	2.35E-02
Indeno(1,2,3-cd)pyrene[2]	9.19E-04	lb/Mgal	5.80E-05

Table EC - 4c: lb/hr - Nonroad Engine 2
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Pollutant[1,2,3]	Emission Factor & Units [1,2,3]		Calcualted Emissions [4,5]
			lb/hr
Lead[1]	8.30E-03	lb/Mgal	1.57E-04
Manganese[1]	3.10E-03	lb/Mgal	5.87E-05
Mercury[1]	2.00E-03	lb/Mgal	3.79E-05
Naphthalene[2]	3.57E-02	lb/Mgal	2.25E-03
Nickel[1]	3.90E-03	lb/Mgal	7.38E-05
Propylene[1]	4.67E-01	lb/Mgal	2.95E-02
Selenium[1]	2.20E-03	lb/Mgal	4.16E-05
Toluene[1]	1.05E-01	lb/Mgal	6.65E-03
Xylenes, Total[1]	4.24E-02	lb/Mgal	2.68E-03
CO_2	73.96	kg/MMBtu	2,848
CH_4	0.003	kg/MMBtu	0.12
N_2O	0.0006	kg/MMBtu	2.31E-02
CO_2e	--	--	2,858

Notes:

1) Emission factors for some Toxc Air Pollutants (TAP), as denoted, were derived from Ventura County Pollution Controll District AB 2588 Combustion Emission Factors, Diesel Combustion Factors Table, dated May 17, 2001,accessed at: http://vcapcd.org/pubs/Engineering/AirToxics/combem.pdf

2) Emission factors for some TAPs, as denoted were derived from California Air Toxics Emission Factors accessed at: https://ww2.arb.ca.gov/california-air-toxics-emission-factor. The lb/Mgal factors were calculated as the average values of the mean lb/Mgal factors derived from the various test data sets for diesel-fired intermal combustion engines.

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

4) Example Calculations (Acetaldehyde):
Hourly Acetaldehyde Emissions = 126.20 gal/hr * 0.7833 lb/Mgal * 1 engines / 1000 gal/Mgal = 0.099 lb/hr
Annual Acetaldehyde Emissions = 0.049 lb/hr * 100 hr/yr / 2,000 lb/tons = 0.00247 tpy

5) Example Calculations (CO_2e):
(i) Hourly CO2 Emissions = 17.47 MMBtu/hr * 73.96 kg/MMBtu / 453.5924 g/lb * 1,000 kg/g * 1 engine = 2,848 lb/hr
(ii) Annual CO2 Emissions = 2,848.16 lb/hr * 100 hr/yr / 2,000 lb/tons = 142.41 tpy
Therefore, CO_2e Emissions = CO_2 Emissions + (CH_4 Emissions * GWP of CH_4) + (N_2O Emissions * GWP of N_2O)
(ii) Hourly CO2e Emissions = 2,848.16 lb/hr + (0.12 * 25) + (0.02 * 298) = 2,858 lb/hr
(iv) Annual CO2e Emissions = 2,857.93 lb/hr * 100 hr/yr / 2,000 lb/tons = 142.90 tpy

Table EC - 5: Fuel Based Emissions - Electrical Bypass Operation
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Primary Generator Engines			
Number of Engines =	5		11
Annual Hours of Operation =	4		44
SO_2 Emission Factor =		1.21E-05 lb/hp-hr	
Max HP for Support gensets =		2,935 hp	

Pollutant (80%)	Warm Emissions	Total Hourly Warm Emissions for 5 Engines
	lb/hr/engine	lb/hr
NO_X	31.34	156.68
CO	2.92	14.60
VOC	1.10	5.48
$PM_{Filterable}$	0.30	1.521
PM_{10}	1.40	6.997
$PM_{2.5}$	1.40	6.997
SO_2	3.56E-02	0.178

Pollutant (40%)	Warm Emissions	Total Hourly Warm Emissions for 11 Engines
	lb/hr/engine	lb/hr
NO_X	7.82	86.04
CO	2.85	31.33
VOC	0.83	9.17
$PM_{Filterable}$	0.28	3.06
PM_{10}	1.11	12.22
$PM_{2.5}$	0.00	0.00
SO_2	3.56E-02	0.39

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.

Table EC - 6a: Hourly Emissions at Various Load Percentages - Electrical Bypass Operations
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Primary Generator Engines

Engine Model:	Caterpillar 3516C
Engine Rating:	2000 kWe 2935 hp
Operating Hours:	4 hr/yr

Emission Factors at Various Load Percentages [1]							
Brake Horsepower	3633	2935	2760	1889	1000	1029	497
Percent Load (%)	100	80	75	50	40	25	10
NO_x (g/bhp-hr)	6.38	5.40	5.15	3.74	3.55	3.50	6.47
CO (g/bhp-hr)	0.76	0.54	0.48	0.58	1.29	1.47	4.26
VOC (g/bhp-hr)	0.14	0.17	0.18	0.29	0.38	0.40	0.89
PM (g/bhp-hr)	0.05	0.05	0.05	0.07	0.13	0.14	0.29

Hourly Emissions at Various Load Percentages [2]							
Percent Load (%)	100	80	75	50	40	25	10
NO_x (lb/hr)	51.10	34.92	31.34	15.58	7.82	7.94	7.09
CO (lb/hr)	6.09	3.47	2.92	2.42	2.85	3.33	4.67
VOC (lb/hr)	1.12	1.11	1.10	1.21	0.83	0.91	0.98
$PM_{Filterable}$ (lb/hr)	0.40	0.32	0.30	0.29	0.28	0.32	0.32
$PM_{10}/PM_{2.5}$ (lb/hr)	1.52	1.44	1.40	1.50	1.11	1.23	1.29

Notes:

1) Brake horsepower values and emission factors were obtained from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" forthe 350-kWe Caterpillar C13 generator engine (see product specifications sheets in Appendix H).
2) 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. PM10/PM2.5 emissions are set equal to the $PM_{Filterable}$ emission rates plus the VOC emission rates (conservatively assumed to estimate CPM emissions).

Table EC - 6b: Hourly Emissions at Various Load Percentages - Nonroad Engines
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
Microsoft Corporation

Nonroad Engine 1

Engine Model:	Caterpillar C18
Tier 4 Genset Model:	CAT XQ1140BG
Engine Rating:	500 kWe 744 hp
Operating Hours:	100 hr/yr

Hourly Uncontrolled Emission Factors from Like Engines[1]					
Brake Horsepower	744	566	390	218	110
Percent Load (%)	100	75	50	25	10
NO_x (g/bhp-hr)	5.47	3.30	3.24	7.89	10.35
SO_2 (lb/bhp-hr)	1.2E-05	1.2E-05	1.2E-05	1.2E-05	1.2E-05

Hourly Uncontrolled Emission Rates from Like Engines[2]					
Brake Horsepower	744	566	390	218	110
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	8.97	4.12	2.79	3.79	2.51

Hourly Controlled Emission Rates from Performance Data Sheets[3]					
Brake Horsepower	744	566	390	218	110
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	0.51	0.50	0.15	0.05	0.42
CO (lb/hr)	0.005	0.005	0.005	0.005	0.001
VOC (lb/hr)	0.04	0.02	0.005	0.005	0.001
$PM_{Filterable}$ (lb/hr)	0.04	0.02	0.01	0.01	0.001

Max Controlled Emissions for NOx with Warm-up Emissions[4]					
Brake Horsepower	744	566	390	218	110
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	2.63	1.40	0.81	0.99	0.42

Max Controlled Emission Rates from Each Engine or Exhaust Stack[5]					
Brake Horsepower	744	566	390	218	110
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	2.63	1.40	0.81	0.99	0.42
CO (lb/hr)	0.005	0.005	0.005	0.005	0.001
VOC (lb/hr)	0.04	0.02	0.005	0.005	0.001
$PM_{Filterable}$ (lb/hr)	0.04	0.02	0.01	0.01	0.001
$PM_{10}/PM_{2.5}$ (lb/hr)	0.08	0.04	0.02	0.02	0.002
SO_2 (lb/hr)	0.0090	0.0069	0.0047	0.0026	0.00022

Nonroad Engine 2

Engine Model:	Caterpillar 3516C
Tier 4 Genset Model:	CAT XQ2280G
Engine Rating:	1,825 kWe 2,692 hp
Operating Hours:	100 hr/yr

Hourly Uncontrolled Emission Factors from Like Engines[1]					
Brake Horsepower	2,692	2,061	1,439	827	431
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	6.56	4.67	3.82	5.03	7.13
SO_2 (lb/bhp-hr)	1.2E-05	1.2E-05	1.2E-05	1.2E-05	1.2E-05

Hourly Uncontrolled Emission Rates from Like Engines[2]					
Brake Horsepower	2,692	2,061	1,439	827	431
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	38.93	21.22	12.12	9.17	6.77

Hourly Controlled Emission Rates from Performance Data Sheets[3]					
Brake Horsepower	2,692	2,061	1,439	827	431
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	3.52	2.38	1.51	0.96	1.13
CO (lb/hr)	0.70	0.50	0.34	0.22	0.030
VOC (lb/hr)	0.22	0.24	0.22	0.18	0.037
$PM_{Filterable}$ (lb/hr)	0.17	0.15	0.13	0.12	0.008

Max Controlled Emissions for NOx with Warm-up Emissions[4]					
Brake Horsepower	2,692	2,061	1,439	827	431
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	12.37	7.09	4.16	3.01	1.13

Max Controlled Emission Rates from Each Engine or Exhaust Stack[5]					
Brake Horsepower	2,692	2,061	1,439	827	431
Percent Load (%)	100	75	50	25	10
NO_x (lb/hr)	6.19	3.54	2.08	1.51	0.56
CO (lb/hr)	0.35	0.25	0.17	0.11	0.015
VOC (lb/hr)	0.11	0.12	0.11	0.090	0.018
$PM_{Filterable}$ (lb/hr)	0.085	0.075	0.065	0.060	0.004
$PM_{10}/PM_{2.5}$ (lb/hr)	0.20	0.20	0.18	0.15	0.023
SO_2 (lb/hr)	0.016	0.013	0.0087	0.0050	0.00044

Notes:

1) Emission factors for uncontrolled NOx emissions were acquired from a manufacturer "Emissions Data" table labeled "Rated Speed Potential Site Variation" from the same model engines without Tier 4 controls. SO_2 emission factors were acquired from AP-42.

2) Emission rates (lb/hr) for uncontrolled NOx emissions were acquired by multiplying emission factors (g/bhp-hr) by brake horsepower values at different loads and dividing by 453.592 grams per lb.

3) Hourly controlled emission rates were acquried from the manufacturer "Emissions Data" table labeled, "Rated Speed Potential Site Variation" for each generator engine with Tier 4 controls. For rates showing values as 0.00 lb/hr, a rate of 0.005 was presumed. NOx rates at the 10% load condition were acquired from manufacturer data from like engines without NOx controls (SCR controls assumed not to be in operation at that load condition). Hourly emission rates at the 10% load condition were also adjusted because operations at this condition are limited to 10 minutes of an hourly period, during which monthly engine idling is conducted for reliability testing and maintenance runs with no electrical loads produced (emissions calcuated by multiplying hourly emissions by 10 min and dividing by 60 min/hr).

4) Maximum hourly controlled emission rates for NOx with warmup periods assumed a 15-minute period in which SCR controls did not reduce emissions. These rates were derived by multiplying controlled emission rates by 0.75, multiplying uncontrolled emission rates by 0.25, and adding the results to obtain an hourly rate that included warm-up period emissions. Hourly NOx rates at the 10% load condition were not adjusted as these were already assumed to be without NOx controls (SCR controls assumed not to be in operation at that load condition).

5) Maxium hourly emission rates from each engine or exhaust stack for NOx, CO, VOC, and $PM_{Filterable}$ emissions were derived from previously calculated rates and divided by two for the 1,825-kWE generator with two stacks. $PM_{10}/PM_{2.5}$ emissions were set equal to the $PM_{Filterable}$ emission rates plus the VOC emission rates (the VOC rates conservatively assumed to estimate condensible PM emissions). Rates for SO_2 emissions were acquired by multiplying emission factors (lb/bhp-hr) by brake horsepower values; the SO2 rates were also divided by two for the 1,825-kWE generator with two stacks.

Table EC - 7a: Startup Emissions Summary - Electrical Bypass Operations
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
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 (80%)	Worst-case Emission Rate (lb/hr/engine)	
	Primary Generator Engines	
	Warm	Cold-Start/Warm-up [2]
NO_X [3]	31.34	31.34
CO	2.92	26.29
HC	1.10	4.67
DEEP/ $PM_{Filterable}$	0.30	1.30
PM_{10}/ $PM_{2.5}$	1.40	5.97

Worst-case Emission Rates

Pollutant (40%)	Worst-case Emission Rate (lb/hr/engine)	
	Primary Generator Engines	
	Warm	Cold-Start/Warm-up [2]
NO_X [3]	7.82	7.82
CO	2.85	25.64
HC	0.83	3.56
DEEP/ $PM_{Filterable}$	0.28	1.19
PM_{10}/ $PM_{2.5}$	1.11	4.74

Startup emission rates (for 1 engine)

Pollutant (80%)	Primary Generator Engines - Single Hour Emissions (lb/hr) [4]		
	Cold-Start (1-min)	Warm (59 min)	Total (1 hr)
NO_X	0.52	30.81	31.34
CO	0.44	2.87	3.31
HC	0.08	1.08	1.15
DEEP/ $PM_{Filterable}$	0.02	0.30	0.32
PM_{10}/ $PM_{2.5}$	0.10	1.38	1.48

Startup emission rates (for 1 engine)

Pollutant (40%)	Primary Generator Engines - Single Hour Emissions (lb/hr) [4]		
	Cold-Start (1-min)	Warm (59 min)	Total (1 hr)
NO_X	0.13	7.69	7.82
CO	0.43	2.80	3.23
HC	0.06	0.82	0.88
DEEP/ $PM_{Filterable}$	0.02	0.27	0.29
PM_{10}/ $PM_{2.5}$	0.08	1.09	1.17

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.

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.

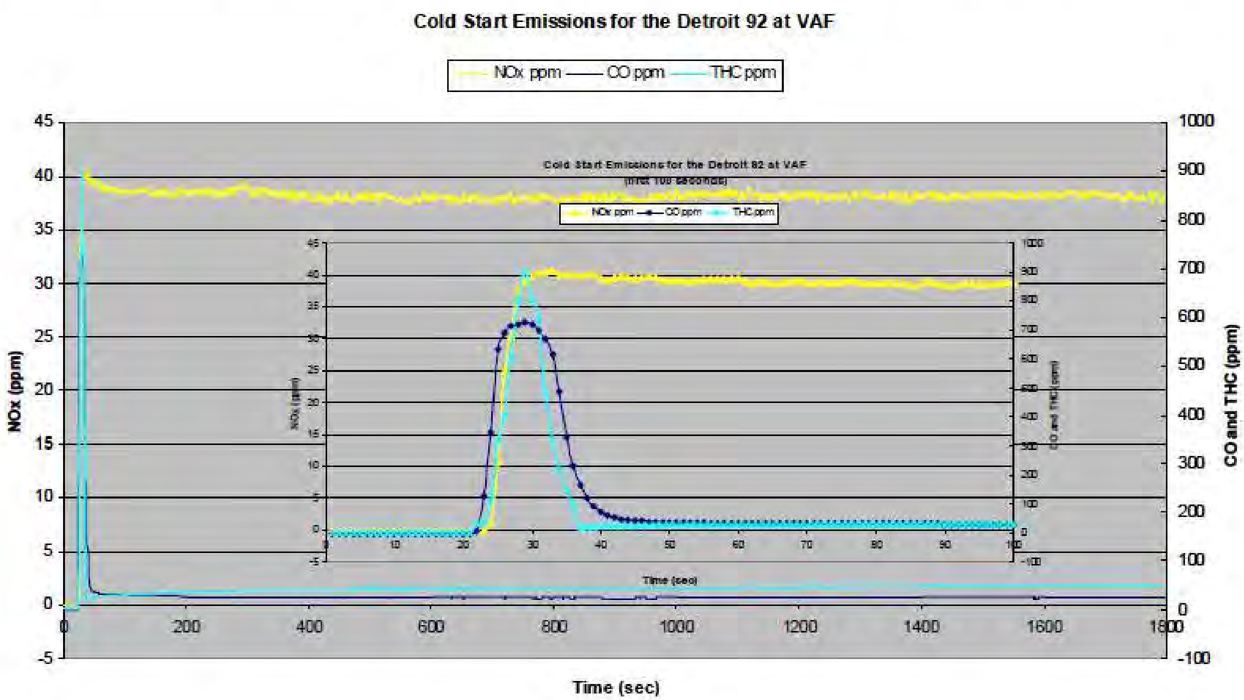


Figure 19. Cold-start emissions for CO and NO_X as a function of time

Table EC - 7b: Startup Emissions Summary - Nonroad Engines
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - Columbia Data Center
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)[3]			
	Nonroad Engine 1 (Each Engine)		Nonroad Engine 2 (Each Stack)	
	Warm Emissions	Cold-Start emissions	Warm Emissions	Cold-Start emissions
NO_X	0.51	8.97	1.76	19.47
CO	0.005	0.045	0.35	3.15
HC	0.04	0.17	0.12	0.51
DEEP/ $PM_{Filterable}$	0.04	0.17	0.085	0.36
PM_{10}/ $PM_{2.5}$	0.08	0.34	0.20	0.83
Ammonia Slip	0.072	—	0.125	—

Startup emission rates (for each engine or each stack)

Pollutant	Nonroad Engine 1 (Each Engine) - Hourly Emissions (lb/hr)[4]			Nonroad Engine 2 (Each Stack) - Hourly Emissions (lb/hr)[4]		
	Cold-Start (1-min) or Warm-up (15-min)	Warm (59 or 45 min)	Total (1 hr)	Cold-Start (1-min) or Warm-up (15-min)	Warm (59 or 45 min)	Total (1 hr)
NO_X	2.24	0.38	2.63	4.87	1.32	6.19
CO	0.00075	0.0049	0.0057	0.053	0.34	0.40
HC	0.0028	0.039	0.042	0.0085	0.12	0.13
DEEP/ $PM_{Filterable}$	0.0028	0.039	0.042	0.0060	0.084	0.090
PM_{10}/ $PM_{2.5}$	0.0057	0.079	0.084	0.014	0.19	0.21
Ammonia Slip	—	0.054	0.054	—	0.094	0.094

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 uncontrolled 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 or 15 minutes of warm-up emissions and 59 or 45 minutes of warm engine controlled emissions.

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.

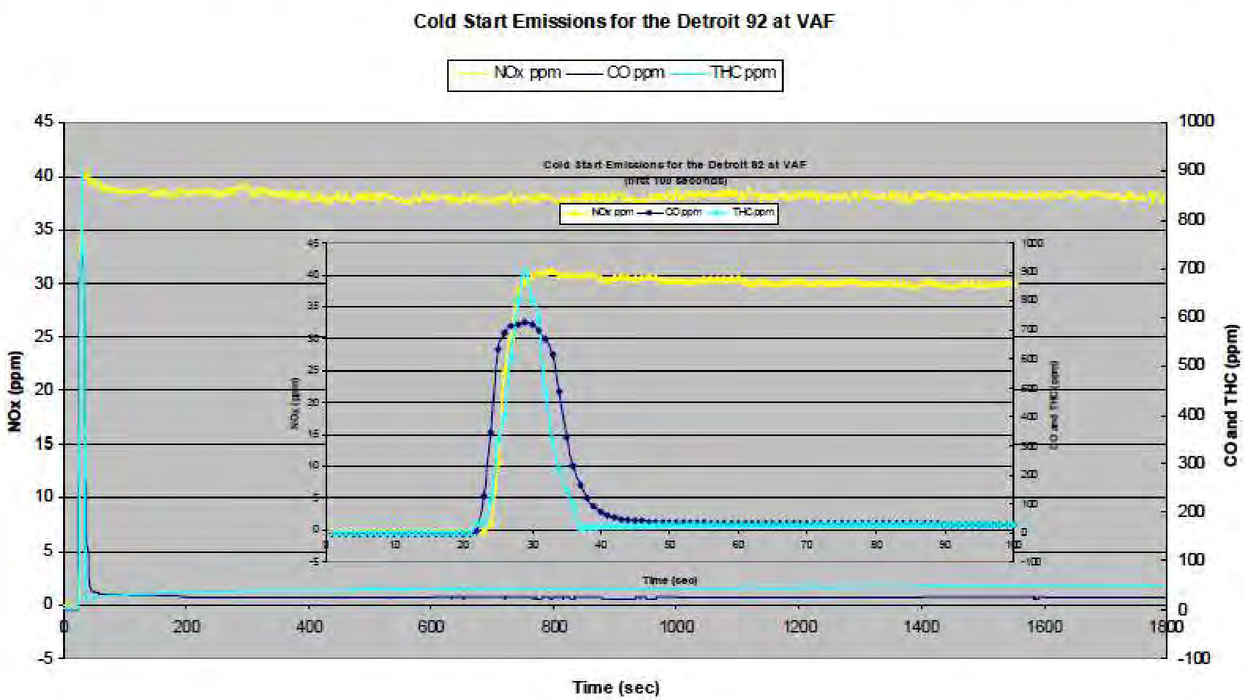


Figure 19. Cold-start emissions for CO and NO_X as a function of time

Table EC - 8: Ammonia Emissions Summary - Nonroad Engines
Emergency Generator Diesel Engine Emissions Calculations
NOC Modification - 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 Slip, ppm =	10	ppm
% O_2 value =	15	%O_2
Ammonia Emissions, 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

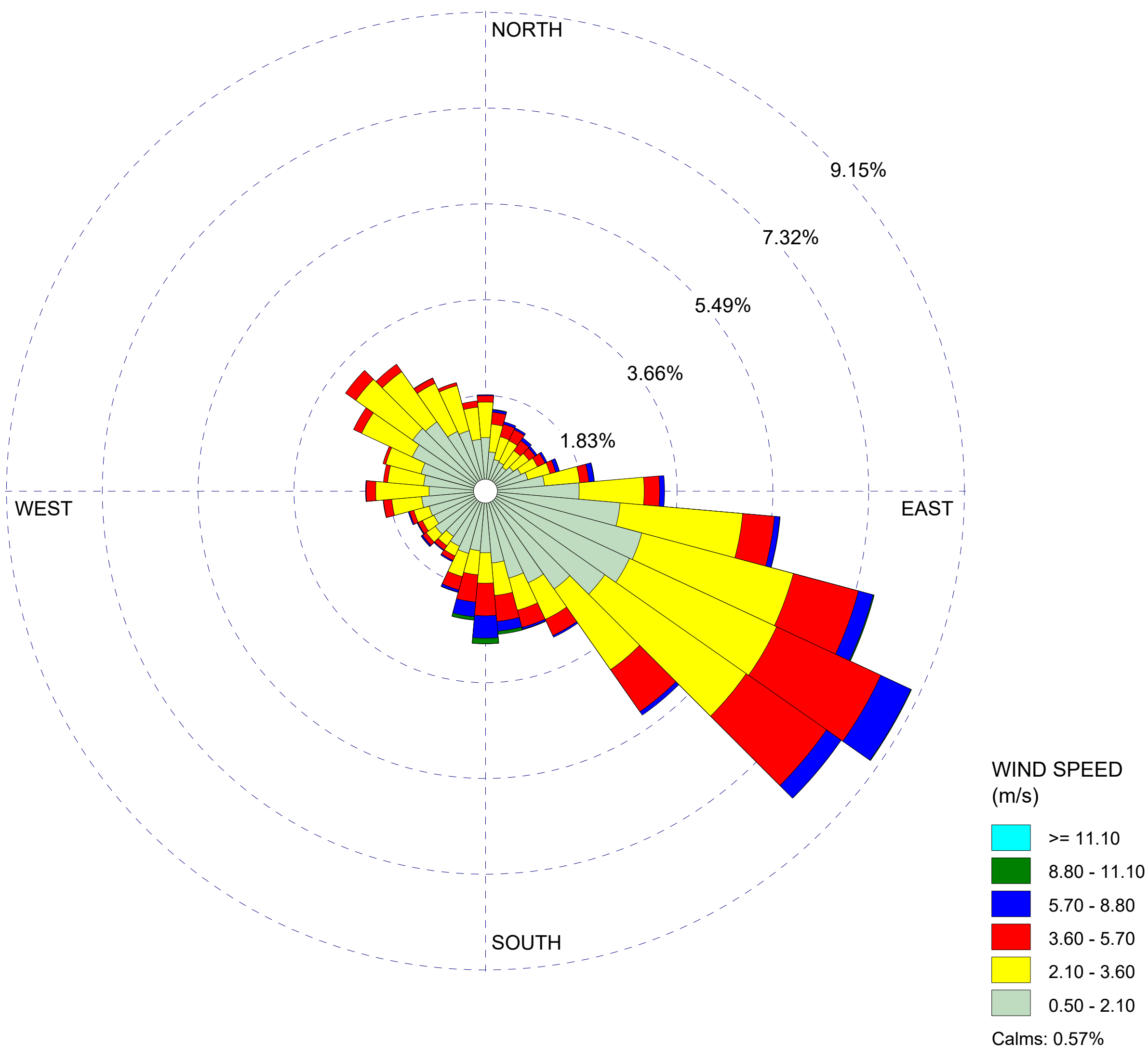
APPENDIX G – MODELING FIGURES

WIND ROSE PLOT:

Figure G-1: Wind Speed and Direction Frequency Distribution
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: **0.57%**	TOTAL COUNT: **26272 hrs.**	
	AVG. WIND SPEED: **2.38 m/s**	DATE: **5/12/2023**	PROJECT NO.:

Figure G-2: NO_2 1-hour Significance (3 years)

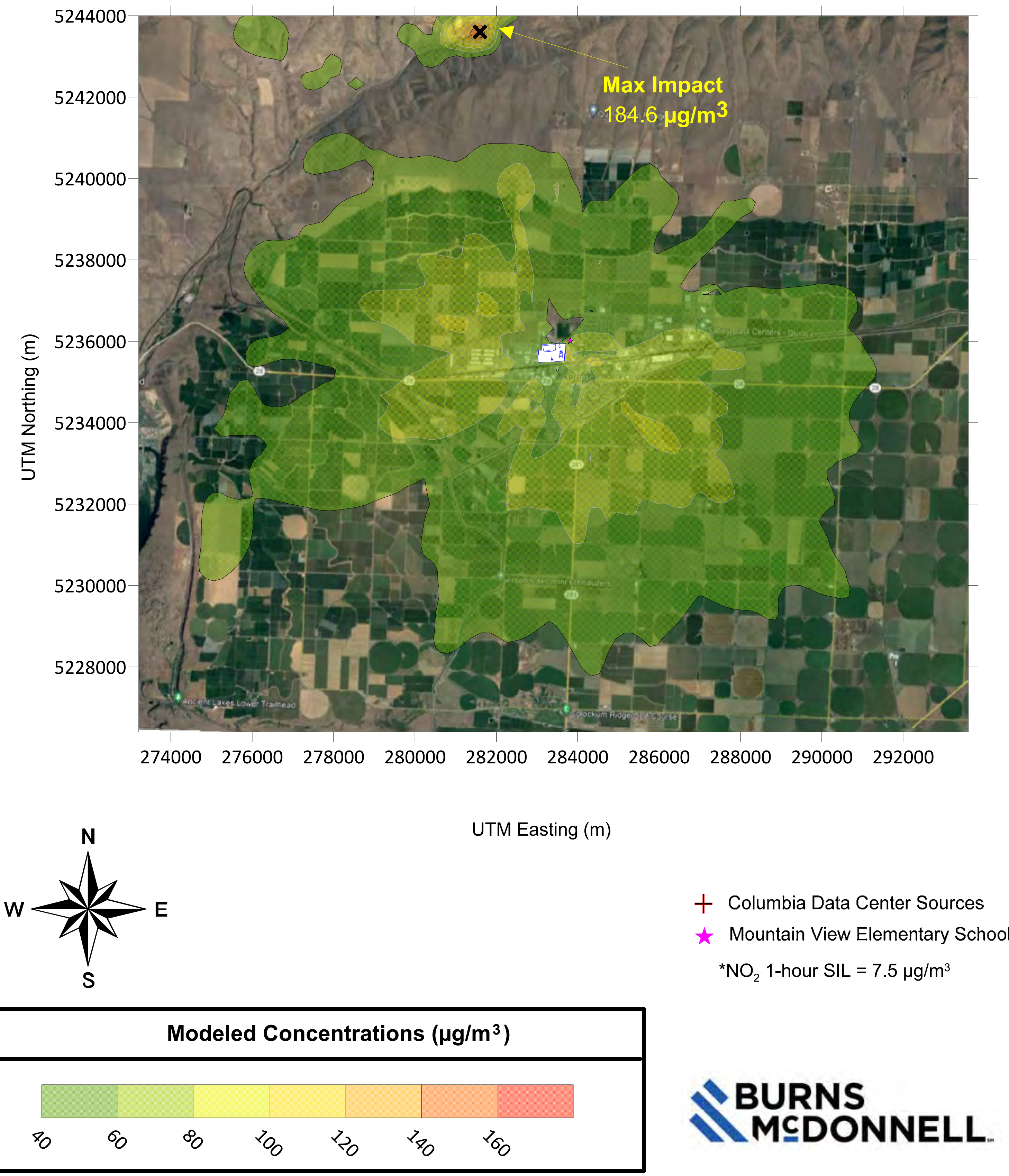


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Figure G-3: NO_2 Annual Significance (3 years)

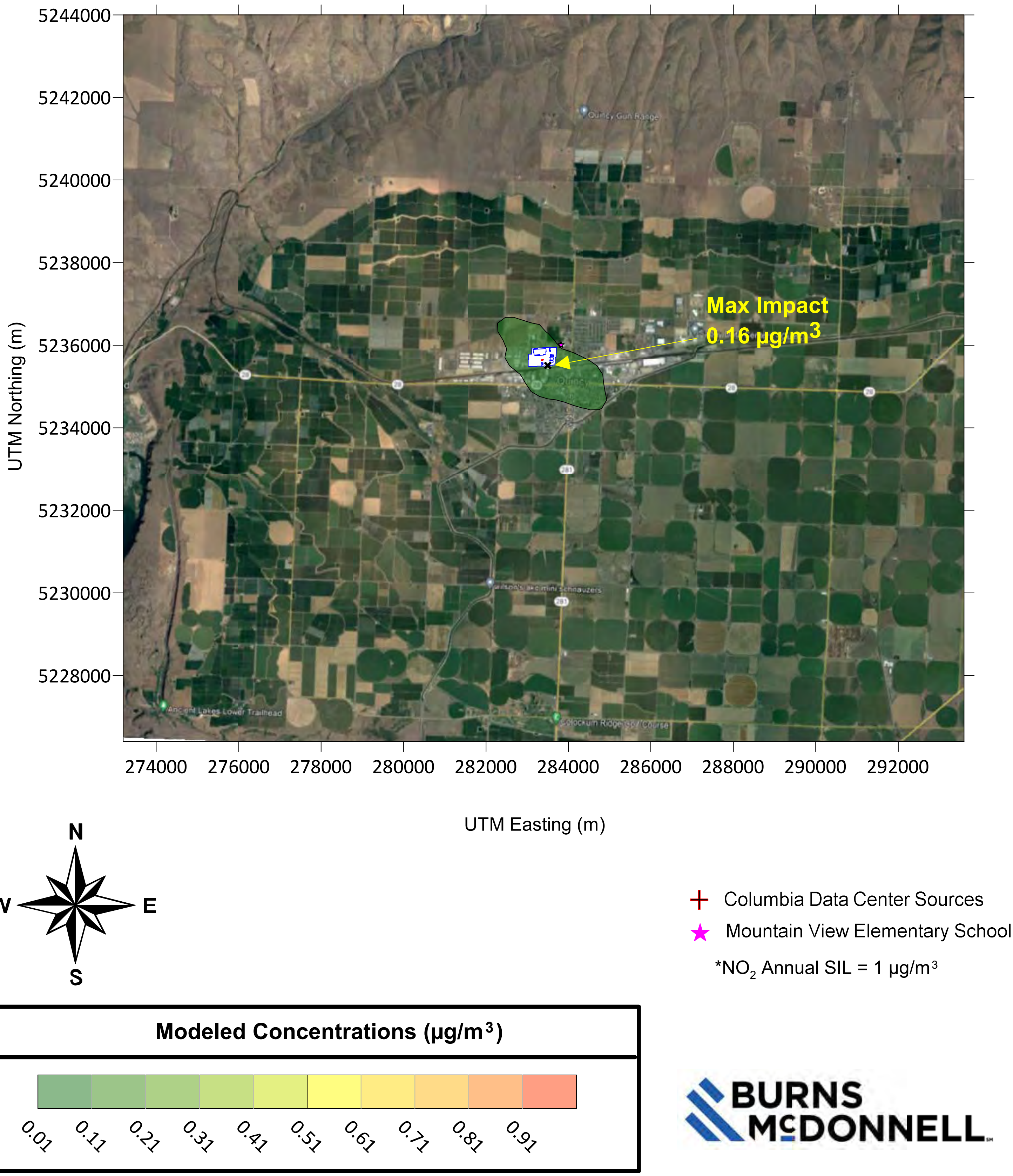

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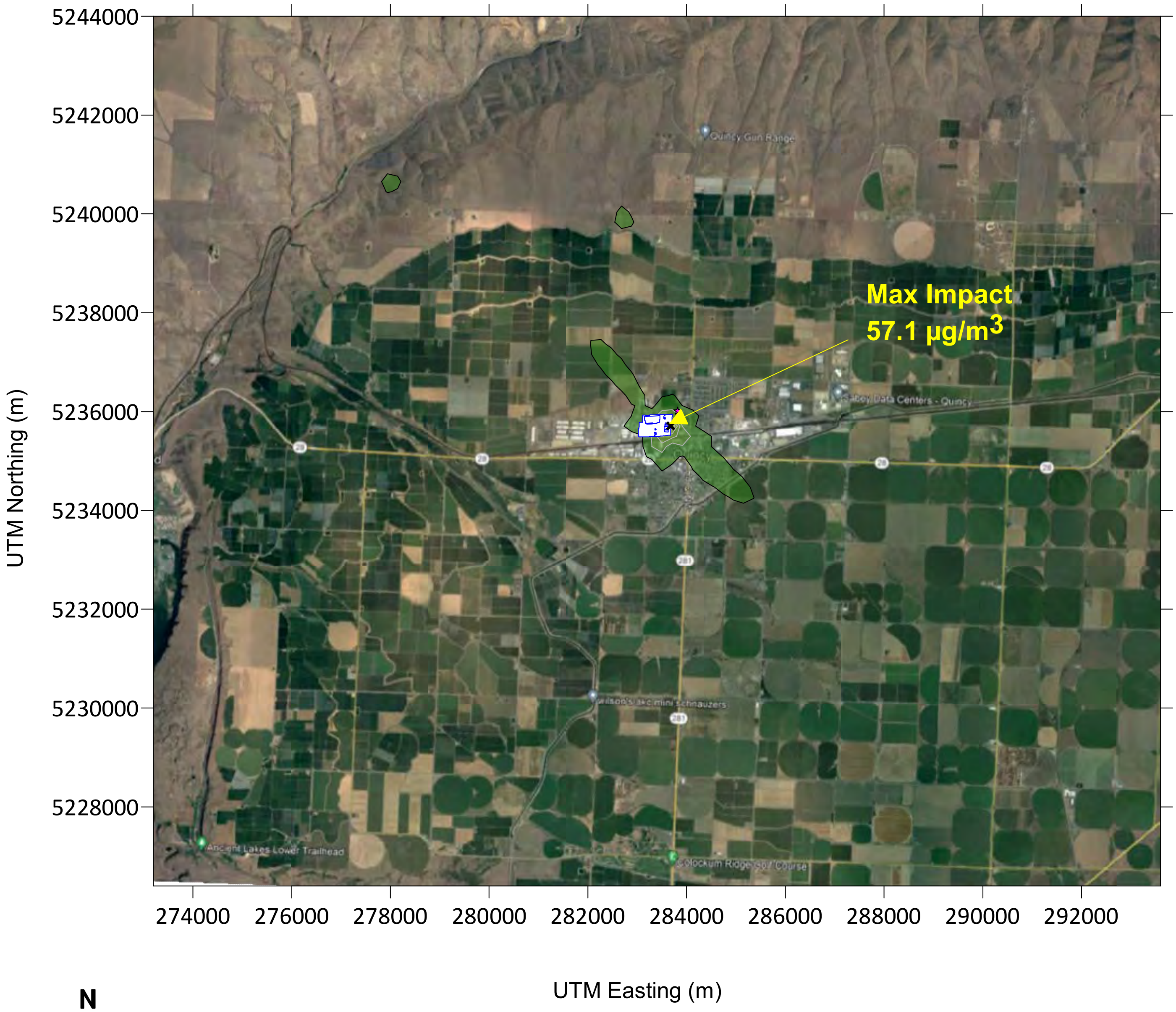
Figure G-4: CO 8-hour Significance (2019)



N
W E
S

+ Columbia Data Center Sources

★ Mountain View Elementary School

*CO 8-hour SIL = 500 µg/m³

Modeled Concentrations (µg/m³)

5 10 15 20 25 30 35 40 45 50 55 60 65 70

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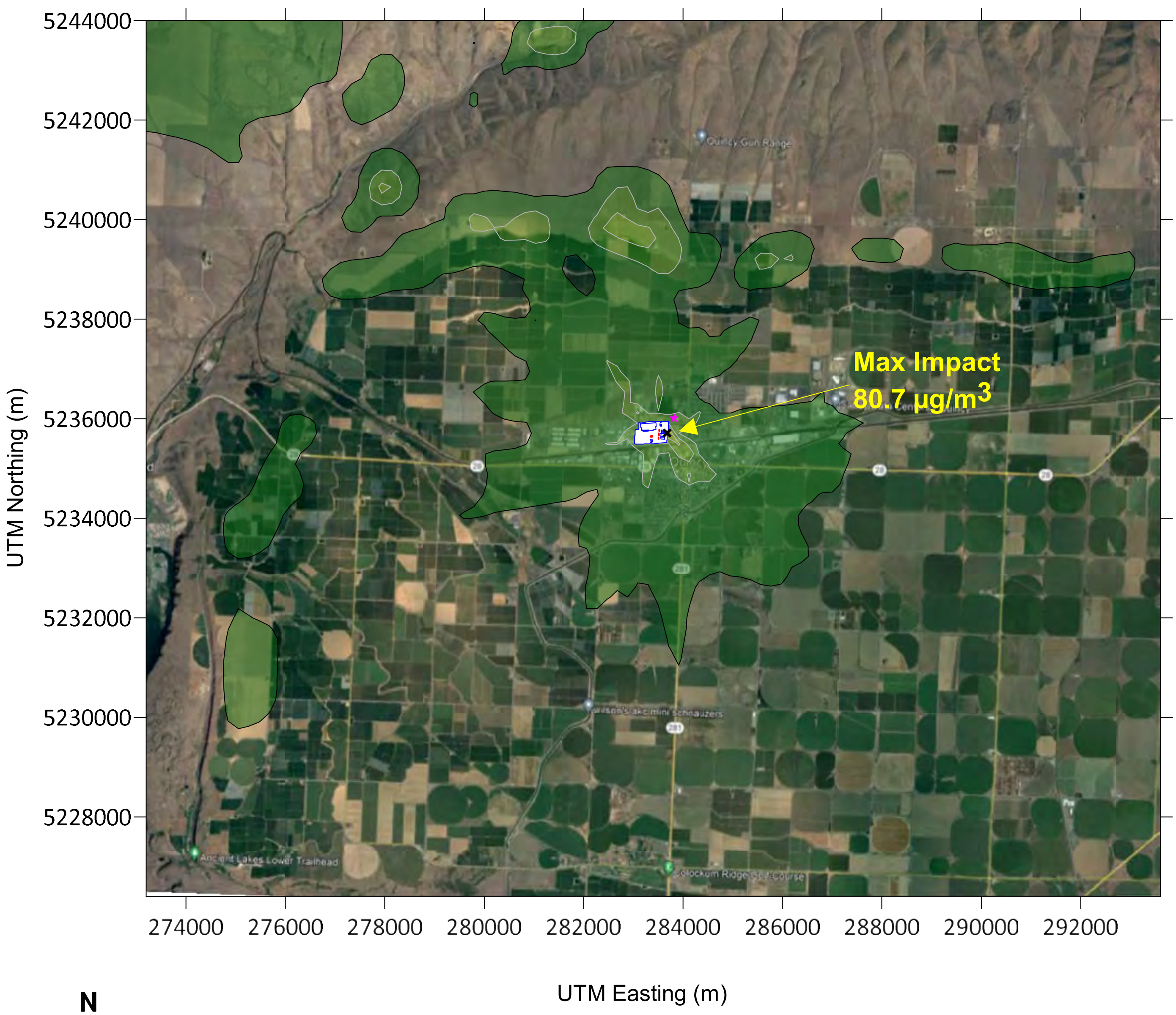
Figure G-5: CO 1-hour Significance (2018)



N
W E
S

+ Columbia Data Center Sources

★ Mountain View Elementary School

*CO 1-hour SIL = 2,000 µg/m³

Modeled Concentrations (µg/m³)

10 20 30 40 50 60 70 80 90 100

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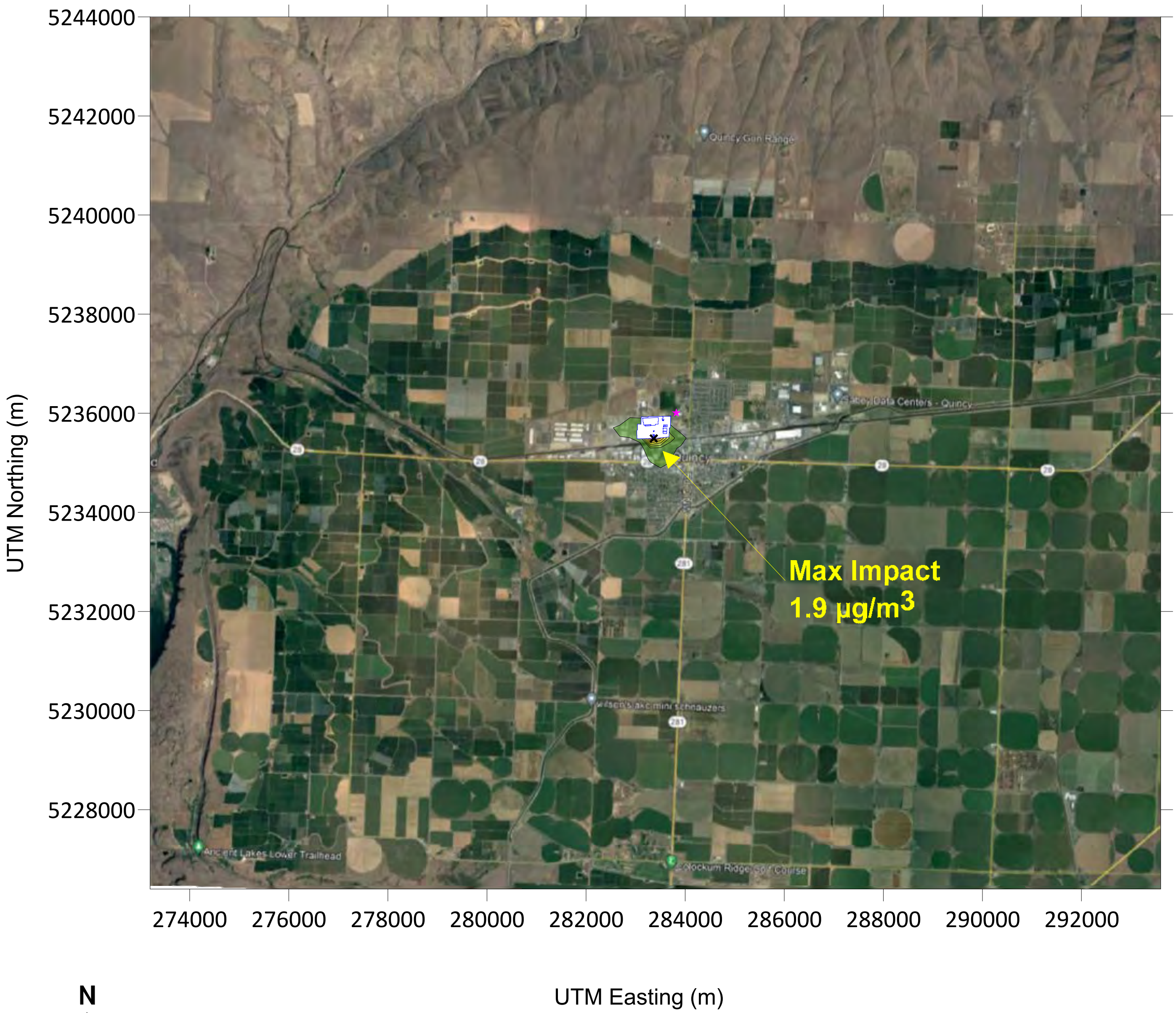
Figure G-6: PM_{10} 24-Hour Significance (2019)



Columbia Data Center Sources

Mountain View Elementary School

*PM_{10} 24-hour SIL = 5 µg/m³

Modeled Concentrations (µg/m³)

0.2 | 0.4 | 0.6 | 0.8 | 1 | 1.2 | 1.4 | 1.6 | 1.8 | 2

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Figure G-7: $PM_{2.5}$ 24-Hour Significance (3 Years)

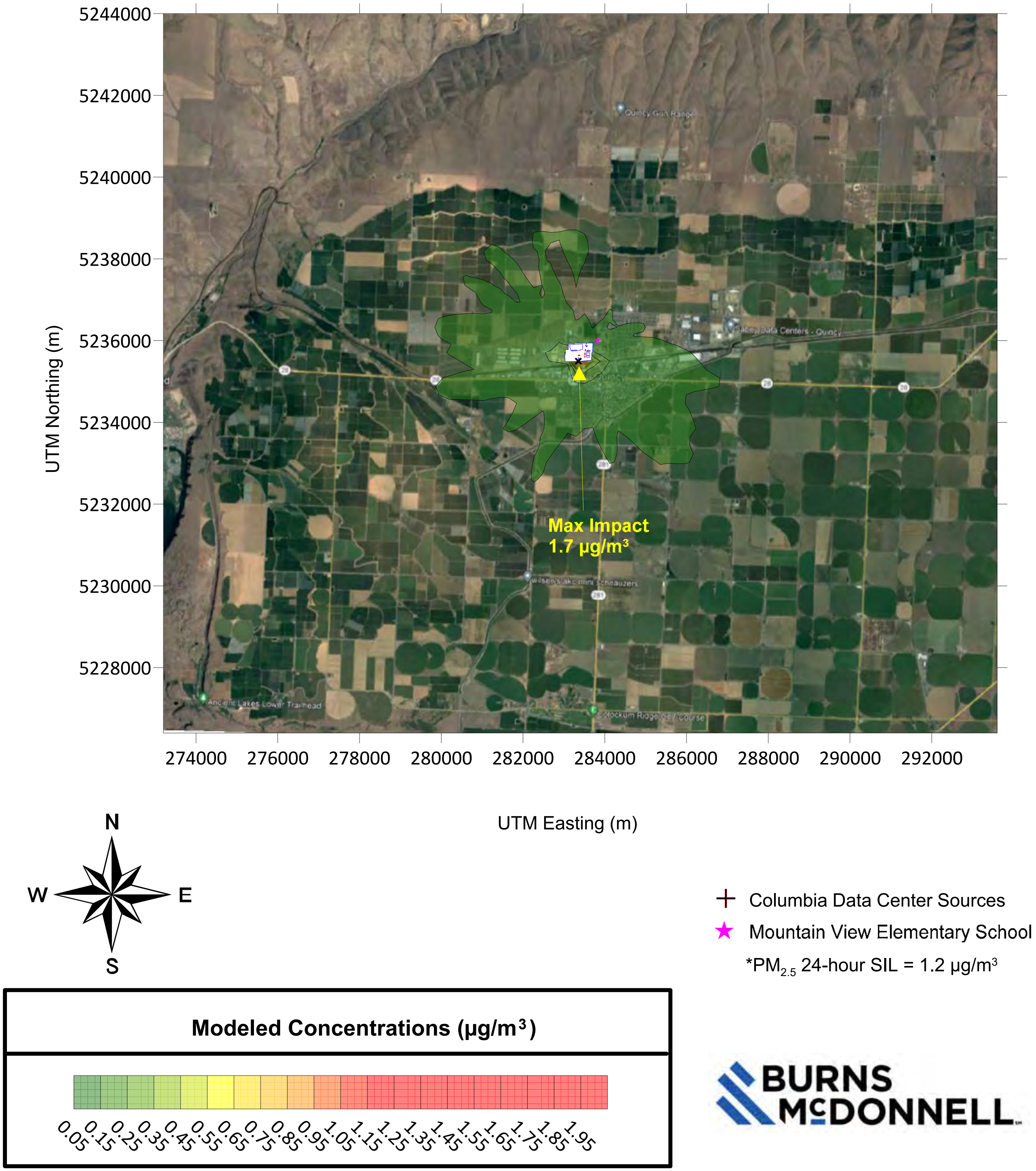
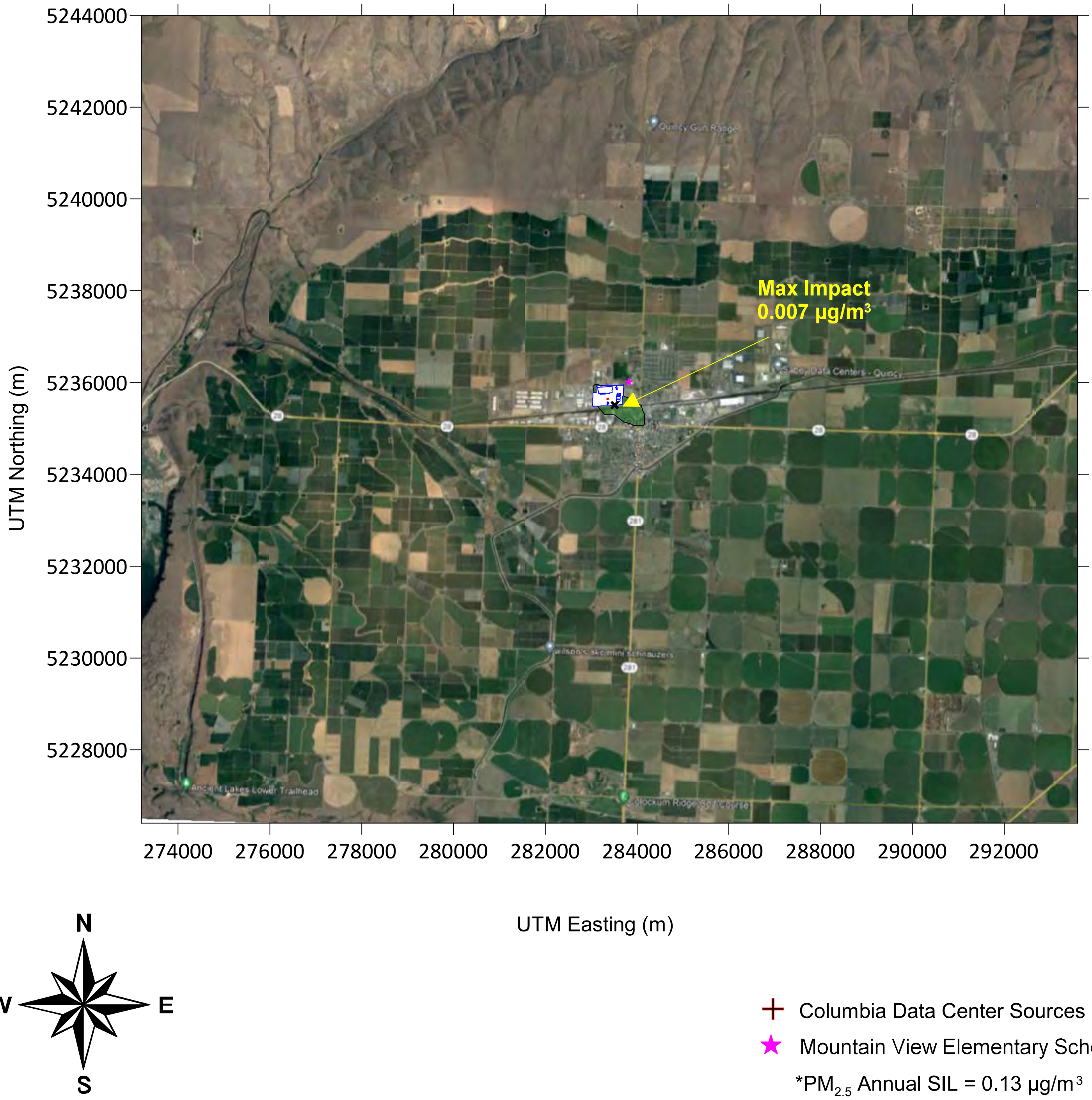


Figure G-8: $PM_{2.5}$ Annual Significance (3 Years)



Columbia Data Center Sources

Mountain View Elementary School

*$PM_{2.5}$ Annual SIL = 0.13 µg/m³

Modeled Concentrations (µg/m³)

0.001 0.011 0.021 0.031 0.041 0.051 0.061 0.071 0.081 0.091 0.101 0.111 0.121

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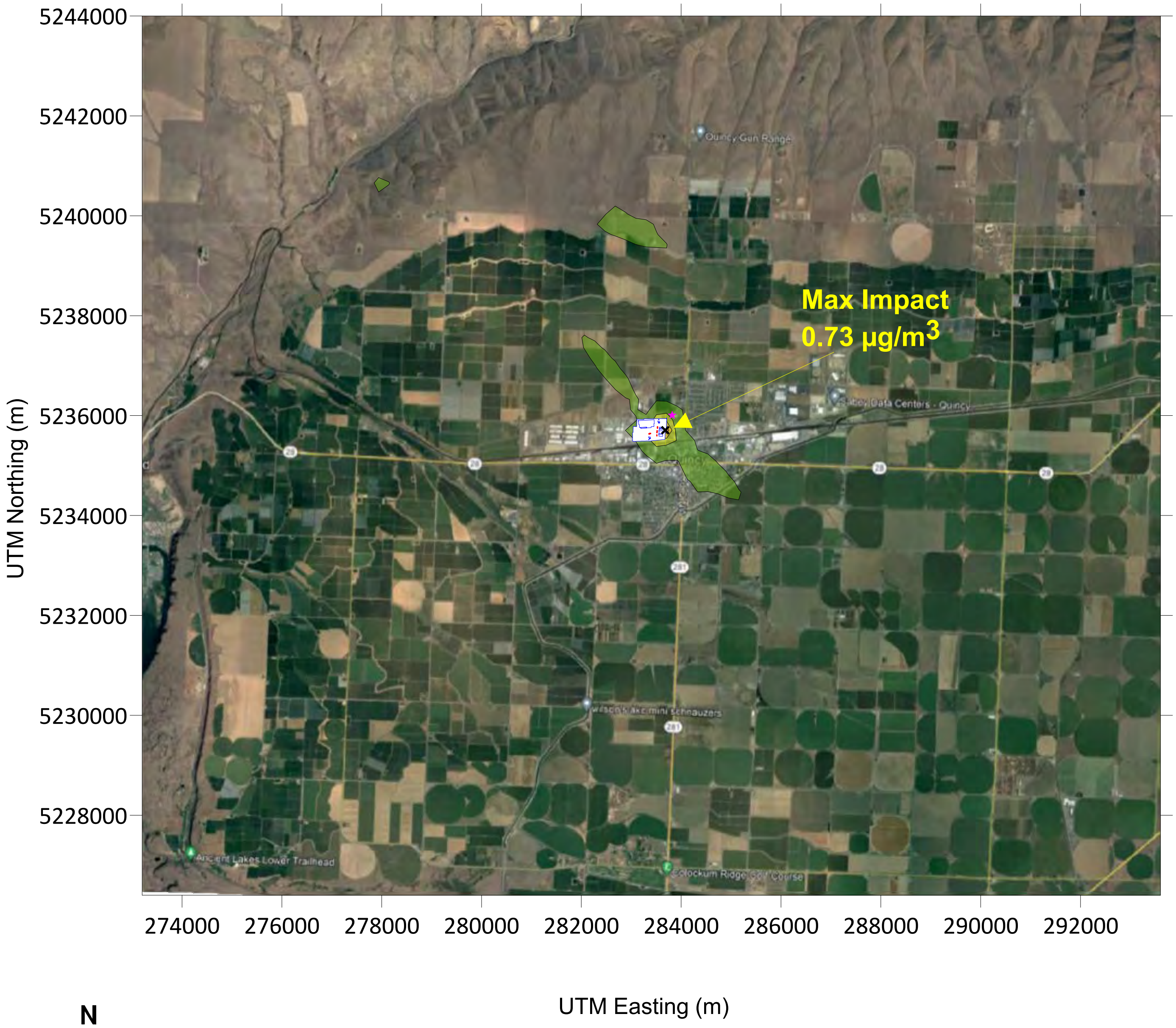
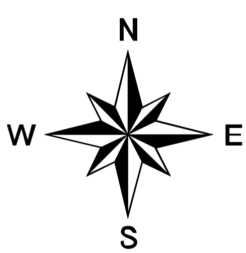
Figure G-9: SO_2 3-hour Significance (2019)





+ Columbia Data Center Sources

★ Mountain View Elementary School

*SO_2 3-hour SIL = 25 µg/m³

Modeled Concentrations (µg/m³)

0.1 | 0.2 | 0.3 | 0.4 | 0.5

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Figure G-10: SO_2 1-hour Significance (3 years)

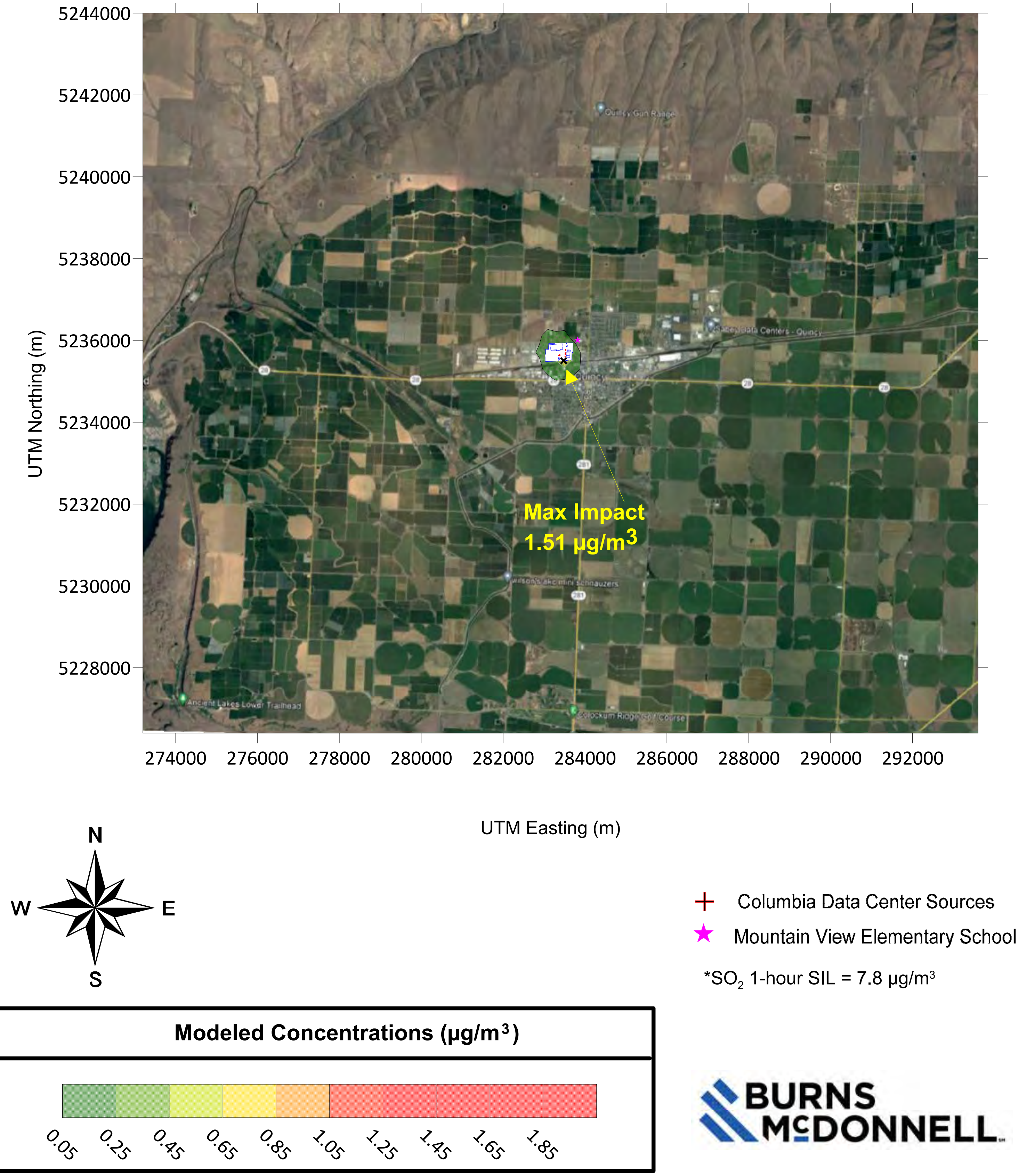
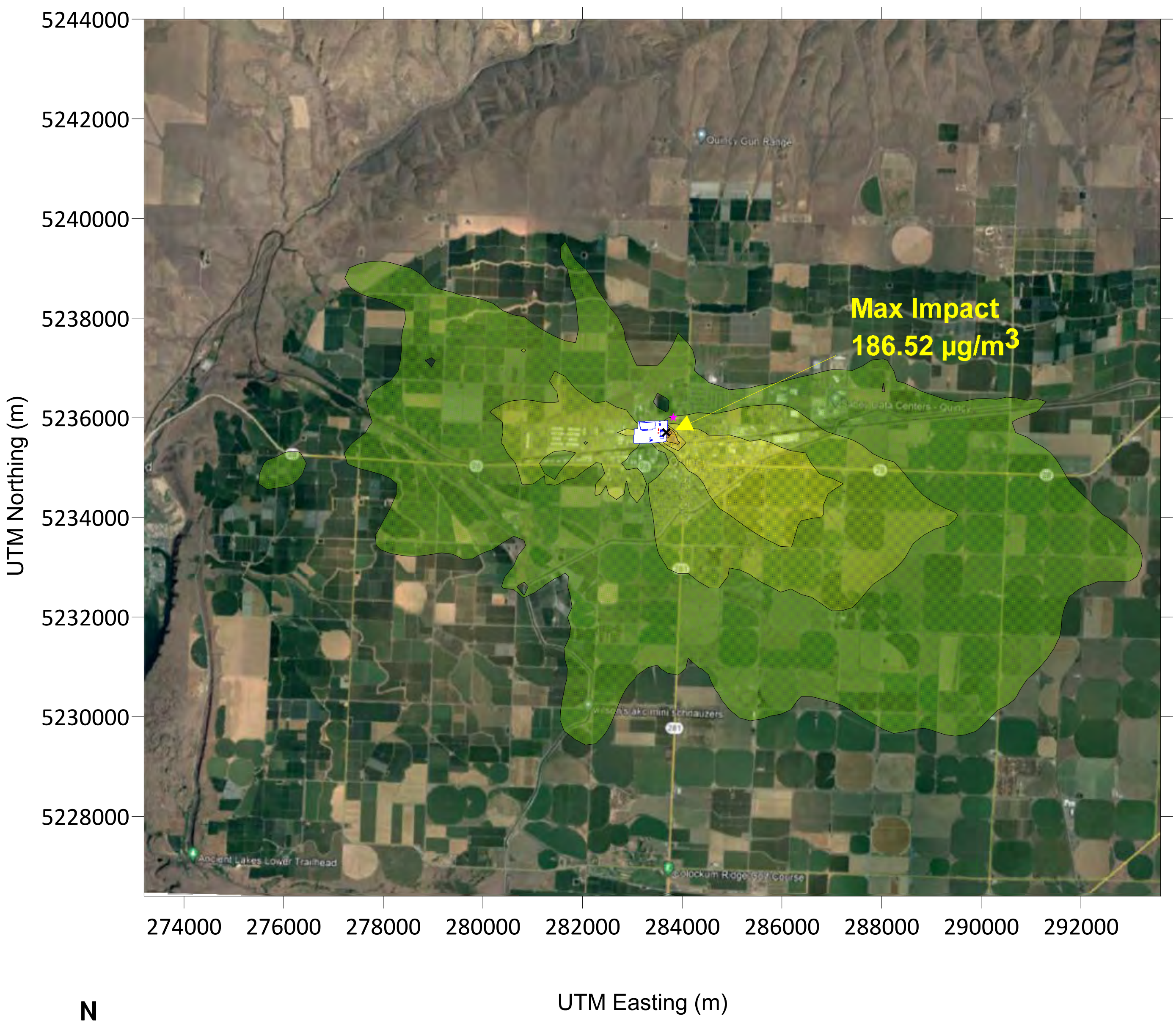


Figure G-11: NO_2 1-hour NAAQS (3 years)



Columbia Data Center Sources

Mountain View Elementary School

*Plot includes background concentration (58.75 µg/m³)

*NO_2 1-hour NAAQS = 188 µg/m³

Modeled Concentrations (µg/m³)

80 90 100 110 120 130 140 150 160 170 180 190 200

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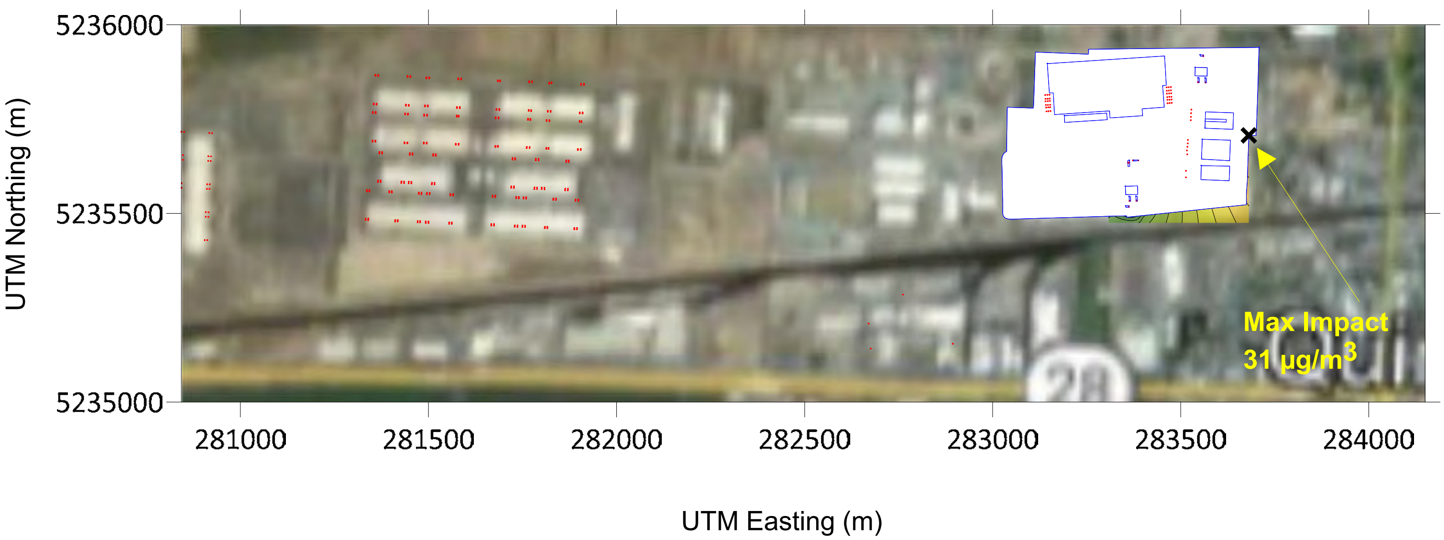
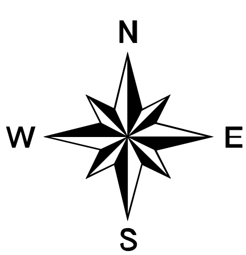
Figure G-12: $PM_{2.5}$ 24-Hour NAAQS (3 years)





Columbia Data Center and Inventory Sources

Mountain View Elementary School

*Plot includes background concentration (18.9 µg/m³)

*$PM_{2.5}$ 24-hour NAAQS = 35 µg/m³

Modeled Concentrations (µg/m³)

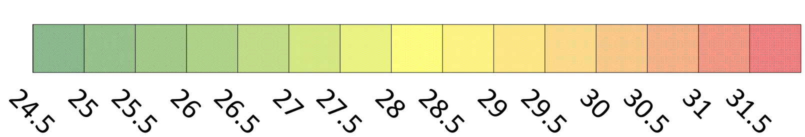


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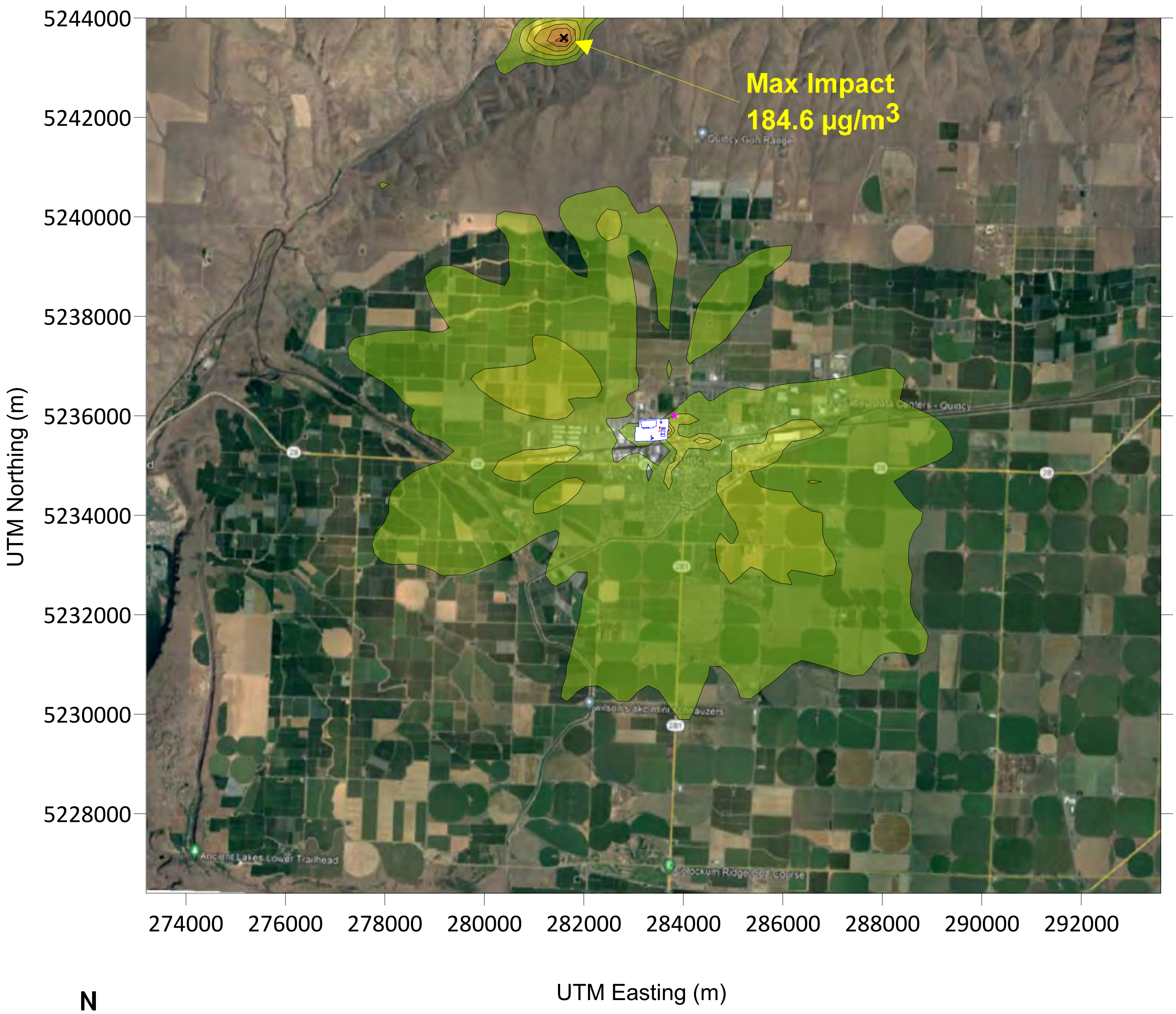
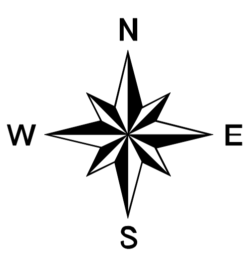
Figure G-13: NO_2 1-hour ASIL (3 years)





+ Columbia Data Center Sources

★ Mountain View Elementary School

*NO_2 1-hour ASIL = 470 µg/m³

Modeled Concentrations (µg/m³)

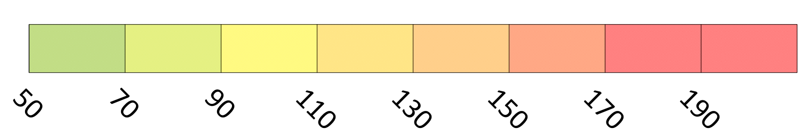


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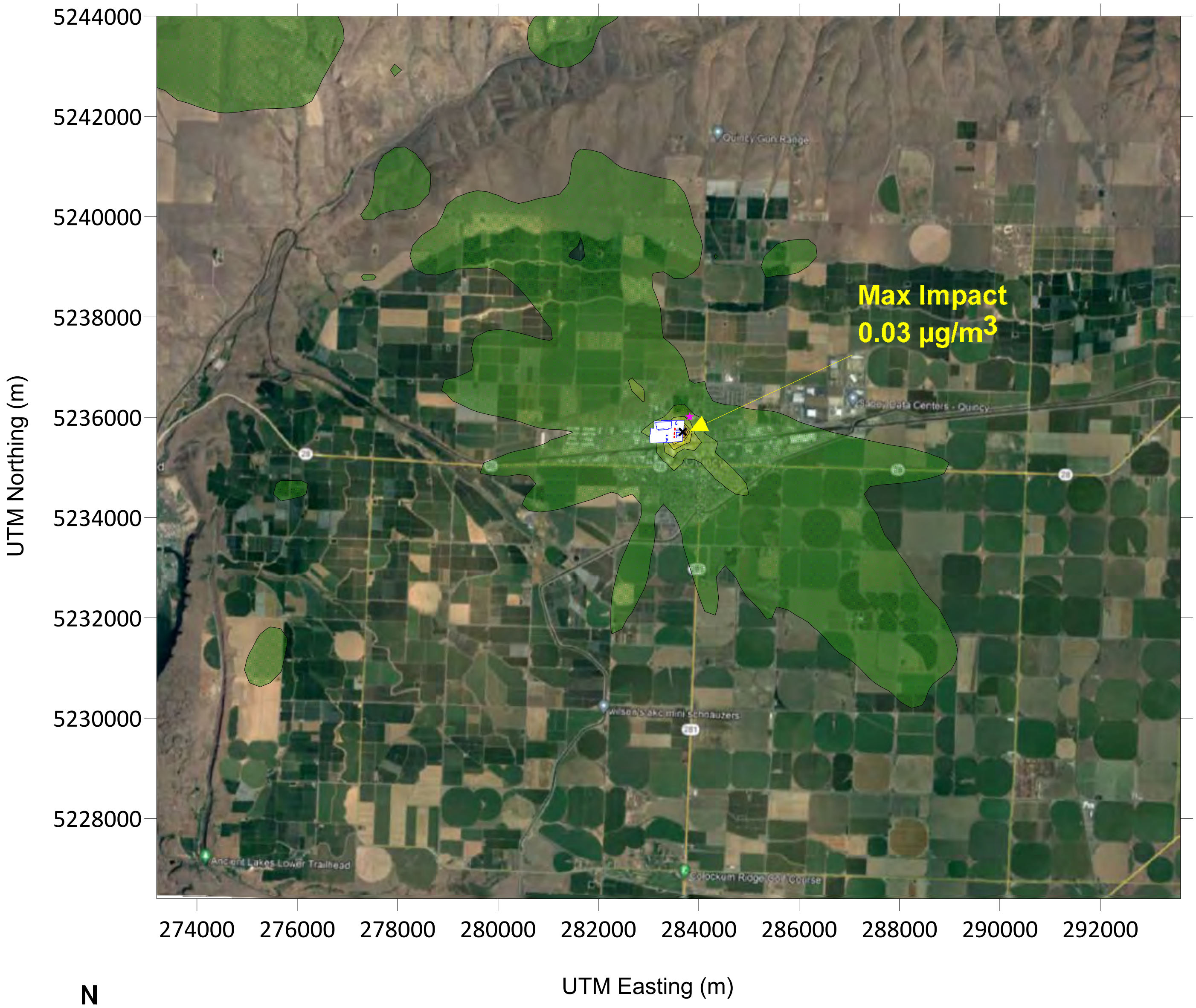
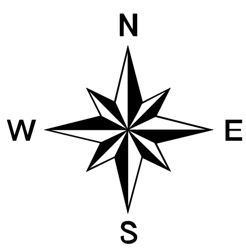
Figure G-14: Acrolein 24-hour ASIL (2019)





Columbia Data Center Sources

Mountain View Elementary School

*Acrolein 24-hour ASIL = 0.35 μg/m³

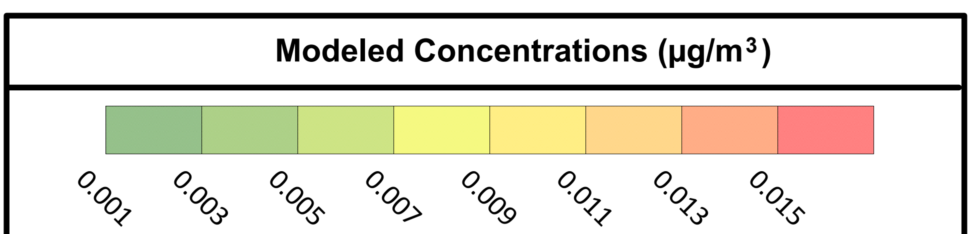


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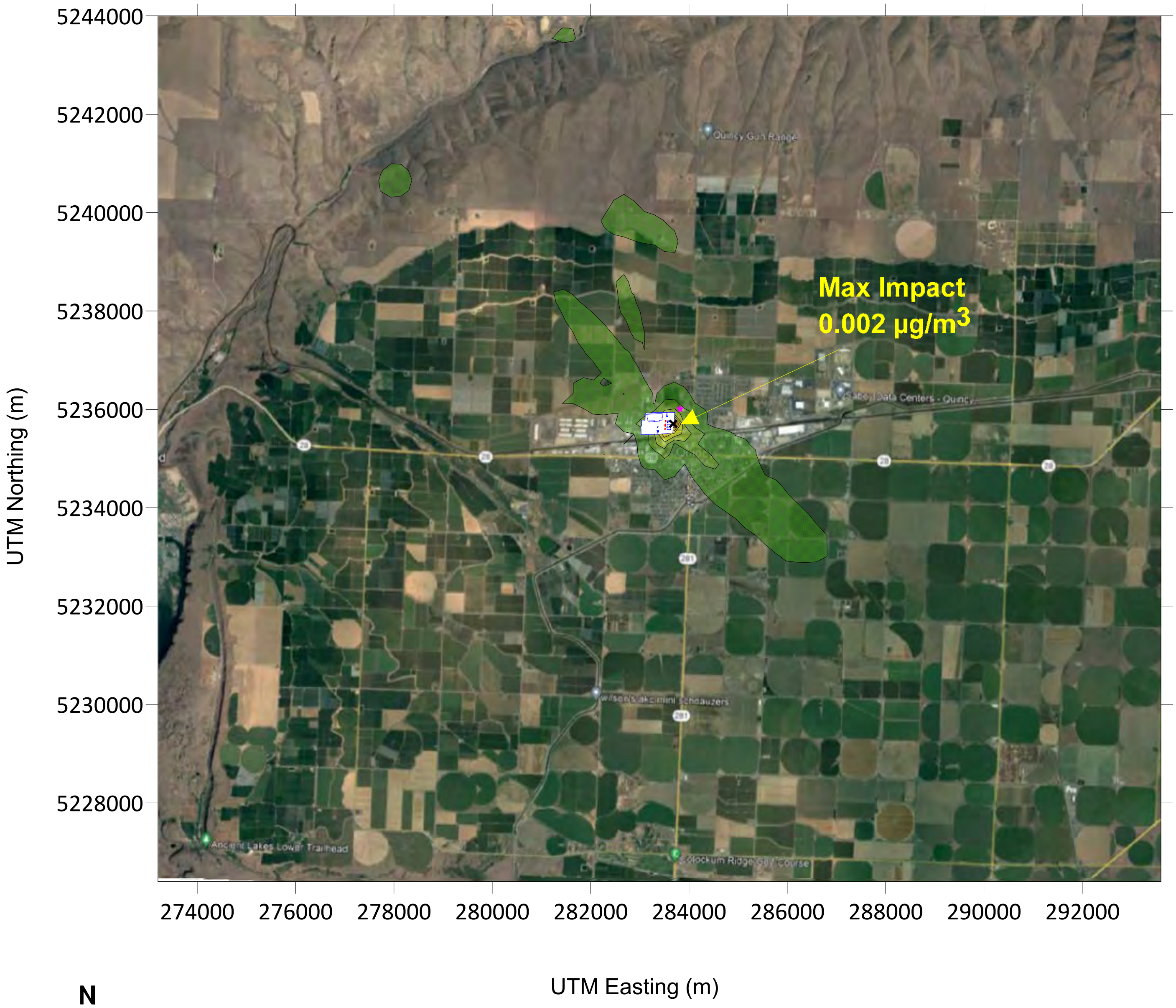
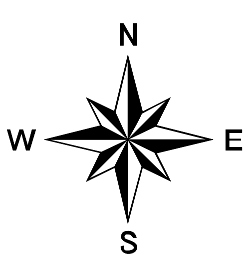
Figure G-15: Mercury 24-hour ASIL (2019)





+ Columbia Data Center Sources

★ Mountain View Elementary School

*Mercury 24-hour ASIL = 0.03 µg/m³

Modeled Concentrations (µg/m³)

0.0001 0.0002 0.0003 0.0004 0.0005 0.0006 0.0007 0.0008 0.0009

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APPENDIX H – EQUIPMENT INFORMATION

MANUFACTURER DATA, BUILDINGS
CO9 and CO3.2 EMERGENCY GENERATOR ENGINES

N C POWER SYSTEMS CAT

OPERATION AND MAINTENANCE MANUAL

CATERPILLAR 3516C STANDBY POWER PACKAGE
DIESEL ENGINE GENERATOR SETS
RATED 2500KW 13.2KV, 60 Hz,
AND ASSOCIATED EQUIPMENT

PREPARED FOR:

MICROSOFT INC
PO MP.11748-YY044394

PROJECT:

CO 3 DATA CENTER
QUINCY WA

COMPILED BY:

N C POWER SYSTEMS CO.
16711 WEST VALLEY HIGHWAY
TUKWILA, WA 98188
425-251-5877

NC PROJECT # 100213

JANUARY 28, 2011

NC

PERFORMANCE DATA [SBK00949]

JANUARY 28, 2011

(SBK00949)-ENGINE (G8D00117)-GENERATOR

For Help Desk Phone Numbers Click here

Perf No: DM8266 **Change Level: (**

General Heat Rejection Emissions Regulatory Altitude Derate Cross Reference General Notes Perf Param Re

View PDF

SALES MODEL:	3516C	**COMBUSTION:**	DI
ENGINE POWER (BHP):	3,634	**ENGINE SPEED (RPM):**	1,800
GEN POWER WITH FAN (EKW):	2,500.0	**HERTZ:**	60
COMPRESSION RATIO:	14.7	**FAN POWER (HP):**	130.1
APPLICATION:	PACKAGED GENSET	**ASPIRATION:**	TA
RATING LEVEL:	STANDBY	**AFTERCOOLER TYPE:**	ATAAC
PUMP QUANTITY:	2	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
FUEL TYPE:	DIESEL	**INLET MANIFOLD AIR TEMP (F):**	122
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (F):**	210.2
GOVERNOR TYPE:	ADEM3	**TURBO CONFIGURATION:**	PARALLEL
ELECTRONICS TYPE:	ADEM3	**TURBO QUANTITY:**	4
CAMSHAFT TYPE:	STANDARD	**TURBOCHARGER MODEL:**	GT6041BN-48T-1.
IGNITION TYPE:	CI	**CERTIFICATION YEAR:**	2006
INJECTOR TYPE:	EUI	**CRANKCASE BLOWBY RATE (FT3/HR):**	3,619.4
FUEL INJECTOR:	2501368	**FUEL RATE (RATED RPM) NO LOAD (GAL/HR):**	16.2
REF EXH STACK DIAMETER (IN):	12	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,539.4
MAX OPERATING ALTITUDE (FT):	2,953		

General Performance Data Top

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
2,500.0	100	3,633	336	0.334	173.5	78.1	121.9	1,235.6	67.6	915.2
2,250.0	90	3,283	303	0.335	157.1	71.3	119.4	1,190.0	61.3	881.2
2,000.0	80	2,935	271	0.339	142.3	64.3	116.9	1,158.9	55.3	864.0
1,875.0	75	2,760	255	0.342	134.9	60.7	115.8	1,145.6	52.3	858.5
1,750.0	70	2,586	239	0.346	127.6	57.0	114.7	1,133.3	49.3	854.6
1,500.0	60	2,237	207	0.354	113.0	49.5	112.7	1,112.4	43.2	851.2
1,250.0	50	1,889	174	0.365	98.4	41.3	111.0	1,091.8	36.8	850.7
1,000.0	40	1,547	143	0.373	82.5	31.4	109.4	1,061.5	29.3	856.6
750.0	30	1,203	111	0.385	66.2	21.7	107.9	1,010.3	22.1	848.2
625.0	25	1,029	95	0.394	57.9	17.2	107.2	968.3	18.7	831.1
500.0	20	854	79	0.403	49.2	12.7	106.4	902.0	15.5	796.1
250.0	10	497	46	0.441	31.3	4.8	104.1	700.7	9.8	647.3

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	WET INLET AIR MASS FLOW	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98	DRY EXH VOL FLOV RATE (32 DEG F AND 29.9

						RATE	RATE		IN HG)	IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
2,500.0	100	3,633	85	466.7	7,212.2	19,578.8	32,046.3	33,260.4	7,001.7	6,362.4
2,250.0	90	3,283	78	443.0	6,831.8	17,980.7	30,219.3	31,318.8	6,593.0	6,013.7
2,000.0	80	2,935	70	417.8	6,404.5	16,560.6	28,284.6	29,277.2	6,151.5	5,625.4
1,875.0	75	2,760	66	404.7	6,173.3	15,893.2	27,261.3	28,202.4	5,928.1	5,427.1
1,750.0	70	2,586	63	391.2	5,929.9	15,232.6	26,196.0	27,086.8	5,698.4	5,222.0
1,500.0	60	2,237	55	363.5	5,411.9	13,879.0	23,947.5	24,739.5	5,205.5	4,779.1
1,250.0	50	1,889	46	334.6	4,843.3	12,413.0	21,444.3	22,133.2	4,657.5	4,283.2
1,000.0	40	1,547	36	297.5	4,121.4	10,609.5	18,262.0	18,840.0	3,963.0	3,647.2
750.0	30	1,203	25	249.8	3,423.0	8,763.8	15,175.3	15,640.3	3,294.6	3,037.8
625.0	25	1,029	21	223.4	3,104.6	7,844.6	13,765.1	14,171.8	2,988.1	2,760.8
500.0	20	854	16	197.2	2,791.2	6,823.5	12,376.2	12,722.2	2,671.7	2,476.1
250.0	10	497	7	152.3	2,237.9	4,800.2	9,917.6	10,136.8	2,132.0	1,999.8

Heat Rejection Data Top

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHUAST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HI HE VA EN
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU
2,500.0	100	3,633	46,992	9,146	142,265	79,907	19,835	44,723	154,077	372,403	396
2,250.0	90	3,283	44,242	8,557	127,929	70,449	17,960	39,380	139,243	337,204	359
2,000.0	80	2,935	41,477	8,162	116,879	63,561	16,262	34,167	124,444	305,311	325
1,875.0	75	2,760	40,076	8,007	111,588	60,518	15,425	31,612	117,053	289,608	308
1,750.0	70	2,586	38,657	7,874	106,293	57,637	14,588	29,085	109,651	273,881	291
1,500.0	60	2,237	35,755	7,684	95,729	52,220	12,915	24,201	94,874	242,485	258
1,250.0	50	1,889	32,626	7,527	85,184	46,626	11,245	19,401	80,109	211,118	224
1,000.0	40	1,547	29,235	7,262	72,693	40,153	9,427	13,873	65,583	176,995	188
750.0	30	1,203	25,476	6,784	59,425	32,726	7,565	8,706	51,005	142,037	151
625.0	25	1,029	23,394	6,435	52,542	28,568	6,621	6,496	43,653	124,317	132
500.0	20	854	21,006	5,995	44,739	23,683	5,624	4,534	36,223	105,594	112
250.0	10	497	15,737	5,026	27,795	12,371	3,578	1,916	21,071	67,181	71,

Emissions Data Top

Units Filter All Units

RATED SPEED NOT TO EXCEED DATA: 1800 RPM

GENSET POWER WITH FAN ENGINE POWER		EKW BHP	2,500.0 3,633	1,875.0 2,760	1,250.0 1,889	625.0 1,029	250.0 497
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
TOTAL NOX (AS NO2)		G/HR	22,948	14,101	7,004	3,568	3,185
TOTAL CO		G/HR	2,726	1,304	1,092	1,496	2,098
TOTAL HC		G/HR	500	499	543	408	437
PART MATTER		G/HR	185.5	123.7	132.1	139.5	141.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,818.9	2,229.5	1,544.3	1,352.7	2,230.2
TOTAL CO	(CORR 5% O2)	MG/NM3	351.8	213.9	252.3	594.6	1,552.7
TOTAL HC	(CORR 5% O2)	MG/NM3	55.9	72.8	108.8	140.7	282.4
PART MATTER	(CORR 5% O2)	MG/NM3	19.7	16.5	25.8	48.5	88.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,373	1,086	752	659	1,086
TOTAL CO	(CORR 5% O2)	PPM	281	171	202	476	1,242
TOTAL HC	(CORR 5% O2)	PPM	104	136	203	263	527
TOTAL NOX (AS NO2)		G/HP-HR	6.38	5.15	3.74	3.50	6.47
TOTAL CO		G/HP-HR	0.76	0.48	0.58	1.47	4.26
TOTAL HC		G/HP-HR	0.14	0.18	0.29	0.40	0.89
PART MATTER		G/HP-HR	0.05	0.05	0.07	0.14	0.29
TOTAL NOX (AS NO2)		LB/HR	50.59	31.09	15.44	7.87	7.02

TOTAL CO		LB/HR	6.01	2.88	2.41	3.30	4.62
TOTAL HC		LB/HR	1.10	1.10	1.20	0.90	0.96
PART MATTER		LB/HR	0.41	0.27	0.29	0.31	0.31

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN **ENGINE POWER**		**EKW** **BHP**	**2,500.0** **3,633**	**1,875.0** **2,760**	**1,250.0** **1,889**	**625.0** **1,029**	**250.0** **497**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
TOTAL NOX (AS NO2)		G/HR	19,123	11,751	5,837	2,974	2,654
TOTAL CO		G/HR	1,515	725	607	831	1,165
TOTAL HC		G/HR	376	375	408	307	329
TOTAL CO2		KG/HR	1,740	1,340	966	559	296
PART MATTER		G/HR	132.5	88.4	94.3	99.6	100.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,349.1	1,857.9	1,286.9	1,127.3	1,858.5
TOTAL CO	(CORR 5% O2)	MG/NM3	195.4	118.8	140.1	330.3	862.6
TOTAL HC	(CORR 5% O2)	MG/NM3	42.1	54.8	81.8	105.8	212.3
PART MATTER	(CORR 5% O2)	MG/NM3	14.1	11.8	18.4	34.7	63.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,144	905	627	549	905
TOTAL CO	(CORR 5% O2)	PPM	156	95	112	264	690
TOTAL HC	(CORR 5% O2)	PPM	79	102	153	197	396
TOTAL NOX (AS NO2)		G/HP-HR	5.32	4.30	3.12	2.92	5.39
TOTAL CO		G/HP-HR	0.42	0.26	0.32	0.82	2.37
TOTAL HC		G/HP-HR	0.10	0.14	0.22	0.30	0.67
PART MATTER		G/HP-HR	0.04	0.03	0.05	0.10	0.20
TOTAL NOX (AS NO2)		LB/HR	42.16	25.91	12.87	6.56	5.85
TOTAL CO		LB/HR	3.34	1.60	1.34	1.83	2.57
TOTAL HC		LB/HR	0.83	0.83	0.90	0.68	0.72
TOTAL CO2		LB/HR	3,836	2,955	2,130	1,233	654
PART MATTER		LB/HR	0.29	0.19	0.21	0.22	0.22
OXYGEN IN EXH		%	9.4	10.4	11.3	12.2	14.4
DRY SMOKE OPACITY		%	1.7	1.4	1.9	2.5	3.8
BOSCH SMOKE NUMBER			0.58	0.49	0.62	0.92	1.27

Regulatory Information Top

EPA TIER 2 **2006 - 2010**

GASEOUS EMISSIONS DATA MEASUREMENTS ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 89 SUBPART D AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. GASEOUS EMISSIONS VALUES ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIAN WITH THE NON-ROAD REGULATIONS.

Locality	Agency	Regulation	Tier/Stage	Max Limits - G/BKW - HR
U.S. (INCL CALIF)	EPA	NON-ROAD	TIER 2	CO: 3.5 NOx + HC: 6.4 PM: 0.20

EPA EMERGENCY STATIONARY **2011 - ----**

GASEOUS EMISSIONS DATA MEASUREMENTS ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. GASEOUS EMISSIONS VALUES ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIAN WITH THE NON-ROAD 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 Top

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	50	60	70	80	90	100	110	120	130	NORMAL
ALTITUDE (FT)										
0	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,634
1,000	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,625	3,563	3,634
2,000	3,634	3,634	3,634	3,634	3,634	3,614	3,551	3,490	3,430	3,634
3,000	3,634	3,634	3,634	3,607	3,542	3,478	3,417	3,358	3,301	3,634
4,000	3,634	3,604	3,536	3,470	3,407	3,346	3,288	3,231	3,176	3,574
5,000	3,534	3,466	3,401	3,338	3,277	3,218	3,162	3,107	3,055	3,461
6,000	3,398	3,332	3,270	3,209	3,151	3,094	3,040	2,987	2,937	3,351
7,000	3,266	3,203	3,142	3,084	3,028	2,974	2,922	2,871	2,823	3,243
8,000	3,137	3,077	3,019	2,963	2,909	2,857	2,807	2,758	2,712	3,137
9,000	3,013	2,955	2,899	2,845	2,794	2,744	2,696	2,649	2,604	3,034
10,000	2,892	2,837	2,783	2,732	2,682	2,634	2,588	2,543	2,500	2,933
11,000	2,776	2,722	2,671	2,621	2,574	2,528	2,483	2,441	2,399	2,835
12,000	2,663	2,611	2,562	2,515	2,469	2,425	2,382	2,341	2,301	2,739
13,000	2,553	2,504	2,457	2,411	2,367	2,325	2,284	2,245	2,207	2,645
14,000	2,447	2,400	2,354	2,311	2,269	2,228	2,189	2,151	2,115	2,554
15,000	2,344	2,299	2,256	2,214	2,174	2,135	2,097	2,061	2,026	2,465

Cross Reference Top

Engine Arrangement

Arrangement Number	Effective Serial Number	Engineering Model	Engineering Model Version
2666136	SBK00001	GS336	-

Test Specification Data

Test Spec	Setting	Effective Serial Number	Engine Arrangement	Governor Type	Default Low Idle Speed	Default High Idle Speed
0K7009	LL5718	SBK00001	2666136	ADEM3		

General Notes Top

DM8266 - 04

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

Performance Parameter Reference Top

Parameters Reference: DM9600 - 02

PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600

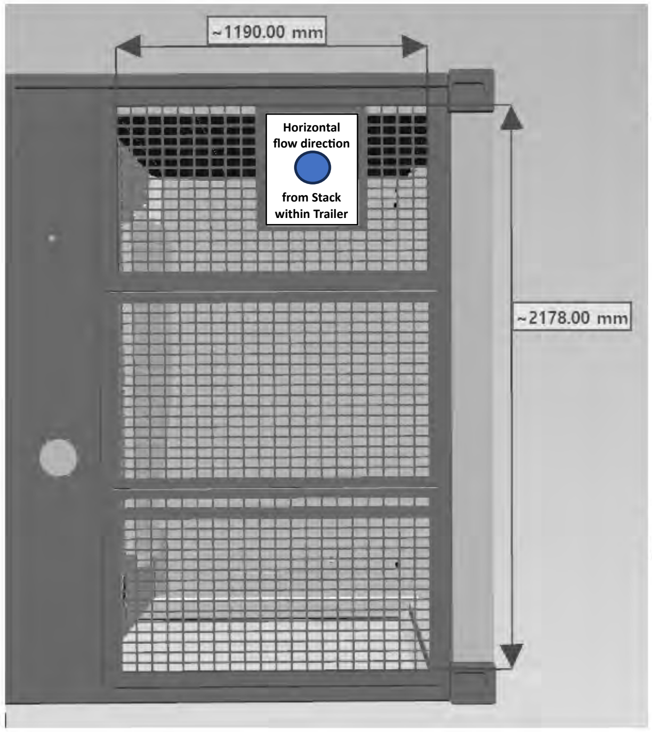
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure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

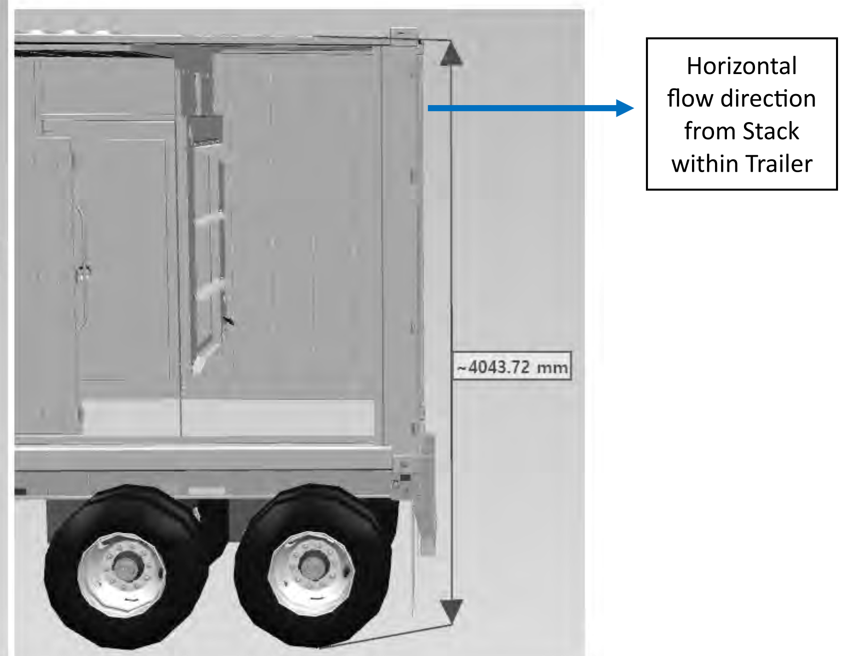
500-kWe NONROAD ENGINE PRODUCT SHEETS

These records may be available upon request. To find out if there are more records for this project, contact Ecology's Public Records Office.

Online: https://ecology.wa.gov/footer-pages/public-records-requests
Public Records Officer email: PublicRecordsOfficer@ecy.wa.gov
Call: 360-407-6040

Horizontal flow Vents – 500-kWe Nonroad Engine





Height/Area Calcs:

Height of Top of Trailer: 4043.72 mm x ft/304.8 mm = 13.27 ft
Estimated Vertical Dimension of Each Vent Square: 2178 mm / 55 squares = 39.6 mm
Estimated Horizontal Dimension of Each Vent Square: 1190 mm / 20 squares = 59.5 mm
Estimated Height of Top of Larger Vent: 3916 mm
Estimated Height of Top of Smaller Cut-out Vent: 3916 mm - 39.6 mm = 3876.4 mm
Estimated Vertical Dimension of Smaller Cut-out Vent: 10.5 x 39.6 mm = 415.8 mm
Estimated Horizontal Dimension of Smaller Cut-out Vent: 6 x 59.5 mm = 357 mm
Estimated Height of Bottom of Smaller Cut-out Vent: 3876.4 mm - 415.8 mm = 3460.6 mm
Estimated Height of Center of Smaller Cut-out Vent: 3460.6 mm + (415.8/2) mm = 3668.5 mm x ft/304.8 mm = 12.04 ft
Presumed Horizontal Flow Diameter (based on stack outlet diameter = 5 in
Cross-sectional area of Horizontal Flow, estimated from stack diameter: $(5\ in)^2 \times PI \div 4 = 19.63\ in^2$

500-kWe NONROAD ENGINE PERFORMANCE DATA

PERFORMANCE DATA[EM1017]

June 2, 2023

Performance Number: EM1017 | **Change Level: 03**

SALES MODEL:	C18	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
MACHINE SALES MODEL:		**HERTZ:**	60
ENGINE POWER (BHP):	779	**FAN POWER (HP):**	32.2
GEN POWER WITH FAN (EKW):	500.0	**ADDITIONAL PARASITICS (HP):**	2.7
COMPRESSION RATIO:	16.1	**ASPIRATION:**	TA
RATING LEVEL:	STANDBY	**AFTERCOOLER TYPE:**	ATAAC
PUMP QUANTITY:	1	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
FUEL TYPE:	DIESEL	**INLET MANIFOLD AIR TEMP (F):**	127
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (F):**	192.2
GOVERNOR TYPE:	ELEC	**TURBO CONFIGURATION:**	SINGLE
ELECTRONICS TYPE:	ADEM4	**TURBO QUANTITY:**	1
CAMSHAFT TYPE:	STANDARD	**TURBOCHARGER MODEL:**	S430S 0.88 A/R VOF
IGNITION TYPE:	CI	**CERTIFICATION YEAR:**	2015
INJECTOR TYPE:	EUI	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,161.4
REF EXH STACK DIAMETER (IN):	6		
MAX OPERATING ALTITUDE (FT):	3,002		

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET

General Performance Data

INLET MANIFOLD AIR TEMPERATURE ("INLET MFLD TEMP") FOR THIS CONFIGURATION IS MEASURED AT THE OUTLET OF THE AFTERCOOLER.

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	ISO BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	ISO VOL FUEL CONSUMPTN (VFC)
EKW	%	BHP	PSI	LB/BHP-HR	LB/BHP-HR	GAL/HR	GAL/HR
500.0	100	744	296	0.348	0.343	36.5	36.0
450.0	90	673	267	0.349	0.344	33.0	32.6
400.0	80	601	239	0.348	0.343	29.5	29.1
375.0	75	566	225	0.349	0.344	27.8	27.4
350.0	70	530	211	0.350	0.345	26.2	25.8
300.0	60	460	183	0.354	0.349	22.9	22.6
250.0	50	390	155	0.360	0.355	19.8	19.5
200.0	40	321	128	0.370	0.364	16.7	16.5
150.0	30	252	100	0.386	0.381	13.8	13.6
125.0	25	218	87	0.400	0.394	12.3	12.1
100.0	20	182	73	0.419	0.413	10.8	10.6
50.0	10	110	44	0.506	0.498	7.8	7.7

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
500.0	100	744	69.3	122.2	1,261.4	86.5	836.8	76	401.6
450.0	90	673	63.8	122.1	1,208.5	79.6	799.7	70	382.0
400.0	80	601	57.8	122.1	1,152.4	72.0	761.9	64	360.3
375.0	75	566	54.7	122.1	1,125.7	68.2	744.2	60	349.3
350.0	70	530	51.5	122.1	1,100.2	64.4	727.6	57	338.1
300.0	60	460	45.2	122.0	1,048.6	56.7	694.6	50	315.1
250.0	50	390	38.6	122.0	993.0	49.1	659.8	43	290.8
200.0	40	321	31.6	121.7	930.1	41.7	620.8	36	261.7
150.0	30	252	24.9	121.2	856.8	34.2	576.1	29	232.7
125.0	25	218	21.8	120.9	815.8	30.5	551.4	25	218.8
100.0	20	182	18.9	120.0	769.5	27.2	523.9	22	205.9
50.0	10	110	14.1	114.9	654.1	23.6	456.8	18	183.4

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)

PERFORMANCE DATA[EM1017]

EKW	%	BHP	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
500.0	100	744	1,340.0	2,465.3	5,817.5	6,076.5	934.9	843.1
450.0	90	673	1,282.0	2,350.9	5,554.9	5,788.7	917.8	831.6
400.0	80	601	1,211.3	2,221.8	5,237.0	5,446.2	894.3	813.8
375.0	75	566	1,173.9	2,156.0	5,069.8	5,267.1	880.5	802.8
350.0	70	530	1,135.6	2,089.2	4,899.2	5,084.7	865.2	790.2
300.0	60	460	1,056.3	1,949.9	4,547.3	4,709.8	830.6	761.4
250.0	50	390	972.6	1,801.9	4,177.8	4,318.1	791.4	728.3
200.0	40	321	871.7	1,621.2	3,735.6	3,854.2	737.7	682.0
150.0	30	252	780.5	1,440.5	3,336.9	3,434.4	683.8	635.7
125.0	25	218	742.6	1,354.0	3,171.5	3,258.4	658.4	614.1
100.0	20	182	714.2	1,274.2	3,047.2	3,123.6	637.0	596.4
50.0	10	110	688.2	1,136.5	2,933.1	2,988.7	609.7	577.6

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
500.0	100	744	16,038	5,739	24,758	12,589	4,231	6,509	31,568	79,429	84,612
450.0	90	673	14,560	5,356	22,331	11,023	3,827	5,781	28,519	71,857	76,546
400.0	80	601	13,203	4,843	19,835	9,453	3,419	4,995	25,499	64,187	68,376
375.0	75	566	12,567	4,609	18,654	8,732	3,222	4,613	23,998	60,493	64,440
350.0	70	530	11,954	4,397	17,522	8,056	3,030	4,239	22,495	56,894	60,607
300.0	60	460	10,771	3,992	15,335	6,779	2,656	3,515	19,509	49,869	53,123
250.0	50	390	9,626	3,651	13,207	5,563	2,292	2,825	16,539	43,040	45,848
200.0	40	321	8,495	3,583	10,986	4,318	1,939	2,095	13,629	36,413	38,788
150.0	30	252	7,376	3,338	8,946	3,194	1,593	1,490	10,707	29,906	31,858
125.0	25	218	6,818	3,097	8,025	2,691	1,421	1,243	9,230	26,674	28,414
100.0	20	182	6,239	2,779	7,179	2,218	1,249	1,048	7,733	23,449	24,979
50.0	10	110	4,839	2,191	5,647	1,288	907	804	4,660	17,030	18,141

Emissions Data

DIESEL

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	500.0	375.0	250.0	125.0	50.0
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**744**	**566**	**390**	**218**	**110**
NON-ETHANE HC	(CORR 15% O2)	PPM	2.4233763	1.2835633	0.0	0.0	0.0
TOTAL NOX (AS NO2)		G/HR	161	156	48	15	37
TOTAL CO		G/HR	0	0	0	0	0
TOTAL HC		G/HR	9	4	0	0	0
TOTAL CO2		KG/HR	375	285	203	125	80
PART MATTER		G/HR	4.3	2.0	1.3	0.8	0.6
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	100.5	127.4	55.8	31.4	130.7
TOTAL CO	(CORR 5% O2)	MG/NM3	0.0	0.0	0.0	0.0	0.0
TOTAL HC	(CORR 5% O2)	MG/NM3	4.9	2.5	0.0	0.0	0.0
PART MATTER	(CORR 5% O2)	MG/NM3	2.2	1.4	1.3	1.4	1.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	49	62	27	15	64
TOTAL CO	(CORR 5% O2)	PPM	0	0	0	0	0
TOTAL HC	(CORR 5% O2)	PPM	9	5	0	0	0
TOTAL NOX (AS NO2)		G/HP-HR	0.22	0.28	0.13	0.07	0.34
TOTAL CO		G/HP-HR	0.00	0.00	0.00	0.00	0.00
TOTAL HC		G/HP-HR	0.01	0.01	0.00	0.00	0.00
PART MATTER		G/HP-HR	0.01	0.00	0.00	0.00	0.01
TOTAL NOX (AS NO2)		LB/HR	0.36	0.34	0.11	0.03	0.08
TOTAL CO		LB/HR	0.00	0.00	0.00	0.00	0.00
TOTAL HC		LB/HR	0.02	0.01	0.00	0.00	0.00
TOTAL CO2		LB/HR	826	628	447	275	176

PART MATTER	LB/HR	0.01	0.00	0.00	0.00	0.00
OXYGEN IN EXH	%	7.6	9.5	11.1	13.2	15.7

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	500.0	375.0	250.0	125.0	50.0
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**744**	**566**	**390**	**218**	**110**
TOTAL NOX (AS NO2)		G/HR	232	225	70	22	53
TOTAL CO		G/HR	0	0	0	0	0
TOTAL HC		G/HR	20	8	0	0	0
PART MATTER		G/HR	16.6	7.8	5.0	3.2	2.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	144.8	183.4	80.3	45.3	188.2
TOTAL CO	(CORR 5% O2)	MG/NM3	0.0	0.0	0.0	0.0	0.1
TOTAL HC	(CORR 5% O2)	MG/NM3	10.5	5.4	0.0	0.0	0.0
PART MATTER	(CORR 5% O2)	MG/NM3	8.3	5.3	4.9	5.3	5.8
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	71	89	39	22	92
TOTAL CO	(CORR 5% O2)	PPM	0	0	0	0	0
TOTAL HC	(CORR 5% O2)	PPM	20	10	0	0	0
TOTAL NOX (AS NO2)		G/HP-HR	0.31	0.40	0.18	0.10	0.49
TOTAL CO		G/HP-HR	0.00	0.00	0.00	0.00	0.00
TOTAL HC		G/HP-HR	0.03	0.01	0.00	0.00	0.00
PART MATTER		G/HP-HR	0.02	0.01	0.01	0.01	0.02
TOTAL NOX (AS NO2)		LB/HR	0.51	0.50	0.15	0.05	0.12
TOTAL CO		LB/HR	0.00	0.00	0.00	0.00	0.00
TOTAL HC		LB/HR	0.04	0.02	0.00	0.00	0.00
PART MATTER		LB/HR	0.04	0.02	0.01	0.01	0.00

Regulatory Information

EPA TIER 4 FINAL		**2015 - ----**		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 1039 SUBPART F 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 NON-ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	NON-ROAD GENSET	TIER 4 FINAL	CO: 3.5 NOx: 0.67 HC: 0.19 PM: 0.03

EU STAGE V		**2019 - ----**		
GASEOUS EMISSION DATA MEASUREMENTS ARE CONSISTENT WITH THOSE DESCRIBED IN EU 2016/1628, ECE REGULATION NO. 96 AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. GASEOUS EMISSION VALUES ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE NON-ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
EUROPE	EU	GENSET	STAGE V	CO: 3.5 NOx: 0.67 HC: 0.19 PM: 0.035

Altitude Derate Data

STANDARD

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	50	60	70	80	90	100	110	120	130	140	NORMAL
ALTITUDE (FT)											
0	779	779	779	779	777	774	771	768	576	516	779
1,000	779	779	779	777	774	771	768	699	557	511	778
2,000	779	778	776	774	771	751	719	593	529	501	776
3,000	777	775	773	770	751	651	571	543	516	489	773
4,000	773	771	769	754	674	582	552	526	501	476	770
5,000	769	761	736	669	602	557	533	509	485	462	765
6,000	725	679	653	604	560	536	514	492	470	449	704
7,000	648	592	577	560	537	515	495	474	454	435	648
8,000	585	567	553	538	516	495	475	456	437	418	595
9,000	557	544	531	516	496	476	456	436	418	400	573

10,000	533	522	508	494	474	454	431	404	380	362	555
11,000	514	503	495	487	462	431	398	373	358	357	534
12,000	495	485	483	471	445	417	384	372	371	369	514
13,000	473	463	461	444	412	381	379	378	376	374	495
14,000	449	434	420	392	381	379	378	376	374	372	470
15,000	397	379	367	381	379	377	376	374	372	370	442

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
4150867	PP7129	4190902	PS072	LS	CM800001	
4150867	PP7129	4190904	GS759	LS	CM800001	
4150867	PP7129	5194410	PS072	LS	CM800001	
5526359	PP7990	5424853	EE545	-	TC400001	

Performance Parameter Reference

Parameters Reference:DM9600-14
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.
On 3500 and C175 engines, at speeds below Peak Torque 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.
WET & DRY EXHAUST/EMISSIONS DESCRIPTION:
Wet - Total exhaust flow or concentration of total exhaust flow
Dry - Total exhaust flow minus water vapor or concentration of exhaust flow with water vapor excluded
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 : 10/27/21

C18 GENERATOR
UNCONTROLLED EMISSIONS PERFORMANCE DATA

PERFORMANCE DATA[DM8521]

September 11, 2023

Performance Number: DM8521 **Change Level: 05**

SALES MODEL:	C18	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
MACHINE SALES MODEL:		**HERTZ:**	60
ENGINE POWER (BHP):	766	**FAN POWER (HP):**	40.9
GEN POWER W/O FAN (EKW):	521.0	**ASPIRATION:**	TA
GEN POWER WITH FAN (EKW):	500.0	**AFTERCOOLER TYPE:**	ATAAC
COMPRESSION RATIO:	14.5	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
RATING LEVEL:	PRIME	**INLET MANIFOLD AIR TEMP (F):**	120
PUMP QUANTITY:	1	**JACKET WATER TEMP (F):**	192.2
FUEL TYPE:	DIESEL	**TURBO CONFIGURATION:**	PARALLEL
MANIFOLD TYPE:	DRY	**TURBO QUANTITY:**	2
GOVERNOR TYPE:	ELEC	**TURBOCHARGER MODEL:**	S310S089 1.10A/R
CAMSHAFT TYPE:	STANDARD	**CERTIFICATION YEAR:**	2006
IGNITION TYPE:	CI	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,161.4
INJECTOR TYPE:	EUI		
REF EXH STACK DIAMETER (IN):	6		
MAX OPERATING ALTITUDE (FT):	5,577		

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

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	ISO BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	ISO VOL FUEL CONSUMPTN (VFC)
EKW	%	BHP	PSI	LB/BHP-HR	LB/BHP-HR	GAL/HR	GAL/HR
550.0	110	838	333	0.329	0.324	38.8	38.3
500.0	100	766	305	0.335	0.330	36.2	35.7
450.0	90	690	275	0.343	0.339	33.4	32.9
400.0	80	617	245	0.353	0.348	30.7	30.3
375.0	75	580	231	0.358	0.353	29.3	28.9
350.0	70	544	216	0.363	0.358	27.8	27.4
300.0	60	472	188	0.373	0.368	24.8	24.5
250.0	50	401	159	0.377	0.372	21.3	21.0
200.0	40	332	132	0.371	0.366	17.4	17.1
150.0	30	262	104	0.360	0.355	13.3	13.1
125.0	25	227	90	0.357	0.351	11.4	11.2
100.0	20	191	76	0.354	0.349	9.5	9.4
50.0	10	117	47	0.396	0.391	6.6	6.5

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	ENGINE OUTLET TEMP	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP
EKW	%	BHP	IN-HG	DEG F	DEG F	DEG F	IN-HG	DEG F
550.0	110	838	65.5	125.1	1,245.5	960.0	71	394.8
500.0	100	766	62.7	119.8	1,210.7	934.7	68	383.2
450.0	90	690	59.6	115.0	1,174.5	909.9	65	370.9
400.0	80	617	56.6	111.4	1,139.2	888.4	62	358.7
375.0	75	580	54.7	110.6	1,121.4	878.4	60	351.3
350.0	70	544	52.5	109.8	1,103.4	868.5	57	342.9
300.0	60	472	47.5	108.1	1,066.8	848.5	52	322.9
250.0	50	401	39.6	106.0	1,011.4	820.7	44	289.0
200.0	40	332	29.0	102.9	924.5	773.9	33	242.3
150.0	30	262	18.1	99.3	821.3	711.0	21	192.8
125.0	25	227	13.3	97.4	765.4	674.5	16	171.0
100.0	20	191	8.9	95.4	706.6	633.5	11	150.8
50.0	10	117	4.9	91.1	580.5	535.4	7	128.6

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	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN

							HG)	HG)
EKW	%	BHP	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
550.0	110	838	1,618.9	4,460.0	7,342.3	7,617.7	1,544.6	1,393.2
500.0	100	766	1,581.9	4,290.4	6,946.1	7,202.7	1,512.8	1,364.6
450.0	90	690	1,543.1	4,110.3	6,540.4	6,777.5	1,475.6	1,331.0
400.0	80	617	1,504.2	3,926.6	6,155.5	6,373.2	1,432.1	1,291.7
375.0	75	580	1,475.7	3,819.8	5,945.8	6,153.5	1,403.6	1,266.0
350.0	70	544	1,440.7	3,700.7	5,720.1	5,917.6	1,370.0	1,235.7
300.0	60	472	1,352.4	3,421.6	5,212.9	5,389.0	1,286.0	1,160.0
250.0	50	401	1,214.6	3,004.8	4,480.9	4,632.2	1,153.8	1,040.8
200.0	40	332	1,030.9	2,468.1	3,548.4	3,671.6	983.7	887.3
150.0	30	262	839.2	1,906.8	2,593.2	2,687.6	800.8	722.3
125.0	25	227	755.3	1,654.4	2,177.9	2,258.7	717.2	646.9
100.0	20	191	678.7	1,418.4	1,799.1	1,866.7	637.9	575.4
50.0	10	117	604.1	1,145.6	1,325.8	1,372.3	566.0	510.5

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
550.0	110	838	10,172	4,227	33,146	23,057	4,530	7,605	35,548	85,044	90,593
500.0	100	766	9,441	3,941	31,223	21,441	4,220	7,336	32,474	79,228	84,398
450.0	90	690	8,701	3,611	29,289	19,905	3,896	6,995	29,278	73,143	77,915
400.0	80	617	8,019	3,225	27,525	18,426	3,574	6,540	26,149	67,107	71,486
375.0	75	580	7,707	3,095	26,540	17,639	3,410	6,249	24,604	64,026	68,204
350.0	70	544	7,393	2,980	25,479	16,834	3,242	5,915	23,062	60,863	64,834
300.0	60	472	6,711	2,775	23,146	15,127	2,889	5,118	20,018	54,240	57,779
250.0	50	401	6,028	2,707	19,903	12,738	2,479	3,924	17,009	46,551	49,588
200.0	40	332	5,380	2,488	15,841	9,729	2,019	2,558	14,060	37,901	40,374
150.0	30	262	4,715	2,035	11,689	6,749	1,547	1,359	11,103	29,036	30,931
125.0	25	227	4,361	1,586	9,875	5,430	1,323	973	9,609	24,837	26,458
100.0	20	191	3,985	1,181	8,206	4,220	1,105	685	8,091	20,755	22,110
50.0	10	117	3,081	870	5,874	2,403	759	399	4,973	14,254	15,184

Emissions Data

DIESEL

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**550.0**	**500.0**	**375.0**	**250.0**	**125.0**	**50.0**
PERCENT LOAD		**%**	**110**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**838**	**766**	**580**	**401**	**227**	**117**
TOTAL NOX (AS NO2)		G/HR	4,597	3,852	1,766	1,199	1,652	1,122
TOTAL CO		G/HR	274	171	140	127	127	240
TOTAL HC		G/HR	9	9	21	27	18	24
TOTAL CO2		KG/HR	393	361	293	213	114	67
PART MATTER		G/HR	27.0	22.5	24.7	25.3	9.0	6.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,701.3	2,454.0	1,362.7	1,439.5	3,431.7	3,748.1
TOTAL CO	(CORR 5% O2)	MG/NM3	159.4	108.8	109.1	142.7	264.9	932.1
TOTAL HC	(CORR 5% O2)	MG/NM3	4.6	4.6	14.7	26.6	33.4	78.4
PART MATTER	(CORR 5% O2)	MG/NM3	13.1	11.9	17.3	22.7	15.7	22.6
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,316	1,195	664	701	1,672	1,826
TOTAL CO	(CORR 5% O2)	PPM	128	87	87	114	212	746
TOTAL HC	(CORR 5% O2)	PPM	9	9	28	50	62	146
TOTAL NOX (AS NO2)		G/HP-HR	5.53	5.06	3.06	3.00	7.31	9.59
TOTAL CO		G/HP-HR	0.33	0.22	0.24	0.32	0.56	2.05
TOTAL HC		G/HP-HR	0.01	0.01	0.04	0.07	0.08	0.20

PART MATTER		G/HP-HR	0.03	0.03	0.04	0.06	0.04	0.06
TOTAL NOX (AS NO2)		LB/HR	10.13	8.49	3.89	2.64	3.64	2.47
TOTAL CO		LB/HR	0.60	0.38	0.31	0.28	0.28	0.53
TOTAL HC		LB/HR	0.02	0.02	0.05	0.06	0.04	0.05
TOTAL CO2		LB/HR	866	797	647	471	252	148
PART MATTER		LB/HR	0.06	0.05	0.05	0.06	0.02	0.01
OXYGEN IN EXH		%	9.5	10.1	11.6	12.8	13.9	15.9
DRY SMOKE OPACITY		%	0.7	0.6	0.8	0.9	0.6	0.5
BOSCH SMOKE NUMBER			0.37	0.34	0.52	0.57	0.32	0.18

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	550.0	500.0	375.0	250.0	125.0	50.0
PERCENT LOAD		%	110	100	75	50	25	10
ENGINE POWER		BHP	838	766	580	401	227	117
TOTAL NOX (AS NO2)		G/HR	4,964	4,160	1,907	1,295	1,784	1,212
TOTAL CO		G/HR	513	320	261	238	238	448
TOTAL HC		G/HR	17	16	39	51	34	45
PART MATTER		G/HR	52.7	43.9	48.3	49.2	17.6	12.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,917.4	2,650.3	1,471.7	1,554.7	3,706.2	4,048.0
TOTAL CO	(CORR 5% O2)	MG/NM3	298.2	203.4	204.0	266.8	495.4	1,743.0
TOTAL HC	(CORR 5% O2)	MG/NM3	8.7	8.7	27.9	50.2	63.1	148.2
PART MATTER	(CORR 5% O2)	MG/NM3	25.6	23.2	33.7	44.2	30.6	44.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,421	1,291	717	757	1,805	1,972
TOTAL CO	(CORR 5% O2)	PPM	239	163	163	213	396	1,394
TOTAL HC	(CORR 5% O2)	PPM	16	16	52	94	118	277
TOTAL NOX (AS NO2)		G/HP-HR	5.97	5.47	3.30	3.24	7.89	10.35
TOTAL CO		G/HP-HR	0.62	0.42	0.45	0.60	1.05	3.83
TOTAL HC		G/HP-HR	0.02	0.02	0.07	0.13	0.15	0.38
PART MATTER		G/HP-HR	0.06	0.06	0.08	0.12	0.08	0.11
TOTAL NOX (AS NO2)		LB/HR	10.94	9.17	4.20	2.85	3.93	2.67
TOTAL CO		LB/HR	1.13	0.70	0.58	0.52	0.53	0.99
TOTAL HC		LB/HR	0.04	0.04	0.09	0.11	0.08	0.10
PART MATTER		LB/HR	0.12	0.10	0.11	0.11	0.04	0.03

Regulatory Information

EPA TIER 2		2006 - 2010		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 89 SUBPART D 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 NON-ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	NON-ROAD	TIER 2	CO: 3.5 NOx + HC: 6.4 PM: 0.20

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

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	766	766	766	766	766	766	766	766	766	766	766	766	766
1,000	766	766	766	766	766	766	766	766	766	766	766	766	766
2,000	766	766	766	766	766	766	766	766	766	766	766	766	766
3,000	766	766	766	766	766	766	766	766	766	766	766	758	766
4,000	766	766	766	766	766	766	766	766	766	754	742	729	766
5,000	766	766	766	766	766	766	765	751	738	725	713	701	766
6,000	766	766	766	766	763	749	736	722	710	697	686	674	766
7,000	766	766	762	748	734	720	707	694	682	670	659	648	757
8,000	762	747	732	718	705	692	679	667	655	644	633	623	732
9,000	732	717	703	690	677	664	652	641	629	618	608	598	708
10,000	703	689	675	662	650	638	626	615	604	594	584	574	685
11,000	674	661	648	636	624	612	601	590	580	570	560	551	662
12,000	647	634	622	610	598	587	576	566	556	547	537	528	639
13,000	620	608	596	585	574	563	553	543	533	524	515	507	618
14,000	595	583	571	560	550	539	530	520	511	502	494	486	596
15,000	570	558	547	537	527	517	507	498	490	481	473	465	575

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
0K7280	PP5702	2726915	GS338	-	EST00001	
0K7280	PP5702	4206877	GS338	-	FST00001	

Performance Parameter Reference

Parameters Reference:DM9600-14

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.
On 3500 and C175 engines, at speeds below Peak Torque 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.
WET & DRY EXHAUST/EMISSIONS DESCRIPTION:

Wet - Total exhaust flow or concentration of total exhaust flow
Dry - Total exhaust flow minus water vapor or concentration of exhaust flow with water vapor excluded
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 : 10/27/21

1,825-kWe NONROAD ENGINE PRODUCT SHEETS

These records may be available upon request. To find out if there are more records for this project, contact Ecology's Public Records Office.

Online: https://ecology.wa.gov/footer-pages/public-records-requests
Public Records Officer email: PublicRecordsOfficer@ecy.wa.gov
Call: 360-407-6040

1,825-kWe NONROAD ENGINE PERFORMANCE DATA

PERFORMANCE DATA[EM6255]

July 19, 2023

Performance Number: EM6255 **Change Level: 01**

SALES MODEL:	3516C	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,800
MACHINE SALES MODEL:		**HERTZ:**	60
ENGINE POWER (BHP):	2,695	**ASPIRATION:**	TA
GEN POWER WITH FAN (EKW):	1,825.0	**AFTERCOOLER TYPE:**	ATAAC
COMPRESSION RATIO:	14	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
RATING LEVEL:	PRIME	**INLET MANIFOLD AIR TEMP (F):**	113
PUMP QUANTITY:	1	**JACKET WATER TEMP (F):**	210.2
FUEL TYPE:	DIESEL	**TURBO CONFIGURATION:**	PARALLEL
MANIFOLD TYPE:	DRY	**TURBO QUANTITY:**	4
GOVERNOR TYPE:	ADEM4	**TURBOCHARGER MODEL:**	GTB6041BN-48T-1.04
ELECTRONICS TYPE:	ADEM4	**CERTIFICATION YEAR:**	2021
CAMSHAFT TYPE:	STANDARD	**FUEL RATE (RATED RPM) NO LOAD (GAL/HR):**	16.1
IGNITION TYPE:	CI	**PISTON SPD @ RATED ENG SPD (FT/MIN):**	2,539.4
INJECTOR TYPE:	EUI		
REF EXH STACK DIAMETER (IN):	12		

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

General Performance Data

THE INLET MANIFOLD AIR TEMP LISTED IN THE HEADER, AND IN THE GENERAL PERFORMANCE DATA, IS THE AVERAGE INLET MANIFOLD TEMP FRONT TO REAR ON THE ENGINE.

DIESEL EMISSION FLUID (DEF) BRAKE SPECIFIC CONSUMPTION, AND FLOW RATE ARE LISTED IN BOTH 32.5% UREA CONCENTRATION, AND 40% UREA CONCENTRATION. THIS IS BASED ON A DEF DENSITY OF 1.090, AND 1.112 G/ML AT 20 DEG C RESPECTIVELY.

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	ISO BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	ISO VOL FUEL CONSUMPTN (VFC)	ELEC SPEC FUEL CONSUMPTN (ESFC)	ISO ELEC SPEC FUEL CONSUMPTN (ESFC)	BRAKE SPEC DEF CONSUMPTN (32.5%)	BRAKE SPEC DEF CONSUMPTN (40%)	VOL DEF CONSUMPTN (32.5%)	VOL DEF CONSUMPTN (40%)
EKW	%	BHP	PSI	LB/BHP-HR	LB/BHP-HR	GAL/HR	GAL/HR	LB/EKW-HR	LB/EKW-HR	GAL/HR	GAL/HR	G/HP-HR	G/HP-HR
2,007.5	110	2,948	272	0.332	0.324	137.9	134.6	0.487	0.476	10.203	7.693	14.08	10.83
1,825.0	100	2,692	249	0.333	0.325	126.2	123.2	0.491	0.479	8.892	6.705	13.44	10.34
1,642.5	90	2,438	225	0.334	0.326	114.9	112.2	0.496	0.484	7.640	5.760	12.75	9.81
1,460.0	80	2,186	202	0.338	0.330	104.3	101.8	0.507	0.495	6.321	4.766	11.76	9.05
1,368.8	75	2,061	190	0.342	0.334	99.4	97.1	0.515	0.503	5.583	4.209	11.02	8.48
1,277.5	70	1,936	179	0.346	0.338	94.5	92.2	0.525	0.512	4.873	3.674	10.24	7.88
1,095.0	60	1,687	156	0.352	0.344	83.7	81.7	0.542	0.529	3.892	2.934	9.39	7.22
912.5	50	1,439	133	0.356	0.348	72.3	70.5	0.562	0.548	3.156	2.380	8.92	6.86
730.0	40	1,197	111	0.364	0.356	61.5	60.0	0.597	0.583	2.468	1.861	8.39	6.46
547.5	30	952	88	0.379	0.370	50.8	49.6	0.658	0.643	1.743	1.315	7.45	5.73
456.2	25	827	76	0.386	0.377	45.0	43.9	0.700	0.683	1.554	1.172	7.65	5.89
365.0	20	699	65	0.395	0.386	38.9	38.0	0.756	0.738	1.497	1.129	8.72	6.71
182.5	10	431	40	0.447	0.437	27.2	26.5	1.057	1.032	1.103	0.831	10.41	8.01

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
2,007.5	110	2,948	58.5	111.6	1,205.4	49.9	917.2	63	370.6
1,825.0	100	2,692	52.3	108.7	1,178.6	44.9	911.6	57	349.0
1,642.5	90	2,438	46.3	106.0	1,150.8	40.2	900.8	50	327.1
1,460.0	80	2,186	40.9	103.8	1,123.6	36.1	888.8	45	305.8
1,368.8	75	2,061	38.6	103.2	1,110.4	34.3	882.7	42	296.8
1,277.5	70	1,936	36.3	102.7	1,097.4	32.6	876.0	40	287.7
1,095.0	60	1,687	30.9	100.6	1,064.4	28.7	856.6	34	263.6
912.5	50	1,439	24.9	98.4	1,016.9	24.4	827.9	28	236.8
730.0	40	1,197	19.7	98.6	959.5	20.7	794.7	22	210.9
547.5	30	952	15.0	97.1	884.3	17.4	745.9	17	185.9
456.2	25	827	12.4	95.8	827.8	15.5	698.5	15	170.9
365.0	20	699	9.7	94.5	761.1	13.5	643.3	12	155.2
182.5	10	431	5.5	92.4	612.9	10.4	526.9	7	131.1

General Performance Data (Continued)

PERFORMANCE DATA[EM6255]

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)	CEM RESTRICTION
EKW	%	BHP	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN	PSI
2,007.5	110	2,948	6,128.3	16,331.3	26,728.9	27,707.2	5,831.8	5,322.9	1.20
1,825.0	100	2,692	5,700.6	15,074.5	24,773.7	25,669.8	5,404.8	4,936.3	1.05
1,642.5	90	2,438	5,313.3	13,871.3	23,000.4	23,815.6	5,012.9	4,585.6	0.92
1,460.0	80	2,186	4,971.5	12,811.0	21,450.4	22,191.3	4,671.0	4,281.2	0.80
1,368.8	75	2,061	4,821.7	12,354.5	20,785.4	21,491.2	4,525.2	4,151.9	0.76
1,277.5	70	1,936	4,669.8	11,891.3	20,115.2	20,785.6	4,377.1	4,020.5	0.71
1,095.0	60	1,687	4,306.9	10,765.0	18,504.7	19,098.6	4,021.1	3,702.7	0.61
912.5	50	1,439	3,894.2	9,472.1	16,672.0	17,184.6	3,617.1	3,340.7	0.50
730.0	40	1,197	3,518.9	8,305.2	15,028.0	15,464.1	3,255.3	3,017.7	0.41
547.5	30	952	3,189.3	7,214.3	13,609.9	13,970.5	2,942.2	2,741.6	0.33
456.2	25	827	3,002.9	6,525.0	12,801.5	13,120.8	2,770.0	2,589.7	0.29
365.0	20	699	2,807.6	5,782.0	11,953.2	12,229.2	2,577.4	2,418.9	0.25
182.5	10	431	2,521.8	4,657.7	10,730.8	10,923.7	2,321.2	2,200.5	0.19

Heat Rejection Data

HEAT REJECTION TO ATMOSPHERE SHOWN HERE IS ENGINE ONLY. CEM HEAT REJECTION TO ATMOSPHERE SHOWN IN THE SUPPLEMENTARY DATA IS THE ADDITIONAL HEAT REJECTED TO ATMOSPHERE FROM THE CEM. THIS ADDITIONAL HEAT IS INCLUDED IN THE HEAT REJECTION TO EXH AND EXH RECOVERY SHOWN HERE AND WOULD NEED TO BE DEDUCTED FROM THE EXH AND EXH RECOVERY VALUES WHEN SIZING EXHAUST RECOVERY HEAT EQUIPMENT.

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
2,007.5	110	2,948	40,207	8,603	117,867	66,726	15,972	27,863	125,034	299,878	319,445
1,825.0	100	2,692	37,597	8,275	108,261	61,160	14,619	24,000	114,155	274,475	292,385
1,642.5	90	2,438	35,230	7,970	98,938	55,572	13,307	20,622	103,384	249,836	266,138
1,460.0	80	2,186	33,164	7,756	90,446	50,561	12,084	17,358	92,721	226,879	241,683
1,368.8	75	2,061	32,149	7,610	86,809	48,357	11,515	16,151	87,416	216,191	230,298
1,277.5	70	1,936	31,141	7,453	83,122	46,139	10,942	14,996	82,101	205,441	218,846
1,095.0	60	1,687	28,837	7,119	74,185	40,721	9,698	12,260	71,551	182,072	193,952
912.5	50	1,439	26,251	6,760	63,985	34,448	8,369	9,250	61,040	157,127	167,380
730.0	40	1,197	23,689	6,383	54,831	28,730	7,122	6,832	50,756	133,708	142,433
547.5	30	952	20,877	5,890	45,573	22,971	5,885	4,844	40,361	110,491	117,701
456.2	25	827	19,737	5,576	39,943	18,898	5,212	3,845	35,061	97,847	104,232
365.0	20	699	18,525	5,249	33,760	14,741	4,507	2,902	29,635	84,610	90,131
182.5	10	431	14,430	4,691	23,913	7,833	3,150	1,681	18,287	59,137	62,995

Emissions Data

EMISSIONS VALUES ARE TAILPIPE OUT WITH AFTERTREATMENT. VALUES SHOWN AS ZERO MAY BE GREATER THAN ZERO BUT WERE BELOW THE DETECTION LEVEL OF THE EQUIPMENT USED AT TIME OF MEASUREMENT.

CATERPILLAR EMISSIONS CERTIFIED ENGINES TESTED WITHIN EPA SPECIFIED TEST CONDITIONS, AND USING TITLE 40 CFR PART 1065 TEST PROTOCOL, MEET THE NEW SOURCE PERFORMANCE STANDARDS. POTENTIAL SITE VARIATION DATA ACCOUNT FOR PRODUCTION ENGINE AND SYSTEM VARIABILITY IN ADDITION TO MEASUREMENT VARIABILITY FOR TYPICAL FIELD TEST METHODS AS DESCRIBED IN DM1176. THIS DATA ASSUMES SITE CORRECTIONS FOR AMBIENT HUMIDITY TO 75 GRAINS, AND STANDARD CONDITIONS OF 25 C (77 F) AIR TO TURBO TEMPERATURE AND 152.4 M (500 FT) ALTITUDE. GUIDANCE ON HUMIDITY CORRECTION METHODS ARE AVAILABLE IN TITLE 40 CFR SECTION 1065.670. FOR APPLICATIONS WITH GEOGRAPHIC OR AMBIENT CONDITIONS BEYOND THESE PUBLISHED VALUES, CONSULT CATERPILLAR (APPLICATION SUPPORT CENTER) FOR ADDITIONAL VARIABILITY INFORMATION.

DIESEL

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	2,007.5	1,825.0	1,368.8	912.5	456.2	182.5
PERCENT LOAD		**%**	**110**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**2,948**	**2,692**	**2,061**	**1,439**	**827**	**431**
METHANOL	(CORR 15% O2)	PPM	0.001	0.001	0.0016990401	0.001	0.0014147002	0.010847521
TOTAL NOX (AS NO2)		G/HR	1,123	997	675	428	274	338

TOTAL CO		G/HR	72	62	44	30	19	16
TOTAL HC		G/HR	21	22	25	22	18	22
TOTAL CO2		KG/HR	1,448	1,318	1,034	751	466	284
PART MATTER		G/HR	27.0	29.2	26.0	23.3	21.0	9.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	168.9	164.1	141.7	124.3	129.1	272.3
TOTAL CO	(CORR 5% O2)	MG/NM3	11.4	10.8	9.8	9.1	9.4	12.9
TOTAL HC	(CORR 5% O2)	MG/NM3	2.9	3.3	4.7	5.7	7.7	15.4
PART MATTER	(CORR 5% O2)	MG/NM3	3.6	4.2	4.8	6.0	8.9	6.7
TOTAL NOX (AS NO2)	(CORR 15% O2)	MG/NM3	62.7	60.9	52.6	46.1	47.9	101.0
TOTAL CO	(CORR 15% O2)	MG/NM3	4.2	4.0	3.6	3.4	3.5	4.8
TOTAL HC	(CORR 15% O2)	MG/NM3	1.1	1.2	1.7	2.1	2.8	5.7
PART MATTER	(CORR 15% O2)	MG/NM3	1.3	1.6	1.8	2.2	3.3	2.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	82	80	69	61	63	133
TOTAL CO	(CORR 5% O2)	PPM	9	9	8	7	8	10
TOTAL HC	(CORR 5% O2)	PPM	5	6	9	11	14	29
FORMALDEHYDE	(CORR 5% O2)	PPM	0.05	0.07	0.05	0.05	0.12	0.38
ACROLEIN	(CORR 5% O2)	PPM	0.01	0.00	0.00	0.00	0.00	0.01
ACETALDEHYDE	(CORR 5% O2)	PPM	0.01	0.01	0.01	0.01	0.01	0.02
METHANOL	(CORR 5% O2)	PPM	0.00	0.00	0.00	0.00	0.00	0.03
TOTAL NOX (AS NO2)	(CORR 15% O2)	PPM	31	30	26	22	23	49
TOTAL CO	(CORR 15% O2)	PPM	3	3	3	3	3	4
TOTAL HC	(CORR 15% O2)	PPM	2	2	3	4	5	11
TOTAL NOX (AS NO2)		G/HP-HR	0.38	0.37	0.33	0.30	0.33	0.79
TOTAL CO		G/HP-HR	0.02	0.02	0.02	0.02	0.02	0.04
TOTAL HC		G/HP-HR	0.01	0.01	0.01	0.02	0.02	0.05
PART MATTER		G/HP-HR	0.01	0.01	0.01	0.02	0.03	0.02
TOTAL NOX (AS NO2)		G/KW-HR	0.52	0.51	0.45	0.41	0.45	1.07
TOTAL CO		G/KW-HR	0.03	0.03	0.03	0.03	0.03	0.05
TOTAL HC		G/KW-HR	0.01	0.01	0.02	0.02	0.03	0.07
PART MATTER		G/KW-HR	0.01	0.01	0.02	0.02	0.03	0.03
TOTAL NOX (AS NO2)		LB/HR	2.48	2.20	1.49	0.94	0.60	0.74
TOTAL CO		LB/HR	0.16	0.14	0.10	0.07	0.04	0.04
TOTAL HC		LB/HR	0.05	0.05	0.05	0.05	0.04	0.05
TOTAL CO2		LB/HR	3,193	2,905	2,279	1,657	1,028	626
PART MATTER		LB/HR	0.06	0.06	0.06	0.05	0.05	0.02
OXYGEN IN EXH		%	9.6	9.8	10.5	11.5	13.4	15.5
DRY SMOKE OPACITY		%	0.0	0.0	0.0	0.6	1.5	0.5
BOSCH SMOKE NUMBER			0.66	0.66	0.68	0.74	0.80	0.73

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**2,007.5**	**1,825.0**	**1,368.8**	**912.5**	**456.2**	**182.5**
PERCENT LOAD		**%**	**110**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**2,948**	**2,692**	**2,061**	**1,439**	**827**	**431**
TOTAL NOX (AS NO2)		G/HR	1,797	1,596	1,080	684	438	540
TOTAL CO		G/HR	368	318	227	152	98	81
TOTAL HC		G/HR	94	99	110	98	82	99
PART MATTER		G/HR	70.2	75.9	67.5	60.7	54.6	23.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	270.2	262.5	226.7	198.9	206.6	435.7
TOTAL CO	(CORR 5% O2)	MG/NM3	58.1	55.1	50.0	46.2	47.8	66.0
TOTAL HC	(CORR 5% O2)	MG/NM3	12.9	14.8	21.1	25.7	34.6	69.5
PART MATTER	(CORR 5% O2)	MG/NM3	9.2	10.9	12.5	15.7	23.2	17.5
TOTAL NOX (AS NO2)	(CORR 15% O2)	MG/NM3	100.3	97.4	84.1	73.8	76.7	161.7
TOTAL CO	(CORR 15% O2)	MG/NM3	21.6	20.4	18.5	17.1	17.7	24.5
TOTAL HC	(CORR 15% O2)	MG/NM3	4.8	5.5	7.8	9.5	12.8	25.8
PART MATTER	(CORR 15% O2)	MG/NM3	3.4	4.0	4.6	5.8	8.6	6.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	132	128	110	97	101	212
TOTAL CO	(CORR 5% O2)	PPM	46	44	40	37	38	53
TOTAL HC	(CORR 5% O2)	PPM	24	28	39	48	65	130
TOTAL NOX (AS NO2)	(CORR 15% O2)	PPM	49	47	41	36	37	79
TOTAL CO	(CORR 15% O2)	PPM	17	16	15	14	14	20
TOTAL HC	(CORR 15% O2)	PPM	9	10	15	18	24	48

TOTAL NOX (AS NO2)	G/HP-HR	0.61	0.60	0.53	0.48	0.53	1.26
TOTAL CO	G/HP-HR	0.13	0.12	0.11	0.11	0.12	0.19
TOTAL HC	G/HP-HR	0.03	0.04	0.05	0.07	0.10	0.23
PART MATTER	G/HP-HR	0.02	0.03	0.03	0.04	0.07	0.06
TOTAL NOX (AS NO2)	G/KW-HR	0.84	0.81	0.72	0.65	0.72	1.71
TOTAL CO	G/KW-HR	0.17	0.16	0.15	0.14	0.16	0.26
TOTAL HC	G/KW-HR	0.04	0.05	0.07	0.09	0.14	0.31
PART MATTER	G/KW-HR	0.03	0.04	0.04	0.06	0.09	0.07
TOTAL NOX (AS NO2)	LB/HR	3.96	3.52	2.38	1.51	0.96	1.19
TOTAL CO	LB/HR	0.81	0.70	0.50	0.34	0.22	0.18
TOTAL HC	LB/HR	0.21	0.22	0.24	0.22	0.18	0.22
PART MATTER	LB/HR	0.15	0.17	0.15	0.13	0.12	0.05

Regulatory Information

EPA TIER 4 FINAL		2015 - ----		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 1039 SUBPART F 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 NON-ROAD REGULATIONS BY PARTICIPATING IN THE AVERAGE, BANKING, AND TRADING PROGRAM.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (EXCL CALIF)	EPA	NON-ROAD GENSET	TIER 4 FINAL	CO: 3.5 NOx: 0.67 HC: 0.19 PM: 0.03

EPA NON-EMERGENCY STATIONARY GENSET		2015 - ----		
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 NON-EMERGENCY STATIONARY REGULATIONS BY PARTICIPATING IN THE AVERAGE, BANKING, AND TRADING PROGRAM.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (EXCL CALIF)	EPA	STATIONARY	NON-EMERGENCY STATIONARY GENSET	CO: 3.5 NOx: 0.67 HC: 0.19 PM: 0.03

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	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695
1,000	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695
2,000	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695
3,000	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695
4,000	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695
5,000	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695
6,000	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,687	2,641	2,597	2,695
7,000	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,678	2,631	2,586	2,542	2,500	2,695
8,000	2,695	2,695	2,695	2,695	2,695	2,672	2,624	2,577	2,532	2,488	2,446	2,405	2,695
9,000	2,695	2,695	2,695	2,670	2,619	2,571	2,524	2,479	2,435	2,393	2,352	2,313	2,695
10,000	2,695	2,670	2,617	2,567	2,518	2,472	2,427	2,383	2,342	2,301	2,262	2,224	2,611
11,000	2,619	2,567	2,516	2,468	2,421	2,376	2,333	2,291	2,251	2,212	2,175	2,138	2,528
12,000	2,517	2,467	2,418	2,372	2,327	2,284	2,242	2,202	2,163	2,126	2,090	2,055	2,447
13,000	2,419	2,370	2,324	2,279	2,236	2,195	2,155	2,116	2,079	2,043	2,008	1,975	2,368
14,000	2,324	2,278	2,233	2,190	2,148	2,109	2,070	2,033	1,998	1,963	1,930	1,898	2,292
15,000	2,233	2,188	2,145	2,104	2,064	2,026	1,989	1,953	1,919	1,886	1,854	1,823	2,218

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number

5958078	LL2890	6177035	PS141	-	4T400001

Supplementary Data

Type	Classification	Performance Number
AFTERTREATMENT	SCR	DM8843

Performance Parameter Reference

Parameters Reference:DM9600-14
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.
On 3500 and C175 engines, at speeds below Peak Torque 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.
WET & DRY EXHAUST/EMISSIONS DESCRIPTION:
Wet - Total exhaust flow or concentration of total exhaust flow
Dry - Total exhaust flow minus water vapor or concentration of exhaust flow with water vapor excluded
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

PERFORMANCE DATA[EM6255]

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 : 10/27/21

General Performance Data

Genset Power With Fan	Percent Load	Engine Power	Brake Spec DEF Consumption	Vol DEF Consumption	CEM Outlet Temp
eKw	%	bhp	lb/bhp-hr	gal/hr	°F
1825.0	100	2695	0.030	8.9	876.9
1642.5	90	2441	0.029	7.6	863.7
1460.0	80	2190	0.026	6.3	850.4
1368.8	75	2064	0.025	5.6	843.7
1277.5	70	1939	0.023	4.9	836.3
1095.0	60	1690	0.022	4.0	816.1
912.5	50	1440	0.020	3.2	790.0
730.0	40	1196	0.019	2.5	755.7
547.5	30	948	0.017	1.7	702.8
456.3	25	821	0.017	1.5	659.1
365.0	20	691	0.018	1.4	609.7
182.5	10	418	0.023	1.0	506.3

Heat Rejection Data

Genset Power With Fan	Percent Load	Engine Power	CEM Rejection to Atmosphere
eKw	%	bhp	BTU/min
1825.0	100	2695	4886
1642.5	90	2441	4724
1460.0	80	2190	4596
1368.8	75	2064	4543
1277.5	70	1939	4491
1095.0	60	1690	4237
912.5	50	1440	3830
730.0	40	1196	3226
547.5	30	948	2829
456.3	25	821	2366
365.0	20	691	1788
182.5	10	418	890

3516C GENERATOR
UNCONTROLLED EMISSIONS PERFORMANCE DATA

PERFORMANCE DATA[EM1896]

Performance Number: EM1896 **Change Level: 03**

SALES MODEL:	3516C
BRAND:	CAT
MACHINE SALES MODEL:	
ENGINE POWER (BHP):	2,937
GEN POWER WITH FAN (EKW):	2,000.0
COMPRESSION RATIO:	14.7
RATING LEVEL:	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):	12
MAX OPERATING ALTITUDE (FT):	3,117
COMBUSTION:	DIRECT INJECTION
ENGINE SPEED (RPM):	1,800
HERTZ:	60
FAN POWER (HP):	114.0
ASPIRATION:	TA
AFTERCOOLER TYPE:	ATAAC
AFTERCOOLER CIRCUIT TYPE:	JW+OC, ATAAC
INLET MANIFOLD AIR TEMP (F):	122
JACKET WATER TEMP (F):	219.2
TURBO CONFIGURATION:	PARALLEL
TURBO QUANTITY:	4
TURBOCHARGER MODEL:	GTA5518BN-56T-1.12
CERTIFICATION YEAR:	2006
CRANKCASE BLOWBY RATE (FT3/HR):	2,937.9
FUEL RATE (RATED RPM) NO LOAD (GAL/HR):	13.6
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.

THE INLET MANIFOLD AIR TEMP LISTED IN THE HEADER, AND IN THE GENERAL PERFORMANCE DATA, IS THE AVERAGE INLET MANIFOLD TEMP FRONT TO REAR ON THE ENGINE.

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	ISO BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	ISO VOL FUEL CONSUMPTN (VFC)	ELEC SPEC FUEL CONSUMPTN (ESFC)	ISO ELEC SPEC FUEL CONSUMPTN (ESFC)
EKW	%	BHP	PSI	LB/BHP-HR	LB/BHP-HR	GAL/HR	GAL/HR	LB/EKW-HR	LB/EKW-HR
2,000.0	100	2,937	307	0.329	0.323	136.2	133.6	0.483	0.474
1,800.0	90	2,641	276	0.331	0.325	123.3	120.9	0.486	0.477
1,600.0	80	2,353	246	0.337	0.330	111.6	109.5	0.495	0.486
1,500.0	75	2,212	231	0.340	0.334	106.1	104.1	0.502	0.492
1,400.0	70	2,071	216	0.344	0.338	100.5	98.6	0.509	0.500
1,200.0	60	1,795	188	0.352	0.345	88.9	87.3	0.526	0.516
1,000.0	50	1,521	159	0.357	0.350	76.5	75.1	0.543	0.533
800.0	40	1,250	131	0.357	0.350	62.9	61.7	0.558	0.547
600.0	30	977	102	0.365	0.358	50.2	49.3	0.594	0.583
500.0	25	839	88	0.374	0.367	44.2	43.4	0.628	0.616
400.0	20	699	73	0.388	0.381	38.3	37.5	0.678	0.666
200.0	10	411	43	0.450	0.441	26.1	25.6	0.926	0.908

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
2,000.0	100	2,937	78.3	121.2	1,118.5	71.5	752.1	83	454.3
1,800.0	90	2,641	73.1	119.6	1,067.5	65.7	716.0	77	428.8
1,600.0	80	2,353	68.0	118.2	1,027.0	60.0	693.3	72	404.5
1,500.0	75	2,212	65.2	117.5	1,008.1	57.2	684.6	69	392.7
1,400.0	70	2,071	62.3	116.8	989.4	54.4	676.9	66	380.9
1,200.0	60	1,795	55.5	115.4	952.0	48.0	662.8	59	353.9
1,000.0	50	1,521	46.5	113.7	913.4	40.1	654.0	50	318.8
800.0	40	1,250	34.8	111.8	863.8	30.3	655.0	38	271.1
600.0	30	977	24.2	110.6	803.8	22.0	650.0	27	225.0
500.0	25	839	19.7	110.2	767.0	18.7	641.7	22	204.1
400.0	20	699	15.7	109.8	724.6	15.7	629.0	18	184.1
200.0	10	411	9.0	109.1	596.9	10.9	552.8	11	148.5

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
2,000.0	100	2,937	6,548.9	15,292.8	28,512.8	29,478.4	6,205.0	5,738.7
1,800.0	90	2,641	6,318.7	14,243.0	27,390.5	28,264.7	5,956.5	5,533.7
1,600.0	80	2,353	6,073.3	13,331.0	26,220.6	27,012.9	5,685.0	5,301.6
1,500.0	75	2,212	5,932.2	12,897.9	25,568.0	26,319.7	5,542.0	5,176.6
1,400.0	70	2,071	5,777.2	12,448.0	24,862.1	25,573.8	5,384.8	5,037.5
1,200.0	60	1,795	5,397.2	11,422.5	23,141.0	23,771.1	5,003.4	4,694.0
1,000.0	50	1,521	4,857.3	10,138.7	20,731.5	21,274.5	4,476.2	4,208.4
800.0	40	1,250	4,090.0	8,488.8	17,357.1	17,803.6	3,744.5	3,524.2
600.0	30	977	3,394.1	6,989.6	14,328.5	14,684.4	3,097.0	2,920.6
500.0	25	839	3,103.5	6,328.1	13,075.2	13,388.4	2,825.1	2,668.8
400.0	20	699	2,840.4	5,696.0	11,947.2	12,218.4	2,572.5	2,435.7
200.0	10	411	2,409.4	4,478.2	10,105.7	10,290.7	2,174.6	2,076.8

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
2,000.0	100	2,937	43,150	7,564	101,696	49,615	15,778	38,240	124,558	296,234	315,563
1,800.0	90	2,641	40,179	7,175	92,069	43,106	14,280	34,105	111,977	268,102	285,596
1,600.0	80	2,353	37,427	6,907	84,225	38,510	12,931	30,201	99,774	242,774	258,615
1,500.0	75	2,212	36,092	6,791	80,632	36,523	12,286	28,303	93,784	230,664	245,715
1,400.0	70	2,071	34,737	6,671	77,064	34,629	11,640	26,432	87,835	218,548	232,809
1,200.0	60	1,795	31,877	6,341	69,432	30,722	10,302	22,179	76,103	193,426	206,048
1,000.0	50	1,521	28,631	6,026	60,835	26,675	8,865	17,129	64,508	166,434	177,294
800.0	40	1,250	24,910	5,810	50,784	22,387	7,288	11,280	53,005	136,837	145,766
600.0	30	977	21,252	5,496	41,420	18,139	5,820	6,677	41,431	109,268	116,397
500.0	25	839	19,405	5,303	37,082	16,055	5,124	4,986	35,574	96,210	102,488
400.0	20	699	17,492	5,098	32,738	13,986	4,431	3,593	29,634	83,193	88,622
200.0	10	411	13,286	4,670	23,481	8,473	3,022	1,516	17,448	56,745	60,447

Sound Data

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

Emissions Data

DIESEL

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	2,000.0	1,500.0	1,000.0	500.0	200.0
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**2,937**	**2,212**	**1,521**	**839**	**411**
TOTAL NOX (AS NO2)		G/HR	16,047	8,598	4,842	3,518	2,444
TOTAL CO		G/HR	878	474	497	985	996
TOTAL HC		G/HR	317	386	385	308	333
TOTAL CO2		KG/HR	1,393	1,073	765	430	250
PART MATTER		G/HR	75.3	71.0	87.5	183.4	145.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,754.3	1,944.8	1,541.2	1,982.3	2,379.2
TOTAL CO	(CORR 5% O2)	MG/NM3	143.3	101.0	151.4	497.5	952.4
TOTAL HC	(CORR 5% O2)	MG/NM3	44.7	70.3	99.0	145.9	285.0
PART MATTER	(CORR 5% O2)	MG/NM3	10.4	13.1	24.6	85.6	115.2
TOTAL NOX (AS NO2)	(CORR 15% O2)	MG/NM3	1,022.0	721.7	571.9	735.6	882.9

TOTAL CO	(CORR 15% O2)	MG/NM3	53.2	37.5	56.2	184.6	353.4
TOTAL HC	(CORR 15% O2)	MG/NM3	16.6	26.1	36.7	54.2	105.8
PART MATTER	(CORR 15% O2)	MG/NM3	3.9	4.9	9.1	31.8	42.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,342	947	751	966	1,159
TOTAL CO	(CORR 5% O2)	PPM	115	81	121	398	762
TOTAL HC	(CORR 5% O2)	PPM	83	131	185	272	532
TOTAL NOX (AS NO2)	(CORR 15% O2)	PPM	498	352	279	358	430
TOTAL CO	(CORR 15% O2)	PPM	43	30	45	148	283
TOTAL HC	(CORR 15% O2)	PPM	31	49	69	101	197
TOTAL NOX (AS NO2)		G/HP-HR	5.46	3.89	3.18	4.19	5.94
TOTAL CO		G/HP-HR	0.30	0.21	0.33	1.17	2.42
TOTAL HC		G/HP-HR	0.11	0.17	0.25	0.37	0.81
PART MATTER		G/HP-HR	0.03	0.03	0.06	0.22	0.35
TOTAL NOX (AS NO2)		G/KW-HR	7.43	5.29	4.33	5.70	8.08
TOTAL CO		G/KW-HR	0.41	0.29	0.44	1.60	3.29
TOTAL HC		G/KW-HR	0.15	0.24	0.34	0.50	1.10
PART MATTER		G/KW-HR	0.03	0.04	0.08	0.30	0.48
TOTAL NOX (AS NO2)		LB/HR	35.38	18.96	10.68	7.76	5.39
TOTAL CO		LB/HR	1.94	1.05	1.09	2.17	2.20
TOTAL HC		LB/HR	0.70	0.85	0.85	0.68	0.73
TOTAL CO2		LB/HR	3,070	2,365	1,687	949	552
PART MATTER		LB/HR	0.17	0.16	0.19	0.40	0.32
OXYGEN IN EXH		%	10.8	12.3	13.3	14.2	15.8
DRY SMOKE OPACITY		%	0.0	0.0	1.0	3.9	3.2
BOSCH SMOKE NUMBER			0.65	0.68	0.77	1.12	1.06

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	2,000.0	1,500.0	1,000.0	500.0	200.0
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BHP**	**2,937**	**2,212**	**1,521**	**839**	**411**
TOTAL NOX (AS NO2)		G/HR	19,256	10,318	5,811	4,222	2,933
TOTAL CO		G/HR	1,581	854	894	1,773	1,794
TOTAL HC		G/HR	422	514	512	410	442
PART MATTER		G/HR	105.4	99.5	122.5	256.7	203.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,305.2	2,333.8	1,849.4	2,378.8	2,855.1
TOTAL CO	(CORR 5% O2)	MG/NM3	258.0	181.8	272.6	895.6	1,714.4
TOTAL HC	(CORR 5% O2)	MG/NM3	59.5	93.5	131.7	194.1	379.0
PART MATTER	(CORR 5% O2)	MG/NM3	14.6	18.4	34.4	119.9	161.2
TOTAL NOX (AS NO2)	(CORR 15% O2)	MG/NM3	1,226.5	866.0	686.3	882.7	1,059.4
TOTAL CO	(CORR 15% O2)	MG/NM3	95.7	67.5	101.1	332.3	636.2
TOTAL HC	(CORR 15% O2)	MG/NM3	22.1	34.7	48.9	72.0	140.7
PART MATTER	(CORR 15% O2)	MG/NM3	5.4	6.8	12.8	44.5	59.8
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,610	1,137	901	1,159	1,391
TOTAL CO	(CORR 5% O2)	PPM	206	145	218	716	1,371
TOTAL HC	(CORR 5% O2)	PPM	111	175	246	362	708
TOTAL NOX (AS NO2)	(CORR 15% O2)	PPM	597	422	334	430	516
TOTAL CO	(CORR 15% O2)	PPM	77	54	81	266	509
TOTAL HC	(CORR 15% O2)	PPM	41	65	91	134	263
TOTAL NOX (AS NO2)		G/HP-HR	6.56	4.67	3.82	5.03	7.13
TOTAL CO		G/HP-HR	0.54	0.39	0.59	2.11	4.36
TOTAL HC		G/HP-HR	0.14	0.23	0.34	0.49	1.08
PART MATTER		G/HP-HR	0.04	0.04	0.08	0.31	0.49
TOTAL NOX (AS NO2)		G/KW-HR	8.91	6.34	5.19	6.84	9.69
TOTAL CO		G/KW-HR	0.73	0.53	0.80	2.87	5.93
TOTAL HC		G/KW-HR	0.20	0.32	0.46	0.66	1.46
PART MATTER		G/KW-HR	0.05	0.06	0.11	0.42	0.67
TOTAL NOX (AS NO2)		LB/HR	42.45	22.75	12.81	9.31	6.47
TOTAL CO		LB/HR	3.48	1.88	1.97	3.91	3.95
TOTAL HC		LB/HR	0.93	1.13	1.13	0.90	0.98
PART MATTER		LB/HR	0.23	0.22	0.27	0.57	0.45

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

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	2,937	2,937	2,937	2,937	2,937	2,937	2,937	2,937	2,937	2,937	2,849	2,731	2,937
1,000	2,937	2,937	2,937	2,937	2,937	2,937	2,937	2,937	2,937	2,931	2,820	2,702	2,937
2,000	2,937	2,937	2,937	2,937	2,937	2,937	2,937	2,927	2,876	2,826	2,761	2,614	2,937
3,000	2,937	2,937	2,937	2,937	2,937	2,926	2,873	2,822	2,772	2,724	2,673	2,526	2,937
4,000	2,849	2,849	2,849	2,849	2,849	2,820	2,768	2,719	2,671	2,625	2,581	2,467	2,849
5,000	2,752	2,752	2,752	2,752	2,752	2,716	2,667	2,619	2,573	2,529	2,486	2,350	2,752
6,000	2,659	2,659	2,659	2,659	2,659	2,616	2,569	2,523	2,478	2,436	2,379	2,261	2,659
7,000	2,570	2,570	2,570	2,570	2,567	2,519	2,473	2,429	2,386	2,345	2,261	2,144	2,570
8,000	2,484	2,484	2,484	2,484	2,471	2,425	2,381	2,338	2,297	2,257	2,144	1,968	2,484
9,000	2,401	2,401	2,401	2,401	2,377	2,333	2,291	2,250	2,211	2,172	1,997	1,792	2,401
10,000	2,321	2,321	2,321	2,321	2,287	2,245	2,204	2,165	2,127	1,997	1,792	1,586	2,321
11,000	2,244	2,244	2,244	2,242	2,200	2,159	2,120	2,082	2,027	1,821	1,615	1,439	2,244
12,000	2,171	2,171	2,171	2,156	2,115	2,076	2,038	1,997	1,821	1,615	1,439	1,292	2,171
13,000	2,100	2,100	2,100	2,072	2,033	1,995	1,959	1,850	1,645	1,439	1,292	1,175	2,100
14,000	2,027	2,027	2,027	1,991	1,954	1,917	1,821	1,645	1,469	1,322	1,175	1,028	2,027
15,000	1,938	1,938	1,938	1,913	1,877	1,792	1,674	1,469	1,322	1,175	1,057	940	1,938

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
4577177	LL1859	5084279	GS334	-	SBJ02000	
4581557	LL6752	5157719	PG237	-	LY500001	

Supplementary Data

Type	Classification	Performance Number
SOUND	SOUND PRESSURE	DM8779

Performance Parameter Reference

Parameters Reference:DM9600-14

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.
On 3500 and C175 engines, at speeds below Peak Torque 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.

PERFORMANCE DATA[EM1896]

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.
WET & DRY EXHAUST/EMISSIONS DESCRIPTION:
Wet - Total exhaust flow or concentration of total exhaust flow
Dry - Total exhaust flow minus water vapor or concentration of exhaust flow with water vapor excluded
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 : 10/27/21

APPENDIX I – RENEWABLE DIESEL FUEL TEST DATA

CERTIFICATE OF ANALYSIS

	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 — Lab Supervisor — Geismar, LA — 09/25/2020

Name	Title	Location	Date
Keith Gill	Lab Supervisor	Geismar, LA	09/25/2020

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

CATERPILLAR LETTER – RENEWABLE FUEL EMISSIONS

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 EMISSIONS TEST RESULTS

These records may be available upon request. To find out if there are more records for this project, contact Ecology's Public Records Office.

Online: https://ecology.wa.gov/footer-pages/public-records-requests Public Records Officer email: PublicRecordsOfficer@ecy.wa.gov
Call: 360-407-6040

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**

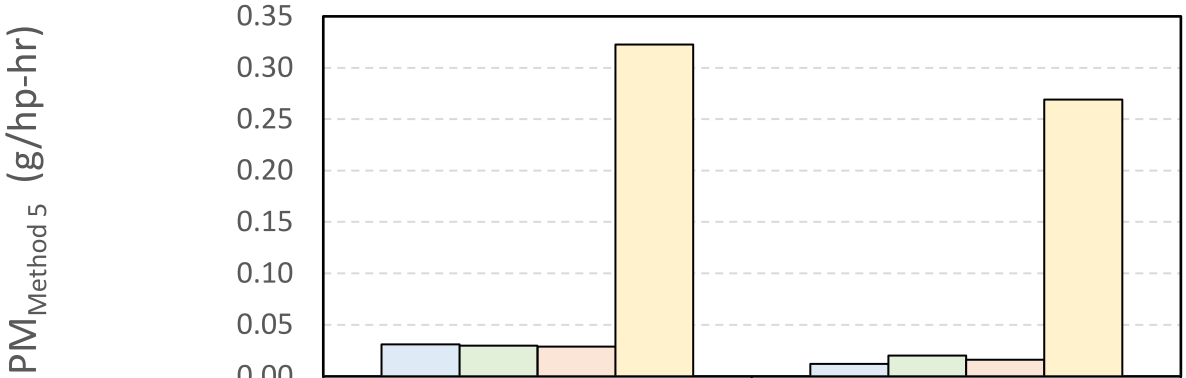
Notes:

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.

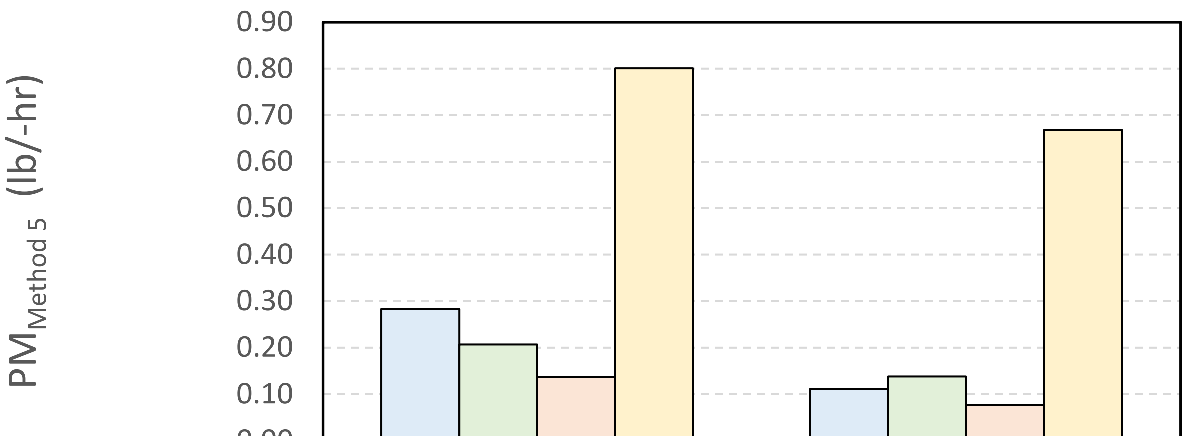
COMPARISON CHARTS FROM TEST RESULTS

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



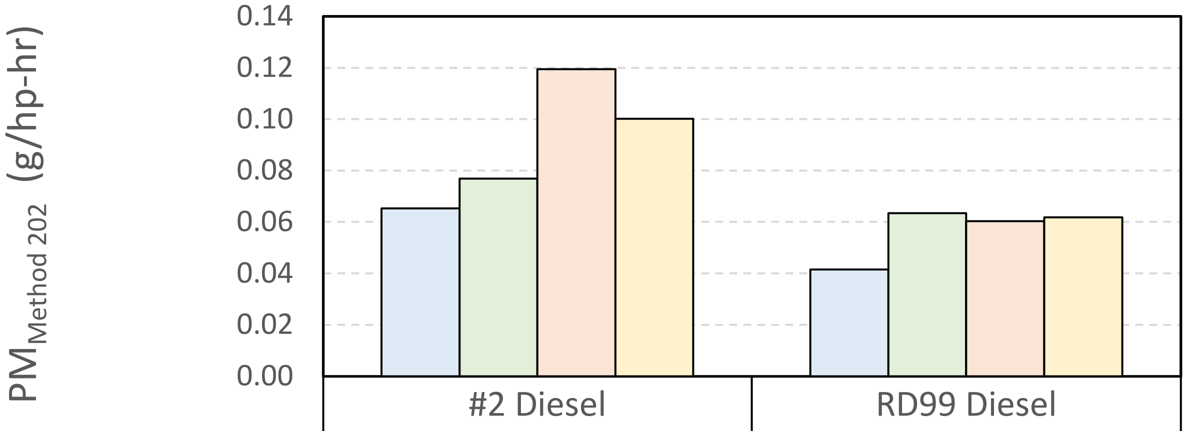
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0308	0.0121
75% of Full Load	0.0297	0.0199
50% of Full Load	0.0288	0.0161
25% of Full Load	0.3227	0.2691

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



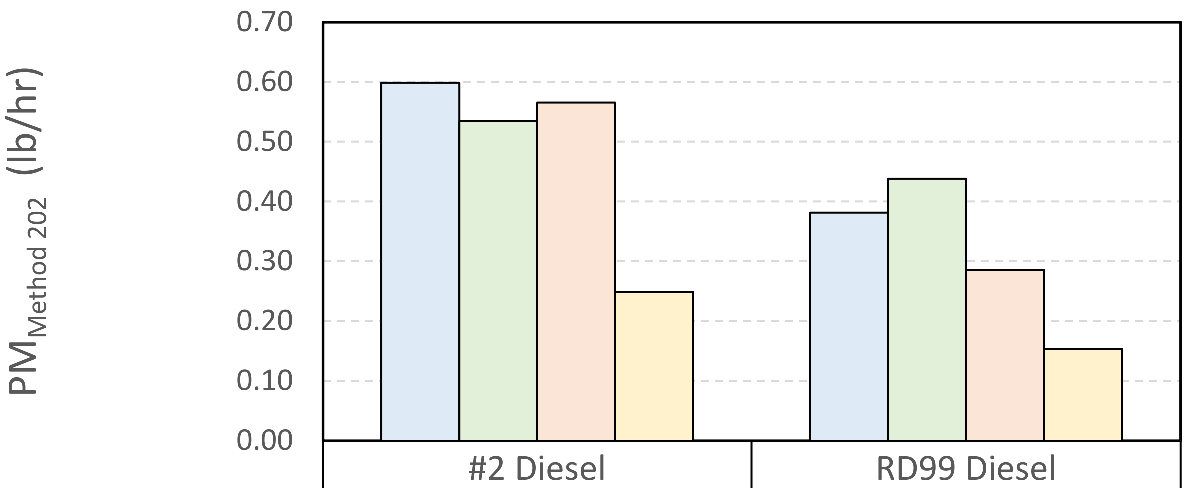
	#2 Diesel	RD99 Diesel
100% of Full Load	0.2829	0.1112
75% of Full Load	0.2066	0.1378
50% of Full Load	0.1366	0.0763
25% of Full Load	0.8010	0.6681

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



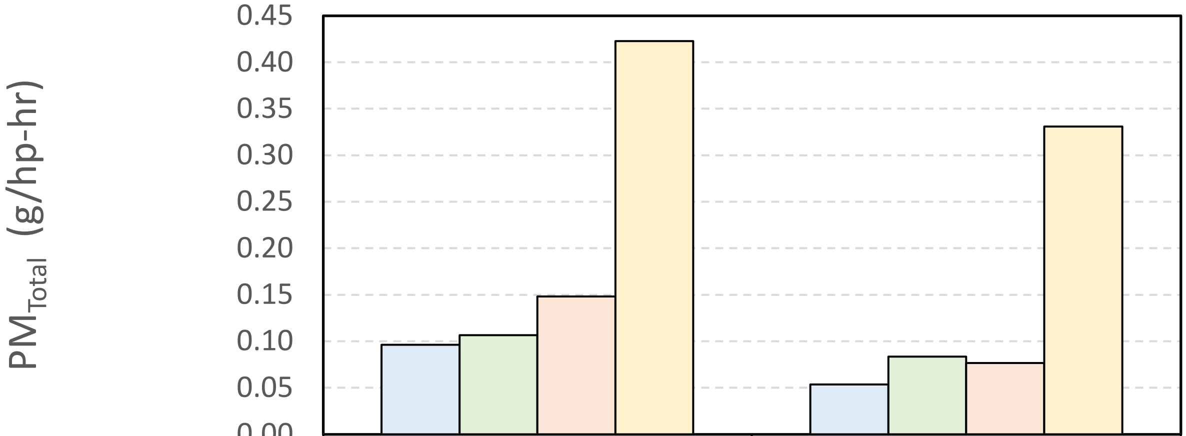
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0653	0.0415
75% of Full Load	0.0769	0.0634
50% of Full Load	0.1194	0.0603
25% of Full Load	0.1001	0.0618

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



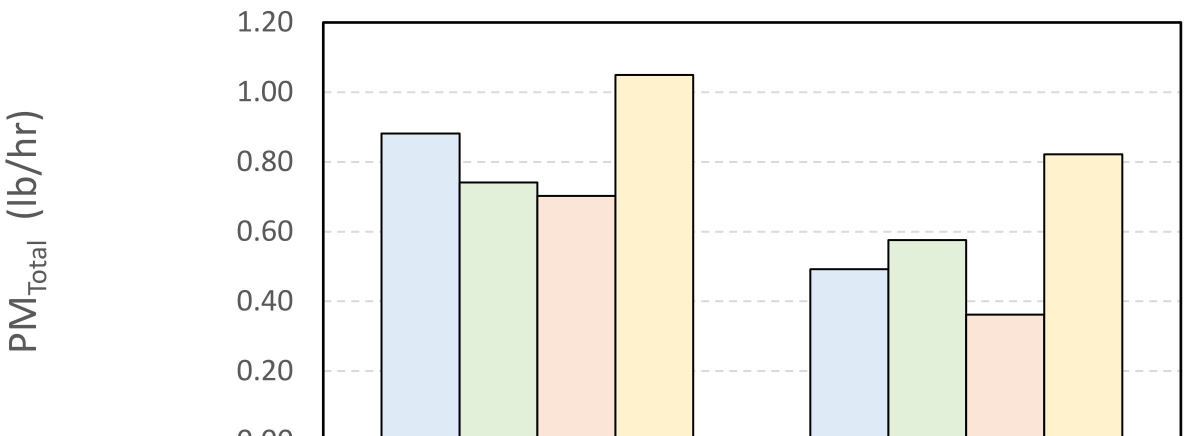
	#2 Diesel	RD99 Diesel
100% of Full Load	0.5988	0.3812
75% of Full Load	0.5342	0.4380
50% of Full Load	0.5654	0.2857
25% of Full Load	0.2486	0.1534

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



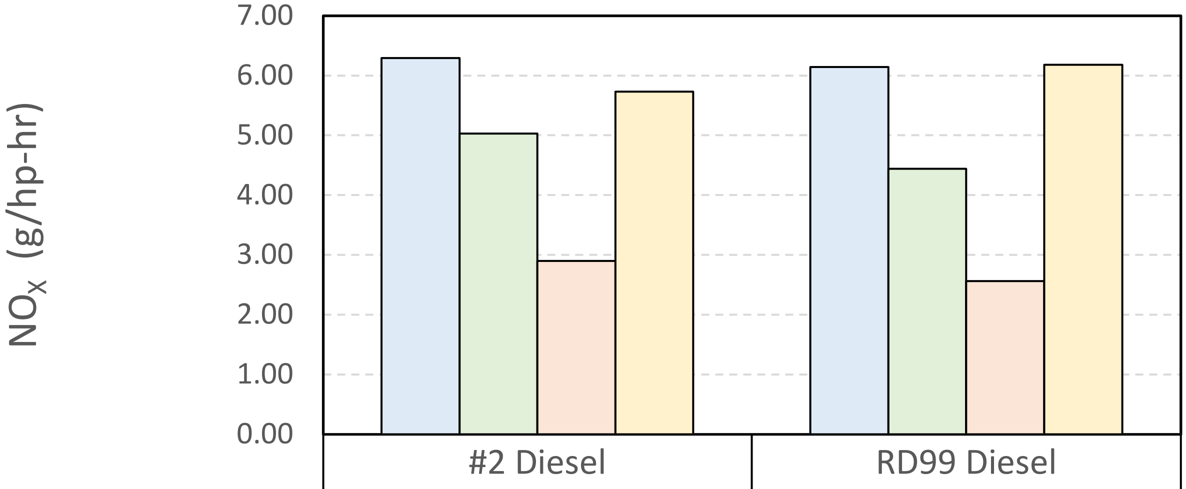
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0961	0.0536
75% of Full Load	0.1066	0.0834
50% of Full Load	0.1483	0.0764
25% of Full Load	0.4228	0.3309

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



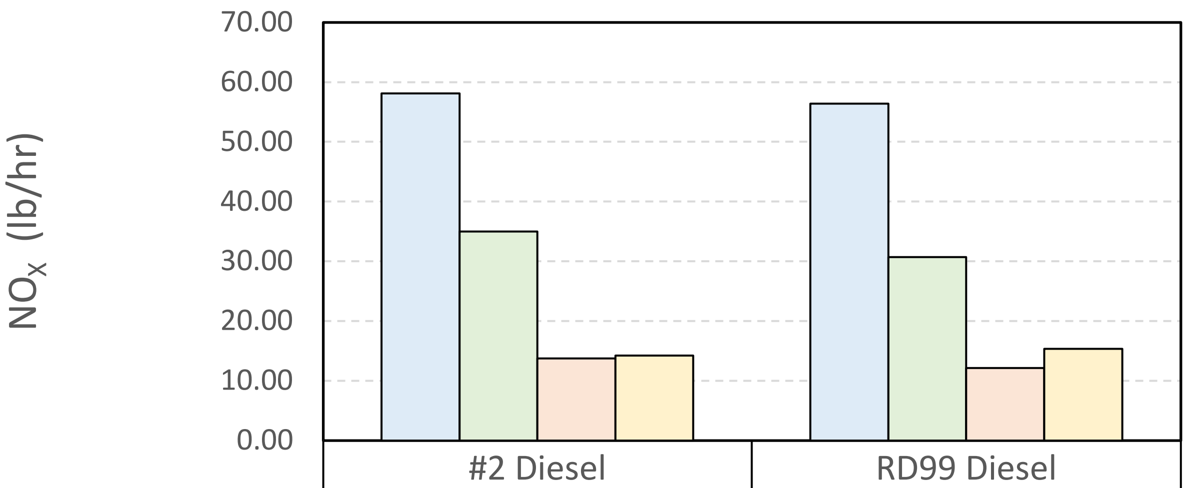
	#2 Diesel	RD99 Diesel
100% of Full Load	0.8817	0.4924
75% of Full Load	0.7409	0.5757
50% of Full Load	0.7021	0.3620
25% of Full Load	1.0495	0.8214

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



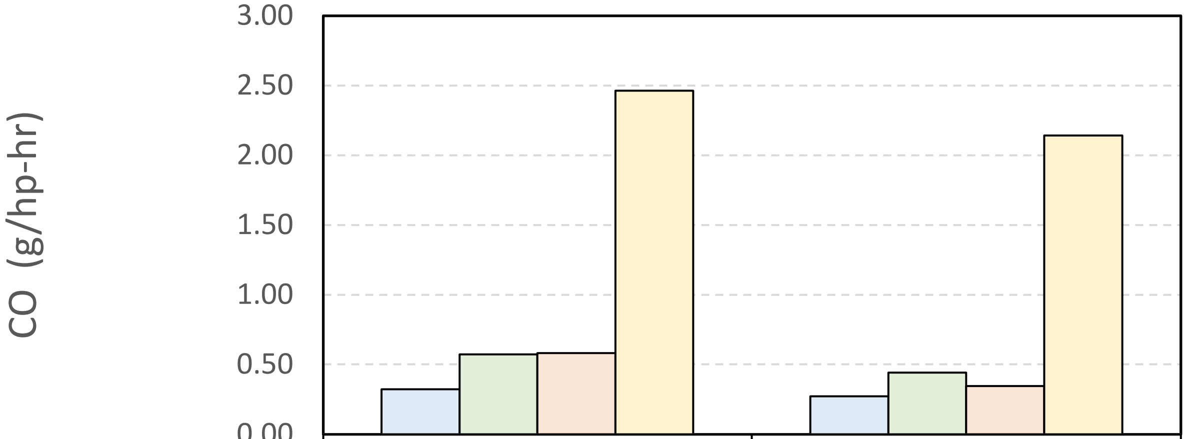
	#2 Diesel	RD99 Diesel
100% of Full Load	6.2908	6.1399
75% of Full Load	5.0312	4.4419
50% of Full Load	2.8958	2.5598
25% of Full Load	5.7292	6.1802

Emissions Test Comparisons - NO_X (lb/hr)



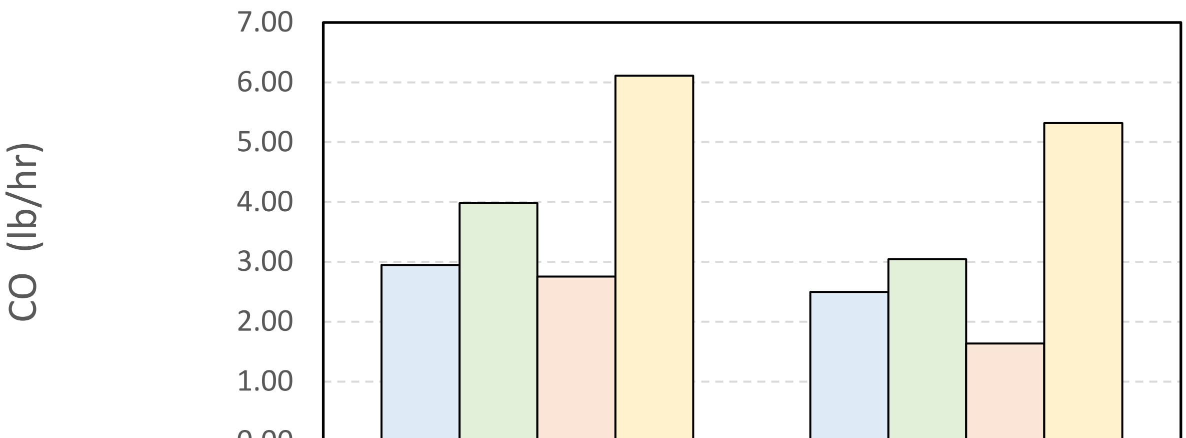
	#2 Diesel	RD99 Diesel
100% of Full Load	58.0785	56.3874
75% of Full Load	34.9503	30.6804
50% of Full Load	13.7131	12.1221
25% of Full Load	14.2221	15.3419

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



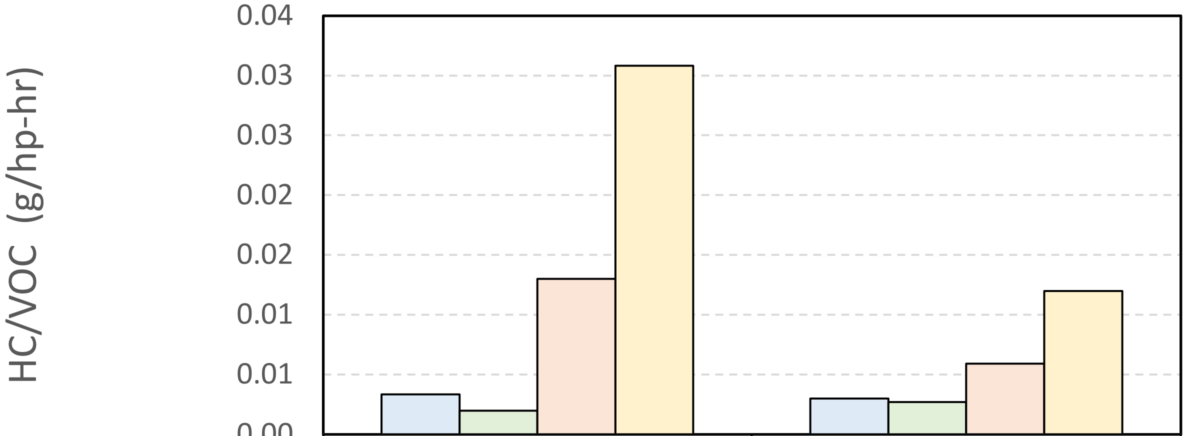
	#2 Diesel	RD99 Diesel
100% of Full Load	0.3212	0.2721
75% of Full Load	0.5726	0.4408
50% of Full Load	0.5809	0.3450
25% of Full Load	2.4619	2.1417

Emissions Test Comparisons - CO (lb/hr)



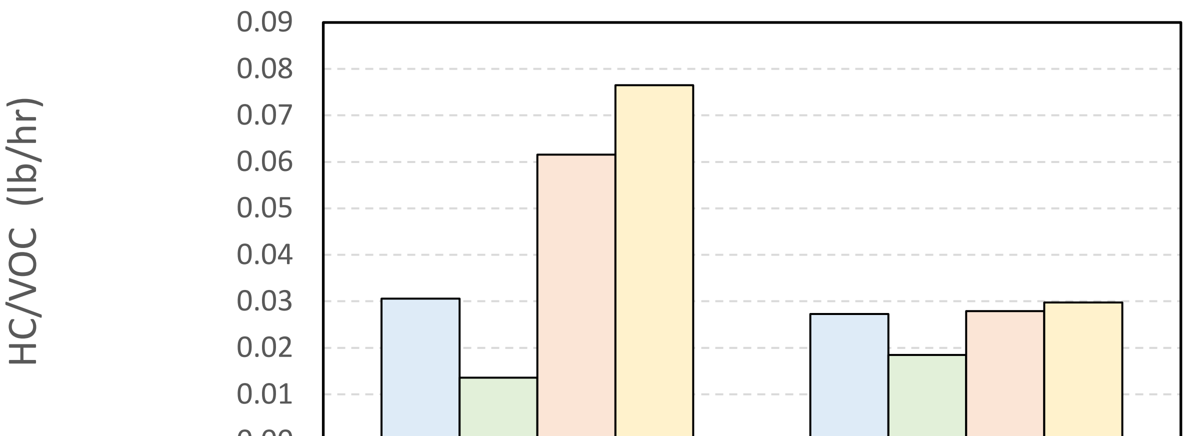
	#2 Diesel	RD99 Diesel
100% of Full Load	2.9471	2.4987
75% of Full Load	3.9776	3.0445
50% of Full Load	2.7510	1.6339
25% of Full Load	6.1115	5.3166

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



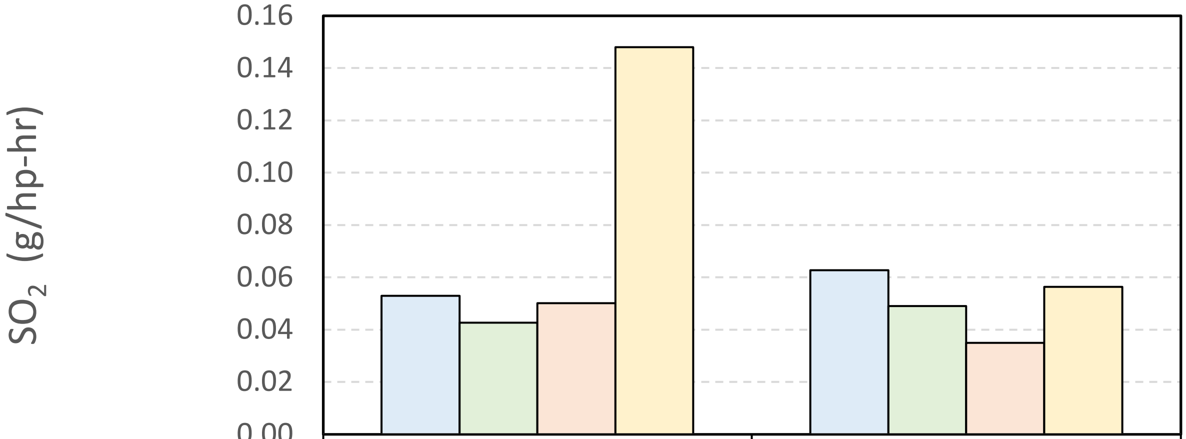
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0033	0.0030
75% of Full Load	0.0020	0.0027
50% of Full Load	0.0130	0.0059
25% of Full Load	0.0308	0.0120

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



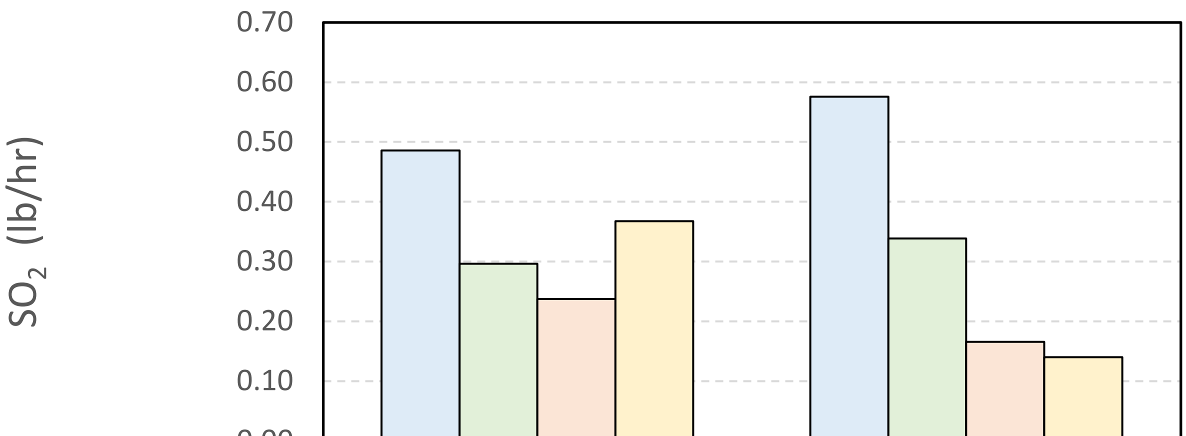
	#2 Diesel	RD99 Diesel
100% of Full Load	0.0306	0.0273
75% of Full Load	0.0136	0.0185
50% of Full Load	0.0616	0.0279
25% of Full Load	0.0765	0.0297

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

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